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RAISING THE BAR FOR PRODUCTIVE CITIES IN LATIN AMERICA & THE CARIBBEAN[1]

BRAZIL

Cities are engines of productivity and economic growth. Today, they occupy 2 percent of total land, but are home to more than 50 percent of the global population[2] and are responsible for close to 70 percent of total GDP. By allowing the proximity of people and firms, they facilitate production, innovation and trade. For instance, the concentration of individuals can facilitate knowledge-sharing while firms located in a city benefit from accessing large local markets. Cities have historically accompanied the productive transformation of economies. They are, the main engine for agglomeration economies. But proximity also gives rise to negative externalities or congestion effects. Without additional investments in infrastructure or innovations in urban management and policy, the city can become congested, roads and other public infrastructure more crowded, and crime more prevalent. All cities are subject to the opposing forces of agglomeration and congestion, but their net outcomes can be influenced by policy choices, determining their productivity. Understanding how cities are fostering these agglomeration economies, and counteracting congestion effects, is thus key to inform policy-makers on the best policies to promote long term growth.

Brazil is South America's most populous country and largest economy. Many cities are among the most productive in the region. In fact, half of the top ten most *productive* cities of Latin America and the Caribbean (LAC) are in Brazil. As in other LAC countries productivity is on par with the world average. Yet, while in fact, cities in LAC are in general more productive than those in many other regions, they lag the world productivity "frontier", as measured by North American and Western European cities. Considerable scope thus exists to raise the bar for productive cities in the region, and the contribution that urban areas in the region make to national GDP per capita.

There is evidence of positive agglomeration economies in Brazilian cities, and yet the country has large regional inequalities: incomes for the average individual in the Midwest and Southeast regions (the richest regions) are almost twice as high as in the Northeast (the poorest region). Cities in Brazil could be even more productive if they tackled the negative externalities of density such as congestion, slums, crime and inequalities, and invested in institutions and infrastructure. Understanding the patterns of urbanization and the drivers of cities productivity in Brazil is key to push the country to its productivity frontier. Indeed, although LAC cities benefit from strong positive agglomeration effects, they may lack the "enabling environment" needed to fully leverage the wider benefits of agglomeration and mitigate congestion costs. For instance, urban infrastructure management and urban planning may not be adequate to curb the congestion of roads, basic urban services, and land and housing markets associated with the high urban density in most LAC countries. Included in this is inadequate coordination across local governments within fragmented metropolitan areas. Second, a lack of integration among cities within countries is associated with underinvestment in national transport networks, opening wide productivity gaps across cities and undermining the aggregate contribution of cities to national productivity.

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[1] This country-note summarizes the findings in the World Bank Flagship Report 2018 (Ferreyra and Roberts, eds., 2018) Raising the Bar for Productive Cities in Latin America and the Caribbean. It focuses on conclusions that can be derived for Brazil, and provides policy-implications. Detailed discussions and definitions can be found in the overall report. All references not specifically cited are in the main report.

[2] This is based on official national definitions of urban areas; whereas the first few chapters of the report focus on the use of alternative measures of urbanization (i.e. both the "cluster" method and the AI) that are consistently defined across countries. These measures tend to indicate a higher level of urbanization globally (around 70 percent based on the cluster method).

This country-note puts forward the specific features of urbanization in Brazil and the characteristics of 3 critical proximate determinants of its cities' productivity – skills, access, and form – summarizing the findings presented in the recently released flagship report *Raising the Bar for Productive Cities in Latin America and the Caribbean* (Ferreyra and Roberts, eds., 2018), and highlighting the country-specific dynamics. Policy implications are discussed in the last section.

BOX 1. KEY DEFINITIONS

The World Bank Flagship Report 2018 (Ferreyra and Roberts, eds., 2018), *Raising the Bar for Productive Cities in Latin America and the Caribbean*, looks at the drivers of productivity in LAC cities along three lines: form, skills, and access.

Form refers to the size and configuration of a city. A city's size (usually measured by population or density) influences the likelihood of interactions among individuals and firms. These interactions can stimulate a wide array of positive, productivity-enhancing, agglomeration effects. However, they can also generate negative congestion effects, such as increased crime. A city's configuration, meanwhile, encompasses several dimensions. The first dimension is whether a city is, in fact, a broader metropolitan area or multicity agglomeration (MCA). In such an agglomeration, the boundaries between one administratively defined "city" and another blur to such an extent that it becomes difficult to tell where one ends and the other begins. The second dimension is geometric shape. For instance, in a perfectly circular city, the average distance between two locations is lower than in an elongated city of the same area. All else being equal, therefore, interactions take place more easily in a circular city. The third dimension of form is internal structure, which depends on a city's road network among other things. Mobility is easier in cities with well-planned road networks that follow a regular pattern, such as a grid, than in cities with more haphazard networks. Finally, the fourth dimension is land use. For example, building restrictions may favor sprawl, which in turn can increase journey to work, as well as other travel times. Similarly, overly stringent zoning requirements may create unnecessary distance between the places where people live, and the places where they work.

Skill refers to a city's aggregate stock of human capital, or aggregate skill. When individuals choose where to live in a country, they compare locations based on such attributes as wages and job opportunities, housing values, natural amenities, manmade amenities -including, for example, cultural attractions- and the demographic composition of the population. Given their preferences and personal characteristics (such as age, education, and place of birth), they thus sort into different cities. A city that attracts more skilled individuals could be more productive simply because its residents are on average more productive—yet this is not the meaning of "skill" as it relates to city productivity. Instead, skill refers here to the productivity contribution of skilled individuals above and beyond their own productivities. This contribution arises because a person's human capital benefits not only her, but others in the city as well.

Access refers to a city's connectedness to other cities through the transportation network. When a city is well connected to others, transporting people or goods to and from other cities is not costly. In such a city, firms have access to markets that extend beyond that of the city itself. By promoting trade with other cites both domestically and internationally, this allows firms in a city to expand, become more specialized, and benefit from economies of scale. And when firms and workers become freer to move between cities, they flock to more productive cities. In a system of well-connected cities, the dispersion of productivity across cities is minimized, and cities maximize their overall contribution to national productivity.

Definitions of productivity:

- **Per capita gross domestic product (GDP) at the national level proxies average labor productivity** at the national level and is relevant to the aggregate contribution of urbanization and cities to national productivity.

- **Nighttime lights (NTL) at the city level measures output at the city level.** Since city-level GDP is typically not available, researchers have used the intensity of an area's nighttime lights as a proxy for its level of economic activity. NTL net of (log) population at the city level measures average labor productivity at the city level.

- **Average nominal wages at the city level** is a commonly used measure of a worker's productivity in the urban economics literature, especially in literature that estimates the strength of agglomeration economies. All other things equal, a city that pays a higher average nominal wage can be considered to have a higher average level of labor productivity.

- **Average nominal wages net of individual worker characteristics at the city level** measures a city's labor productivity, having controlled for differences in the composition of its workforce. If workers with the same observable characteristics (such as age, education, marital status, and gender) who live in different cities within a country earn different wages, it must be because their cities have different productivity levels.

- **Location premia** are calculated through augmented Mincerian wage regressions (nominal wages), where the estimated coefficients can be interpreted as an estimated of its (natural) log of underlying productivity (or location premium).

Selection of comparator countries:

Careful analysis was carried out to select a set of appropriate comparator countries for each LAC country using a two-stage procedure that classified all countries globally according to their geography in a first stage, and then selected "nearest neighbors" in terms of population, land area, and overall mean population density within their group. During this process, one country was selected from each of the East-Asia and Pacific (EAP), and Europe and Central Asia (ECA) regions; the last comparator was chosen unrestricted from the rest of the world. For Brazil, these are (1) China, (2) Turkey and (3) United States (Global Comparators); and United States (1), Canada (2) and Saudi Arabia (3) (High-income comparators).

See Boxes O.1 & 2.1, Annexes O.A & 2A in the full report for more details.

A BALANCED SYSTEM OF PRODUCTIVE & DENSE CITIES WITH YET UNTAPPED POTENTIAL

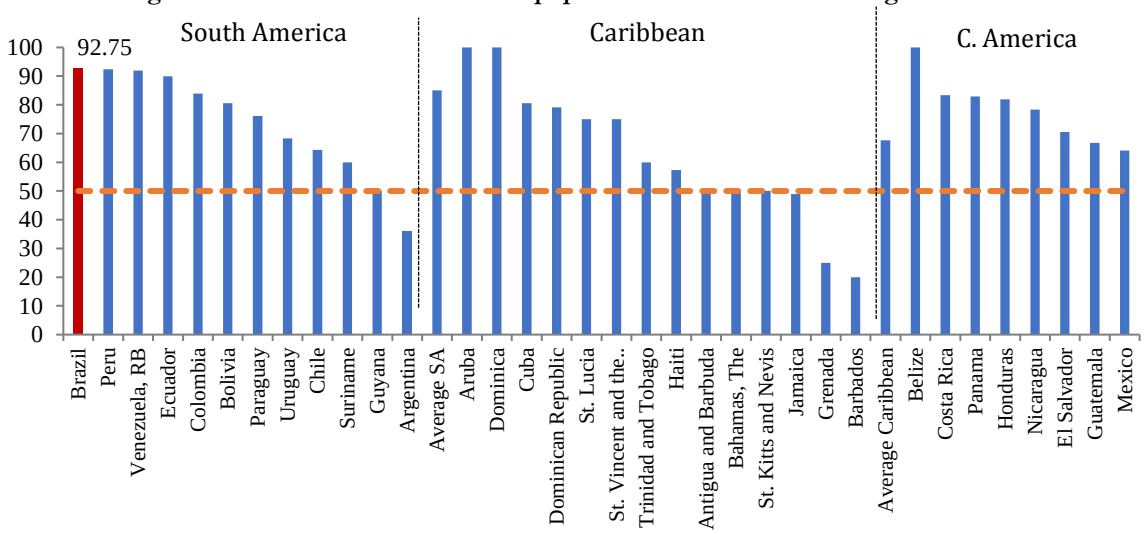
Brazil is the fifth most populous country in the world (2016); it has high levels of urbanization consistent with LAC averages. By 1960, on official urbanization measures, half of LAC's population lived in urban areas, a milestone achieved globally only in 2008. By 2016, more than 80 percent of the region's population lived in urban areas. While using consistent measures of urbanization across countries[3] brings LAC's

[3] For definitions see the official WB Flagship Report "Cities & Productivity in LAC" (Ferreyra and Roberts, eds., 2018), Introduction & Overview; and the background paper: Roberts, M., Blankespoor, B., Deuskar, C. and Stewart, B.P., 2017. Urbanization and development: is Latin America and the Caribbean different from the rest of the world?. World Bank Policy Research Working Paper No. 8019

urban share closer to that of the rest of the world, they remain high. Brazil is similar. More than 85 percent of the population lives in officially defined urban areas. While the share is between 70-80 percent by harmonized definitions, they remain almost as high and in line with the region's averages (71-78 percent by the same measures).

On average, Brazilian cities have high densities, that foster agglomeration economies. LAC exhibits urban densities that are well above the world average (almost 2,400 people per square km vs. just over 1,500 worldwide). Population density is above the global median in 80 percent of LAC cities. In contrast, in the more developed regions of ECA and North America, less than 14 percent, and a little over 2 percent of cities respectively, have densities above this median. The high-density stems from the smaller geographical extent of LAC's cities. They are the highest in South American cities: Brazil is one of three countries where 90 percent of urban areas have average population densities above the global median (Figure 1). High urban densities represent a double-edged sword. On the one hand, they can help stimulate positive agglomeration economies that spur productivity. However, high densities also give rise to adverse congestion forces, which can undermine productivity within cities. In Brazil, evidence suggests that density contributes to productivity, implying positive agglomeration economies in the country. Only Peru and Ecuador in South America seem to have similar positive relationships.

Figure 1. Most Brazilian cities have population densities above the global median



Source: Calculations based on analysis of urban areas defined using the cluster algorithm of Dijkstra and Poelman (2014), as applied to LandScan 2012 gridded population data. Notes in Ferreyra and Roberts (eds.) 2018.

Within the region, Brazilian cities have relatively high-levels of productivity, with five cities among LAC's top ten in terms of absolute economic activity. LAC urban areas tend to have levels of economic activity significantly greater than that predicted based on their populations —relative to the rest of the world they are, on average, more productive.[4] Cities in South America and Mexico drive these results. Half of the 10 cities with the highest economic outputs in LAC are in Brazil.

[4] Because the authors do not control for an urban area's capital stock given data limitations, they caution that this higher productivity may be attributable to a higher capital–labor ratio, higher TFP, or both—in other words, the higher level of productivity most accurately represents higher labor productivity.

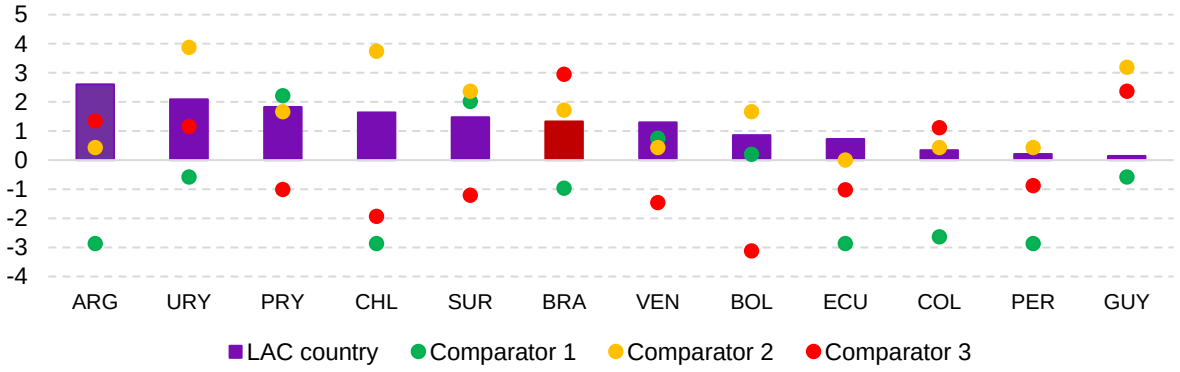
Based on nighttime lights data[5], Table 1 shows the 10 urban areas in LAC with the highest estimated absolute economic activity. Sao Paulo is second in LAC from a *labor productivity* standpoint; together with Rio de Janeiro, Brasilia, Porto Alegre and Belo Horizonte they are at the top of the regional distribution. Further, Brazilian cities boasts high-levels of productivity when compared to comparators countries, only significantly lagging against comparator 3, i.e. USA (Figure 2). Overall, cities in Brazil are also twice more productive than rural areas, mirroring worldwide trends and partly reflecting the compositional differences of the rural-urban populations.

Table 1. Brazilian cities are among LAC's top 10 in terms of estimated economic activity measured by NTL 2015

Rank	Country	Urban area	Relative sum of lights	Population	Pop. density
1	**Argentina**	**Buenos Aires**	**367.1**	**14,183,924**	**4,167**
2	**Brazil**	**Sao Paulo**	**269.4**	**20,588,698**	**6,455**
3	Mexico	Mexico City	207.1	19,782,701	7,462
4	**Brazil**	**Rio de Janeiro**	**153.2**	**9,932,480**	**5,730**
5	Chile	Santiago	99.9	5,837,310	5,238
6	Peru	Lima	91.2	9,056,851	8,931
7	**Brazil**	**Brasilia**	**67.7**	**2,019,961**	**4,126**
8	**Brazil**	**Porto Alegre**	**62.9**	**3,453,232**	**3,299**
9	**Brazil**	**Belo Horizonte**	**52.2**	**4,181,234**	**4,937**
10	Mexico	Monterrey	50.5	3,870,579	4,373

Source: Analysis of VIIRS nighttime lights data from the 2015 annual composite product, https://ngdc.noaa.gov/eog/viirs/download_dnb_composites.html. Notes in Ferreira et al. 2018

Figure 2. Mean urban area productivity in South American countries benchmarked against international comparators

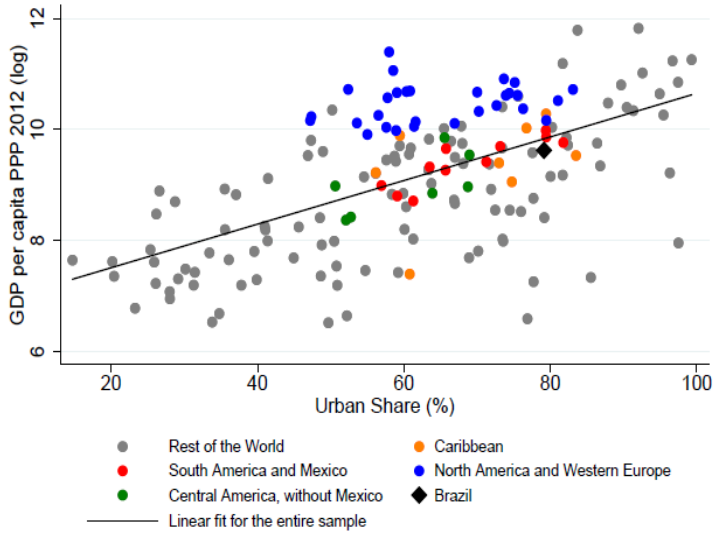


Source: Based on analysis of VIIRS nighttime lights data from the 2015 annual composite product, https://ngdc.noaa.gov/eog/viirs/download_dnb_composites.html. *Note:* A country's mean urban area productivity is given by the mean of these residuals across its urban areas.

[5] See original data and definitions in Box 1.

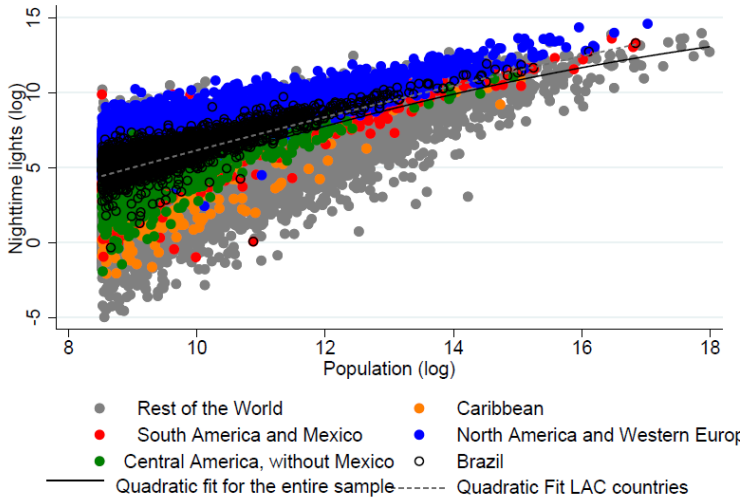
However, similar to other LAC countries, Brazil's productivity lags the global frontier. Overall, Brazilian cities are very similar to other LAC cities, in that their productivity are generally on par with the world average (Figure 3a). Yet, while in general, cities in the region are more productive than those in many others, they lag behind the world productivity "frontier", as measured by North American and Western European cities (Figure 3b). Considerable scope thus exists to raise the bar for productive cities in the region, and the contribution that urban areas in the region make to national GDP per capita.

Figure 3a. LAC countries exhibit average productivity given their urbanization levels



Source**:** Calculations based on World Development Indicators data and cities defined using the cluster algorithm of Dijkstra and Poelman (2014), as applied to Landscan 2012 gridded population data. Note: GDP per capita is measured in constant international dollars at 2012 PPP exchange rates. It is expressed in natural logs on the vertical axis.

Figure 3.b Productivity of LAC & Brazilian cities are above average but lag the global frontier

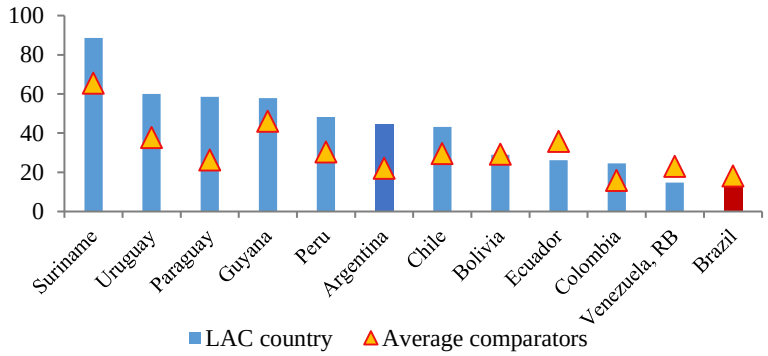


Source: Calculations based on nighttime lights data from the 2015 VIIRS (Visible Infrared Imaging Radiometer Suite) annual composite product (https://ngdc.noaa.gov/eog/viirs/download_dnb_ composites.html). Cities

are defined using the cluster algorithm of Dijkstra and Poelman (2014), as applied to Landscan 2012 gridded population data. Note: Nighttime lights on the vertical axis is the sum of nighttime lights luminosity values within a given city. LAC = Latin America and the Caribbean.

Contrary to most South American countries, Brazil has low urban primacy. A considerable number of LAC countries exhibit unusually high urban primacy.[6] One of the most debated characteristics of urbanization in LAC is "excessive" primacy in many of the region's countries. Primacy is considered excessive when it acts as a drag on overall national productivity and on economic growth. Yet, despite these frequently expressed concerns, there is no evidence of a negative relationship between primacy and GDP per capita.[7] Brazil has the lowest urban primacy rates in the region; but is at similar levels than comparator countries[8] (Figure 4).

Figure 4. Brazil has the lowest urban primacy in South America



Source: Calculations based on analysis of urban areas defined using the cluster algorithm of Dijkstra and Poelman (2014), as applied to LandScan 2012 gridded population data, and World Bank World Development Indicators (WDI) data, Notes in Chapter 2, Ferreyra and Roberts (eds.) 2018.

Yet, productivity dispersion across urban areas is high, suggesting cities are still below their full potential. While LAC's most productive cities rival many North American cities, the least productive are close to the top-performing African cities. In fact, within country productivity is widely dispersed across cities in LAC.[9] Dispersion of productivity across a country's urban areas provides direct information on inequalities in performance and can yield indirect clues on their aggregate contribution to GDP and productivity nationally. A lack of domestic market integration may be contributing to the high productivity dispersion in the region. In Brazil, subnational differences are lower than in other South American countries but they exist even after controlling for worker characteristics and thus population sorting.[10] Evidence suggests that differentials in nominal wages[11] across metropolitan areas of Brazil have declined during the last 15 years. While this trend points to an improvement in the spatial allocation of workers across metro areas, Brazilian cities still lag all comparator countries. A shortage in affordable housing in the most productive metro areas has been raised as a probable explanation. In the largest metropolitan regions, during 2000-2010, slums consistently grew in the outskirts of urban areas. For example, part of the more visible growth of slum areas in metropolitan São Paulo

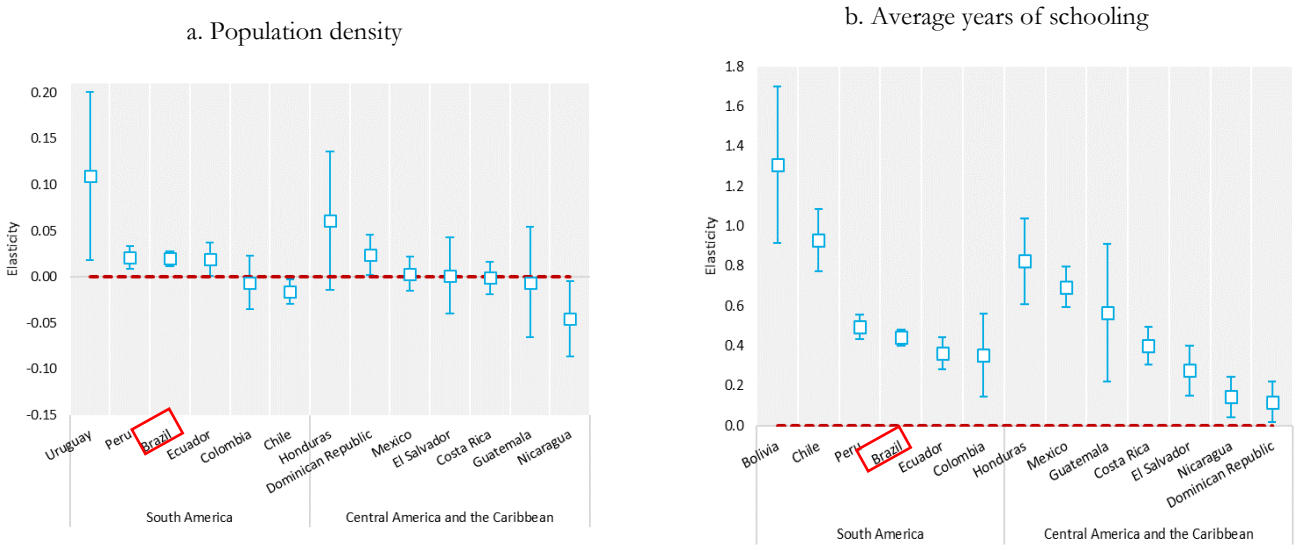
[6] Urban primacy is defined as the share of a country's urban population living in its most populous urban area.
[7] Based on a global sample of countries.
[8] Original graph and definitions can be found in Roberts 2018, Chapter 2.
[9] Location premiums are calculated using nominal average wages (see Chapter 3, Figures 3.3 and 3.4 p.102).
[10] Population sorting refers to the fact that people do not randomly locate across space, but they rate locate based on the place's or their own characteristics.
[11] These are conditioned on workers characteristics.

in this period is located in the western zone, while existing slums in the capital (which grew from 8 percent to 10 percent) and adjacent areas such as ABC and Guarulhos have shown persistent or low growth rates. In the Metropolitan Area of San Salvador and Santa Ana, roughly 45 percent of the new urban land incorporated from 2001 to 2010 corresponds to informal settlements.[12] On average, housing deficits have risen more in high-wage than in low-wage metropolitan areas. Although informal housing presumably filled the gap for some migrants to high-wage metro areas, the poor quality of such housing may have deterred would-be migrants, thereby keeping them "trapped" in less productive cities.[13] Lack of adequate market access is another explanation. In a well-integrated system of cities, the flow of goods, people, and resources across cities closes productivity gaps among cities and maximizes the contribution of the system of cities.

BUT STRONGER SKILLS, MANAGED DENSITIES & BETTER MARKET ACCESS COULD PLAY A LARGER ROLE IN FOSTERING AGGLOMERATION ECONOMIES.

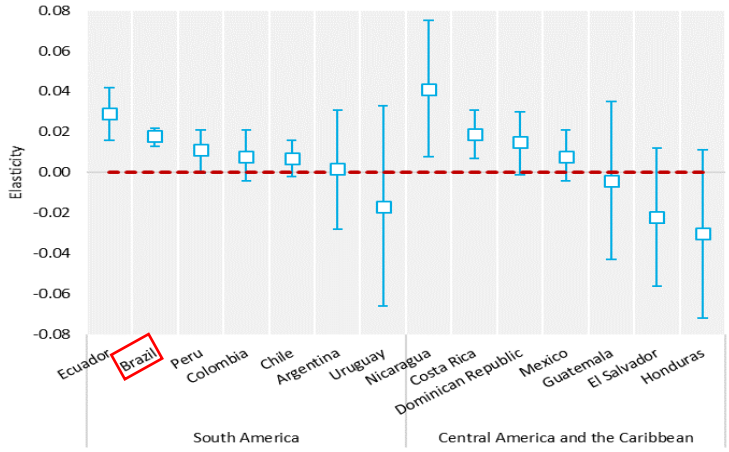
The productivity of Brazilian cities is driven by density, skills and market access; but all three forces are below potential. Positive agglomeration effects are present in LAC countries. Yet, these effects are driven mostly by skills, with a lesser role for market access and seemingly no positive influence of population density. This is not true in Brazil where all three factors are positively correlated with underlying productivity. While Brazil, next to Ecuador, is the only country in LAC where all three forces are exerting a positive effect on agglomeration economies, the size of their contribution is small (Figure 5) with elasticities always below 0.5 and even smaller than 0.1 for population density and market access; supporting the view that negative externalities may still be hampering cities from reaching the productivity frontier.

Figure 5. Cross-country heterogeneity in estimated elasticities of underlying productivity with respect to: (a) population density; (b) average years of schooling; and (c) market access



[12] LAC Infrastructure GAP. A Territorial Development Perspective (2015); World Bank.
[13] See background paper, *Spatial misallocation of labor in Brazil*, Bastos 2017.

c. Market Access



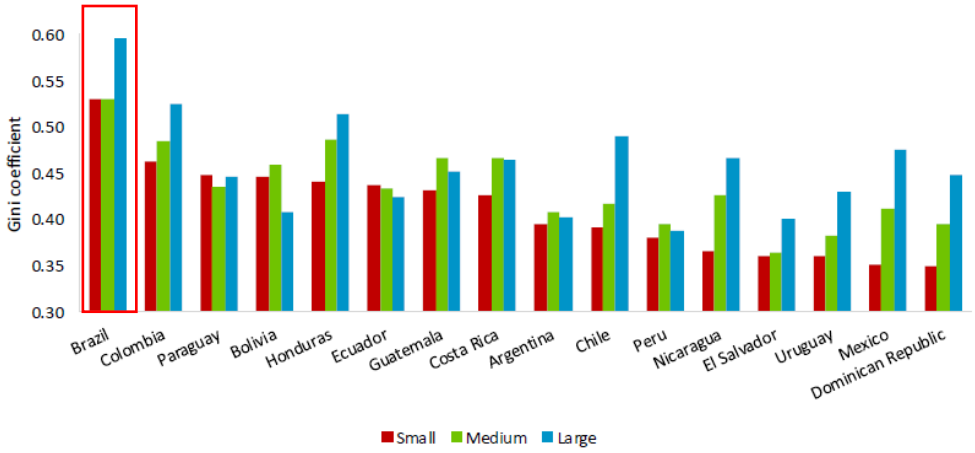
Source: Quintero and Roberts (2017), background paper.
Note: Figures show the estimated elasticities for each country derived from regressing—in individual country-level regressions—estimated subnational underlying productivity (measured in natural logs) on the variables shown in column 3 of **Error! Reference source not found.**. The squares represent the point estimates, while the upper and lower caps indicate the upper and lower bounds of the 95 percent confidence intervals. ARG = Argentina, BOL = Bolivia, BRA = Brazil, CHL = Chile, COL = Colombia, CRI = Costa Rica, DOM = Dominican Republic, ECU = Ecuador, GTM = Guatemala, HND = Honduras, MEX = Mexico, NIC = Nicaragua, PER = Peru, SLV = El Salvador, URY = Uruguay.

Brazilian cities boast high skill inequalities, leading to large disparities in income. Skills have been found to be one of the major contributors to cities productivity in LAC. Holding density and access constant, a 1-percent increase in skill (measured as average years of schooling) is associated with a 0.57 percent increase in productivity across LAC cities. While the contribution of skill to productivity varies across countries, it is significantly different from zero and positive for all LAC countries. Skilled individuals sort very strongly into large cities across LAC. This sorting is stronger in the region compared to countries such as the United States. For instance, in the latter a 10-percent increase in a city's population is associated with a 1.2 percent increase in the share of the city's population that is skilled, but the associated increase is 2.9 percent in LAC. This may partly reflect a more unequal distribution of amenities and public services -which serve to attract skilled people- across cities in LAC. The average share of the skilled adult population in the region is 13 percent; Brazil is below average with that number just above 10 percent. Yet, there are important regional disparities. In Brazil, college-educated workers tend to gravitate towards larger cities with already high college shares and other locational attributes. Evidence suggests that Brazilian workers of all educational attainments value college-

educated neighbors and intercity connectivity. They value density only to the extent that it raises the share of college-educated neighbors.[14]

More than in other LAC country, Brazilian high-skill individuals sort in large cities. The sorting of high-skill and higher earning individuals in large cities contributes to the high-level of income inequalities within these cities. On average, in LAC a 10-percent point increase in city population is associated with a 0.29-percent increase in income inequality, measured by the Gini coefficient. The corresponding increase in the United States is lower (0.12 percent). Brazilian cities are among LAC's most unequal. This is true independent of their size even if larger cities display even higher levels of inequalities (Figure 6).

Figure 6. Average Gini coefficient by area size (2014)



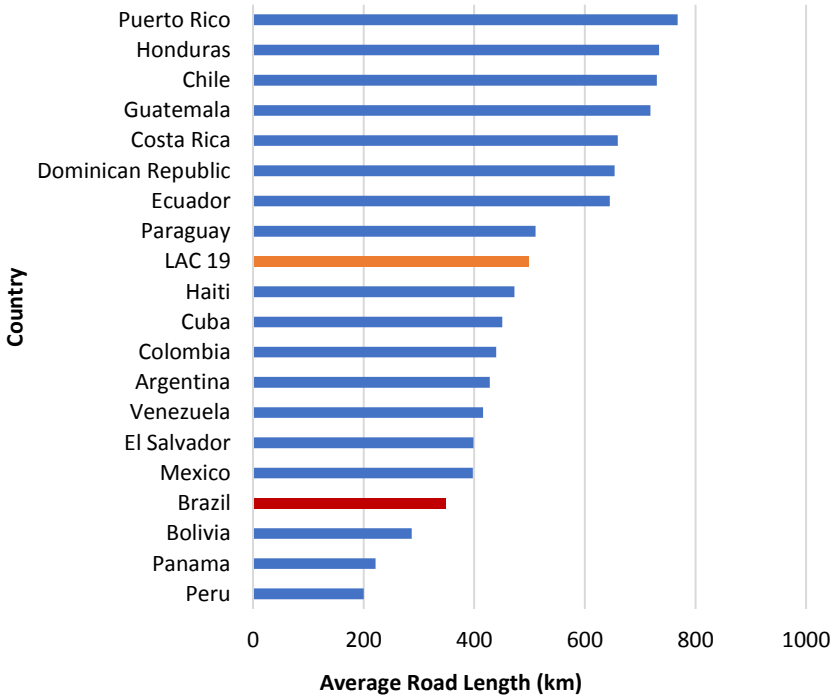
Source: World Bank calculations using SEDLAC (for countries other than Brazil) and IPUMS for Brazil.
Notes: The figure displays average Gini coefficient by area size (weighted average by size); area size calculations follow country-specific threshold

Cities are poorly connected and investment in infrastructure is low, weakening agglomeration economies. LAC countries have poor road networks limiting cities connectivity and increasing transport costs. For instance, LAC tends to exhibit higher transport costs than developed countries. They rely increasingly on roads as the main mode of passenger transport and surface freight. The region has the highest road occupancy rate in the world with more than 800,000 vehicle-km to paved lane–km, and with 80 percent of total surface freight transport by roads. While in countries like Argentina and Uruguay, this number is close to 100, in Brazil railways represents close to 20 percent of the country's surface freight. The number however is small when compared to India or China were freight transported by truck only represents is 39 and 21 percent respectively. Investment in transport infrastructure has historically lagged in LAC. While transport spending as a share of regional GDP went up from a mere 0.4 percent in 2003 to about 2.7 percent in 2013, there are significant variations between countries. Brazil actually experienced a slight decline of close to 0.25 percent between 2008 and 2015, displaying one of the lowest levels in LAC for the period 2008-2015 (only 1.06 percent of GDP). Only 12.3 percent of roads in Brazil are paved, and 44 percent of the network faces deficiencies such as the need for rehabilitation, widening to accommodate additional traffic, and paving. In Brazil, it was estimated that poor road conditions (including pavement, signaling and geometries) were on average responsible for close to 25 percent higher operational costs, but could increase operational costs by up to 90 percent.[15] At the same time, most of the transport infrastructure investments are in road, with nonroad spending in rail, air, and water

[14] See background paper, *Spatial misallocation of labor in Brazil*, Bastos 2017.
[15] Pesquisa CNT de Rodovias 2016.

transport very low. Further, LAC cities appear to have limited access to improved road infrastructure. They are only better than Sub-Saharan Africa (SSA) in terms of the average cumulative length of primary roads within a 100-km radius of cities with at least 1 million inhabitants. Brazil (348 km) is well below the region's average (500km), see Figure 7. Poor road networks can have large effects on local development and productivity, as they often obstruct access to markets and economic opportunities. These issues are particularly important given that market access is an important determinant of productivity in Brazil.

Figure 7. Average road length in a 100km radius around cities with at least a million inhabitants



Source: Calculations based on DeLorme database (2015) and Blankespoor et al. (2017b). *Note*: Road length within 100km radius of a city's centroid does not measure density as effective land area may vary, for instance, in the presence of water surface.

Six Brazilian cities are among the 100 most congested in the world; one is among the top 10 and 3 among the top 50. In LAC cities, transport is associated with high congestion. Although regional rates of motorization in LAC (about 100–300 vehicles per 1,000 people) fall short of existing rates in developed nations (about 500–700 in the United States, Europe, and Canada), they are nonetheless linked to congestion, accidents, and pollution that are among the highest in the world. On congestion, the 2016 TomTom traffic index shows that Mexico City, is the most congested city in the world. 8 other LAC cities are among the world's top 100 congested places, 6 of which are in Brazil. Rio de Janeiro is among the top 10 (#8) (Table 2). High congestion and related social and environmental challenges can be extremely expensive for LAC's regional economy. Bull and Thomson (2002), estimate that the costs of negative externalities linked to traffic congestion in large cities are nearly 3.5 percent of LAC's aggregate GDP.

Table 2 LAC cities among the top 100 congested places in the world

World Rank	City	Country	Congestion	Morning Peak	Evening Peak
1	Mexico City	Mexico	66	96	101
8	Rio de Janeiro	Brazil	47	63	81

World Rank	City	Country	Congestion	Morning Peak	Evening Peak
17	Santiago de Chile	Chile	43	73	88
19	Buenos Aires	Argentina	42	64	68
28	Salvador	Brazil	40	63	70
43	Recife	Brazil	37	60	65
47	Fortaleza	Brazil	35	56	57
71	Sao Paulo	Brazil	30	42	53
99	Belo Horizonte	Brazil	27	42	59

Source: TomTom traffic index, www.tomtom.com. *Note:* The TomTom index for congestion measures the percentage of extra travel time (relative to a free-flow situation) due to traffic congestion; morning and evening peak cover peak hour times. The TomTom data covers 48 countries and 390 cities worldwide.

In general, urban forms of Brazilian cities tend to support productivity. Beyond density, other spatial dimensions of urban form[16] matter for productivity. Smooth, rounded, compact, and well-connected cities tend to have higher productivity levels than rugged or elongated cities, or cities with poorly connected streets. While the average city in LAC is rounded, has smooth border (perimeters), a dense street network, and tends to be compactly built, the region is home to cities with a great diversity of urban form. Cities in Brazil reflect this diversity. They tend to display low smoothness values indicating unplanned growth patterns, and high roundness indices reflected in compact urban areas. Yet cities such as Sao Paulo have a high density built urban form contrary to Brasilia with a higher proportion of open spaces within its urban area. These disparities support the finding that high productivity can be achieved by different shapes as long as they guarantee inner-city connectivity.

But institutional fragmentation does not: Brazil is the country in LAC with the most Multicity agglomerations (MCAs). Institutional fragmentation also matters for productivity, and most metropolitan areas in LAC are hampered by it. Among world regions, LAC has the most MCAs. Multi-city agglomerations are those cities that by definition, span multiple "cities".[17] About 40 percent of LAC's urban population resides in MCAs, compared with a third of the world's urban population. One half (27 out of 54) of LAC's MCAs are in two countries: Brazil (19) and Mexico (8). The largest Brazilian cities are MCAs. For instance, Sao Paulo has *39 urban areas* and the boundaries of the city as officially defined (i.e. the yellow boundary) differ quite radically from those of the "true" extent of the city (Figure 8). Even more cities face institutional fragmentation[18], 28 Brazilian cities encompass more than 1 administrative unit, with the average encompassing 17. With progressive interaction of different metropolitan areas and smaller cities nearby, urban mega-regions are emerging. An example of such a mega-region is the urban system formed by the metropolitan areas of São Paulo, Campinas and Baixada Santista, an area with 26 million inhabitants and which has become the main economic, financial and industrial center in the country (UN-Habitat 2012, 2014). Shortcomings of MCAs and institutionally fragmented cities arise when their local jurisdictions fail to coordinate governance and the provision of public goods and services. Although the association between a country's productivity (measured by log GDP per capita) and its share of a country's population that lives in MCAs is positive in North American and Western European countries, it is virtually zero in LAC, suggesting that they may not handle effectively the difficult

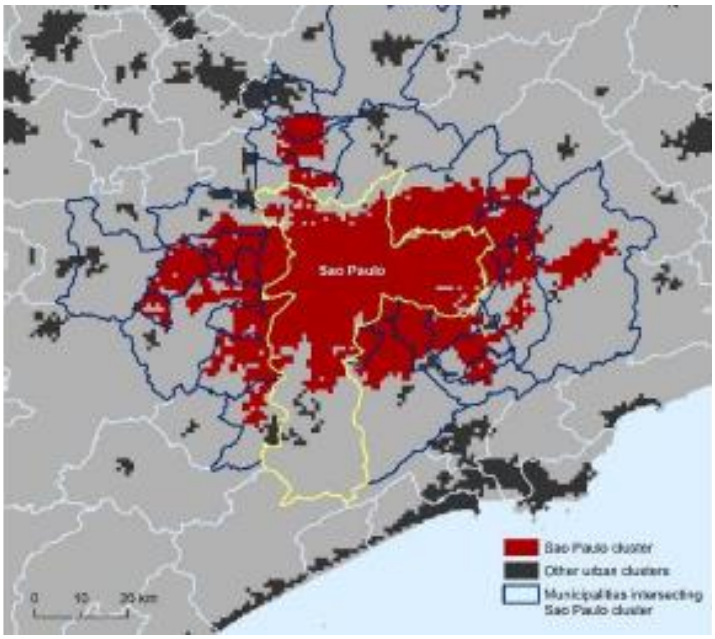
[16] Urban form has multiple spatial dimensions, such as the geometric shape of the urban extent, the internal structure of the city as determined for example by its transport network, and the land use patterns as reflected through the distribution of population and buildings under a city's footprint. See Box 1 for definitions.

[17] MCAs are defined as urban areas identified by the cluster algorithm that encompass two or more cities as given by countries' own definitions. Each component city must have at least 100,000 people.

[18] Number of administrative units in 2010.

coordination challenges. Further, there is no evidence that the presence of a governance body at the metropolitan level mitigates the negative effects of fragmentation.

Figure 7. MCAs in Sao Paulo, Brazil.



Source: World Bank using Geographic Information Systems (GIS) software and administrative boundary data from the LAC Geospatial Database (Branson et al., 2016). Note: in the maps, the red areas correspond to urban areas as defined using the cluster algorithm of Dijkstra and Poelman (2014), as applied to Landscan-2012 gridded population data. The yellow lines represent sub-national administrative boundaries at the Admin-2 (i.e. municipality) level that belong to a city as officially defined, while the blue lines represent the boundaries of Admin-2 areas that intersect with the urban area, but which do not belong to the officially defined city.

Other *demons of density*[19] may weaken agglomeration forces in Brazilian cities: crime. Congestion effects in the form of crime might also be aggravated by little basic protection from theft, kidnapping, and other criminal activity. High levels of inequalities within cities driven by skill sorting may also fuel social discontent. Across the world, labor productivity and firm total factor productivity (TFP) are indeed lower in cities with higher private security costs, perhaps because firms must pay for private security to fill the void left by local police. Similarly, people may be unwilling to move to a city where they would be more productive because of its high crime rate, especially if they cannot afford to "isolate" themselves from crime by living in, e.g., a gated community. According to data from the Brazilian think tank *Igarapé Institute*, LAC was, excluding war zones, home to 43 out of the 50 most murderous cities in the world in 2016, with San Salvador, the capital city of El Salvador, holding the distinction of being the global "murder capital" with 137 homicides per 100,000 inhabitants. Brazil is home to half of the cities in the ranking; being the country with higher overall murders in 2015.

[19] Ed Glaeser, The Triumph of the City (2011).

POLICY IMPLICATIONS: STRENGTHENING INSTITUTIONS, SHAPING CITIES & IMPROVING CONNECTIVITY

Cities are the immediate context in which people live and work; they also have the potential to contribute to raising the productivity bar in Brazil. The system of cities in Brazil appears to be overall more "balanced" than that in other LAC countries, with many cities boasting high productivity levels that are also at the top of the region. Density, skills and market access all drive positive agglomeration economies in the country. Yet, the size of their contribution is small, supporting the view that negative externalities may still be hampering cities and preventing them from reaching the productivity frontier. Indeed, Brazilian cities still display very high levels of inequalities, high congestion costs, poor connectivity and institutional fragmentation.

Focusing in reducing the negative effects of density by tackling inequalities, congestion, connectivity and fragmentation is key for pushing the productivity of Brazilian cities to the global frontier. Policymakers need to create a more enabling environment for broader agglomeration effects to take place, addressing market failures, but also possible policy failures in the areas.

Better institutions for metropolitan coordination can help reduce the negative effects of administrative fragmentation in large cities

A system of cities with large cities as is the case in Brazil needs institutions for coordination at the subnational level, but also between the subnational and Federal government. Indeed, addressing municipal coordination in large metropolitan areas with institutional fragmentation or MCAs, predominant in Brazil, is an important bottleneck to tackle. Tension between state governments and municipalities (who are autonomous entities), lack of resources and continuing regional inequalities have increased the complexity of metropolitan governance in Brazil.[20] A new framework for metropolitan governance, known as the Statute of the Metropolis was enacted in January 2015. It includes principles to facilitate the formal collaboration and constitution of metropolitan regions in Brazil. However, the critical aspect of municipal financing is not addressed[21], and little advances have been made to date to include a harmonized approach for inter-federative arrangements, and deal with low local capacity in secondary cities. Further, there is an ongoing legal discussion on whether a higher metropolitan coordination body is allowed within the Brazilian Constitution, that currently gives full autonomy to municipalities. A vast literature has argued that the presence of multiple local governments within metropolitan areas may generate coordination failures that reduce efficiency in providing transport infrastructure and land use planning, with negative repercussions for economic performance (Ahrend, Gamper and Schumann 2014). Fragmentation may also reduce the ease of doing business because of the additional bureaucracy that it imposes on firms (Kim, Schumann and Ahrend 2014) and the associated higher transaction costs. The Flagship Report[22] finds no evidence of metropolitan coordination mitigating the negative impacts of institutional fragmentation on cities productivity in LAC, suggesting they fail to mitigate the negative associated negative externalities. Ensuring the effectiveness of current bodies for metropolitan coordination, by reducing overlapping responsibilities across local and federal government agencies, and reviewing these bodies' limited authority could be a starting point. In Brazil the need to build metropolitan coordination arrangements needs also to focus on strengthening municipalities capacities.

Invest in shaping cities, especially medium sized cities that are growing fast

Infrastructure and transport investments, land use, and zoning regulations are not only tools for planning the form a city takes but can also—through their role in building the shape, texture, and land use of a city—

[20] Metropolitan Governance in Brazil: Inputs for an Agenda and Strategy, World Bank 2015.
[21] Ibid.
[22] See chapter 6 (Lozano-Gracia and Cadavid, 2018) for more details.

influence productivity. Shapes of Brazilian cities reflect the region's great variety of urban form. Evidence suggests that as long as they guarantee intra-city connectivity these different shapes can still achieve high-productivity. To this aim, it is important to instill the need to coordinate these different instruments (i.e. housing, transport, zoning and land use regulations) in all cities and state plans. Increasing intra-city connectivity through coordinated efforts between urban planning and public transport, embracing Transit Oriented Development (TOD) practices, will be key to reduce congestion and increase density's contribution to agglomeration economies. Further, these coordinated efforts can also help cities raise land-based revenues to finance infrastructure and social development. Planning visions that integrate land-use and transit are crucial for ensuring that different city-shapes are sustainable and respond to their residents' needs. Designing the right type of housing policies that meet these principles will also be an important element. A shortage in affordable housing in the most productive metro areas in Brazil has been raised as a probable explanation for the dispersion of productivity across cities. Housing deficits have risen more in high-wage than in low-wage metropolitan areas. Although informal housing presumably filled the gap for some migrants to high-wage metro areas, the poor quality of such housing may have deterred would-be migrants, thereby keeping them "trapped" in less productive cities (Bastos 2017).

Reduce the costs of density by improving within cities connectivity

Improvements may include carefully planned transport policies and infrastructure to mitigate the congestion created by current density. In cities like Rio de Janeiro and Sao Paulo studies have found that in 2013 congestion had a cost close to 8 percent of their metropolitan area GDP, and up to 2 percent of Brazil's.[23] WB Projects in the public transit sector have aimed at increasing accessibility to services and economic opportunities by reducing travel time through the improvement of mass transit systems (Sao Paulo Line 4 & Line 5, for instance) and the support of regulatory processes that ensure the coordination of the different modes, including pedestrian and cycling. Many cities have also implemented vehicle use restrictions which have proven positive in other LAC countries. For instance, gasoline emissions, for example, were reduced by 9–11 percent during peak hours and by 6 percent during the day after vehicle use restrictions in Quito, Ecuador (Carrillo et al. 2016); and similar regulations induced a shift to public transport in Santiago de Chile (De Grange and Troncoso, 2011). They failed however to reduce emissions or vehicle use in Mexico (Eskeland and Feyzioglu, 1997; Davis, 2008).[24] Further, reducing congestion in LAC cities requires a coordinated effort between urban planning and public transport, embracing Transit Oriented Development (TOD) practices (shaping cities), and overcoming their political economy barriers.

Maintain and strengthen a balanced system of cities by strengthening connections between cities and investing in local infrastructure and skills

Connectivity between cities also matters. Expanding transportation networks, and lowering the pecuniary and nonpecuniary costs of their use, would in principle raise cities' productivity. Access to the markets of other cities in the same country through transportation networks has a statistically significant association with city productivity. Indeed, improvements in national transport networks can help create a more integrated system of cities—with lower productivity dispersion across cities, and with a higher contribution to national productivity. Evidence from countries throughout the world shows that the within-country productivity dispersion is lower in countries with higher road density. Further, the literature examining the economic consequences of improved intercity transport infrastructure, in developed and developing countries, has in general found very positive effects. In the United States, for example, highway connection is found to increase earnings in services (Chandra and Thompson 2000), boost the wage of skilled relative to low-skilled workers (Michaels 2008), and stimulate

[23] Nota Técnica, Diretoria de Desenvolvimento Economico #3, Julho 2014 (FIRJAN), *Os custos da (i) mobilidade nas regiões metropolitanas do Rio de Janeiro e São Paulo.*

[24] See Chapter 4 (Selod, 2018) for a more detailed discussion.

city-level specialization in heavy goods through its effects on the weight of city exports (Duranton et al. 2014). In Brazil, Bird and Straub (2014) exploit the creation of Brasilia and subsequent infrastructure investment as a "natural experiment," and find that access to roads reduced the inequality in the spatial distribution of economic activities among Brazilian regions. Prominent examples of road-integration achievements in Brazil include the Trans-Amazonian Highway. Yet, increasing connectivity alone will not be enough to correct for the inequalities in urban services and amenities that are pushing higher skilled individuals into larger cities, increasing inequalities within and between urban areas. In the short-to medium term, medium-size cities can think of attracting skilled human capital by improving livability, increasing the supply of amenities desired by skilled individuals as well as basic urban services.