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Cities in the Developing World

Gharad Bryan,[1] Edward Glaeser,[2,3] and Nick Tsivanidis[4]

[1]Department of Economics, London School of Economics, London WC2A 2AE, United Kingdom

[2]Department of Economics, Harvard University, Cambridge, Massachusetts 02138, USA; email: eglaeser@harvard.edu

[3]National Bureau of Economic Research, Cambridge, Massachusetts 02138, USA

[4]Haas School of Business and Department of Economics, University of California, Berkeley, California 94720, USA

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Abstract

The fast and often chaotic urbanization of the developing world generates both economic opportunity and challenges, like contagious disease and congestion, because proximity increases both positive and negative externalities. In this article, we review the expanding body of economic research on developing-world cities. One strand of this literature emphasizes the economic benefits of urban connection, typically finding that agglomeration benefits are at least as high in poor countries as they are in rich countries. Yet there remains an ongoing debate about whether slums provide a path to prosperity or an economic dead end. A second strand of research analyzes the negative externalities associated with urban density, and the challenges of building and maintaining infrastructure to moderate those harms. Researchers are just beginning to understand the links between institutions (such as public–private partnerships), incentives (such as congestion pricing), and the effectiveness of infrastructure spending in addressing urban problems. A third line of research addresses the spatial structure of cities directly with formal, structural models. These structural models seem particularly valuable when analyzing land-use and transportation systems in the far more fluid cities of the developing world.

1. INTRODUCTION

The United Nations forecasts that the world's urban population will grow from 4.2 billion to 6.7 billion between 2018 and 2050, with "close to 90% of this increase taking place in Asia and Africa" (UN Dep. Econ. Soc. Aff. 2019). The urbanization of our planet's poorer countries is one of the most important phenomena of the twenty-first century, yet our intellectual tools for dealing with the great challenges of developing-world cities remain underdeveloped. In this review, we survey the economics of developing-world cities, and try to make the case that development economists should spend more of their time thinking about and working in cities and that urban economists should spend more of their time thinking about and working in developing countries.

The study of developing-world cities provides a window into topics at the heart of economics. Cities are the home of market failures, both positive and negative. They present both the angels and the demons of human behavior. 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 hypercharged in the extreme densities of poorer cities.

In this review, we divide the field of urban development economics into three broad categories: agglomeration economies, density's downsides, and spatial models of transportation and housing. These three categories necessarily leave out key areas of urban research. We do not address the important problems of raising taxes to pay for public goods or job creation programs that are run predominantly in urban areas. The decision to exclude these problems reflects not that we think they are unimportant, but rather the need to limit coverage if we are to give the existing research its due, and the belief these areas are concerns that spread far beyond our focus on cities.

The central question of agglomeration economics is whether cities actually increase productivity, or whether the observed relationship between density and earnings represents the selection of more-skilled people into cities or omitted variables that both attract people and make them wealthier. The growing urban development literature appears to confirm the positive effects of urbanization on earnings that have been found in the wealthy world (Chauvin et al. 2017). Randomized controlled trials that induce migrants to come to cities have provided some of the most compelling evidence supporting the hypothesis that density increases earnings (Bryan et al. 2014).

Yet there is also evidence suggesting that slums contain millions of people who have been in cities for decades and remain poor (Marx et al. 2013). Resolving the question of whether developing-world slums are dead ends or pathways to prosperity remains central to research on developing-world agglomeration. There is also a need for research that uncovers means of improving the productivity of developing-world cities or discovers 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, traffic congestion, and the perpetration of crime. Western-world cities were known for epidemics until the early twentieth century, and for high murder rates through the 1990s. Economists are increasingly analyzing the roles that incentives, infrastructure, and institutions can play in moderating urban crime, traffic congestion, and disease in developing-world cities. High levels of homicide in many developing-world cities have been linked to extremely low probabilities of arrest and punishment. A large and growing literature is examining how institutions such as public–private partnerships (PPPs) affect road maintenance and demand management. A 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 et al. 2014).

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 4 of this review focuses on the growing subfield of developing structural spatial models that can use empirically estimated parameters to forecast the citywide impact of policy changes.

While many development economists have been appropriately excited about the scientific precision generated by randomized controlled trials (e.g., Banerjee & Duflo 2011), cities are complex systems, and many urban problems cannot be addressed only with research interventions that can be randomized at the individual or cluster level. The structural approach to urban economics typically embeds a series of optimization problems, including the locations and employment decisions of people and firms as well as developers' decisions about construction. These models' parameters are then estimated directly from the data or by using other sources of information, including randomized controlled 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-world cities.

The future of the developing world is urban, which generates both challenges and opportunities. The research that we discuss next represents the beginnings of a robust literature on developing-world 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 IN THE DEVELOPING WORLD

Figure 1 documents two remarkable facts. **Figure 1*a*** plots, at the country level, the correlation between nonagricultural labor share and the log of output per worker in agriculture and nonagriculture. Not only are developing countries relatively worse at agriculture, but also most of their workers labor on farms (Vollrath 2018). **Figure 1*b*** shows the correlation between GDP 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 who work in rural areas in agriculture to access the productivity levels of its nonagricultural, more urban workers, increasing their productivity above that of Great Britain? In this section, we try to understand whether these possibilities are real or whether higher urban productivity might simply reflect the selection of more-skilled people or better firms into cities.[1]

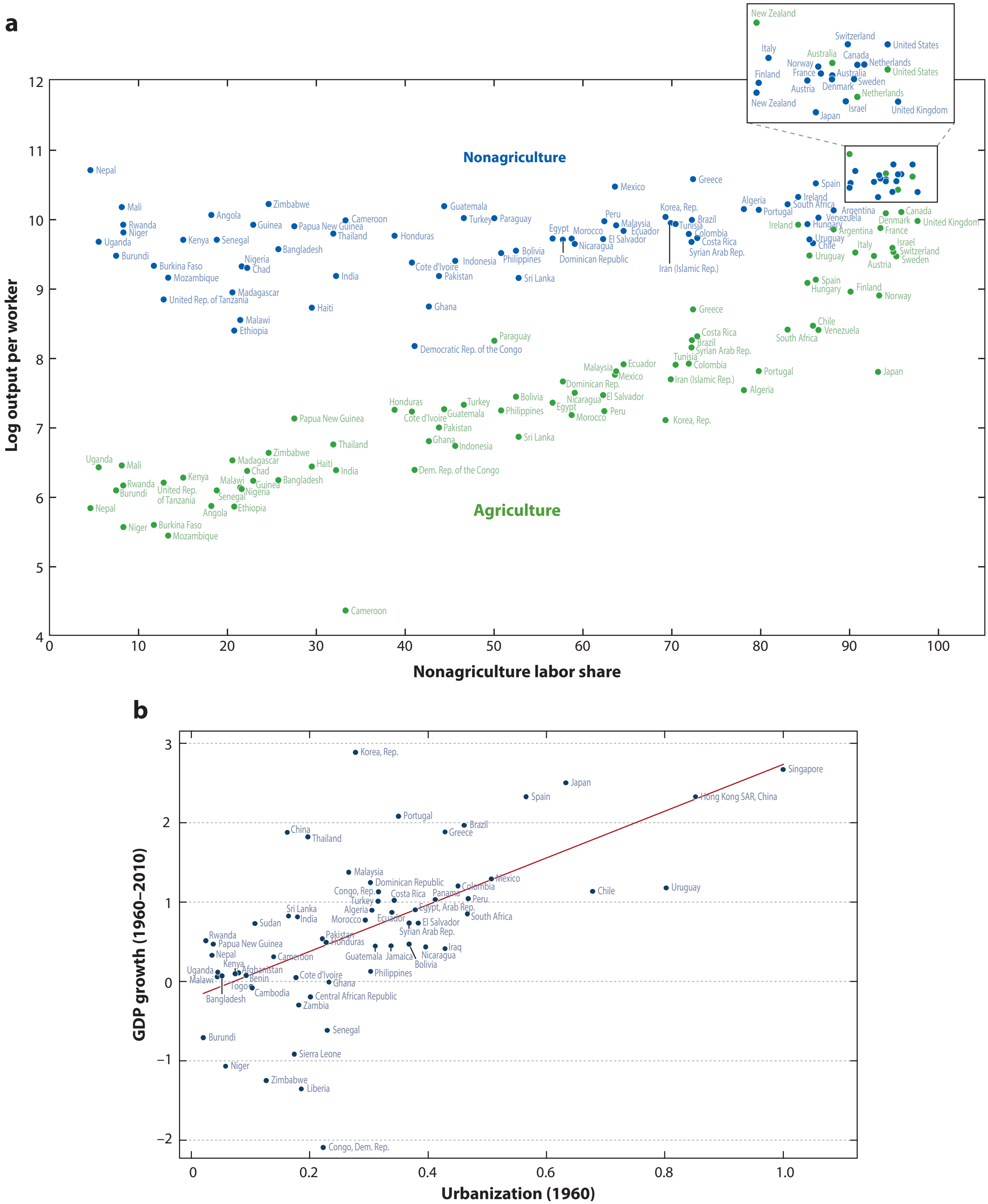
2.1. Is There Economic Opportunity in Developing-World Cities?

Figure 1*a* invites the hope that if more people lived in cities in the developing world, then productivity and wages would be higher. In this section we review three classes of theories, all of which are consistent with the facts but have different implications for whether these opportunities are real or illusory.

The first model is that more-able people simply select to live in cities, which would occur if people who have an absolute ability advantage also enjoy a comparative advantage at producing in cities.[2] The second model is that the urban wage premium is real but that the amenity losses

[1] Gollin et al. (2014) investigate and reject the hypothesis that the urban productivity advantages suggested by **Figure 1*a*** are purely measurement error.

[2] Lagakos & 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 & Morten (2019) use a structural model which assumes that absolute and comparative advantage are uncorrelated along with Indonesian data to estimate the speed with which average wages drop with movement across space.



(Caption appears on following page)

Figure 1 (*Figure appears on preceding page*)

(*a*) Cross-country productivity gaps: The poorest countries in the world are predominantly rural and agricultural, implying that these countries lie toward the left of the panel. (*b*) Urbanization and growth: correlation between GDP in 1960 and growth between 1960 and 2010 among a sample of poor countries in 1960.

or high housing prices ensure that there is no welfare benefit from increasing urbanization.[3] This model still suggests an urban productivity premium; why else would private sector employers be willing to pay higher wages in cities, but not a welfare premium for rural-to-urban migrants?

The 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 (e.g., Krugman 1991). Dynamic externalities might occur if cities spread ideas and speed up the right of technological progress (e.g., Lucas 1988).

If the urban wage premium simply 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 the urban wage premium represents place-specific assets, then moving to that area will make people more productive, but it will not have any positive effect on overall regional welfare. If the urban wage premium represents local externalities, then relocating to the area may generate benefits for existing residents or for the country as a whole. The externalities typically represent market failures.

2.2. Empirical Estimates of Agglomeration Economies

Urban workers typically earn more, but does that represent a true effect of place or merely selection of more-able people into cities? The simplest and most standard 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 United States, such estimates typically yield a coefficient of 0.05 when the logarithm of wages is regressed on the logarithm of population (Ciccone & Hall 1996, Glaeser & Gottlieb 2008, Ahlfeldt & Pietrostefani 2019), meaning that wages increase by approximately 5% when total population or density doubles.[4] Chauvin et al. (2017) perform three comparable exercises for Brazil, China, and India and find much larger density for India and China.

Young (2013) uses Demographic and Health Surveys data to construct consumption equivalents of education so as to document 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 approximately 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 et al. (2017) document large consumption differences across density levels in 20 African countries.

To address the problem of selection on unobservable attributes, researchers have increasingly relied on migration, natural experiments, and even randomized controlled trials to estimate the

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 finding implies that, despite large spatial wage differences, there are only moderate gains to moving people across space.

[3] In the classic Harris & Todaro (1970) model, urban unemployment is higher than rural unemployment, but urban workers earn higher wages if they are lucky enough to be employed.

[4] Combes et al. (2010) are particularly effective at estimating agglomeration effects in France, using a series of tools that control for firm characteristics and soil characteristics as an exogenous source of variation for density.

treatment effect of place on earnings. Glaeser & Maré's (2001) paper began the literature that estimates the urban wage premium by looking at the wage gains experienced by rural-to-urban migrants. The key identifying assumption is that unmeasured worker ability does not change over time, or at least that changes in unobserved worker ability are not correlated with moving across space. Glaeser & Maré (2001) find that workers who come to cities experience faster wage growth in the years after they move to large urban areas, which is compatible with the view that cities enable human capital accumulation. De la Roca & Puga (2017) use administrative data to follow the wage patterns of almost all Spanish workers 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]

In the developing world, 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 approximately 2.8% more per hour and that urban Kenyans earn approximately 26% more.

Limited by the lack of panel data sets, other researchers have surveyed rural-to-urban migrants who moved first to impoverished neighborhoods. 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 grandparents' generation were illiterate and 94% worked in manual jobs, only 6% of their children in 2001 were illiterate and 63% held manual jobs. Sixty-one percent of the grandchildren's primary jobs were nonmanual. Alesina et al. (2019) similarly find that intergenerational upward mobility is related to urbanization in Africa.

By contrast, Marx et al. (2013) examine a cross section of migrants in a number of present-day slums and focus on whether the migrants who came earlier earn more now. They find no relationship between time in the city and earnings in Kenya's Kibera and a negative relationship between tenure in the city and earnings in Bangladesh's Tongi. If successful people simply leave the slum, then 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 quite poor for decades afterward.

In another approach, researchers seek cases in which people, typically immigrants, have been literally allocated by government programs across space. Edin et al. (2004) provide a classic example in which the Swedish government directed new immigrants to particular places across Sweden. However, because administrators are rarely willing to completely ignore the idiosyncratic needs of individuals, unobserved immigrant characteristics may well have influenced the choice of location and biased the results.[6]

Sarvimäki et al. (2019) study Finnish farmers who were forced to move after World War II and given similar farms in different parts of the country. Compared with a comparison group that was geographically nearby, these forced migrants were more likely to be urban in the long run, and had substantially higher earnings. Nakamura et al. (2016) study individuals from a wealthy fishing village whose homes were destroyed by a volcano. Using a spatial discontinuity design, their study shows that, 30 years later, the displaced workers were more likely to be urban, had higher education, and had much higher earnings.

In a third approach, researchers help design social programs that provide incentives for people to move across locations. The Moving to Opportunity experiment required a randomized share of recipients of housing vouchers to move to lower-poverty neighborhoods in order to receive the vouchers. Early estimates of the program found few effects on the children who moved out

[5] Chetty & Hendren (2018) use income tax data in the United States to study families who move across areas, establishing the impact of place on economic opportunity.

[6] The Gautreaux Project in the United States is an earlier experiment in which apparent administrative randomness was used to estimate the effect of place.

of poverty (Katz et al. 2001), but more recent research has found sizable 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 bus fare) for rural Bangladeshi workers to move (at least temporarily) to a nearby city. A 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 during the yearly lean season, and had a sizable impact on average household expenditure, which increased by approximately 33%. The study also showed that, up to 3 years after the small incentive was paid, the treatment households were approximately 10 percentage points more likely to have a member of their household migrate for work during the lean season. This study suggests that there are real utility gains from moving to the city because workers continued to come to cities even after the incentive was no longer available, perhaps suggesting that initial migration was limited by credit constraints.[7] Small-scale experiments, however, cannot estimate the general equilibrium effects of large-scale migration to the city, and may also lack external validity.

While these studies seem able to rule out the possibility that selection explains all of the agglomeration earnings effect, they use data on migrants themselves and thus cannot look at whether urban location generates positive or negative externalities. Another type of experiment shocks the place, not the person, and then looks at the impact on people who were in the place originally. Greenstone et al. (2010) measured the differing fates of medium-density communities that did and did not receive the investment generated by a "million-dollar plant." Their results suggest a 12% increase in total factor productivity for incumbent plants, indicative of strong positive spillovers that are not internalized in plant opening decisions. This study 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 investments 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 & Gottlieb (2009) emphasize, policy requires comparing the benefits that the winning place gains from having a new plant with the losses that the losing place faces. Relocation policies require us to know the full functional form of agglomeration economies.

Imbert et al. (2018) use variation in international agricultural prices to generate plausibly exogenous variation in earnings across rural areas in China and resulting 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 labor-intensive production. These results seem to suggest a standard downward-sloping demand curve, rather than positive externalities from the in-migration of low-skilled 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, so-called quantities approach looks at the colocation of industries and tests whether firms locate near other firms that buy and sell their goods, near other firms that use that same type of workers, or near other firms that exchange ideas (Ellison et al. 2010). In the United States, the coagglomeration estimate indicates the importance of transportation costs for goods and people, at least in manufacturing industries.

The literature linking urbanization with dynamic externalities and national growth is smaller and necessarily less compelling. Many classic theories could also rationalize a causal effect of

[7]This repeat migration may also represent the removal of a credit constraint.

urbanization on growth. If fixed-cost technologies required large market sizes (e.g., Rosenstein-Rodan 1943, Murphy et al. 1989), then urbanization could provide the "big push" toward industrialization. Cities might enable poorer countries to trade with rich countries. The apparent ease of shopping in the famous electronics markets of Dongguan and Shenzhen, China, for all the parts required to create a state-of-the-art smartphone illustrates this possibility nicely. A final hypothesis is that cities enable political change, and dictatorships certainly face more revolutions in more urbanized countries (Wallace 2014).

The scale of these theories makes them hard to test. Rauch's (1993) pioneering research estimating human capital spillovers in cities was directly motivated by Lucas (1988). Henderson (2000), for example, links country-level growth and the level of urban primacy and finds a non-monotonic relationship. The endogeneity of urbanization 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 components of growth, such as new patent creation and patent citation (e.g., Jaffe et al. 1993), foreign direct investment (Guimarães et al. 2000), and education (Muralidharan & Sundararaman 2015). Subnational data make identification more plausible and make it easier to see the mechanisms, if any, through which cities are enabling national transitions from poverty to prosperity.

2.3. Can Developing-World Cities Become More Productive?

The simple cross-national growth correlation shown in **Figure 1*b*** cautions that restricting urbanization may have adverse consequences. Yet for most developing-world 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.

Transportation infrastructure is an obvious place to look for productivity gains. Firms operate in particular locations and need a supply of physical space as well as 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 (e.g., limited nonrivalry) and usually requires large-scale coordination. As the relationship among transportation, building supply, and firm productivity cannot be studied in simple partial equilibrium models, we return to this topic in Section 4, below.

Productivity may also benefit from improvement in the legal infrastructure that governs firm behavior. The dense urban environment—and the negative externalities it gives rise to—intensifies the need for government rules that create both the rights and the obligations of firms. These rules, if too onerous, can reduce productivity (Djankov et al. 2003), but some regulations 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 & 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 & Udry 2008), as well as red tape that appears inefficient. The cause of corruption may function as a second-best means to fund public goods in the presence of tight government budgets (Banerjee 1997, Banerjee et al. 2013). More generally, enforcing rights or obligations requires a solution to the problem of guarding the guardians (Hurwicz 2008, Björkman & Svensson 2009).

Research on institutional improvements requires viable actual or natural experiments, and a small but growing literature is attempting to understand solutions to these problems. Khan et al. (2016) work with government in Punjab, Pakistan, to randomize an incentive pay scheme that rewards property tax collectors for the revenue they raise. They find a large increase in government revenues at 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 was passed through to consumers in the form of lower prices. Work by Banerjee et al. (2014) with police in Rajasthan, India, provides a more nuanced view. The negative results from several seemingly sensible strategies serve to remind us of the difficulty of reforming complicated institutions.

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 United States (Glaeser et al. 2015). Yet it is unclear whether poor countries need more local entrepreneurship or more foreign direct investment. If developing-world cities today will be built by people like Soichiro Honda, who began with a small repair shop, then improving the permitting and regulatory process for small businesses will be crucial. If foreign inputs are critical, then there should be an emphasis on making the urban environment more attractive for outside talent.

2.4. How Can the Economic Benefits of Cities Be More Widely Shared?

Plato's *Republic* famously noted that "any city, however small, is in fact divided into two, one the city of the poor, the other of the rich; these are at war with one another" (Plato 1920). 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.

The Opportunity Atlas developed by Chetty et al. (2018) documents the low levels of upward mobility for poorer children growing up in America's cities. While urban America may be productive, it does not seem to be providing much opportunity for many of its poorer residents. In China, Combes et al. (2019) find that better-educated rural-to-urban migrants seem to experience much larger wage gains than less educated workers who come to cities. This finding is echoed in the United States by Autor (2019).

As these studies suggest, individual education is strongly linked with upward mobility in cities (Psacharopoulos & 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 by population growth (Glaeser et al. 1995). Urban density and education appear to be complements (Glaeser & Resseger 2010), suggesting that better education may enable poorer children to take advantage of urban opportunities.

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 movement of pathogens and congestion of city roads. In the developing world, urbanization has proceeded far more quickly than institutional development. Consequently, massive developing-world cities must address 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.

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

While these papers focus on the United States, there is also a literature (surveyed by Currie & Vogl 2013) that looks at developing-world cities as well. Arceo-Gomez et al. (2016) find that bad air quality has more serious effects in Mexico City than in the United States. Cesur et al. (2017, 2018) show that switching from coal to natural gas led to air quality improvements in Turkey, which in turn improved children's health outcomes.[8] A smaller literature links air pollution to economic outcomes, such as labor supply, and also finds negative effects of air pollution (Hanna & Oliva 2015, Fan & Grainger 2019).[9] At the city level, air pollution can harm the local economy by repelling skilled high-productivity individuals (Kahn 1999).

Among economists, Cutler & Miller (2005) and Troesken (2008) have been particularly important in establishing the historic link between water infrastructure and public health. More recently, there has been a dramatic increase in research by economists on water in the developing world. Gamper-Rabindran et al. (2010) found that piped water decreased infant mortality in Brazil. Devoto et al. (2012) found that piped water in urban Morocco increased happiness but not health, presumably because families already had access to high-quality nonpiped water. Buchmann et al. (2019) found 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 fecal contamination.[10]

As traffic congestion is defined by excessive time spent in travel relative to driving on an uncrowded road, economists have valued this lost time by multiplying minutes lost by after-tax wage (Alonso 1964). More sophisticated papers have used survey instruments and found that the cost of time spent in traffic is lower than lost wages (Calfee & Winston 1998).[11] Investment in transportation infrastructure may lead to urban growth (Duranton & Turner 2012) or suburbanization (Baum-Snow 2007). While reduced-form methods can estimate these impacts, interpreting such estimates requires the structural models that we discuss in Section 4, below.

Another kind of congestion externality can occur when people build housing in close proximity. Formal housing comes bundled with a series of obligations that aim to overcome the externalities of dense living. Space is provided for transport access, sanitation, and water. Building regulations are meant to ensure that low-quality construction does not threaten neighbors' 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 costs and benefits. We discuss the issues and evidence more fully below, which reflects our belief that general equilibrium impacts of projects in slum areas make quantitative models important to complement and interpret reduced-form results.

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[8]Quah & Boon (2003) place a dollar value on health outcomes with tools such as multiplying mortality estimates by the value of a statistical life.

[9]Heath et al. (2018) find that high-frequency health shocks significantly reduce female labor supply.

[10]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 wastes (Giusti 2009).

[11]While US studies typically assume that traffic speeds in the absence of congestion would have been the speed limit, the poor quality of roads in the developing world can reduce travel speeds considerably, even in the middle of the night (Kreindler 2018).

A small reduced-form literature also estimates the impacts of upgraded housing on individual well-being. For example, Galiani et al. (2017, 2018) report on a randomized controlled trial that provided improved homes to residents in urban areas of El Salvador, Mexico, and Uruguay. They argue that improving the quality of slum housing increases short-run welfare but that hedonic adaptation means that there are no lasting self-reported welfare effects.[12] McIntosh et al. (2018), also in Mexico, evaluate the impact of a broad infrastructure improvement program on home prices and amenities, showing a large increase in land values reported by professional surveyors. This research is obviously important but does not allow for a quantitative evaluation of the extent of externalities created by housing density and public good provision, which are key to inform public policy.

Most urban leaders accept on faith that reducing crime, and particularly violent crime, to wealthy-country norms is desirable. Governments have, after all, 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 of crime of different policies, such as capital punishment (Ehrlich 1975), more policing (Levitt 1997), and lengthier prison sentences (Kessler & Levitt 1999).

The standard approach is to estimate the loss to the victims of crimes that do occur (Chalfin 2015), such that murders cost millions and robberies cost hundreds. These costs may overestimate the true social costs of crime because they omit the benefits of crime to the criminal, but it seems far more likely that they underestimate the costs of crime arising from fear and avoidance behavior.[13] Ludwig & Cook (2001) use a contingent valuation survey to estimate the 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 social losses due to fear of crime (Thaler & Rosen 1976). Most estimates find that urban crime, unsurprisingly, generates significant costs, including spurring out-migration (Cullen & Levitt 1999) and reducing tourism (Biagi & Detotto 2014).

3.2. Incentives and Behavioral Change

Much urban infrastructure, such as subways and aqueducts, can be interpreted as adding effective space to a city where space is scarce. Yet adding infrastructure may not be as cost effective as reducing the behavior, especially when added infrastructure induces more socially harmful behavior. Duranton & Turner (2011) empirically document the so-called fundamental law of highway traffic, which is that the vehicular miles traveled increase roughly one for one with highway miles built. If this law holds, then building more roads does little to solve traffic problems, because new drivers will congest the new roads. Consequently, problems associated with density often need some combination of infrastructure and incentives.

The crime and economics literature has long asked whether incentives changes can reduce harmful behavior (e.g., Ehrlich 1975, Levitt 1998, Nagin 2013), but much of this US-based literature may not translate easily to developing-world cities. Whereas more than 50% of murders typically lead to an indictment in the United States, fewer than 15% of murders in Brazil are solved (Misse & Vargas 2007). Corruption, malfeasance, and gang power may be worse in developing-world cities.

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[12] Cattaneo et al. (2009) present results from a natural experiment evaluating a related program that replaces dirt floors with cement floors. They show general increases in several health and education outcomes.

[13] 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 somewhat more problematic, since 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.

The pollution and congestion literatures focus more on the impact of regulations than on flexible incentives. Davis (2008) documents the impact on air quality in Mexico City of the Hoy No Circula program, which limited cars' ability to drive on certain days. Similarly, Kreindler (2016) shows that license plate–based bans on driving effectively reduced congestion in Delhi.

The introduction of congestion pricing in London, Stockholm, Oslo, and Singapore provides case studies on the impact of pricing roads. Typically, the most that can be done with these interventions is to compare before-and-after congestion pricing, and it appears that London's roads became more passable after it imposed its congestion charge (Leape 2006). Yet it is not obvious that the results for London will generalize to Jakarta (e.g., Hanna et al. 2017).

Kreindler (2018) estimates a model of demand for driving trips in Bangalore by using an experimental structure in which drivers were experimentally offered incentives to avoid peak times on crowded roads. Because the incentives were offered privately, the author was able to randomize. Strikingly, he found that the behavioral adjustment was modest and that Indian roads would not flow very quickly even if congestion was reduced substantially. This type of experimental model has promise, yet any small experiment will shortchange the general equilibrium effects that are ubiquitous in cities.

In congestion, the key behavior is driving, which can reduce the benefits of new infrastructure. In public health interventions, the usual problem is take-up, in which people choose not to pay connection fees that cover the "last mile." Ashraf et al. (2016) note that, both historically in New York City and today in African cities, poorer citizens are often unwilling to pay the marginal cost for connections to cleaner water sources. An empirical question is whether these citizens will connect if given subsidies, or whether penalties imposed on people who do not connect will be more effective.

3.3. Estimating the Social Benefits of Infrastructure

Randomized controlled trial methods are much harder to implement for infrastructure than for incentives, because infrastructure affects an 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 & Goldin (2019) did for sewerage in greater Boston or Duranton & Turner (2011) did for roads within the United States. Yet these estimates may tell us little about any particular new project in Delhi or Nairobi.

The primary tool that economists have brought to infrastructure is cost–benefit analysis, which attempts to catalog the gains and losses from building new roads, tunnels, and sewerage systems. Typically, this research brings together the knowledge of economists and engineers (e.g., Meyer et al. 1965). A central result of 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 focused largely on the benefits gained by users directly. Infrastructure boosters then forecast high projected ridership levels, which economists disputed (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 costs 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 modeling that we discuss in Section 4.

New infrastructure projects are often given precedence over maintenance, which is especially problematic if there are particularly high returns on maintaining older roads and bridges (Gramlich 1994). World Bank statistics claim that Lusaka, Zambia, has almost complete water connections, but some areas of the city seem to lack viable connections much of the time (Ashraf et al. 2017). The quality of the management that maintains infrastructure will depend on institutions and incentives. Ashraf et al. (2017) show that the Lusaka water company is much quicker to respond to supply problems for customers who pay by the liter than for customers who pay by the month. We turn now to the institutional side of urban management.

3.4. Institutional Reform and Public Capacity

Public institutional capacity is a precondition for any meaningful reform, but it is often difficult to use modern empirical methods, such as randomized controlled trials, to understand paths toward better institutions. Some studies measure whether changes in incentives can alter the behavior of public officials. Muralidharan & Sundararaman (2011) show that Indian teachers come to work more often when pay is linked to performance. Ferraz & Finan (2011) show that federal auditing of mayors in Brazil reduces corruption. Yet the impact of any incentive can easily be distorted in a corrupt institution, so proving that an innovation can work is not the same as showing that it will actually change institutional performance.

Most research on the institutions that matter for developing-world cities is descriptive or involves simple comparison. For example, Engel et al. (2014) present a magisterial overview of PPPs throughout the world. Their research typically reviews the performance of PPPs and sometimes compares that performance with governmental alternatives. Singh (2018) presents a similar, persuasive study comparing the roughness of Indian roads that are maintained by public versus private entities, showing that private roads are far smoother than their public counterparts.

More generally, private provision of public services has a far more mixed track record. As Engel et al. (2014) show, private companies often manage to renegotiate with public entities and radically increase their compensation. Theoretically, private entities should have better incentives to maintain quality, because they can reap returns only if customers use them, but in some cases, even quality is poor. Certainly, private entities that are paid with public money have a strong incentive to subvert the system and extract more public resources.

While much institutional research focuses on the executive branch, the judiciary is also critical, as every market failure is ultimately a failure to maintain property rights (Coase 1960). If courts fail to protect land rights, then people lack the incentives 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 right to use, the right to develop, the right to sell, the right to rent, and the right to mortgage. In many developing-world 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 particular 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 disentangles the separate impacts of different land rights on urban land markets.

3.5. 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 wealth constant, urban density is associated with lower, not higher, carbon emissions (Glaeser & Kahn 2010). 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.

Kahn (2010) argues that poorer countries will be able to adapt to climate change by moving population centers inland and toward 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.

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 emphasizes that cities are better regarded as massed humanity, the physical city is still profoundly important. Land-use planning plays a central role for many city governments. Yet, typically, economists have had little to say about efficient land-use rules or the costs of bad planning. The growing field of formal spatial modeling offers the possibility of delivering pragmatic tools to policy makers that can help them plan better and more fully incorporate the far-ranging impacts of any large-scale change to the built environment.

The randomized controlled trial approach to development economics is ideal when considering targeted interventions, which are akin to medical drug trials. Large-scale urban investments are more akin to macroeconomic policies, such as changes to monetary or fiscal policy, that 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 rely largely on simulations to understand how new investments or policies will change life within a city.

4.1. 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 simplification belies the immensely rich spatial differences that make cities so complex and interesting. Economic activity, in fact, occurs in most locations, which vary in air quality, crime rates, 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 confront this richness head-on (see Redding & Rossi-Hansberg 2017 for a comprehensive review). These frameworks allow researchers to quantify the aggregate implications of economic policies, assess how their impacts reverberate throughout agents' behavioral responses and linkages across space, and simulate 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 composed of many discrete locations (such as census tracts or blocks). They differ in attributes such as the time it takes to commute to any 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 its amenities, productivity, or the cost 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 floorspace prices) and work in (e.g., the wage paid by firms), as well as on the cost of commuting between each pair of locations. Depending on the model, residents can differ in their attributes (e.g., education or location of prior residence; Bryan & Morten 2019, Tsivanidis 2019), may make additional choices such as where to shop or which mode of transit to commute with (Allen et al. 2015), and often have idiosyncratic preferences for each live–work pair (generating upward-sloping resident and labor–supply curves as functions of location attributes; Ahlfeldt et al. 2015).

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

Housing supply and usable production space are constructed by developers by 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 optimization 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 labor and floorspace determines wages and house prices, respectively. These models also allow for externalities: Levels of productivity, amenities, or travel time across (pairs of) locations are often endogenous (Ahlfeldt et al. 2015, Fajgelbaum & 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, the deep parameters assumed to be invariant to the counterfactual policy must be estimated. These typically consist of elasticities that govern, for example, the sensitivity of commute choices to commute costs or of housing supply to housing prices. Second, the model's unobserved location characteristics (such as amenities and productivities) 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 (e.g., new transport infrastructure or zoning regulations) on the full urban equilibrium.

4.2. What's Different About the Developing World?

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

BRT systems have quickly become a popular alternative to subways in developing-world cities. They provide similar reductions in commute times at a fraction of the construction cost. New public transit systems such as BRT may also have profound distributional implications, since the poor rely on public transit, which 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 public transit system, in Bogotá, Tsivanidis (2019) develops a model that allows for both low- and high-skilled workers with nonhomothetic preferences over different modes of transit. By accounting for the impacts of transit on the residence, employment, and mode choices of heterogeneous workers, Tsivanidis uses the model to trace the system's effect on aggregate performance not only through reducing time lost in transit but also by improving the allocation between workers and places of employment and residence. He finds that the 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 maximize returns on investments. Tsivanidis (2019) shows that the feeder bus system that reduces the last-mile problem of getting residents from poor, dense neighborhoods at the city's edge to the BRT system improves welfare more than any single trunk line. He also runs a counterfactual exercise to show that the welfare gains would have been 18% larger had the government implemented a land-value capture scheme, in which zoning densities are increased near stations and building permits are auctioned off to developers. Revenues from permit sales would have covered around 10–40% of construction costs, depending on the extent of in-migration from the rest of Colombia (see Hong et al. 2015 for a comprehensive review of land-value capture instruments).

Future research needs to incorporate more features of transit in developing-world cities. First, we require evidence that quantifies the wider costs of congestion through distorting the behavior of firms and residents. 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 address the fact that the vast majority of public transit is informal. Tools from industrial organization combined with recent research on routing and congestion (Allen & Arkolakis 2014, Fajgelbaum & Schaal 2019) should be used to understand how this industry responds to mass transit interventions, how policy makers can ensure that it complements rather than competes with it, and what other forms of regulation could improve its performance. Third, new technologies such as ride sharing are changing the nature of mobility in cities. Research is needed to understand how developing-world-specific variants, such as motorbike hailing or Uber buses, will affect mobility, demand for cars, and existing public transit services.

Land markets in developing-world cities are characterized by a high degree of informality. To understand patterns of land use and density in these contexts, Henderson et al. (2016) develop a structural, dynamic monocentric city model that allows for formal and informal construction. They use the estimated model to infer the high costs of converting slums to formal use. Gechter & Tsivanidis (2018) develop a quantitative model that allows for both formal and informal housing. They use the framework to quantify the implications for both equity and efficiency of the redevelopment of Mumbai's 58 textile mills during the 2000s. These redevelopments increased the stock of formal housing in the city center but also displaced poor residents from nearby slums whose homes were converted following ensuing house-price appreciation.

Quantitative models are well placed to help inform policy makers about the consequences of zoning or land-use policies. Allen et al. (2015) develop a model that allows them to characterize optimal zoning across residential and commercial use around an observed equilibrium. Since agents do not account for externalities arising from colocation in space, in applying their framework to Chicago the authors find too little specialization of land use, with excess residence (employment) in the city center (outskirts). Bird & Venables (2019) apply a similar framework to evaluate the impact of tenure reform in Kampala, Uganda.

The prevalence of rent control, density restrictions, mixed-use zoning, and minimum floorspace requirements for formal housing sector construction in developing-world cities suggests a need for more research in this area. Governments will also spend vast sums on housing investments that reshape the structure of cities, from upgrading slums (Harari & Wong 2018) to constructing massive new housing developments at the urban periphery (Franklin 2019). Quantitative research 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? Tsivanidis (2019) shows that Bogotá's BRT system increased spatial segregation between low- and high-skilled workers, a feature that is replicated by the model due to the nonhomothetic preferences for residential amenities. Couture et al. (2019) develop a model with nonhomotheticities and find that sorting responses and endogenous amenities amplified the increase in wealth inequality in the United States since 1990 by 1.7% in terms of welfare inequality. More research to improve our understanding of the sorting of residents in developing-world cities and its implications for the distributional consequences of spatial policies is clearly needed.

Lastly, these models should address the coordination problems that are particularly salient in land markets of the developing world, where urban growth is typically haphazard, unorganized, and sprawling. Motivated by the ring of vacant land surrounding Detroit's central business district, Owens et al. (2020) 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 internalize agglomeration externalities in production. As more migrants arrive in a city, it may simply run out of plots large enough to allow for concentration of large manufacturing plants in accessible areas.[14] Empirical research by Brandily & Rauch (2018) and Michaels et al. (2019) highlights the dynamic consequences of land-use planning in African cities. The dynamic quantitative models of Desmet & Rossi-Hansberg (2015) and Caliendo et al. (2019) could be extended to understand these effects.

4.3. Providing Better Parameter Estimates to Make Structural Models More Useful

If quantitative models are to provide useful policy insights, their results have 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-world cities has immense potential to validate and estimate these models in the contexts of quasi-natural experiments or, occasionally, through randomized interventions.

The most basic form of model validation involves showing that key parametric relationships defined in the model capture the salient features of the data relevant for 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 behavior posited by the model should provide a tight fit to the data. Ahlfeldt et al. (2015) and Monte et al. (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.

[14]Gollin et al. (2016) discuss the service-led nature of urbanization in African cities, which has missed the higher rates of industrialization commensurate with urban growth in other continents.

Our trust in these models increases if they can replicate the response of cities to real-world policy changes. Heblich et al. (2018) estimate a quantitative model using 1 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 80-year period. They find that the model can replicate the gradual concentration of employment in the city center 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 summarized 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 system, he shows that this is precisely what occurs in the data. Future research should leverage increasingly available high-frequency data (discussed below) to incorporate preanalysis plans into structural work. If researchers can show that quantitative models accurately predict the effects of new infrastructure or other policy interventions that they have yet to see, then the model's insights will be more credible.

The next task is to credibly estimates of the model's parameters. Some randomized interventions exist. Akram et al. (2018) assess the equilibrium impacts of urban emigration on rural villages by randomly varying the fraction of residents offered transport subsidies. Brooks & Donovan (2019) randomly construct bridges across Nicaraguan villages to evaluate their effects through reducing the market access risk posed by seasonal flash floods. In a more urban context, Gonzalez-Navarro & Quintana-Domeque (2016) exploit randomization in road upgrading across Mexican neighborhoods to examine its impact on house prices.

The second approach is to estimate the parameters of a structural model by matching reduced-form coefficients from (quasi-)experimental settings. Fogli & Guerrieri (2019) examine the extent to which spatial sorting and neighborhood effects amplify wealth inequality. These authors estimate the parameter governing the strength of neighborhood effects by ensuring that, in their model simulations, a child experiencing a one-standard-deviation increase in neighborhood quality will have a 10%-higher income as an adult, precisely the estimate from Chetty & Hendren (2018).[15] Randomized housing interventions in developing-world 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 approach has long been popular in trade and economic geography (Donaldson & Hornbeck 2016, Donaldson 2018) but has become increasingly popular in urban economics. The seminal study by Ahlfeldt et al. (2015) exploits the construction and fall of the Berlin Wall as quasi-random variation in the density of economic activity, allowing them to estimate the strength of agglomeration spillovers 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 (Gechter & Tsivanidis 2018, Tsivanidis 2019).

To date, quantitative research has focused on rich countries due to data availability, but new sources of large-scale data will allow researchers to increasingly take this class of models to cities of the developing world. Machine vision techniques have opened up the possibility of using daytime satellite imagery to measure slums (Gechter & Tsivanidis 2018) and urban areas (Baragwanath et al. 2019). Google Street View can be used to predict income (Naik et al. 2015). Cell phone metadata, Google Maps, and credit card data can be used to measure commute flows,

[15] Faber & Gaubert (2019) estimate the spillover parameters of a quantitative spatial model in Mexico through an indirect inference approach, which ensures that the coefficient from an instrumental variables regression of employment on tourism attractiveness on data generated from their model matches that from the reduced-form analysis.

congestion, and consumption across space (Blondel et al. 2015, Akbar et al. 2018, Kreindler & Miyauchi 2019). Large-scale administrative data sets on residential locations, income tax, and firm-to-firm transactions have similar promise, although concerns about misreporting persist.

Structural work has limitations. These models make strong functional-form assumptions for tractability that are typically log linear. Parameter estimates 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 & Gottlieb 2008). Static models used to evaluate the impact of transit infrastructure, for example, may ignore adjustment costs involved in individuals relocating from one neighborhood to another or the larger impacts this churn may have on children. Therefore, the results of structural models should provide an additional input to inform policy by quantifying the effects of alternative options along clearly stated dimensions, rather than acting as the sole guide to policy decisions.

5. CONCLUSION

The population of the world's poorest cities is growing massively and will continue to expand. These migrants come for economic opportunity, but many of them remain poor and living in slums for decades (Marx et al. 2013). Many of these slum dwellers face risks from both criminal gangs and contagious disease. Many urbanites struggle with long commutes and relatively high housing costs. More effective government may be able to alleviate these downsides of urbanization, and more research is needed to learn how to make government more effective.

We conclude this review with one clear message. The cities of the developing world are the stage on which the lives of millions will be played out. They are incredibly important and deserving of more research.

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