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International Growth Centre

IGC evidence paper
Cities

EVIDENCE PAPER
CITIES / MAY 2021

DIRECTED BY

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1 Introduction

The United Nations forecasts that "Africa's urban population is likely to nearly triple between 2018 and 2050". Together, Africa and India account for almost two thirds of the projected growth in the world's urban population from 4.2 billion in 2018 to 6.7 billion in 2050. The urbanisation of our planet's poorer countries is one of the most important phenomena of the twenty-first century and a critical component of structural change. Yet, our intellectual tools for dealing with the great challenges of developing-country cities remain underdeveloped. In this paper, we survey the economics of developing-country cities and try to make the case that development economists should spend more of their time thinking about and working in cities and urban economists should spend more of their time thinking about and working in developing countries.

Throughout most of history, agricultural prosperity and transportation infrastructure generally preceded mass urbanisation, because agricultural surpluses were needed to feed city dwellers. Today, much of the developing world is urbanising at lower levels of income and with less developed governance than America enjoyed when it became a majority-urban nation in 1920. Consequently, developing-country cities must face the ubiquitous challenges of urban life with far fewer resources. The difficulties of developing-country urbanisation only increase when national leaders seek to stymie urbanisation for some reason—perhaps out of a fear that cities will enable the mobilisation of political opposition.

The study of developing-country cities provides a window into topics at the heart of economics. Cities are home to externalities, both positive and negative; they can represent the highest and lowest points of human behaviour. The knowledge-based growth described by Paul Romer and Robert Lucas takes tangible form in urban areas. Pigouvian problems, such as traffic congestion and contagious disease, become hyper-charged in the extreme densities of poorer cities.

In this paper, we divide the field of urban development economics into three broad categories: agglomeration economies, density's downsides, and spatial models of transportation and housing. The central question of agglomeration economics is if cities themselves actually increase productivity or if the observed relationship between density and earnings represents the selection of more skilled people into cities, or if there are some omitted variables that both attract people and make them wealthier. The growing literature on urban development appears to confirm the positive effects of urbanisation on earnings that have been found in the wealthy world (Chauvin et al. 2017). Randomised control trials that induce migrants to come to cities have provided some of the most compelling evidence supporting the hypothesis that density increases earnings (Bryan, Chowdhury, and Mobarak 2014).

Yet, there is also evidence suggesting that city slums are home to millions of people who have lived in urban areas for decades and remain poor (Marx, Stoker, and Suri 2013). Resolving the question of whether developing-country slums are dead ends or offer pathways to prosperity remains central to research on developing world agglomeration. There is also a need for research that uncovers the means of improving developing-country cities' productivity, as well as how to spread the benefits of urban productivity more widely.

Urban proximity enables poorer workers to connect with employers, but it also enables the spread of disease and the perpetration of crimes. Western cities were known for epidemics—cholera, typhoid, influenza—until the early 20th century, and water-borne illnesses remain a serious challenge in the world's poorest cities. Even relatively rich New York had high murder rates through the early 1990s, and homicide continues to bedevil many Latin American and African cities today. Demand for urban density can also collide with a limited housing supply and make living space unaffordable. Density can also slow actual mobility; as the automobile became more widely used throughout the twentieth century, spreading even to cities with limited public capacity, traffic congestion became severe in many urban areas. Today, workers in highly congested cities, such as Jakarta and Sao Paulo, can often face commutes that exceed one hour. These types of challenges posed by density create scope for research and public policy action that can potentially make developing-country cities more liveable for all their inhabitants.

Economists are increasingly analysing the roles that incentives, infrastructure, and institutions can play in moderating urban crime, traffic congestion, and disease in developing-country cities. High levels of homicide in many poor world cities has been linked to extremely low probabilities of arrest and punishment. A large and growing literature is examining how certain institutions, such as public-private partnerships, impact road maintenance and demand management. One major finding of this literature is that weak public institutions do not imply better performance by private institutions; such private providers of public services often have incentives to subvert the government that is allegedly overseeing them (Engel, Fischer, and Galetovic 2014). In many cases in the developing world, where governments are ineffective or mired in complex bureaucratic systems, the road to a solution can be less clear than it initially appeared.

These complex environments must be considered when proposing any public policy changes. For example, analysing the impact of land use in a city requires fully fledged spatial models that can assess the full equilibrium implications of building up one area of the city. Similarly, large-scale changes in transportation infrastructure may have impacts that ripple throughout a metropolitan area. Section IV of this paper focuses on the growing subfield of developing structural spatial models that can use empirically estimated parameters and forecast the city-wide impact of policy changes.

While many development economists have been rightfully enthusiastic about the scientific precision generated by randomised control trials, cities are complex systems, and many urban problems cannot be addressed solely through performing research interventions that can be randomised at the individual. The structural approach to urban economics typically embeds a series of optimisation problems, including the locations and employment decisions of people and firms, and developers' decisions about construction. These models' parameters are then estimated directly from the data or by using other sources of information, including randomised control trials. Different policy choices can then be simulated using these parameter estimates. These models are just starting to be applied to contemporary policy challenges, but structural spatial models seem well-suited for land use and transportation decisions in developing-country cities.

The future of the developing countries is urban, and this fact generates both challenges and opportunities. The research that we now discuss represents the beginnings of a robust literature on developing-country cities. There is every reason to believe that this literature will continue to grow and that it will provide fascinating policy-relevant results.

2 Agglomeration economies

Should national governments work to promote or restrain the process of urbanisation? The case for active regulation of spatial policy depends on many factors, particularly whether cities actually enhance productivity or are simply correlated with it. Empirical estimates of the true causal magnitude of agglomeration economies are therefore crucial elements in this most basic urban policy question.

Figure 1 documents two remarkable facts. The first panel plots, at the country level, the correlation between non-agricultural labour share and the log of output per worker in both agricultural and non-agricultural fields. The poorest countries in the world are predominantly rural and agricultural; these can be found on the left side of the figure. Not only are developing countries relatively worse at agriculture, but most of their workers labour on farms (Vollrath 2014), implying a productivity disconnect. The second panel shows the correlation between urbanisation in 1960 and growth between 1960 and 2010 among a sample of poor countries in 1960.

To paraphrase Lucas (1988), these figures suggest enormous possibilities. Is there something that Malawi could do, some action that its government could take, that would allow the 75% of its workers that work in rural areas in agriculture to access the productivity levels of its non-agricultural, more urban workers, increasing their productivity above that of agricultural workers in, for example, Great Britain? In this section, we will try to understand whether these possibilities are real or whether higher urban productivity might just reflect the selection of more skilled people or better firms into cities.[1]

A Is there economic opportunity in developing-country cities?

Figure 1a suggests that if more people lived in cities in the developing world, productivity and wages could be higher. In this section, we review three classes of theories that might explain this phenomenon—each consistent with the facts, but having different implications for whether these opportunities are real or merely illusory.

The first model is that more able people choose to live in cities, which would occur if people who have an absolute ability advantage also enjoy a

1 Gollin, Lagakos, and Waugh (2014) investigate and reject the hypothesis that the urban productivity advantages suggested by Figure 1a are purely measurement error.

FIGURE 1A **Cross Country Productivity Gaps**

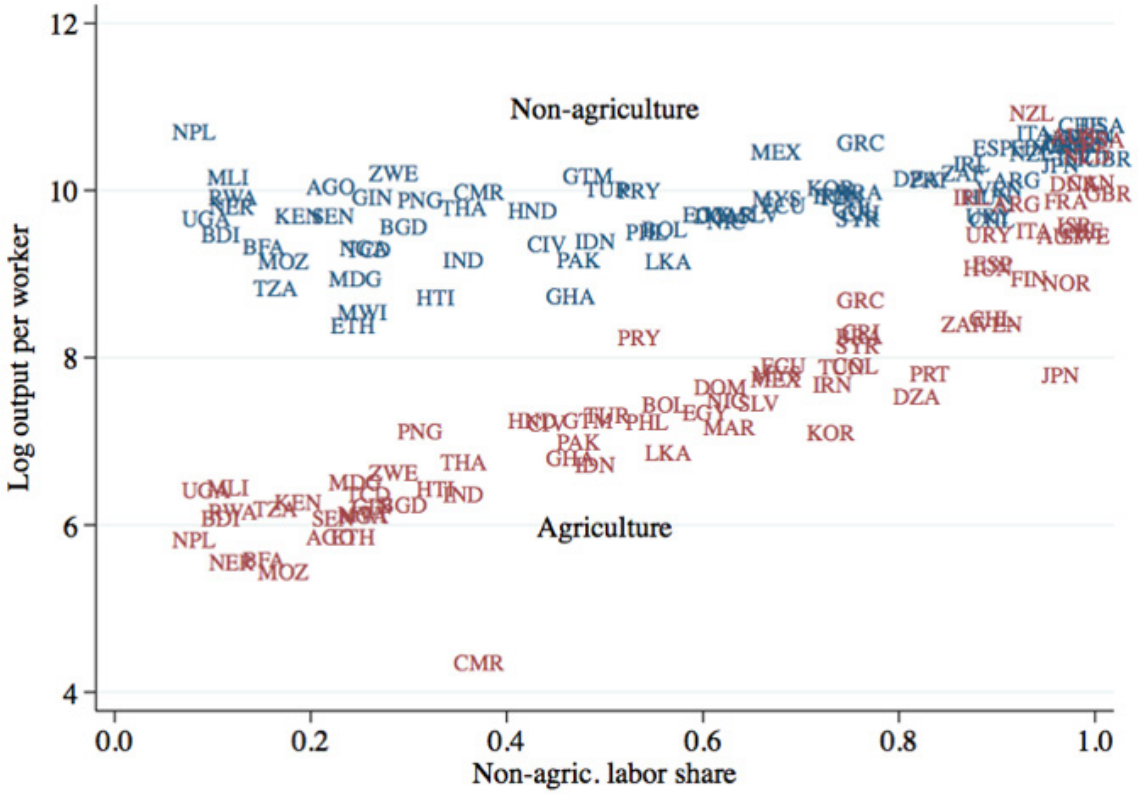
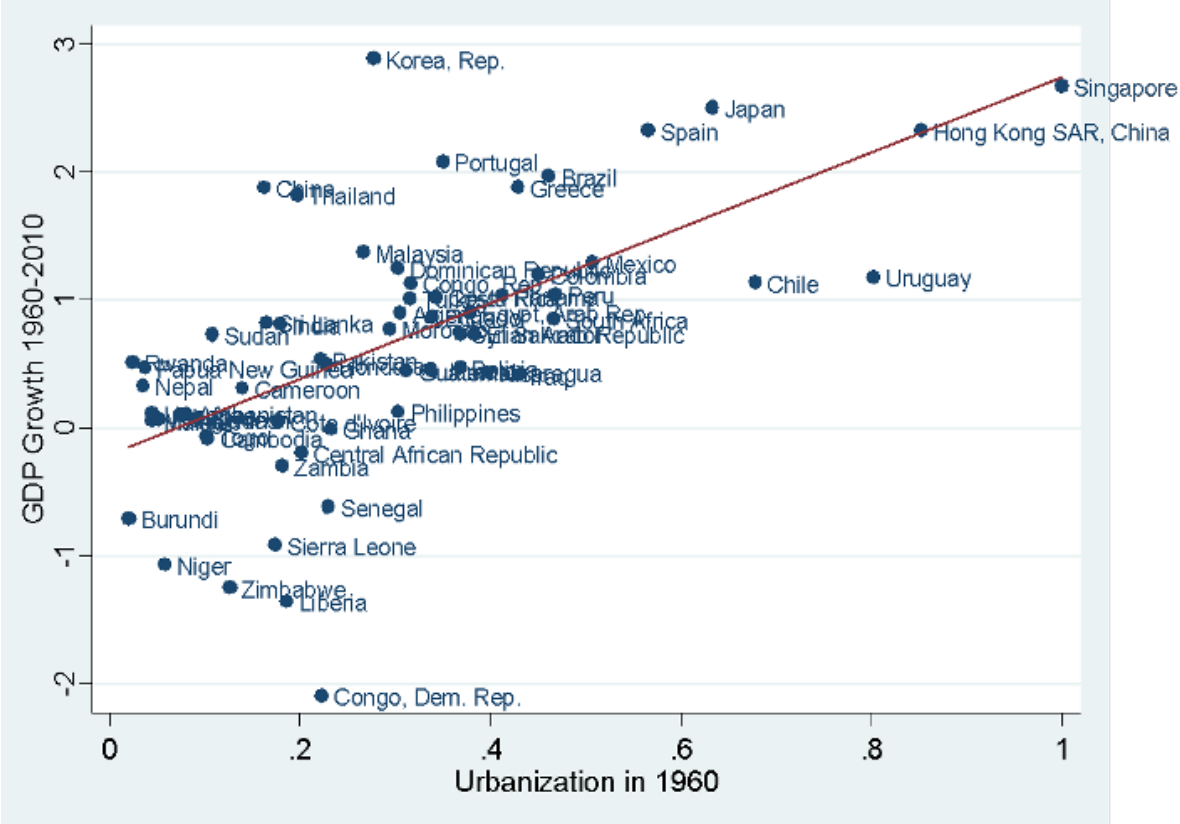


FIGURE 1B **Urbanisation and growth**



comparative advantage of producing in cities.[2] A second possibility is that the urban wage premium is real, but that amenity losses or high housing prices ensure there is no overall welfare benefit from increasing urbanisation.[3] That model still suggests an urban productivity premium—after all, why else would private sector employers be willing to pay higher wages in cities? However, it does not indicate a welfare premium for rural-to-urban migrants.

A third model is that city size generates positive externalities that might be static or dynamic in nature. Static externalities might occur because a larger market size encourages the entry of new product varieties, as in Krugman (1991). Dynamic externalities might occur if cities spread ideas and speed up the right kind of technological progress, as suggested by Lucas (1988).

If the urban wage premium just represents omitted individual characteristics, then there is little reason to think that moving to cities will make people or the country as a whole more productive. If it represents place-specific assets, then moving to that area will make people more productive but will not have any positive effect on overall regional welfare. If the urban wage premium represents local externalities, then workers' relocation to the area may generate benefits for existing residents or the country as a whole. These externalities typically represent market failures.

B Empirical estimates of agglomeration economies

Urban workers do typically earn more, but does this represent a true effect of place or merely the selection of more able people into cities? The simplest and most common approach to measuring the economic benefits of agglomeration is to run an individual-level regression where earnings are regressed on individual characteristics, such as age and education, and local characteristics, such as area density or total population agglomeration. Within the US, such

2 Lagakos and Waugh (2013) note that if absolute and comparative advantage are independent, then a small wedge or friction can lead to large differences in productivity between rural and urban dwellers. Bryan and Morten (2019) use a structural model that assumes that absolute and comparative advantage are uncorrelated and Indonesian data to estimate the speed with which average wages drop with movement across space. They find that the elasticity of average wages with respect to the proportion of an original population moving is around -0.039. In their setting, this implies that despite large spatial wage differences, moving people across space offers only moderate gains.

3 In the classic Harris and Todaro model, urban unemployment is higher than rural unemployment, but urban workers earn higher wages if they are lucky enough to be employed.

estimates typically yield a coefficient of .05 when the logarithm of wages are regressed on the logarithm of population (Ciccone and Hall 1996, Glaeser and Gottlieb 2008, Ahlfeldt and Pietrostefani 2019), meaning that wages increase by about 5% when total population or density doubles.[4] Chauvin et al. (2017) perform three comparable exercises for Brazil, China, and India, finding large effects of density on earnings, especially in India and China.

Young (2013) uses Demographic and Health Survey data to construct consumption equivalents of education, documenting large differences in consumption levels between rural and urban areas in a sample of 65 countries that includes many of the poorest in the world. His results show that the urban/rural wage gap accounts for about 40% of within-country inequality in his sample, but he also notes strong sorting on observable characteristics, which suggests that sorting on unobservables may also be important. Gollin, Kirchberger, and Lagakos (2017) document large consumption differences across density levels in twenty African countries.

To address the problem of selection on unobservable attributes, researchers have increasingly relied on migration, natural experiments, and even randomised control trials to estimate the treatment effect of place on earnings. Glaeser and Mare (2001) founded the literature that estimates the urban wage premium by looking at the wage gains experienced by urban-rural migrants. The key identifying assumption is that unmeasured worker ability doesn't change over time, or at least that changes in unobserved worker ability are not correlated with moving across space. Glaeser and Mare (2001) find that workers who move to large urban areas experience faster wage growth in the years following, which is compatible with the view that cities enable human capital accumulation. De la Roca and Puga (2017) use administrative data that enables them to follow the wage patterns of almost all workers in Spain as they move across geographies. They also find that workers who come to large cities, like Barcelona and Madrid, experience wage gains over time.[5]

Workers who move to large urban areas experience faster wage growth in the years following.

In developing countries, Hicks et al. (2017) use panel data from Kenya and Indonesia to present fixed effect estimates of the urban rural wage gap. Their fixed effect estimates show that urban workers in Indonesia earn 2.8% more per hour while urban Kenyans earn 26% more.

4 Combes et al. (2010) is a particularly effective paper estimating agglomeration effects in France. The authors control for firm characteristics and use soil characteristics as an exogenous source of variation for density.

5 Chetty and Hendren (2018) use income tax data in the U.S. to look at families who move across areas and establish the impact of place on economic opportunity.

Though limited by the lack of panel data sets, other researchers have produced work surveying rural-urban migrants who moved first to impoverished neighbourhoods. Perlman (2010) starts with an initial sample of favela-dwellers in Brazil in 1969 and looks at the outcomes for their children and grandchildren. She finds that while 72% of the first generation were illiterate and 94% worked in manual jobs, by 2001, only 6% of their children were illiterate, and 63% held manual jobs. By the time their grandchildren come of age to work, only 39% hold manual jobs. Alesina et al. (2019) similarly find that intergenerational upward mobility is related to urbanisation in Africa.

By contrast, Marx, Stoker, and Suri (2013) examine a cross-section of migrants living in a number of slums across the developing world today and ask whether those who relocated from rural areas earlier now earn more than those who migrated more recently. They find no relationship between time in the city and earnings in Kenya's Kibera, and a negative relationship between city tenure and earnings in Bangladesh's Tongi. If successful people ultimately end up leaving the slum, these facts may reflect the selection of who remains in the slum over 40 years, not a broader lack of upward urban mobility. Yet, it is undoubtedly true that many of those who come to the city remain poor for decades afterward.

Intergenerational upward mobility is related to urbanisation in Africa.

A second approach has been to seek cases in which people, typically immigrants, have been allocated across space by government programmes. Edin et al. (2004) provide a classic example in which the Swedish government directed new immigrants to specific locations across Sweden. However, administrators are rarely willing to completely ignore the idiosyncratic needs of individuals, and so unobserved immigrant characteristics may well have influenced the choice of location and biased the results.[6]

Sarvimaki et al. (2019) study the forced relocation of 11% of Finns after World War II, in which farmers who were given a similar farm in a different part of the country. Relative to a comparison group who were geographically nearby, the forced migrants were more likely to transition out of farming and into an urban location in the long run and had substantially higher earnings and education over time. Nakamura, Sigurdsson, and Steinsson (2016) study individuals from a wealthy fishing village in Iceland's Westman Islands whose homes were destroyed by a volcano. Using a spatial discontinuity design, this

6 The so-called Gautreaux Experiment, a US housing desegregation project that placed welfare recipients in randomised locations chosen by the Chicago Housing Authority, is an earlier experiment where apparent administrative randomness was used to estimate the effect of place.

study shows that 30 years later the displaced workers were more likely to be urban, have a higher education level, and have much higher earnings.

A third approach has seen researchers help design social programmes that provide incentives for people to move across space. The US' Moving to Opportunity for Fair Housing experiment required a randomised share of housing voucher recipients to move to neighbourhoods with lower poverty levels in order to receive the vouchers. Early estimates of the programme found few impacts on the children who moved out of poverty (Katz, Kling, and Liebman 2001). However, more recent work has found quite sizeable impacts on the adult earnings of children who moved out of poverty at an early age (Chetty et al. 2016).

Bryan et al. (2014) take a similar approach and provide small incentives (about the cost of one bus fare) for rural Bangladeshi workers to move (at least temporarily) to a nearby city. Even this small incentive generated a 22-percentage-point increase in the number of families reporting that at least one of their family members had sought work in the city, as well as a 33-percent increase in average household expenditures. The study also showed that up to three years after the small incentive was paid, treatment households were about 10 percentage points more likely to have a migrant worker in their household. This work suggests real utility gains from moving to the city, because workers continued to come to cities when the incentive was no longer available, perhaps suggesting that initial migration was simply limited by credit constraints. It is worth noting, of course, that small-scale experiments cannot estimate the general equilibrium effects of large-scale migration to the city and may also lack external validity. However, the presence of such drastic effects for those given an opportunity to migrate point to cities' potential for increasing income and welfare.

While the latter studies seem to rule out the possibility that selection fully explains the agglomeration earnings effect, they use data on migrants themselves, and so cannot account for whether urban location generates positive or negative externalities. A final form of experiment shocks the place, not the person, then looks at the impact on the people living in that place beforehand. Greenstone, Hornbeck, and Moretti (2010) measured the differing fates of medium-density communities that did or did not receive the investment generated by the opening of a "Million Dollar Plant" in their area. The results suggest a 12% increase in total factor productivity for incumbent plants, indicative of strong positive spillovers that are not internalised in plant opening decisions. This work requires the place-based shock to be independent of unobserved, time-changing attributes at the place level. While the "Million Dollar Plant" experiment comes close, few private or public investment are completely independent of local characteristics.

Greenstone et al.'s (2010) results on agglomeration economies open up the possibility that levels of agglomeration are not optimal, but it is not clear that they are directly relevant to developing countries, where movement costs

may be higher (even in dense areas) and technologies are different. As Glaeser and Gottlieb (2009) emphasise, policy requires comparing the benefits that the winning place gains from having a new plant with the losses that the losing place faces. Designing relocation policies requires us to know the full functional form of agglomeration economies.

Imbert et al. (2018) uses variation in international agricultural prices to generate plausibly exogenous variation in earnings across rural areas in China and thus plausibly exogenous variation in the number of migrants moving to nearby urban areas. In-migration leads to a reduction in wages and value added per worker, along with a move to more labour-intensive production. These results seem to suggest a standard downward-sloping demand curve, rather than positive externalities from the in-migration of low skill workers.

A firm-level literature links area-level characteristics and plant productivity (Henderson 1999). In this case, the selection problem is that more productive plants may move into more productive places. A parallel "quantities" approach looks at the co-location of industries and tests whether firms locate near other firms that buy and sell their goods, use that same type of workers, or offer an opportunity to exchange ideas, finding evidence for all three effects (Ellison, Glaeser, and Kerr 2010). In the US, co-agglomeration estimates point to the importance of transportation costs for goods and people, at least in manufacturing industries.

The literature linking urbanisation with dynamic externalities and national growth is smaller and necessarily less compelling. Many classic theories could also rationalise a causal effect of urbanisation on growth. If fixed-cost technologies required large market sizes, as in Rosentein-Rodan (1943), then urbanisation could provide the "big push" that leads to industrialisation. Cities might enable poorer countries to trade with rich countries. The apparent ease of shopping in Dongguan and Shenzhen's famous electronics markets for all the parts required to create a state-of-the-art smartphone illustrates this possibility nicely; cities bring together more goods and thus more opportunity in places that might otherwise be lacking. A final hypothesis is that cities enable political change, and dictatorships certainly face more revolutions in more urbanised countries, suggesting that certain governments might have an incentive to slow urbanisation in any way possible.

The scale of these theories makes them hard to test. Rauch's (1993) pioneering work estimating human capital spillovers in cities was directly motivated by Lucas (1998)'s paper. In another example, Henderson (2000) links country-level growth and the level of urban primacy and finds a non-monotonic relationship. The endogeneity of urbanisation levels and their correlations with other growth-enhancing factors makes causal inference from cross-national data difficult.

A more plausible research path may be to examine the links between cities and the ingredients of growth, such as new patent creation and citation (e.g. Jaffe, Trajtenberg, and Henderson, 1993), foreign direct investment

(Guimaraes, Figueiredo, and Woodward, 2000), and education (Muralidharan and Sundararaman, 2015). Sub-national data makes it easier and more plausible to identify the mechanisms, if any, through which cities are enabling national transitions from poverty to prosperity.

C Can developing-country cities become more productive?

The simple cross-national growth correlation shown in Figure 1b warns that restricting urbanisation may have adverse consequences. Yet, for most developing-country cities, the pressing policy questions are smaller. City governments need to know whether investment in road quality or reforming the permitting process will enhance urban productivity or whether these expenses are unjustified within tight city budgets.

Transportation infrastructure is one obvious place to look for productivity gains. Firms operate in particular locations, and they need not only a supply of physical space, but access to workers, customers, and suppliers. Government involvement in transport infrastructure is ubiquitous, because transport infrastructure has some of the characteristics of a natural monopoly (limited non-rivalry) and usually requires large-scale coordination. As the relationship between transportation, building supply, and firm productivity cannot be studied through simple partial equilibrium models, we devote Section IV to this topic.

Dense urban environments—and the negative externalities they give rise to—intensify the need for government rules that establish both the rights and obligations of firms.

Productivity may also benefit from improvement of the legal infrastructure that governs firm behaviour. Dense urban environments—and the negative externalities they give rise to—intensify the need for government rules that establish both the rights and obligations of firms. These rules, if too onerous, can reduce productivity (Djankov et al. 2003), but some regulations that preserve safety and uphold obligations seem likely to be beneficial. Designing the optimal set of rights and obligations is difficult enough under ideal circumstances, but developing countries often have small budgets and a dearth of effective legal infrastructure (Besley and Burgess 2000, World Justice Project 2019).

A system that provides the ability to determine property rights also gives rise to the potential to abuse that power (Goldstein and Udry 2008). It could lead to red tape and inefficiency, causing corruption to spread as a second-best means to fund public goods in the presence of tight government budgets (Banerjee, 1997, Banerjee, Hanna, and Mullainathan 2013). More general-

ly, the enforcement of any rights or obligations needs some kind of solution to the guardian's problem (Hurwicz 2008, Björkman and Svensson 2009).

On institutions, there is also the question of which sphere of government has responsibility to design and promote urban productivity. Many policies are set at the national level but require strong coordination on the local level to be successful. It is important to understand how local governments can best design and implement policy to leverage their cities' comparative advantage for job creation and competitive production.

Research on institutional improvements requires viable actual or natural experiments, and a small but growing literature now attempts to understand solutions to these problems. Khan, Khwaja, and Olken (2015) work with government employees in Punjab, Pakistan to randomise an incentive pay scheme that rewards property tax collectors for the revenue they raise. They find a large increase in government revenues for little cost in terms of taxpayer satisfaction or assessment accuracy. In the Kyrgyz Republic, Amodio et al. (2018) provide incentives to reduce bribe-taking among business tax inspectors and find that this reduction in bribes is passed through to consumers in the form of lower prices. The work of Banerjee et al. (2014) with the Rajasthan police provides a more nuanced view. The negative results from several seemingly sensible strategies serves to remind us of the difficulty of reforming complicated institutions and the importance of nuanced understanding of local systems and politics and natural experimentation in problem solving.

The permitting and regulatory environment will be particularly important if local entrepreneurship is a significant determinant of local success, as appears to be true in the US (Glaeser, Kerr, and Kerr 2015). Yet, it is unclear if poor countries need more local entrepreneurship or more foreign direct investment. If developing-country cities today will be built by new versions of Soichiro Honda, the man who began with a small repair shop and grew it into a worldwide automobile empire, then improving permitting and regulatory processes for small businesses is crucial. If foreign inputs are critical, it should lead to an emphasis on making the urban environment more attractive to outside talent and investment.

Developing country cities, specifically those in Sub-Saharan Africa are the last to benefit from the potential demographic dividend. It is the only region in the world where the youth population is increasing. Yet the young, particularly young women struggle to enter the labour market. The young account for 60% of Africa's jobless. If cities are to be productive, harnessing the burgeoning young population in both formal and informal employment is critical. In addition, this informal economy represents between 50 - 75% of total employment (Chen and Beard, 2018) with similar levels of informal settlements. Understanding how cities can plan for and work with this informality is critical.

If cities are to be productive, harnessing the burgeoning young population in both formal and informal employment is critical.

D How can the economic benefits of cities be more widely shared?

Even the most productive cities often contain islands of poverty amidst seas of plenty. Policy makers often want to take action to improve the welfare of their least fortunate citizens. For many urban leaders, the most pressing policy question is how the prosperity of a few can be expanded to include the many.

Plato's Republic famously notes that "Any city, however small, is in fact divided into two, one the city of the poor, the other of the rich". As successful cities attract both rich and poor people, the existence of urban poverty or inequality is not a sign of urban failure. The important question is whether cities are turning poor people into middle-class people or whether the poor are remaining trapped in perpetual pockets of deprivation.

For example, while urban America may be productive, it does not seem to be providing much opportunity for many of its poorer residents. The opportunity atlas of Chetty et al. (2018) documents the low levels of upward mobility for poorer children growing up in America's cities, finding that the conditions that foster overall labour market productivity are not necessarily the same as the ones that allow for upward mobility. In China, Combes et al. (2019) find that better-educated rural-urban migrants seem to experience much larger wage gains than less-educated workers who come to cities, a phenomenon that Autor (2019) finds echoed in the US.

As these studies suggest, individual education is strongly linked with upward mobility in cities (Psacharopoulos and Patrinos, 2018). Schools teach children skills that facilitate communication, such as reading, writing, and grammar, and these skills then enable urban interactions. The overall level of education in a city is also strongly linked to its success, as measured both by earnings (Rauch 1993, Moretti 2004, Chauvin et al. 2017) and population growth (Glaeser, Scheinkman, and Shleifer 1995). Urban density and education appear to be complementary (Glaeser and Resseger 2010), which suggests that better education may enable poorer children to take advantage of urban opportunities.

The spatial structure of cities is another way in which inequality is cemented, with access to opportunities, social networks and safe and secure housing being concentrated more in some areas rather than others. Understanding these location, network and neighbourhood effects on social mobility and access to job opportunities in the city is also important for ensuring that the gains of agglomeration are more widely shared.

One of the main challenges that researchers face in studying how cities provide opportunities for those at the bottom of the distribution is the availability of data. Panel survey data on the poor for example is particularly difficult to collect in cities and even more so in low income countries. To make progress on this agenda, researchers will need to overcome the challenges from

collecting data on the movement of people into the fringes and margins of cities or urban seasonal migrants. New sources of data, more widely discussed in section 4, could help surmount these challenges.

BOX 1 Next steps and research priorities

Policy makers in developing world cities need evidence on the strength and nature of agglomeration, and the constraints that restrain their productivity potential.

- **Measure the size and nature of the returns to concentration across formal and informal activity.**
  - Do cities facilitate matching between firms and workers and encourage the exchange of goods and services? Are they escalators that facilitate the rapid learning of new skills and techniques?
  - For residents, how do neighbourhoods and slums help or hinder access to economic opportunity and mobility across social and vulnerable classes?

- **Understand the forces that reduce these potential agglomeration benefits.**
  - Which constraints on firms —such as a lack of skills, limited access to input and output markets, burdensome regulations or limited energy access—constrain labour demand and support such high levels of unemployment amongst the young and vulnerable population?
  - What limits developing-country workers' abilities to acquire skills and learn from employers and co-workers as workers in the developed world?
  - How do the specific features of developing country cities—unplanned spatial expansion, the persistence of informality across land and labour markets—drag down economic performance?

- **How can the comparative advantage of different cities be identified and how can local governments best design and implement policy to leverage this?**
  - What is the role of local government in local economic development policy?
  - How can national and local government policies for enhancing productivity be better coordinated and complementary? How can national and local government policies for enhancing productivity be better coordinated and complementary?

Evidence on the size and nature of these forces will require a range of empirical work from RCTs and historical policy quasi-experiments to structural modelling, but the answers will help policy makers identify policies with the greatest potential to raise urban productivity.

3 Infrastructure, institutions, incentives, and density's downsides

Urban proximity enables the spread of ideas and the sale of services, but it also leads to the quick spread of bacteria and congestion of city roads. In developing countries, urbanisation has proceeded far more quickly than institutional development. Consequently, massive developing-country cities now must face the downsides of density, such as contagious disease, crime, and traffic congestion, with limited wealth and scarce public capacity. In this section, we focus on three central downsides of density: pollution, congestion, and crime.

We begin by discussing the costs of different urban harms and then explore several central themes that cut through the policy responses to most urban disamenities, such as behavioural responses to policy changes, social returns to infrastructure and public capacity. We then apply these more general ideas to the topics of housing, planning, municipal finance and water and waste management. We end with a brief discussion of climate change and sustainability.

In developing countries, urbanisation has proceeded far more quickly than institutional development – creating an urgent need for these cities to tackle the downsides of density.

It is important to note that while this section discusses the downsides of density and the extra service demands created when people live in dense environments, cities are likely to make the provision of services less expensive and more cost-effective compared to rural areas. Mass vaccination, high quality primary education, and social protection are examples of services that all likely to be easier to deliver in urban areas, due in large part to the lower cost of accessing people. Thus, as highlighted above, cities are likely to be productive places, both in the private and public domain. We note that there is comparably less evidence on this dimension, and that estimates of how the cost of service delivery change with density would be important future work.

A What are the social costs of urban contagion, congestion, and crime?

The first and most basic task is to estimate the size of the costs created by urban disamenities. This question is particularly crucial for policy makers with limited time and resources who are trying to focus on the urban problems that do the most harm. If air pollution does a small amount damage but bad water causes widespread illness, then policy makers may want to invest more in water systems. Conversely, if air pollution is more harmful, then policy makers should turn their regulatory energy toward regulating the corporations and vehicles releasing smoke into the air.

The economics literature on the impact of urban air pollution is large and compelling. The air pollution literature has focused on the adverse health consequences of bad air quality. Currie, Neidell, and Schmeider (2009) examine air-quality-monitor data in New Jersey and find that infant health suffers as air quality deteriorates. One challenge with this work is that poorer people, who are sicker for many reasons, tend to live in places with worse air. The authors address this issue by looking at air quality changes over time for a panel of families in diverse areas. Alexander and Schwandt (2019) look at air-quality deterioration associated with widespread cheating on automobile inspections and find that bad air increases asthma and decreases birth weight.

While these papers focus on the US, there is also a literature, surveyed by Currie and Vogl (2013) that looks at developing-country cities. Arceo-Gomez, Hanna, and Oliva (2016) find that bad air quality has even more serious effects in Mexico City than in the US, suggesting that the health effects of pollution are compounded in poorer places. Cesur, Tekin, and Ulker (2017, 2018) show that switching from coal to natural gas led to air quality improvements in Turkey, which in turn improved health outcomes for children and adults.[7] A smaller literature links air pollution to more negative economic outcomes, such as labour supply, and also finds negative effects of air pollution (Hanna and Oliva, 2015, Fan and Grainger, 2019).[8] At the city level, air pollution can also harm the local economy by repelling skilled high-productivity individuals (Kahn, 1999).

Among economists, Cutler and Miller (2005) and the work of Werner Troesken (e.g., Troesken 2008) has been particularly important in establishing the historic link between water infrastructure and public health. More recently, there has been a dramatic increase in the work of economists on water in the developing world. Gamper-Rabindran, Khan, and Timmins (2010) found that piped water decreased infant mortality in Brazil. Devoto et al. (2012)

7 Quah and Boon (2003) place a dollar value on health outcomes with tools like multiplying mortality estimates by the value of a statistical life.

8 Heath, Mansuri and Rijkers (2018) find that high frequency health shocks significantly reduce female labour supply.

found that piped water in urban Morocco did not increase health, presumably because families already had access to high-quality non-piped water, but increased happiness by making water procurement easier and less contentious and freeing up more time for leisure. Buchmann et al. (2019) find the particularly striking result that a health campaign to reduce exposure to arsenic-contaminated water increased infant mortality by inducing households in Bangladesh to switch to water sources with higher faecal contamination.[9]

Traffic congestion is defined by excessive time spent on travel relative to driving on an uncrowded road. Economists have assigned a value to this lost time by multiplying the lost minutes by after-tax wage (Alonso 1964). More sophisticated papers have used survey instruments to find that the cost of time spent in traffic is actually lower than lost wages (Calfee and Winston 1998.[10] Investment in transportation infrastructure may lead to either urban growth (Duranton and Turner 2012) or suburbanisation (Baum-Snow 2007). While reduced-form methods can estimate these impacts, interpreting those estimates requires the structural models that we will discuss in Section IV.

Most urban leaders accept on faith that reducing crime, and particularly violent crime, to wealthy country norms is desirable. After all, governments have long sought a monopoly on violence. Consequently, the economics of crime and punishment has rarely focused on the costs of crime, but has instead tried to estimate the impact on crime of different policies, such capital punishment (Ehrlich 1975), more policing (Levitt 1997), and lengthier prison sentences (Kessler and Levitt 1999).

The most standard approach to estimating the costs of crime is to estimate victims' losses when crimes do occur (Chalfin 2015), so that murders cost millions and robberies cost hundreds. These costs may overestimate the true social cost of crime, because they omit the benefits of crime to the criminal; however, it seems far more likely that they underestimate the costs, because they neglect the costs of fear and avoidance behaviour for others in the community.[11] Ludwig and Cook (2001) use a contingent valuation survey to

9 The economics literature on solid waste management remains as limited as the literature on water before 2000. There is however a sizable epidemiological literature that finds robust correlations between disease and proximity to a wide range of solid waste (Giusti, 2009).

10 While US studies typically assume that traffic speeds in the absence of the congestion would be the speed limit, the poor quality of roads in the developing world can reduce travel speeds considerably, even outside peak hours (Kreindler, 2018).

11 When person A steals person B's bicycle, then presumably this is a transfer from person B to person A rather than a pure loss of welfare. Applying this logic to murder, however, is more problematic. Even if person A receives some psychic benefit from killing person B, few observers would be willing to include murderous enjoyment as a reasonable element in any social welfare function.

estimate respondents' willingness to pay to live in communities without fear of crime. Hedonic price models can also use the difference in housing prices between safe and unsafe areas to estimate the social losses due to fear of crime (Thaler and Rosen 1976). Most estimates find that urban crime, unsurprisingly, generates significant costs, including spurring on outward migration (Cullen and Levitt 1999) and reducing tourism (Biagi and Detotto 2014).

Measuring the average social costs of contagion, congestion and crime remains a research priority. However, the differential impact of the downsides of density also deserves attention. The most vulnerable economically, who live in specific areas, could be more affected by pollution. The poor in slums typically do not have access to reliable water supply and so improving access could have a significant impact on health outcomes.

B Incentives and behavioural change

Most urban infrastructure, such as subways or aqueducts, can be interpreted as adding effective space to a city in which space is scarce. Yet, adding infrastructure may not be as cost effective as reducing the behaviours that require it, especially when added infrastructure induces more socially harmful behaviour. Duranton and Turner (2011) empirically document the "Fundamental Law of Highway Traffic," which states that overall vehicular miles travelled increase roughly one-for-one with highway miles built. If this law holds, then building more roads does little to solve traffic problems, because the new roads will simply become congested with new drivers. Consequently, the problems associated with density often need some combination of infrastructure and incentives to be effective.

The crime and economics literature has long asked whether incentives can reduce harmful behaviour (e.g., Ehrlich 1975, Levitt 1998, Nagin 2013), but much of this US-based literature may not translate easily to developing world cities. While over 50% of murders typically lead to an indictment in the US, under 15% of murders in Brazil are solved (Misse and Vargas 2007). Corruption, malfeasance, and gang power are often worse in developing-country cities, so the same incentives may not be as effective.

Adding infrastructure may not be as cost effective as reducing the behaviours that require it, especially when added infrastructure induces more socially harmful behaviour.

The pollution and congestion literatures focus more on the impact of regulations than on flexible incentives. Davis (2008) documents the impact of the Hoyo No Circula programme, which limited cars' ability to drive on certain days, on air quality in Mexico City. Kreindler (2016) similarly shows that license-

plate-based bans on driving effectively reduced congestion in Delhi.

The introduction of congestion pricing in London, Stockholm, Oslo, and Singapore all provide case studies on the impact of pricing roads. Typically, the best that can be done with these interventions is to compare before and after congestion pricing. It does appear that London's roads became more passable after it imposed its congestion charge (Leape 2006). Yet it is not obvious the results for London will generalise to Jakarta, as in Hanna, Kreindler, and Olken (2018).

Kreindler (2018) estimates a model of demand for driving trips in Bangalore using an experimental structure where individual drivers were randomly offered incentives to avoid peak times on crowded roads. Strikingly, he found that the behavioural adjustment was modest, and that Indian roads wouldn't flow very quickly even if congestion was reduced substantially. This type of experimental model has promise, yet it is essential to bear in mind that any small experiment will change the general equilibrium effects that reach across cities.

In congestion, the key behaviour that can reduce the benefits of new infrastructure is driving. In public health interventions, the usual problem is take-up, where people choose not to pay connection fees that cover the "last mile."

In congestion, the key behaviour that can reduce the benefits of new infrastructure is driving. In public health interventions, the usual problem is take-up, where people choose not to pay connection fees that cover the "last mile." Ashraf, Glaeser, and Ponzetto (2016) note that both in New York City historically and African cities today, poorer citizens have often been unwilling to pay the marginal cost for connections to cleaner water sources. One empirical question is whether they will connect if given subsidies, or whether the more effective route would be to impose penalties on those who do not connect.

C Estimating the social benefits of infrastructure

Randomised control trial methods are much harder to implement for infrastructure than for incentives, both because infrastructure substantially impacts an entire area and because randomly relocating infrastructure is cost prohibitive. In some cases, simple difference-in-difference methods can estimate the impact of infrastructure, as Alsan and Goldin (2019) did for sewerage in greater Boston or Duranton and Turner (2011) did for roads within the US. Yet, these estimates may tell us little about a new project in Delhi or Nairobi.

The primary tool that economists have brought to infrastructure is cost-benefit analysis, which attempts to catalogue the gains and losses from

building new roads, tunnels, and sewerage systems. Typically, this work brings together the knowledge of economists and engineers, as in Meyer, Kain, and Wohl (1965). A central result of the early forays into urban infrastructure analysis was that bus systems, sometimes on dedicated lanes, are far more cost effective than rail systems. This analysis helped inspire the Bus Rapid Transit (BRT) systems that have been implemented in Curitiba, Brazil; Bogotá, Colombia; and elsewhere.

In early years, the benefits of infrastructure largely focused on the direct benefits to users. Infrastructure boosters would then forecast high projected ridership levels, which would then be disputed by economists (Kain 1992). User-fee financing creates some fiscal discipline, since projects are expected to cover their costs, but if user fees are too low to pay for total or even operating costs, then that discipline vanishes. Low fees are typically justified because marginal costs are below average costs or because of a desire to redistribute to poorer infrastructure users. As infrastructure investment increasingly relies on alleged agglomeration benefits, the scope for overselling becomes even larger, which only increases the need for the rigorous structural modelling that we discuss in Section IV.

Measuring the social benefits of public infrastructure across population groups is an area that requires further research – both to understand for whom and where the returns are greatest, but also the political economy constraints that urban policymakers face.

New infrastructure projects are often given precedence over maintenance, which is especially problematic if there are particularly high returns to maintaining older roads and bridges (Gramlich 1994). This could be particularly true if developing countries are attracting wealthy outside investors who are looking to make an impact and do not do appropriate research on existing infrastructure beforehand. Additionally, the quality of the management of infrastructure will depend on institutions and incentives. While World Bank statistics claim that Lusaka, Zambia, has almost complete water connections, in practice, some areas of the city seem to lack viable connections much of the time. Ashraf et al. (2017) show that the reason behind this is that the water company in Lusaka is much quicker to respond to supply problems for customers who pay per litre than customers who pay per month. We turn now to the institutional side of urban management.

Here again, measuring the social benefits of public infrastructure across population groups is an area that requires further research. This is not only to measure for whom and where the returns to public infrastructure could be the greatest but also to shed light on the political economy constraints that urban policymakers may face when deciding on where the next water pipe should be built. We turn now to the institutional side of urban management.

D Institutional reform and public capacity

Public institutional capacity is a precondition for any meaningful reform. However, it is often difficult to use modern empirical methods, such as randomised control trials, to understand paths toward better institutions. Some studies measure whether changes in incentives can alter the behaviour of public officials. Muralidharan and Sundararaman (2011) show that Indian teachers appear at work more often when pay is linked to performance. Ferraz and Finan (2011) show that federal auditing of mayors in Brazil reduces corruption. Yet the impact of any incentive programme can be easily distorted in a corrupt institution; Corruption could lead to misuse of incentives, information about upcoming audits in exchange for pay, etc. In many developing countries, proving that an innovation can work is not the same as showing that it will actually change institutional performance.

Most work on the institutions that matter for developing-country cities is descriptive or involves simple comparison. For example, Engel, Fischer, and Galetovic (2014) present a magisterial overview of public-private partnerships (PPPs) throughout the world. Their work typically reviews the performance of PPPs and often compares their performance with governmental alternatives. Singh (2018) presents a similar study comparing the roughness of Indian roads that are maintained by public and private entities. In this case, the private roads are far smoother than their public alternatives.

Economic theory makes predictions about the impact of limitations on property rights, but there is little research that fully teases apart the impact of partial control over urban land.

While Singh's study is persuasive, in general, the private provision of public services has a far more mixed track record. As Engel, Fischer, and Galetovic (2014) show, private companies often manage to renegotiate with public entities to radically increase their compensation, leading to a potentially higher cost for the government than if they had supplied the need themselves. Theoretically, private entities should have better incentives to maintain quality because they can only reap returns if customers use them, but in some cases, quality is average or even poor. Certainly, private entities that are paid with public money have a strong incentive to subvert the system and extract more public resources wherever possible.

While much institutional research focuses on the executive branch, the judiciary is also critical, for every market failure is ultimately a failure in the maintenance of property rights (Coase 1960). If courts fail to protect land rights, then people lack the incentive to develop that land. When courts fail, ordinary people waste time protecting their property from expropriation (Field 2007).

Property rights over urban land are actually a nexus of rights including the rights to use, develop, sell, rent, and mortgage. In many developing-country cities, these rights are far more fragmented than they are in the West. For example, the residents of informal settlements may well be protected in their right to use a piece of land, but since they have no title, they cannot sell that land or mortgage their property to start a business (de Soto, 2000). Economic theory makes predictions about the impact of limitations on property rights, but there is little research that fully teases apart the impact of partial control over urban land.

More broadly, many cities in developing countries are expanding their urban land cover, rather than building higher levels of density. According to Angel (2011) if density-levels remains the same in African cities, urban land cover in 2050 will be four times higher than it was in 2000. This is compounded by institutional structures unable to keep up with the expanded economic footprint of fast-growing cities: often, many government units are responsible for urban service delivery in a single city, with little coordination between them (Collier et al., forthcoming).

There is little research from developing countries that provides economic analyses of the impact of spatially fragmented governance structures on cities. Particularly, along two lines: first, the impact on the productivity-levels in a given city. While there is some evidence of how fragmentation reduces urban productivity-levels from OECD countries, there is none from developing countries (OECD, 2015). Second, on the impact of spatial fragmentation on equity concerns, particularly in cases where fragmentation coexists with fiscal decentralisation. Intuitively, it would be harder in administratively fragmented cities for local governments to redistributing revenue between wealthy and poorer regions. This is particularly of concern due to stagnation of the urban cores in many developing cities, for example, in almost all mega cities in South Asia (Peter and Mark, 2016).

The lack of public funds represents a vicious cycle: a city without public capacity may find it difficult to collect the tax that it needs to fix its public capacity problems.

E Housing, planning, public finance, and water and waste management

Four large policy areas relate to the downsides of density and the issues we have just discussed: local finance, water and waste management, housing, and urban planning and zoning. We now briefly discuss the ways in which public capacity, behavioural responses, and cost-benefit analysis play out in these core areas of urban policy making in the developing world.

Municipal finance is particularly central to almost all efforts to improve urban quality of life. If a city can't raise public funds, then it will have trouble providing better police, fixing potholes, or managing waste. In addition, this problem represents a vicious cycle: a city without public capacity may find it difficult to collect the tax that it needs to fix its public capacity problems. Consequently, cities can get caught in a low capacity/low revenue trap that may be particularly problematic. It is thus valuable to learn whether certain taxes, such as simple land value taxes, are easier to collect than others in weak-capacity environments.

Naturally, the ease of collection needs to be weighed against the other behavioural distortions induced by specific tax rates. There is a large literature on the behavioural impact of different tax rates in the wealthy world. The literature is smaller in the developing world, and there is a need to understand which specific taxes might deter workers and firms from entering into the formal sector. The long-run research goal should be to generate serious cost-benefit analysis of different taxes by combining evidence on implementation challenges with evidence on the magnitude of distortions.

When cities fail to provide decent waste and water management, their residents face the ancient urban scourge of contagious disease. The externalities that come from disease and waste disposal explain why governments have been engaged with these issues at least since Rome built its Cloaca Maxima, one of the world's first sewage systems, under the Tarquinian kings. Today, households appear to have a greater willingness to pay for better water than to pay to dispose their waste, because it is their neighbours who mostly pay for accumulated rubbish, but more research estimating private willingness to pay for water and waste management is important. Such work needs to be combined with larger estimates of the costs of water- and waste-management failure to understand the total benefits of providing better services. The gap between total benefit and private benefit can help inform any public decision to either subsidise adoption of better services or tax non-adoption of those services.

Today, households appear to have a greater willingness to pay for better water than to pay to dispose their waste, because it is their neighbours who mostly pay for accumulated rubbish.

Since water and waste management typically involve significant infrastructure, these policy areas also involve institutional choices. When should these services be provided be governments, and when should cities turn to private provision? How does the institutional nature of service provision determine service quality and access? Are there particular local characteristics, such as public capacity, that should shape the choice of institutional reforms?

Cities typically manage their physical land areas, both through land-use planning and housing policy. These policy actions can have profound

long-run impacts on housing costs, urban mobility, and the very shape of the city. Once again, policy action should be informed by basic studies that estimate the far-ranging impacts of planning decisions. The decision to provide public funding for housing can become better informed if there are better estimates of the long-run impacts of such housing on economic and social outcomes for its residents.

In addition, the decision of where to place this housing is of critical importance, given that housing is more than simply shelter – but rather a proxy for many other urban 'goods', such as connectivity and social networks. Assessing the benefits of concepts such as mixed-income housing, as well as fully understanding the costs and benefits of locating social or public housing on high value land in the urban centre would be very useful in informing future human settlement policies.

The treatment of informal housing (or 'slums') is also an important area to understand. Formal housing comes bundled with a series of obligations aimed at overcoming the externalities of dense living. Space is provided for transport access, sanitation and water, and building regulations ensure that low quality construction does not threaten neighbours assets. These provisions, however, are costly and may limit the ability of the poorest of the poor, and recent rural to urban migrants to reap the benefits of the city's density. The treatment of slum areas requires careful weighing of these costs and benefits. We discuss the issues and evidence through the lens of specific structural models in section 3 below, but note here that general equilibrium impacts of projects in slum areas make them hard to evaluate and may also lead to misinterpretation. For example, a slum improvement programme may lead slum dwellers to sell off their newly improved homes and create a new slum. If observers concentrate on the goal of removing slums, this could be interpreted as a failure. However, this interpretation ignores the fact the original slum dweller has had an increase in wealth, and the household that has moved in has also likely gained, moving from a less desirable location. Comprehensive studies that capture these complex equilibrium effects are important in formulating appropriate policy.

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Access to public housing can be evaluated through randomised control trials, but changes to zoning rules are far more complex to evaluate. As local land-use rules can have complicated impacts that reverberate through the city, the structural models we will discuss in the next section seem particularly well suited for evaluating those rules. A final important question concerns the institutional choices for housing and planning authorities: How can public entities acquire the capacity to do these tasks well?

F Cities and climate change

We end this section by noting the particularly critical issue of climate change, which may end up generating large costs for many of the world's cities. Holding income constant, urban density is associated with lower, not higher, carbon emissions (Glaeser and Kahn, 2010). This is so because proximity facilitates the use of public transport, it reduces commuting distances and smaller homes in urban areas usually come with lower energy use. Moreover, many of the risks associated with climate change are far larger for subsistence farmers than for urbanites who are enmeshed in a global trading system, where food can be provided by formerly colder areas that may become more productive due to climate change. This stresses the need to promote urbanisation not just for its direct impact on structural transformation and growth but also to ensure that growth is sustainable, by reducing the magnitude of global externalities, and to protect the most vulnerable in rural areas for the detrimental effects of climate change.

While conditional on wealth, urbanisation reduces emissions, because cities are responsible for about 75% of global carbon emissions, and as growth and structural transformation in developing countries will push this number upward, there is a significant need for research to think about how cities can become more efficient and compact. One need in particular is to think about local externalities from energy consumption. Most of the world's most polluted cities are now in low and middle income countries (see Figure 8 in the Energy and Environment IGC Evidence paper). The social cost of pollution and other local and global externalities in these cities is now so large that it risks reducing urban density going forward. For example, urban density in China has decreased by an estimated 25% in the past few years.[12] Many of the world's cities by 2050 are yet to be built, especially in Africa, and this offers an opportunity to think about how cities can be designed in a way that reduces both global and local externalities.

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Research is particularly needed to measure the effect of urban policies aimed at reducing the magnitude of carbon emissions. These include, for example, the impact of bus rapid transit systems, the effect of tax policies to incentivise the adoption of more energy-efficient residential buildings or, more broadly, to induce more energy-efficient practices.

12 Source : Pew Research Center, available at: https://www.pewresearch.org/fact-tank/2015/11/19/building-outpaces-population-growth-in-many-of-chinas-urban-areas/

On this issue of supporting the policy effort to mitigate global externalities from urban areas, there is probably greater potential for work on cities of intermediate sizes. The majority of the world's urbanites live in cities of less than 500,000 inhabitants.[13]

Strategies to reduce local pollution deserve more attention as a growth issue not just because of their direct effect on health, but also because effective policies to reduce pollution may also prove important for climate change and hence for generating sustainable growth. The simpler political economy of local pollution policies – where the short-term costs are counter-balanced by short-term benefits – means that such policies are likely to have immediate spillover benefits for climate change, as emissions drop, as well as longer term benefits, by paving the way for broader climate change policies. Many other policies and regulatory reforms to reduce carbon emissions at the city level should be explored.

The expected effects of climate change, especially on coastal areas require that we also think carefully about adaptation and in particular the location of cities. Kahn (2010) argues that poorer countries will be able to adapt to climate change by moving population centres inland and towards higher elevation areas. As long as sea levels rise slowly, the adaptation process that Kahn envisions may be plausible. But if climate change is related to rare natural disasters, such as cyclones and tidal waves, then cities – particularly those in coastal areas – face tremendous risk.

In designing policies to mitigate and adapt to the effects of these growth-generated externalities, the question of where authority lies between the central government and local municipalities is of critical importance. Addressing externalities effectively and efficiently often requires innovation at both the local and national level. There is a thus need to design governance structures that facilitate these policy innovations, while keeping a certain level of central oversight and control to minimise distortions across cities. Finally, political constraints on policy in this area are often stringent; thinking about social norms about environment quality is also important when thinking about the design of urban policies for climate change.

Strategies to reduce local pollution deserve more attention as a growth issue not just because of their direct effect on health, but also because effective policies to reduce pollution may also prove important for climate change and generating sustainable growth.

13 Source: U, World Urbanization prospects

BOX 2 Next steps and research priorities

- **How can sanitation and health services can be provided to effectively maintain public health and a clean environment? More generally, how do the social costs of urban density and social benefits of public services vary across population groups?**

- **Can governments facilitate functioning land markets to allocate space efficiently and provide affordable housing for lower-income residents?**
  - Measure the impact of public housing projects, slum upgrading programmes, and land readjustment, on resident welfare, land prices, productive activity and fiscal costs.
  - Measure the impact of location of public housing, as well as spatial integration of lower and higher income residents on resident welfare, land prices, productive activity and fiscal costs.
  - Find evidence on the effect of land use regulations, including rules that promote or reduce economic inclusion.

- **How can developing countries improve urban mobility?**
  - Measuring the costs of congestion, which include not only hours lost to traffic but also distortions in the land and labour markets
  - Evidence on the role of informal networks that dominate transit in African cities. Can these networks complement the more expensive mass rapid transit being introduced across the developing world? Is it more cost-effective to invest in improving those networks or to introduce traditional mass transit systems? What do new technologies like ride sharing pose for the future of mobility in these cities?

- **How can developing countries manage and finance service provision and the functioning of local government?**
  - Are there ways to enhance existing tax design, enforcement and compliance at the local level?
  - What can new instruments, such as programmes that capture land value, do for areas with low state capacity and high rates of informality?

- **How can developing countries build more efficient, more compact cities?**
  - How large are the benefits from more compact cities, and what policies can incentivise this?
  - How should cities increase public transit adoption, and what is the impact on emissions?
  - What policies incentivise the adoption of more energy-efficient practices?

4 The structural approach to transportation and land use

To many architects and land-use planners, the city is synonymous with the built environment. While urban economics emphasises that cities are better seen as massed humanity, the physical city is still profoundly important. Land-use planning plays a particularly central role for many city governments. Yet, economists have typically had little to say about efficient land-use rules or the costs of bad planning. The growing field of formal spatial modelling offers the possibility of delivering pragmatic tools that can help policy makers plan better and more fully anticipate the far-ranging impacts of any large-scale change to the built environment.

Changes to large-scale urban investments are more akin to changes in macroeconomic policies, such as fiscal policy, which reverberate throughout the layers of the economy.

The randomised control trial approach to development economics is ideal when considering targeted interventions that are akin to medical drug trials. However, changes to large-scale urban investments are more akin to changes in macroeconomic policies, such as fiscal policy, which reverberate throughout the layers of the economy. Just as macroeconomics has turned to simulations using tools like dynamic stochastic general equilibrium models, urban economics has begun using complex structural models that largely rely on simulations to understand how new investments or policies will change life within a city.

A The basic form of structural urban models

The first wave of urban models made drastic simplifications that reduce cities to a sequence of locations that differ only in their distance to a central business district (Alonso 1964, Mills 1967, Muth 1969). A day spent exploring a real city's streets shows how this belies the immensely rich spatial differences that make cities so complex and interesting. Realistically, economic activity occurs in locations that vary in terms of air quality, crime rate, infrastructure, and access to shops and restaurants. Recent models have combined rich spatially disaggregated data with tools from the trade and economic geography literature to address this richness (see Redding and Rossi-Hansberg (2016) for a comprehensive review). These frameworks allow researchers to quantify the aggregate implications of economic policies, assess how their impacts reverberate through agents' behavioural responses and linkages across space, and simu-

late the effect of counterfactual policies to evaluate how competing approaches might best achieve policy goals.

Quantitative models consist of a series of building blocks whose elements are chosen to fit the focus of the research question and the type of data available: geography, workers, firms, the supply of land and housing, and general equilibrium conditions.

The geography of a city is comprised of a large number of discrete locations (such as census tracts or blocks). They differ in attributes such as the time it takes to commute to every other location, the supply of land available, and other exogenous characteristics (such as views, access to roads, or the type and slope of land) that affect the city's available amenities, productivity levels, or the costs of housing development.

Workers must choose where to live and work across pairs of locations. This choice depends on attributes that determine how attractive locations are to live in (e.g., their level of amenities and residential floor space prices), work in (e.g., the wage paid by firms), as well as on the cost of commuting between each pair. Depending on the model, residents can differ in their attributes (such as education or location of prior residence, as in Tsivanidis 2019 or Bryan and Morten 2019), make additional choices such as where to shop or which mode of transit to commute with (Allen, Arkolakis, and Li 2015), or have idiosyncratic preferences for each live-work pair (generating upward sloping resident and labour supply curves as functions of location attributes, as in Ahlfeldt et al. 2015).

Similarly, firms must choose their locations. Production can potentially take place in any location, but depends on characteristics like productivity, access to labour, and supply of commercial floor space. Technologies can allow for perfect or imperfect competition, constant or increasing returns, fixed or free entry (Redding 2016), multiple industries (Caliendo, Dvorkin, and Parro 2019), and differing extents of firm mobility (Fajgelbaum et al. 2018).

Housing supply and usable production space is constructed by developers using capital and developable land available in each location. Land use is determined by landowners who trade off the return to residential or commercial use, potentially subject to zoning restrictions (Ahlfeldt et al. 2015).

These individual optimisation decisions are then connected through general equilibrium market clearing conditions that equate the demand and supply for each factor in each location and pin down prices. For example, equating the demand and supply for labour and floorspace determine wages and house prices respectively. These models also allow for externalities: the levels of productivity, amenities, or travel time across (pairs of) locations are often endogenous (Ahlfeldt et al. 2015, Fajgelbaum and Schaal 2019). In this case, the levels of these variables taken as given by agents must be consistent with equilibrium choices.

Once the researcher fully specifies the model, three steps must be taken in order to conduct quantitative analysis. First, it is necessary to estimate the

"deep" parameters assumed to be invariant to the counterfactual policy. These typically consist of elasticities that govern, for example, the sensitivity of commute choices to commute costs or housing supply to housing prices. Second, the model's unobserved location characteristics (such as amenities and productivity levels) must be recovered. These models are typically exactly identified, so that there exists a unique mapping from observed data (such as residence, employment, and house prices in each location) to unobservables given the model's deep parameters. Third, the researcher can use the now-identified system of equilibrium equations to simulate the effects of alternative policy scenarios (such as new transport infrastructure or zoning regulations) on the full urban equilibrium.

B What's different in developing countries?

The majority of these models have been developed within the contexts of cities in rich countries. Should we expect the results of frameworks built to fit Chicago or Berlin to translate seamlessly to Mumbai or Nairobi? Transit and land use are vastly different in cities of the emerging world, characterised by poverty, informality, and coordination problems. The options available to financially and capacity-constrained governments also differ. We now discuss recent work that has sought to adapt quantitative models to the context of cities in the developing world and outline areas of promise for future work.

Bus rapid transit (BRT) systems have quickly become a popular alternative to subways in developing-country cities. They provide similar reductions in commute times at a fraction of the construction cost. New public transit such as BRT may also have profound distributional implications, since the poor rely on public transit that is often slow in these settings due to the oversupply and lack of coordination among informal minibuses. In his analysis of the world's largest system in Bogotá, Colombia, Tsivanidis (2019) develops a model that allows for multiple skill groups of workers with non-homothetic preferences over different modes of transit. By accounting for the impacts of transit on the residence, employment, and transit mode choices of heterogeneous workers, Tsivanidis uses the model to trace out the system's impact on aggregate performance—not only through reducing time lost in transit, but also by improving the allocation between workers, places of employment, and places of residence. He finds that welfare gains are 20-40% larger after accounting for reallocation and general equilibrium effects.

Quantitative models can provide insights into what other policies might complement expensive infrastructure to maximise returns on investments. Tsivanidis shows the feeder bus system that reduces the last-mile problem of getting residents from poor, dense neighbourhoods at the city's edge to the BRT improve welfare more than any single trunk line. He also runs a counterfactual exercise to show that welfare gains would have been 18% larger

had the government implemented a land value capture scheme in which zoning densities were increased near stations with permits to build auctioned off to developers. Revenues from the permit sales would have covered around 10-40% of construction costs depending on the extent of in-migration from the rest of Colombia.[14] Future work in developing-country cities needs to incorporate more features of transit. However, we need to meet a few requirements to be able to develop smart policy. First, we need evidence that quantifies the wider costs of congestion given their potential distortion of the behaviour of firms and residents. For example, we need to consider that new infrastructure may have different effects in Nairobi or Lagos than in Berlin or Bogotá due to the vast informality of jobs and housing.

Second, these models need to confront the fact that most of the public transit in developing-country cities is informal. Tools from industrial organisation combined with recent work on routing and congestion (Allen and Arkolakis 2019, Fajgelbaum and Schaal 2019) should be used to understand how this industry responds to mass transit interventions, how policy makers can ensure their policy complements rather than competes with it, and what other forms of regulation could improve its performance.

Third, new technologies such as ridesharing are changing the nature of mobility in cities. Work is needed to understand how developing country-specific variants, such as motorbike hailing in Bangkok or the Uber bus service currently being piloted in Cairo, will impact mobility, demand for cars, and existing public transit services.

Land markets in developing-country cities are characterised by a high rate of informality. To understand patterns of land use and density in these contexts, Henderson, Regan, and Venables (2016) develop a structural, dynamic, monocentric city model that allow for formal and informal construction. They use the estimated model to infer high costs of converting slums to formal housing. Gechter and Tsivanidis (2018) develop a quantitative model that allows for formal and informal housing. They use the framework to quantify the implications for equity and efficiency of the redevelopment of Mumbai's 58 textile mills during the 2000s. They find that the redevelopment increased the stock of formal housing in the city centre, but also that it displaced poor residents from nearby slums whose homes were converted following the ensuing housing price appreciation. Policy makers in developing-country cities need to take informal housing into account when making decisions; ignoring it can have disastrous consequences for citizens and the economy.

The presence of externalities in cities suggests the potential for efficiency gains from zoning and land use policies. But more evidence is needed on the size and nature of these spillovers. For example, if businesses become more productive when they cluster together, governments may want to zone

14 See Suzuki et al. (2015) for a comprehensive review of land value capture instruments.

centrally located land to commercial use in order to promote socially beneficial levels of concentration. However excess traffic congestion or pollution from certain industries would make such a configuration less desirable. Once more empirical work has identified these externalities, since these policies are difficult to randomise there is a role for quantitative models to use these estimates to inform policy makers about the consequences of alternative zoning or land use policies. For example, Allen, Arkolakis, and Li (2015) develop a model that allows them to characterise optimal zoning in Chicago around an observed equilibrium, while Bird and Venables (2019) apply a similar framework to evaluate the impact of tenure reform in Kampala.

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The prevalence of rent control, density restrictions, mixed-use zoning, and minimum floor space requirements for formal housing sector construction in developing-country cities suggests a need for more work in this area. Governments will also spend vast sums on housing investments that reshape the structure of cities, from slum upgrading (Harari and Wong 2018) to constructing massive new housing developments at the urban periphery (Franklin 2019). Quantitative work should strive to understand the trade-offs, equilibrium implications, and unintended consequences associated with this menu of options.

The degree of shared prosperity that arises from transit and housing policy also depends on the sorting response of residents. Will new transit or slum developments that increase surrounding property prices simply benefit rich landowners and displace poor renters in the long run? Tsivanidis (2019) shows that Bogotá's BRT increased the spatial segregation between low- and high-skilled workers, a feature that is replicated by the model due to the non-homothetic preferences for residential amenities. Couture et al. (2019) develop a model with non-homotheticities and find that sorting responses and endogenous amenities amplified the increase in wealth inequality in the US since 1990 by 1.7 percentage points in terms of welfare inequality. More work to understand the sorting of residents in developing-country cities and its implications for the distributional consequences of spatial policies is clearly needed.

Finally, these models should address the coordination problems particularly salient in land markets of the developing world, where urban growth is typically haphazard, unorganised, and sprawling. Exploring the ring of vacant land surrounding Detroit's central business district, Owens, Rossi-Hansberg, and Sarte (2019) highlight the coordination problems between residents and developers in the presence of residential externalities. When amenities depend on the number of residents, land may remain vacant even if its fundamentals are sound. Dynamic inefficiencies may arise, for example, if land

use is sticky and agents fail to internalise agglomeration externalities in production. As more migrants arrive in a city, it may simply run out of plots large enough to allow for a concentration of large manufacturing plants in accessible areas.[15] Empirical work by Brandily and Rauch (2018) and Michaels et al. (2018) highlight the dynamic consequences of land-use planning in African cities. The dynamic quantitative models of Desmet and Rossi-Hansberg (2015) and Caliendo, Dvorkin, and Parro (2019) could be extended to understand these effects.

C Providing better parameter estimates to make structural models more useful

If quantitative models are to provide useful policy insights, their results need to be trusted. First, researchers must establish that their model captures relevant features of the data or (ideally) can replicate the real-world response to a policy change. Second, they must provide credible estimates of the model's "deep," policy-invariant parameters. The increasing availability of new, large-scale sources of data in developing country cities provides an immense potential to validate and estimate these models in the contexts of quasi-natural experiments or, occasionally, through randomised interventions.

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The most basic form of model validation involves showing that key parametric relationships defined in the model capture the data features relevant to the question at hand. For example, if a model is used to simulate the impact of new transit infrastructure, then the relationship between commute times and behaviour posited by the model should provide a tight fit to the data. Ahlfeldt et al. (2015) and Monte, Redding, and Rossi-Hansberg (2018) show how the log-linear gravity equations for commuting and migration delivered by their models fit the data in Germany and the United States respectively.

Our trust in these models increases if they can replicate the response of cities to real-world policy changes. Heblich, Redding, and Sturm (2019) estimate a quantitative model using one year of data from historical London, and then feed in a sequence of new commute times induced by the expansion of the city's railway system over an eighty-year period. They find the model can

15 Gollin, Jedwab, and Vollrath (2016) discuss the service-led nature of urbanisation in African cities, which have missed out on the higher rates of industrialisation commensurate with urban growth in other continents.

replicate the gradual concentration of employment in the city centre despite not being targeted in estimation. Tsivanidis (2019) shows that in a wide class of gravity models, the impact of changing transit infrastructure on equilibrium outcomes, such as population or house prices, is summarised solely by its effect on model-defined measures of accessibility. These models predict these relationships to be log linear. Using the variation in accessibility provided by the construction of Bogotá's BRT, he shows this is precisely what occurs in the data. Future work should leverage the increasingly available high-frequency data discussed below to incorporate pre-analysis plans into structural work. If researchers can show that quantitative models accurately predict the effects of new infrastructure or other policy interventions they have yet to see, these models' insights will become yet more believable.

The next task is to credibly estimate a model's parameters. Some randomised interventions do exist. Akram, Chowdhury, and Mobarak (2018) assess the equilibrium impacts of urban emigration on rural villages by randomly varying the fraction of residents offered transport subsidies. Brooks and Donovan (2019) randomly construct bridges across Nicaraguan villages to evaluate their effects on reducing the market-access risks posed by seasonal flash floods. In a more urban context, Gonzalez-Navarro and Quintana-Domeque (2016) exploit randomisation in road upgrades across Mexican neighbourhoods to examine their impact on housing prices.

A second approach is to estimate the parameters of a structural model by matching reduced form coefficients from (quasi-)experimental settings. Fogli and Guerrieri (2019) examine the extent to which spatial sorting and neighbourhood effects amplify wealth inequality. The authors estimate the parameter governing the strength of neighbourhood effects by ensuring a one-standard-deviation increase in neighbourhood quality, as a child delivers a 10% higher income than their parents in their model simulations, precisely the estimate from Chetty and Hendren (2018).[16] Randomised housing interventions in developing-country cities, such as the Ethiopian public housing lottery studied by Franklin (2019), could provide new sets of relevant estimates to calibrate these models.

The third and most common approach is to use quasi-natural experiments directly as sources of identifying variation. This has long been popular in trade and economic geography (Donaldson and Hornbeck, 2016; Donaldson, 2018), but has also recently become increasingly popular in urban economics. The seminal work by Ahlfeldt et al. (2015) exploits the construction and fall of the Berlin wall as quasi-random variation in the density of economic activity. This allows them to estimate the strength of agglomeration spillovers

16 Faber and Gaubert (2018) estimate the spillover parameters of a quantitative spatial model in Mexico through an indirect inference approach. They ensure that the coefficient from an IV regression of employment on tourism attractiveness using data generated from their model matches that of the reduced-form analysis.

across space. Recent examples in Colombia and India use large-scale transit and land-use policy changes to estimate quantitative urban models in poorer countries (Tsivanidis and Gechter 2018, Tsivanidis 2019).

Quantitative work has so far focused on rich countries due to data availability, but new sources of large-scale data will allow researchers to increasingly apply this class of models to cities of the developing world. Machine vision techniques have opened the possibility of using daytime satellite imagery to measure the size and density of slums (Gechter and Tsivanidis 2019) and urban areas (Vogel et al. 2019). Google Streetview can be used to predict income by measuring the attractiveness of neighbourhoods (Naik et al. 2015). Cell-phone metadata, Google Maps, and credit card data can be used to measure commute flows, congestion, and consumption across space (Blondel, Decuyper, and Krings 2015, Kreindler and Miyauchi 2019, Akbar et al. 2019, Donaldson et al. 2019).

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Of course, these datasets have drawbacks, often related to sample selection. The population who use cell phones and credit cards may be very different than the population who do not. This threatens to bias analyses and runs the risk of steering urban work toward higher-income settings where digital traces are available. While large-scale administrative datasets are promising (albeit with their own concerns of misreporting), there remains an important value in primary collection efforts to uncover high-quality, representative data to complement and validate those from alternative sources.

Structural work has limitations. These models make strong functional form assumptions for tractability that are typically log-linear. Parameter estimates will therefore reflect first-order approximations around an observed equilibrium but may no longer be invariant to large policy changes considered in counterfactuals. Slight deviations from these functional forms may deliver very different policy implications (Glaeser and Gottlieb 2008). Static models used to evaluate the impact of transit infrastructure changes, for example, may ignore the adjustment costs involved when individuals need to relocate from one neighbourhood to another, or the larger impacts this churn may have on their children. The results of structural models should therefore be considered an additional input for informing policy by quantifying the effects of alternative options along clearly stated dimensions, rather than a sole guide to policy decisions.

BOX 3 Next steps and research priorities

Two classes of research questions are particularly well-suited to the structural approach.

- **Measuring spillovers, linkages and general equilibrium effects**
  - For example, investments in infrastructure, housing stock or public goods like education induce a host of sorting responses by households and firms as well as feedback effects through prices.

- **Understanding the aggregate impacts of recent policies or potential impacts of future reforms.**
  - How large are the aggregate gains and tax revenues from infrastructure investments?
  - Given the unplanned expansion of cities, is the current spatial configuration of the city (such as the location of ports, markets and schools in central areas) efficient given the current urban organisation and the opportunity cost of allocating that land to other purposes? What zoning or land use planning policies could improve the current and future spatial configuration of cities, given that so many of the world's cities have yet to be built?

5 Conclusion

The population of the world's poorest cities is expanding massively and will continue to do so over the coming years. The existing empirical evidence suggests that agglomeration economies may be particularly large in the developing world, implying that urbanisation can provide a pathway from poverty to prosperity. Large cities in Africa and South Asia have long been conduits for economic exchange between poor countries and rich countries, enabling trade and the spread of knowledge, crucial ingredients for long-term growth.

Yet, even when rural people migrate to cities to take advantage of this greater level of economic opportunity, many of them remain poor, often relegated to living in slums for decades (Marx, Stoker, and Suri 2013). Slum dwellers face risks from criminal gangs and contagious disease. Even beyond these dangers, many urbanites struggle with long commutes and relatively high housing costs. More effective government policy may be able to alleviate these downsides of urbanisation, and more research is critical to learning how to make government more effective. A hope is that the process of urbanisation itself will lead to improvements in governmental accountability and competence.

We conclude this paper with one clear message: The cities of the developing world are the stage on which the lives of billions of people will be played out. These places are vitally important to the future of the world and deserve far more research. Two thirds of Africa's cities are yet to be built; if these cities can be made safer and more efficient, then the prospects for Africa's economic growth could be enormous. It is only by designing smart, data-driven policy for cities that developing countries can make significant progress toward economic and social well-being in the years to come.

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