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Urban infrastructure in Latin America and the Caribbean: public policy priorities

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Abstract Latin America and the Caribbean is the most urbanized region in the developing world. Its urbanization rate of almost 80 % is comparable to that of high-income countries. However, cities in the region are struggling to provide the infrastructure needed for their millions of residents to enjoy a decent quality of life. This paper focuses on analyzing three aspects of this challenge. First, it identifies the main problems in housing and transport infrastructure in the region. Second, it examines the effect of past interventions to improve the living standards of the urban poor. And third, it analyzes the relationship between housing supply and transport networks, two connected topics that shape the region's spatial urban patterns.

Keywords Urban infrastructure · Transport · Slums · Housing · Land titling · Impact evaluation

JEL Classification O18 · R0 · R3 · R4

1 Introduction

Most of the world's population today lives in cities. However, this has been true only since 2007, when the urban population surpassed the rural population due both to natural growth of the urban population as well as accelerated rural migration to cities (United Nations 2009; Henderson 2002). The global urbanization process was mainly driven by the developing world, where the urban population grew at 3.35 %

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annually during the period 1975–2010, while the rural population grew at around 1 % (United Nations 2009).

By 2011, 53 % of the world's population lived in cities, including 80 % of the population in the developed world and 46 % of the population in developing countries. However, Latin America and the Caribbean (LAC) is an outlier among lower- and middle-income regions, with a strikingly high urbanization rate of 79 %—higher even than the urbanization rate of many member countries of the Organization for Economic Cooperation and Development (OECD).

Rural to urban migration is driven by the expectation of better opportunities and living standards. In cities, residents and firms enjoy the benefits of agglomeration and economies of scale as well as network effects, all of which increase labor productivity and reduce the per capita cost of providing urban services (Rauch 1993).

Yet, the expected benefits of living in cities do not materialize for all. The rapid and unplanned expansion of cities has resulted in the growth of informal settlements, which develop because governments are unable to provide urban services for the growing population and because the formal housing market and transport networks cannot meet the new demands. A large proportion of the urban poor in developing countries live in urban or peri-urban areas under conditions of overcrowding, insecure property rights, deficient urban and social services, poverty, and exposure to crime and violence, among other socioeconomic problems. Consequently, migration to urban areas moved the location of global poverty to the cities, triggering the process known as the "urbanization of poverty" (UN-Habitat 2003). In LAC, approximately 60 % of the poor and half of the extreme poor live in urban areas. The urbanization of poverty is projected to continue in the region, particularly in certain areas such as Central America (Fay 2005).

Slums represent a major challenge to development given the deficient provision of urban services to them, the lack of public safety, and environmental hazards. In addition, the geographical and social segregation of slum dwellers accentuates bad peer effects and sometimes inflicts a stigma on slum dwellers that prevents them from joining the formal labor market.

Thus, programs to avoid new informal settlements and to stop the growth of existing ones should be of first-order importance on the LAC research and policy agenda. Also, governments need to urgently find solutions to integrate the actual slum dwellers into the formal city and solve the urban divide.

This paper identifies the main problems in housing and urban infrastructure in LAC and reviews the causal effect of past interventions within urban infrastructure programs in the region. The ultimate goal is to understand what has worked in terms of housing and transport and to detect gaps in knowledge to promote avenues for future research for a more sustainable urbanization process.

The paper looks to explore what drives the decisions of households in terms of consumption of household services and location within a city—decisions that, in turn, shape urban patterns. Many urban poor cannot afford formal housing or are confined to live in substandard conditions close to the city center because transport systems that would enable them to live elsewhere are deficient or inaccessible. This

leads to the first two policy priorities that will be investigated further in this paper: access to the formal housing market and improvement of the public transit network.

The rationale for these first two priorities is based on the fact that the rapid and unplanned urbanization of LAC distorted the equilibrium of housing supply and demand, and to date that equilibrium has not been restored. There are market failures in the formal housing market for the poor that prevent or delay this adjustment. At the same time, in the developing world mass public transport is deficient, which affects the living standards of the urban poor. It is therefore clear that the integration of formal housing supply and mass public transit policies are the key elements to shape more sustainable cities in the future and accommodate the still growing urban population.

Slums could be viewed as a first step in the move to the city. Inner slums are located close to the city center and might be a strategic starting point for newly arrived poor migrants to look for a job and explore opportunities. However, as can be seen in LAC, slums tend to be a permanent rather than a transitory phenomenon. Therefore, the third policy priority explored in this paper is slum upgrading to improve the living standards of slum dwellers and mitigate urban poverty.

Although the urban poverty problem is multi-causal and requires a cross-sectoral approach, including citizen security and health for example, the scope of this paper is limited to the main barriers to the integration of the urban poor in terms of housing and transport. Other important socioeconomic and environmental problems related to the urban poor are excluded from the analysis.

When studying the causal effects of interventions, identification issues are of the first order of relevance. We include mainly papers that exploit experimental or quasi-experimental settings.[1] Those methods have proven to be the most accurate for causal inference. Nevertheless, we also include important observational studies or qualitative evaluations when more rigorous evaluations are not yet available. Most of the programs reviewed take place in the developing world, with priority given to LAC, unless there is no information available for developing regions, in which case relevant papers from other regions are included.

In terms of the first priority area, there is scant knowledge on the best way to expand the supply of housing for the poor and promote the rental market in LAC for low-income households. There is, however, a body of literature with sound identification strategies on formalizing urban poor by giving them land titles.

The second policy priority is to improve transport networks for the poor. The most urgent area for future research is to find ways to make mass public transit accessible and affordable for the poor and to investigate how this can shape the spatial patterns of the city. Policies that integrate transport reforms with supply of housing for low-income households seem the most promising

Finally, for informal settlements, there are many papers investigating the effect of slum upgrading programs. Proposals that involve a single intervention to improve the living standards of the urban poor have improved the level of satisfaction of

[1] In experimental settings, the treated and control groups are randomly selected. In quasi-experimental designs, a variety of statistical methods is employed to choose a control group that can re-create the counterfactual for the nonrandomly selected treatment group.

households, but have not substantially improved the main socioeconomic outcomes of slum dwellers. It seems that integral slum upgrading programs are necessary to produce more profound and long-lasting changes. Rigorous evaluation of integral programs will be very useful to determine which mix of programs produces the best outcomes.

The rest of the document is structured as follows: Section 2 sets the region in the context of the world in terms of a wide range of housing and transport indicators. Section 3 develops a simple spatial equilibrium approach that serves as a theoretical framework to understand housing choices. Section 4 studies a set of programs within the main selected policy areas: (1) access to housing, (2) transport interventions, and (3) upgrading housing. Finally, Sect. 5 presents conclusions that point out avenues for future research.

2 Housing and urban infrastructure in Latin America and the Caribbean

The trend from rural to urban populations occurred earlier in developed regions and is now the main trend in the developing world. Population growth is, therefore, becoming largely an urban phenomenon concentrated in the developing world (Satterthwaite 2007). Table 1 shows that among developing regions, LAC has an exceptionally high level of urbanization (79 %) that is higher than that of Europe.

Table 1 Urbanization trends

	Urban population (millions)		Urban population (percent of population)		Population in urban areas with more than 1 million inhabitants (percent of total population)		Population in largest city (percent of urban population)	
	1990	2012	1990	2011	1990	2011	1990	2011
World	2259	3690	43	53	17	21	17	15
Low-income	108	239	21	28	8	11	35	33
Middle-income	1320	2426	36	50	14	19	15	13
High-income	831	1025	74	80	–	–	18	18
Low- and middle-income	1428	2664	35	46	13	18	16	14
East Asia and the Pacific	451	988	28	50	–	–	9	7
Europe and Central Asia	140	163	57	60	16	19	20	20
Latin America and the Caribbean	295	459	70	79	32	35	23	21
Middle East and North Africa	117	202	52	60	21	21	26	21
South Asia	284	517	25	31	10	13	9	11
Sub-Saharan Africa	141	335	28	37	12	14	28	26

Source World Bank, Human Development Indicators database. Accessed in October 2013

Africa and Asia, in contrast, remain mostly rural, with 40 and 45 % of their respective populations living in cities. In the years ahead, the level of urbanization is expected to increase in all major areas of the developing world, with Africa and Asia urbanizing more rapidly than the rest. Nevertheless, by mid-century, Africa and Asia are still expected to have lower levels of urbanization than the more developed regions or LAC (United Nations 2013).

Table 1 illustrates the urban explosion that took place in LAC from 1950 to 1990. In 1950, only 40 % of the population in LAC lived in cities, while in 1990 that proportion reached 70 %. In 2011, the urbanization rate was 79 %, and by 2050, it is expected to rise to 90 % (United Nations 2013).

Not only is LAC the most urbanized developing region, it also has a high degree of concentration of the population in large cities. Table 1 shows that 35 % of the urban population lives in metropolitan areas of more than 1 million people, which is the highest proportion in the world. LAC also has the largest concentration of mega-cities in the world. In 1950, there were no mega-cities in the region. Today, there are eight: Buenos Aires, Mexico City, Rio de Janeiro, and São Paulo (all with more than 10 million inhabitants), and Belo Horizonte, Bogota, Lima, and Santiago (approaching 10 million inhabitants). While 9 % of the world population lives in cities with more than 10 million inhabitants, in LAC 14 % lives in such mega-cities (UN-Habitat 2012). There are also 55 cities in LAC with populations between 1 to 5 million people, and these cities account for 24 % of the regional population (the world average is 22 % for this city size). These cities include Caracas, Guatemala City, Panama City, San Salvador, and Brasilia. As a result of this rapid urbanization over the years, mega-cities expanded exponentially and new smaller cities also emerged.

This striking level of urbanization and urban agglomeration in LAC is a challenge for the cities that were not prepared to absorb such population growth. As a consequence, the slum population increased in recent decades, with a modest decrease only during the past few years.[2] Figure 1 shows that in 2010 there were 828 million slum dwellers in the developing world (one-sixth of the world's population), 110 million of whom lived in LAC. The proportion of the urban population living in slums has been decreasing thanks to the rapid rate of urbanization that more than offset the increase in slum dwellers.

One of the Millennium Development Goals (MDG) is "cities without slums".[3] To date, 200 million people living in cities have stopped being considered as living in

[2] According to UN-Habitat (2003), a slum household is a group of individuals living under the same roof and lacking one or more of the following conditions: (1) access to safe water: sufficient amount of water (20 l/person/day), at an affordable price (less than 10 % of total household income), available without being subject to extreme effort (less than 1 h a day of walking time); (2) access to improved sanitation: access to an excreta disposal system either in the form of a private toilet or a public toilet shared with a reasonable number of people; (3) sufficient living area: fewer than three people per habitable room; (4) structural quality/durability of dwellings: a house built on a nonhazardous location and with a permanent structure adequate to protect its inhabitants from the extremes of climatic conditions; and (5) security of tenure: the right to effective protection by the State against arbitrary unlawful evictions.

[3] The 11th MDG target is to progress toward a goal of "Cities Without Slums" (within the 7th Goal of "Ensuring Environmental Sustainability"), establishing a target of improving the lives of at least 100 million slum dwellers by 2020.

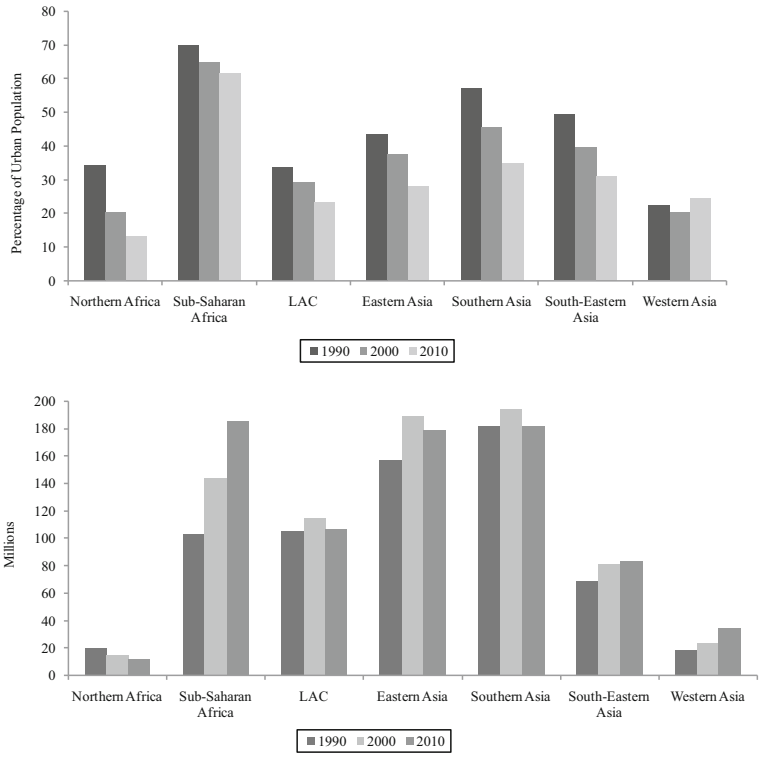

Fig. 1 Slum population and proportion of urban population in slums. *Source* United Nations (2012). *Note* Indicator 7.10 to monitor the Millennium Development Goal Target 7.D is: by 2020 to have achieved a significant improvement in the lives of at least 100 million slum-dwellers. Slum population is defined as the urban population living in dwellings with at least one of these four characteristics: lack of access to improved drinking water, lack of access to improved sanitation, overcrowding (three or more persons per room) and dwellings made of nondurable material. Half of pit latrines are considered improved sanitation. Trends data are not available for Oceania

slums because they gained access to water and sanitation facilities and durable housing. As a consequence, from 2000 to 2010, the proportion of urban residents in developing countries living in slums decreased from 46 to 36 %. However, progress is still insufficient, as the number of people moving to slums is increasing in many regions (UN-Habitat 2011). In LAC, around 25 % of the urban population lives in slums.

There are two MDGs closely related to cities without slums: access to safe water and sanitation services. The MDG to halve by 2015 the population without access to safe water with respect to 1990 will be achieved. In particular, LAC has a high level of coverage (Table 2). However, the MDG to halve by 2015 the population without access to sanitation services with respect to 1990 will not be achieved globally, despite large improvements in many regions. In LAC, the provision of sanitation is lagging behind with respect to safe water provision.

Table 2 Improved water and sanitation coverage (in percent)

	Proportion of population using an improved drinking water source (percentage)						Proportion of population using an improved sanitation facility (percentage)					
	1990			2011			1990			2011		
	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
World	76	95	62	89	96	81	49	77	29	64	80	47
Developing Regions	70	93	59	87	95	79	36	65	21	57	74	43
Northern Africa	87	94	80	92	95	89	72	92	54	90	94	84
Sub-Saharan Africa	49	83	36	63	84	51	26	43	19	30	42	24
Latin America and the Caribbean	85	94	64	94	97	82	68	80	38	82	87	63
Eastern Asia	68	97	56	92	98	85	27	53	16	67	76	57
Southern Asia	72	90	66	90	95	88	24	56	12	41	64	30
Western Asia	85	95	69	90	96	78	80	94	59	88	96	71
Oceania	50	92	37	56	95	45	36	77	23	36	78	24
Caucasus and Central Asia	89	97	81	86	96	79	91	96	86	96	96	95
Developed regions	98	99	94	99	100	97	95	97	90	96	97	92

Source United Nations (2012)

Indicators 7.8 and 7.9 to monitor Millennium Development Goal Target 7.C: Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation

Lack of water and sanitation facilities still constitutes one of the main housing deficits in urban areas of LAC: around 21 million households live in dwellings lacking at least one basic service. Inadequate sanitation is the main infrastructure problem, affecting 13 % of households (almost 17 million). Around 8 million households lack piped water (and the quality of the water received by most households is not optimal). The urban poor are the most affected: in 2009, the percentage of poor households lacking infrastructure was six times higher than that of high-income households. While there is almost no overcrowding or poor-quality building materials in high-income households, these problems affect 16 % of urban poor households (Bouillon 2012).

Tables 3 and 4 show the differential access to urban services of the first quintile (20 % poorest) of the income distribution with respect to the mean. This would indicate that more pro-poor and targeted polices are needed.

Access to housing is the main problem for new urban migrants. There are scant cross-regional statistics on home ownership, but in LAC the home ownership rates are higher on average than in the rest of the developing world (Bouillon 2012). Table 5 shows large disparities among countries of the region according to household income: Nicaragua, Venezuela, Costa Rica, and Panama have home ownership rates of more than 70 % for urban households, while Uruguay and Brazil have rates lower than 55 %. The lowest income quintile has ownership rates far below the mean in Uruguay, Mexico, and Brazil. The rental sector is not developed in the region for low-income residents, so access to housing is a main policy priority. Rental tenure rates in LAC are even lower than in other developing countries in Africa and Asia (Andreasen 1996; Gilbert et al. 1997).

The last topic addressed in this paper is transport systems, which are a pillar for economic development and growth. Within cities, the availability and quality of transportation shapes spatial patterns and is tightly linked to the supply of housing services. When there is an influx of migrants in cities with deficient public transit networks, the poor have to live close to their jobs in the city center with deficient-quality housing (inner-city slums), or in the suburbs, spending a lot of time and money commuting. Also, as in the housing sector, in areas not reached by formal public transport, informal suppliers emerge to meet the demand for transportation at very high prices.

Although transport is important, no target for transport was included in the MDGs, and there are few statistics to make international comparisons. Thus, we use different sources, including certain statistics published by the World Bank, data from some relevant cities, and a mobility index developed by a private company.

Figure 2 shows the Little (2014) Urban Mobility Index for a sample of 84 cities across the world. This index reflects the state of mobility in terms of maturity and performance.[4] Western Europe ranks highest among all regions surveyed, followed by South/Eastern Europe. These regions lead both in the mobility and the maturity components of the index. North America scores below average due to its high

[4] The mobility score per city ranges from 0 to 100 index points; the maximum of 100 points is defined by the best performance of any city in the sample for each criterion. See Little (2014) for a detailed explanation of the index components.

Table 3 Transport indicators

	Motor vehicles		Passenger cars	Road density	Paved roads
	Per 1000 people 2010	Per km of road 2010	Per 1000 people 2010	km of road per 100 sq. kms of land area 2010	Percent 2011
World	176	–	124	28	57
Low-income	10	–	7	–	21
Middle-income	60	13	48	28	54
High-income	620	39	446	41	84
Low- and middle-income	55	–	44	26	38
East Asia and the Pacific	64	21	45	39	65
Europe and Central Asia	199	35	157	23	78
Latin America and the Caribbean	183	23	142	17	26
Middle East and North Africa	88	40	68	10	76
South Asia	17	5	11	99	45
Sub-Saharan Africa	28	–	22	–	16

Source World Bank, Human Development Indicators database. Accessed in October 2013

dependence on cars. The average score of the cities of LAC included in the sample[5] is also slightly below the world average, due to relatively low mobility performance.

Figure 3 shows the mean number of daily trips per person and mode of transport. In Europe, on average 40 % of the trips use individual motorized transport, 24 % use public transport, and 36 % walk or cycle. There is a lot of heterogeneity among the cities: for example, in London the use of public transport accounts for 42 % of trips, while in Amsterdam 58 % of the trips are by walking or (especially) cycling. In LAC, motorization is very high (28 % of trips are in private cars or taxis) but the largest number of trips (42 %) is by public transport.

Table 6 presents more comprehensive statistics for all LAC countries. It shows that LAC is one of the most motorized regions of the world, but does not rank so high in terms of transportation infrastructure (low road density and very low percentage of paved roads). As incomes in the region increased and private vehicles became relatively cheaper, more middle- and high-income individuals had access to cars. There was indeed exponential growth of motorization in the region, similar to the trend experienced earlier in the developed world but much faster (Cervero et al. 2013). In 2010, there were 183 motor vehicles per 1000 inhabitants in LAC, more than the world average of 176 and almost 4 times more than the average for low- and middle-income countries. Also in LAC in 2010 there were 2.5 new motor vehicle registrations for every new child born (Hidalgo and Huizenga 2013).

[5] Bogota, Buenos Aires, Caracas, Lima, Mexico City, Rio de Janeiro, and São Paulo.

Table 4 Coverage of housing services in urban areas

	Water		Hygienic restrooms		Sewerage		Electricity		Telephone	
	Poorest 20 %	Mean	Poorest 20 %	Mean	Poorest 20 %	Mean	Poorest 20 %	Mean	Poorest 20 %	Mean
Latin America										
Argentina										
2003-II	96.2	98.9	65.2	86.4	36.2	59.6				
2011-I	98.4	99.6	74.5	91.5	43.4	65.1				
Bolivia										
2000	84.8	93.2	60.3	86.1	38.7	52.7	91.2	95.9	14.1	37.4
2007	95.2	96.9	78.5	83.5	53.1	55.3	99.2	98.2	66.6	83
Brazil										
2004	84.4	95	57.6	77.5	43.9	65.2	98.5	99.6	42.4	72.5
2009	91.9	97.3	64	80	47.2	67.6	99.6	99.9	77.8	89.6
Chile										
2000	96.6	98.9	83.1	93.7	77.1	858.8	99.2	99.8	35.4	68.9
2009	98.7	99.5	94.6	97.7	89.7	94.2	99.8	99.9		
Colombia										
2006	94.2	97.8	90.8	96.9	78.3	91.2	97.5	99.4	62.9	86.2
2010	94.5	96.9	90.1	96.6	78.1	91.4	99	99.8	83.4	93.6
Costa Rica										
2004	99.2	99.7	95.9	98.4	32.7	40.4	99.9	99.8	64.4	84.2
2010	98.8	99.6	97.2	98.9	28.1	35.1	99.3	99.7	82.5	93
Dominican Republic										
2008	75.4	86.8	57.1	80.6	18.9	33.7	98.8	99.6	63.2	78.6
2010	75.4	84.7	61.5	82.3	19.6	32.3	99.1	99.8	63.8	76.2
Ecuador										

Table 4 continued

	Water		Hygienic restrooms		Sewerage		Electricity		Telephone	
	Poorest 20 %	Mean	Poorest 20 %	Mean	Poorest 20 %	Mean	Poorest 20 %	Mean	Poorest 20 %	Mean
2003	85.1	91.1	71.2	85.9	48.4	67.4	97.8	99.3	26.8	50.6
2010	93.9	95.6	96.3	98.5	66.5	77.5	99	99.7	29.2	50
El Salvador										
2000	44.9	74.1	20.1	52.4	17.5	50.3	82.3	96.1	15.9	51.8
2010	63.3	83.4	34	71.5	22.3	59.1	88.1	97	77.1	92.4
Guatemala										
2000	83.1	88	49.8	66.4	48.5	63.2	83	93.7	7.9	38.9
2006	85.1	90	43.4	74.8	38	68.4	77.7	93.7	29.6	74.8
Honduras										
2001	91.4	94	44.8	64.3	28.3	51.1	87.6	96.7		
2010	93.7	94.7	63	71.2	47.5	59.1	97.3	98.7	43.6	53.7
Mexico										
2000	87.6	95.8	30.5	72.6	26	66.8	96.1	99.5	13.9	48.9
2010	91.6	95.9	48.5	74.8	45.1	70.1	98.7	99.7	62	84.3
Nicaragua										
2001	66.2	83.6	15.4	35.5	12.3	26.6	78.2	92	3.5	19.2
2005	74.3	89.5	19.1	48.3	16.9	36.4	78.8	95.5	12.8	47.6
Paraguay										
2001	95.1	98.5	54.3	80.1	3	17.7	91.5	97.9	16.8	55.1
2010	97.7	98.3	69.6	90.8	4.8	13.7	96.6	99.5	72.7	92.9
Peru										
2003	63.2	80.6	56.2	82.1	45.6	73.5	77	93.9	6.9	34.3
2010	72.9	87.5	68.6	88.2	59.7	83.5	93.2	98.2	12.9	40.9

Table 4 continued

	Water		Hygienic restrooms		Sewerage		Electricity		Telephone	
	Poorest 20 %	Mean	Poorest 20 %	Mean	Poorest 20 %	Mean	Poorest 20 %	Mean	Poorest 20 %	Mean
Uruguay										
2006	93.4	98.3	69.1	91.4	28.9	58.6	97.5	99.3	57.5	84.4
2010	97.4	99.2	74.9	92.7	30.1	57.7	98.4	99.5	22.9	62.9
Venezuela										
2000	97.9	98.7	96.6	98.6			100	99.8	39.5	52.6
2010	87.5	93	83.7	92.4			99.1	99.5	54.2	67.4
The Caribbean										
Bahamas										
2001	72.3	86.7	86.2	94.4	13.4	12.8	88.5	96.1	65.6	80.3
Guyana										
1992–1993	77.5	89	100	99.8	5	1.6	80	91	9.8	16.3
Haiti										
2001	14.9	23.2	1.3	8.7			37.6	61.9	2	12.3
Jamaica										
2002	63	65.3	80.2	79	33.9	32.9	90.4	92.3	57.6	61.9
Suriname										
1999	89.5	87.5			98.2	98.1	98.2	99.6	61.4	64.5

Source Socio-Economic Database for Latin America and the Caribbean, Center for Distributive, Labor and Social Studies (Universidad Nacional de la Plata) and the World Bank

Table 5 Urban infrastructure in Latin America

	Share of housing owners		Number of rooms		Persons per room		Share of poor dwellings		Share of dwellings with low-quality materials	
	Poorest 20 %	Mean	Poorest 20 %	Mean	Poorest 20 %	Mean	Poorest 20 %	Mean	Poorest 20 %	Mean
Latin America										
Argentina										
2003-II	54.4	66.4	2.5	2.9	2.1	1.4				
2012-I	54.3	64	2.6	2.9	1.9	1.2	4.3	1.7	4.4	1.4
Bolivia										
2000	48.4	52.1	2.1	2.7	2.7	2.2	32.8	27	67.2	44.9
2011	46.3	53.6	2.2	2.8	2.4	1.8	36.8	30.9	46.6	28.3
Brazil										
2006	34.4	49.5	2.8	3.4	1.7	1.3	7	2.9	68.7	39.2
2011	30.4	44.2	2.8	3.3	1.7	1.2	7.4	6.1	71.2	35.5
Costa Rica										
2001	71.2	75	4.3	5	1	0.8	2.6	0.7	9.6	2.8
2009	61.4	71.1	4.4	5.2	0.9	0.7	1.7	0.5	7.9	2.9
Dominican Republic										
2008	54.8	58.4	3	3.5	1.6	1.1	0.2	0.5	30.5	13.6
2011	53.1	56.5	3.1	3.4	1.6	1.1	0.1	1.5	26.4	11.8
Ecuador										
2003	71.1	69.4	2.5	3.1	2.3	1.7			33.2	21.1
2011	59	61.8	4.9	5.4	0.8	0.7	16.8	8.7	18	9.5
El Salvador										
2000	44.5	64.2	1.8	2.7	2.9	2	17.2	9.2	43.4	19.2
2010	54.8	64.6	1.9	2.8	2.8	1.7	9.4	5.3	37.8	15.4

Table 5 continued

	Share of housing owners		Number of rooms		Persons per room		Share of poor dwellings		Share of dwellings with low-quality materials	
	Poorest 20 %	Mean	Poorest 20 %	Mean	Poorest 20 %	Mean	Poorest 20 %	Mean	Poorest 20 %	Mean
Guatemala										
2000	41.5	60.7	1.6	2.7	3.5	2.5	15.3	10	56.8	36.6
2011	57.2	64.9	1.8	2.5	3.4	2.3	10	9.5	51.9	26.9
Honduras										
2001	62	61.7	3.3	4.4	2.3	1.5	7.5	10.1	7.5	2.3
2011	61.5	61.2	4	4.7	1.5	1.2	6.6	7.5	4.8	2.2
Mexico										
2000	65	71	3.8	5	1.4	0.9	0.2	0.2	47.8	24.9
2010	45.3	65.6	4.1	5	1.1	0.8	0.4	0.3	40.8	22
Nicaragua										
2001	71.3	76.7	1.9	2.3	4.2	3	14	6.5	24.8	10.5
2009	73.6	80.9	1.9	2.6	3.7	2.2	5.9	2.1	23	10.5
Panama										
2007	54	75								
2012	62.2	79								
Paraguay										
2001	67.2	71.7	2.4	3.4	2.4	1.7	21.1	9.7	1.9	0.7
2011	78.2	78.4	2.9	3.6	1.6	1.3	11.2	4.6	0.6	0.4
Peru										
2003	63	69.3	2.8	3.5	2.6	1.6	5.7	7.4	22.7	13.1
2011	54.6	62.5	2.7	3.7	1.9	1.3	12.2	7.5	20.2	11.9
Uruguay										
2006	30.9	61.3	2.8	3.3	1.8	1	0.8	0.3	4.5	1.4

Table 5 continued

	Share of housing owners		Number of rooms		Persons per room		Share of poor dwellings		Share of dwellings with low-quality materials	
	Poorest 20 %	Mean	Poorest 20 %	Mean	Poorest 20 %	Mean	Poorest 20 %	Mean	Poorest 20 %	Mean
2011	21.7	52.7	3	3.5	1.5	0.9	0.3	0.1	2.6	0.7
Venezuela										
2000	72.7	73.2	3.6	3.9	1.6	1.3	6.9	2.6	6.9	2.9
2011	79.8	81.7	3.1	3.5	1.9	1.4	12	5.5	15.3	7.1
The Caribbean										
Bahamas										
2001	53.9	57.7	3.9	4.1	1.2	1				
Guyana										
1992–1993	35	40.4	4.3	4.4	1.8	1.1			5	0.3
Haiti										
2001	38.9	46	2.8	3.1	2.2	1.8	16	8.6	27.4	14.1
Jamaica										
2002	58	52.5					1.6	1.3	3	4.5
Suriname										
1999	67.3	62.4	2.9	3	1.5	1.4	33.3	43.4		

Source Socio-Economic Database for Latin America and the Caribbean, Center for Distributive, Labor and Social Studies (Universidad Nacional de la Plata) and the World Bank

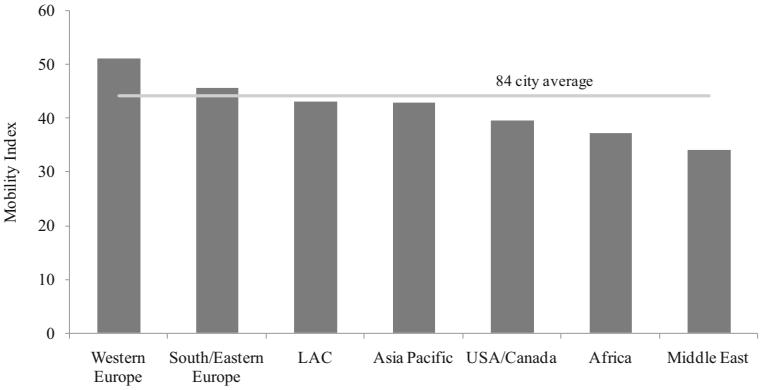

Fig. 2 Mobility index: regional comparison. *Source* Little (2014). *Note* The mobility score ranges from 0 to 100 index points; the maximum of 100 points is defined by the best performance of any city in the sample

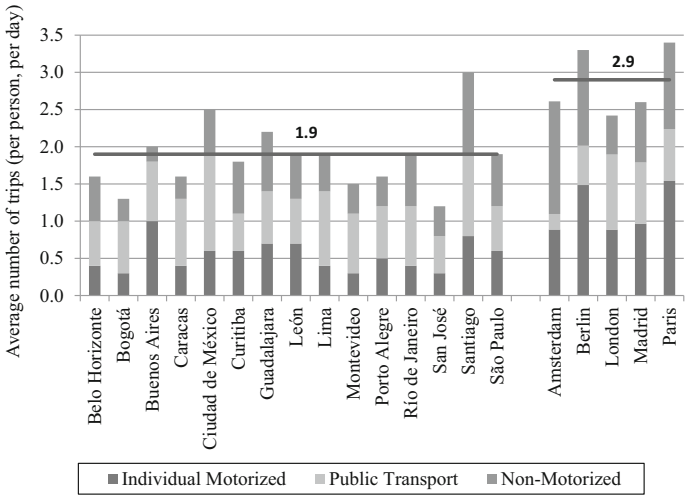

Fig. 3 Average number of trips by mode of transport (per person, per day). *Sources* CAF-OMU (2009) for Latin America and the Caribbean; EMTA (2012) for Europe

Motorization results in congestion, air pollution, and greenhouse gas emissions. In addition, motorization reduces the physical activity implied by nonmotorized modes of transport (cycling and walking), which in turn increases obesity and related illnesses. Costs of negative externalities are estimated to be around 18 % of the average income of 15 selected cities in the region (Hidalgo and Huizenga 2013).

Clearly, cars are not affordable for all in LAC. Table 6 shows that in most countries in the region the probability of having a car when belonging to the fifth income quintile (20 % richest) is more than 10 times higher than for the first income quintile (20 % poorest). This difference is not so large for motorcycle and bicycle

Table 6 Access to transportation in Latin America

	Area			Car					Motorcycle			Bicycle		
	Mean	Urban	Rural	Income Quintile					Area			Area		
				1	2	3	4	5	Urban	Rural	20 % Poorest	Urban	Rural	20 % Poorest
Latin America														
Argentina														
2001	38.7	38.7		17	22	32	40	57	10.9		9.2	55.4		57.6
Bolivia														
2007	10.7	14	4.4	2.8	4.2	7	9.5	24	5.6	5.8	1.6	37	42.3	38.3
Chile														
1998	28.1	29.9	16.9	6.6	12	19	33	60						
Colombia														
2007	12	14.5	3.7	2.4	2.8	4.3	8.3	33	12.8	10.1	4.4	35.3	29.1	23.2
Costa Rica														
2009	36.8	40.9	30.7	14	19	28	42	70						
Dominican Rep.														
2009	19.6	24.5	9.6	4	7.6	12	17	48	21.6	29.4	20.9			
Ecuador														
2009	17.5	21.9	8.1	6.1	6	10	15	40	5.9	6.7	4.5	31.2	21.9	20.6
El Salvador														
2008	16	20	7.5	1	4.1	7	14	45						
Guatemala														
2006	10.3	17.4	2.1	0.2	0.7	2.5	5.3	34	8.6	3.6	0.5	33.3	34.9	20.5
Honduras														
2007	14.8	22.7	7.2	6	3.7	7.4	14	36	2.7	1	0.6	29.3	33.8	22

Table 6 continued

	Area			Car					Motorcycle			Bicycle		
	Mean	Urban	Rural	Income Quintile					Area			Area		
				1	2	3	4	5	Urban	Rural	20 % Poorest	Urban	Rural	20 % Poorest
Mexico														
2008	28.6	33.3	10.6	7.8	14	21	33	58	3.3	2.9	1.8	14	24.3	18.6
Nicaragua														
2005	6.8	9.8	2.5	1.1	0.5	2.7	3.6	21	2.6	0.7	0.1	37.1	29.3	22.2
Panama														
2003	26.6	33	12.9	5.4	8.7	17	27	55	0.5	1.2	0.2	26	28.4	16.8
Paraguay														
2009	23.2	31	11.3	5.5	9.1	14	26	53	30.9	44.9	28.2			
Peru														
2009	9	12.3	2.7	0.7	2.2	4.4	9.1	24	4.4	3.7	1.8	32.5	24.4	20.7
Uruguay														
2007	31.4	30.4	45.6	7.8	17	25	35	55						
Venezuela														
2006	22.4	22.4		7.4	11	15	23	44						
The Caribbean														
Bahamas														
2001	72.5	72.5		49	62	75	80	89	1.3		0.8	25.7		19.4
Guyana														
2004	5.9	7.4	5	0.8	2.4	2.6	2.9	16	2.5	1.7	0.8	34.1	33.3	25.8
Haiti														
2001	3.2	6.7	0.9	0.7	0.9	0.9	0.5	10	1.2	0.8	0.5	11.7	12.7	7.6
Jamaica														

Table 6 continued

	Area			Car					Motorcycle			Bicycle		
	Mean	Urban	Rural	Income Quintile					Area			Area		
				1	2	3	4	5	Urban	Rural	20 % Poorest	Urban	Rural	20 % Poorest
2002	15.1	21.1	9.9	13	5.1	6.5	12	28	2	1.6	1.5	17.8	13.1	10.3

Source Socio-Economic Database for Latin America and the Caribbean, Center for Distributive, Labor and Social Studies (Universidad Nacional de la Plata) and the World Bank

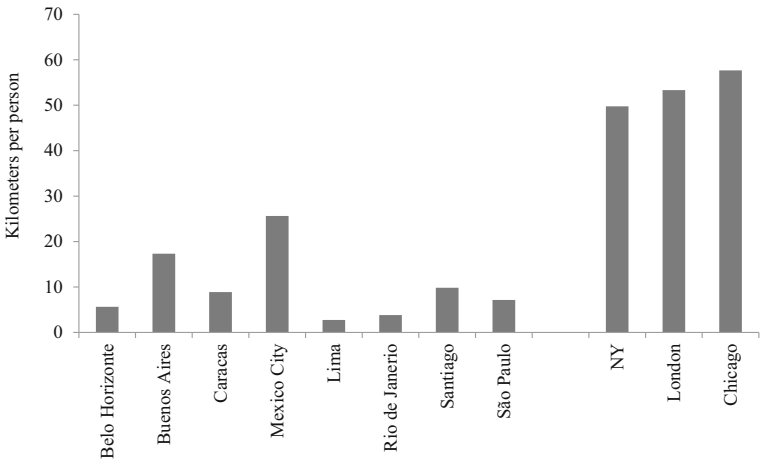

Fig. 4 Length of metro network (kilometers per person). *Source* Author's calculations based on data from CAF-OMU (2009); EMTA (2012); and Urban Rail (http://www.urbanrail.net)

ownership. Consequently, the urban poor rely strongly on public mass transport or nonmotorized transport (walking and cycling).

In many cities in LAC public mass transport is deficient. The coverage of metro lines and availability of passenger cars is very low in the region in comparison with developed cities (Fig. 4; Table 6).[6]

The cheapest mass public transport is the bus (CAF-OMU 2009), and it is used widely in LAC. However, the cost of bus fares (usually subsidized) consumes a significant proportion of the income of the poor. Figure 5 shows the cost of 50 bus rides as a percentage of a month's minimum salary for selected LAC cities, New York, and London. In LAC those earning the minimum wage (or less) spend 16 % (or more) of their salary on transport, while in New York and London that figure is around 5 %. So the burden of transportation on the expenses of the poor is very high in LAC.

From this section it can be concluded that LAC is an outlier among developing regions for its high urbanization rate. The region has many deficits with respect to housing and transport. Inequality in access to urban services is very high in some countries. Therefore, polices should facilitate access to the formal housing market and quality housing services for the poor. There seems to be an imperative need to improve mobility in LAC cities. Deficient public transit disproportionally affects the urban poor, as it hinders their socioeconomic development and conditions their housing choices.

3 Theoretical framework

This section employs a simple city model to provide a conceptual framework for the discussion on housing and transport infrastructure. We employ the traditional spatial Alonso–Mills–Muth framework (AMM) (Alonso 1964; Mills 1972; Muth 1969).

[6] There are no statistics about the quality of public transport (number of stops, frequency, reliability, security) for LAC. For Europe, see EMTA (2012).

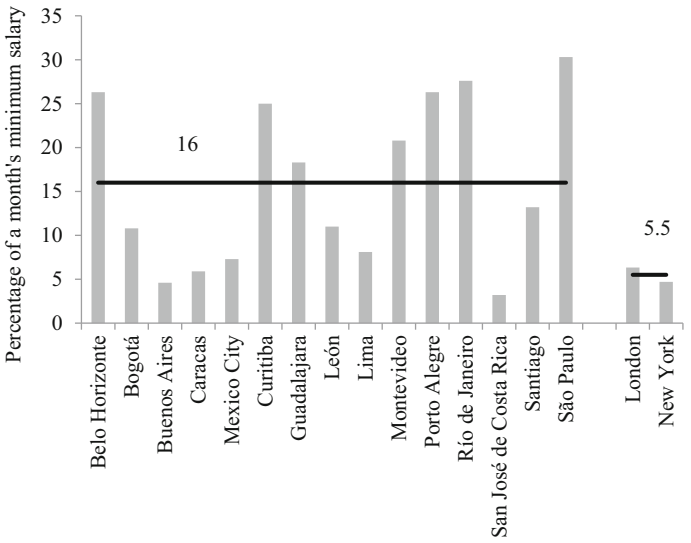

Fig. 5 Cost of 50 bus rides as a percentage of a month's minimum salary. *Source* Author's calculations based on CAF-OMU (2009) for Latin America and the Caribbean; US Department of Transportation, National Transport Statistics, for New York; and Greater London Authority statistics for London

The basic idea of the AMM model is that cities have a central business district where residents work.[7] To focus on residential housing choices, we assume that the central business district is collapsed to a single point at the city center (takes up no space).

There is a dense network of radial roads that are used daily by the residents to commute from home to work in the central business district. Let x be the distance from the house to the city center. Households are identical, of size one, and earn the same income working in the central business district (later we introduce heterogeneity). They consume a basket of two goods: c is consumption of a composite nonhousing good and q is consumption of units of housing services. This is a rental model, so q refers to rented housing services.[8] Most models use q as the area of the housing good consumed (square meters of the house rented), but we interpret q as a unit that measures housing services that is both the quantity and quality of the house (material of floors and walls, sanitation and water services, security of tenure, and other housing amenities). There is a level q_s below which a dwelling is considered substandard (for example, think of q_s as the threshold below which a household lives in a slum according to the criteria described in Sect. 2).

[7] Although the framework can be adapted to increasingly polycentric cities, it is also useful in terms of the main trade-offs households face when choosing their location within the city.

[8] It can be extended to ownership of housing.

3.1 Demand analysis

A household chooses the composition of its consumption basket, given its budget constraint, to achieve the maximum utility level possible. When choosing q, it will also have to choose x (location). The utility function is $U(c, q)$, strictly quasi-concave.

Each household earns an income y working in the central business district and incurs transport costs $T(x)$ that increase with the radial distance x from the central business district.[9] Commuting costs have two parts: the monetary cost (gasoline and car expenses or public transport fare) and the opportunity cost of the time spent commuting. For now we only include monetary costs and assume that there is only one transport technology.

After paying transport costs, the disposable income is $y - T(x)$, to be spent on nonhousing consumption c and on housing services q. The price of the composite nonhousing good is assumed to be the same everywhere and is set to be equal to US$1. The price of housing services is $p(x)$.

There is a maximum utility level that can be achieved by every household. Following Brueckner (1987), when substituting for nonhousing consumption in the budget constraint, the condition that the maximized utility equals U is

$$max_{(q)} v(y - T(x) - p(x)q, q) = U. \tag{1}$$

The condition for locational equilibrium states that all the residents should have the same level of utility in their locations. Otherwise, there are incentives to move to other areas that give a higher utility. To achieve this, the price of the housing services should vary according to the distance to the central business district. Housing services close to the central business district are more expensive, which offsets the expense that households located far away incur for commuting. This is a very important prediction of the model.

More formally, from Eq. (1) we can establish two conditions to find the solution for the unknowns p and q for every given x, and the parameters. The first-order condition for q is

$$\frac{v_q(y - T(x) - p(x)q, q)}{v_c(y - T(x) - p(x)q, q)} = p. \tag{2}$$

The second condition is that the resulting consumption must give utility U:

$$v(y - T(x) - p(x)q, q) = U. \tag{3}$$

There are multiple solutions for this system of equations. In Fig. 6 we can see two possible ones. For utility level U_1, at a given distance to the central business district x_1 we can plot a tangent budget constraint with intercept $y - T(x_1)$. The absolute value of the resulting slope of the budget constraint will be the price of the unit of housing services at that distance: $p(x_1)$. If now we consider rental housing

[9] For example, if residents pay $\$t$ per kilometer, we can represent the commuting costs with a linear function: $T(x) = tx$.

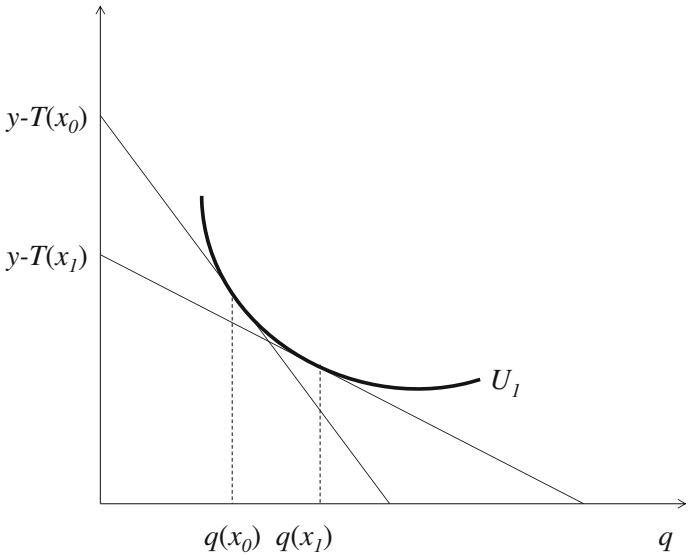

Fig. 6 Trade-off between the price of housing services and transport costs. *Source* Author's calculations

services at a distance x_0 (closer to the central business district), the intercept of the budget constraint would be $y - T(x_0)$ and its slope $p(x_0)$ would be steeper, meaning that closer to the city center ($x_0 < x_1$) the price of housing services is more expensive $p(x_0) > p(x_1)$.

Figure 6 already gives us a hint of the main relationships of interest: between p and x, which determines the price schedule of housing services within the city, and between q and x, which determines housing consumption within the city. We can get an expression for both of them by totally differentiating the last equation with respect to x and replacing $v_q(\cdot) = pv_c(\cdot)$. This very important relationship is called the bid-rent gradient and represents the main trade-off between the cost of housing and transport:

$$\frac{\partial p}{\partial x} = -\frac{Tx}{q}. \tag{4}$$

As the transport cost is an increasing function of the distance, the price of housing services is a decreasing function of distance x to the central business district (as shown in Fig. 6). Commuting cost differences within an urban area must be balanced by differences in the price of housing services.[10]

The other important relationship is between x and q:

$$\frac{\partial q}{\partial x} = \left[\partial \frac{\left(\frac{V_q}{V_c}\right)}{\partial q}\right]^{-1}_{u=U} \frac{\partial p}{\partial x} = \gamma \frac{\partial p}{\partial x} > 0. \tag{5}$$

[10] From Eq. (4) we can also deduce that as long as $T(x)$ is concave, the house pricing curve is convex: prices decrease at a faster rate the closer we are from the central business district.

The positive sign comes from the fact that γ is negative given the convexity of the indifference curves, and the derivative of the price of housing services with respect to the distance to the central business district is also negative (Eq. 4). This means that the further one moves away from the central business district, the more housing services one consumes.

3.2 Supply analysis

Brueckner (1987) provides one example for a supply-side analysis. In his model, housing services q are restricted to the size of the house rented. Building developers use a constant-returns-to-scale technology and there is free entry into this market. The model provides two key insights: (1) the height of buildings, and (2) the decrease in the rent of land according to the distance from the central business district. As a direct implication, it can be derived that population density also decreases with the distance away from the central business district.

The main predictions of this simple model up to now are the following: (1) prices of housing services decrease with the distance from the central business district to offset the fact that households in suburban areas incur higher transport costs; (2) households can consume more housing services far from the central business district, (3) the rental prices of land also decrease with the distance from the central business district to incentivize developers to build in suburban areas, and as a consequence developers get spatially uniform zero profits; (4) buildings are higher close to the central business district; and (5) the closer to the central business district, the higher the population density.

3.3 Extending the demand side to different income groups

Allowing for different income groups gives rise to different spatial sorting patterns that strongly depend on individual preferences (from which we abstract) and transportation costs. One interesting case is that of linear transportation costs, $T(x) = tx$, which are the same for all income groups. In this context one can show that the poor will live in the city center while the rich will move to the suburbs (Fig. 7). The rationale is that the poor consume less housing services and thus outbid the rich at locations closer to the central business district (see Hartwick et al. 1976 for infinite income groups).

This result of the concentration of the poor in the city center is, however, very sensitive to the assumption that transport costs are only monetary and all income groups use the same transport technology.[11] To see this formally, let there be two income groups, the poor P and the rich R. The poor have income y_P, the rich y_R and $y_R > y_P$. Both the poor and the rich consume composite good c_i and housing services q_i and $i = R, P$. Assume that there are two modes of transportation that

[11] Differences in preferences can also affect the sorting. For example, Brueckner et al. (1999) show that if the rich have preferences for amenities that are in the city center, such as historical buildings, they would sort closer to the central business district (like in Paris).

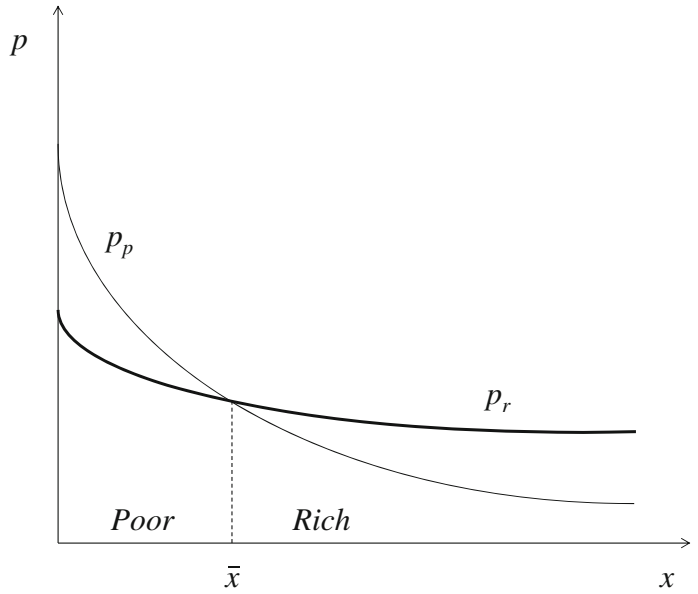

Fig. 7 Sorting of different income groups (with same transport costs per kilometer). *Source* Author's calculations

both income groups can use: public transport (e.g., a bus), with fixed cost f^b,[12] variable costs c^b per kilometer, and opportunity cost $t^b y_i$ per kilometer; or an automobile, which causes fixed cost f^a, variable cost c^a, and opportunity cost $t^a y_i$. We assume that the car is a more expensive mode of transportation than the bus, i.e., $f^a > f^b$, $c^a > c^b$, but is also faster, i.e., $t^b > t^a$. An individual of group I, choosing transport $k \in \{b, a\}$, then faces the following maximization problem:

$$\max U(q_i, c_i) \text{ s.t. } y_i - f^k - c^k x - t^k y_i x \geq q_i p + c_i. \tag{6}$$

As before, rich and poor have to be indifferent between the locations they choose. This is accomplished, in equilibrium, by the price being a decreasing function of the distance to the central business district x. Indeed, an application of the envelope theorem shows that the bid-rent gradient for an individual of group i using transportation mode k is given by (like Eq. 6)

$$\frac{\partial p}{\partial x} = -\frac{w_i t^k + c^k}{q_i} < 0. \tag{7}$$

It remains to investigate under which conditions members of the two groups use public transport or decide to use a car. Let x_i^* be the distance from the center where

[12] The introduction of fixed costs allows for a richer set of equilibria in that members of the same group may use different means of transportation (LeRoy and Sonstelie 1983).

the member of group i is indifferent between the two means of transportation. Clearly, x_i^* solves the equation $f^a + c^a x_i^* + t^a y_i x_i^* = f^b + c^b x_i^* + t^b y_i x_i^*$, leading to

$$x_i^* = \frac{f^b - f^a}{c^a - c^b + (t^a - t^b) y_i}. \tag{8}$$

Whenever $c^a - c^b + (t^a - t^b) y_i < 0$, it is never optimal to use a car for a member of income group i, while otherwise the use of a car is optimal for all locations $x \geq x_i^*$.

The sorting of the two different income groups depends on the means of transport they use, as this determines the bid-rent gradient.[13] Intuitively, the rich have a comparative advantage with respect to the poor to live in the city center, as their opportunity cost of time is higher. This comparative advantage is attenuated once the rich have access to a car, which provides a more efficient way of commuting. It seems thus reasonable to assume that there may be some parameter values for which the rich prefer to locate in the city center, whereas the poor live in suburban areas.

First, consider the case in which both income groups use public transport. The rich will live in the city center, while the poor live in the suburban area, if and only if the bid-rent gradient of the rich is steeper than the bid-rent gradient of the poor:

$$\frac{c^b + t^b y_R}{h_R} > \frac{c^b + t^b y_P}{h_P}. \tag{9}$$

If this is the case, the rich will outbid the poor until some distance $\bar{x}$ from the center. This condition is equivalent to saying that the elasticity of demand for housing services with respect to income is less than the elasticity of the marginal cost of transportation with respect to income (for empirical estimates of the elasticities involved, see LeRoy and Sonstelie 1983; Glaeser et al. 2008).

On the other hand, suppose that x_R^* (distance from the central business district where the rich are indifferent between the two modes of transport) lies within the city's boundaries (but x_P^* does not). Then the rich find it optimal at some distance to use the car. For the rich who use the car to live further from the center than the poor who use the bus, the following condition has to hold:

$$\frac{c^a + t^a y_R}{h_R} > \frac{c^b + t^b y_P}{h_P}. \tag{10}$$

Again this condition can be related to the elasticities of the demand of housing services and marginal transportation costs with respect to income.

3.3.1 Spatial sorting

Consider a situation where the poor never find it optimal to use a car, whereas the rich do find it best to use a car for distances $x \geq x_R^*$. Assume that Eqs. (9) and (10) hold. Then, depending on the parameters, there are two possible equilibria: in one

[13] We restrict attention to the demand side, in the spirit of LeRoy and Sonstelie (1983) and Glaeser et al. (2008). See Hartwick et al. (1976) for the results including the supply side as well.

equilibrium the innermost circle is inhabited by the rich. This is so because their bid-rent gradient is steeper when using the bus than the bid-gradient of the poor. The rich prefer to live in the center as it minimizes their opportunity cost from commuting. Around the rich center, there is a circle of poor who use the bus, which is encircled by a suburban area inhabited by the rich with cars. The existence of this latter layer is guaranteed by Eq. (10), which ensures that the bid-rent gradient of the rich using a car exceeds the gradient of the poor using a bus for sufficiently far locations.

A second possible equilibrium is one in which all the rich move away from the city center and only the poor live there. Intuitively this will be the case when costs for public transport are relatively high, which reduces the number of rich who want to use public transport. In this case, the poor compete so fiercely for the city center locations that all the rich prefer to move to suburban areas and use a car.

Figure 8 represents de price bid gradients for the different groups (subscripts) and means of transport (superscripts). The equilibria described are Fig. 8a, b, respectively.

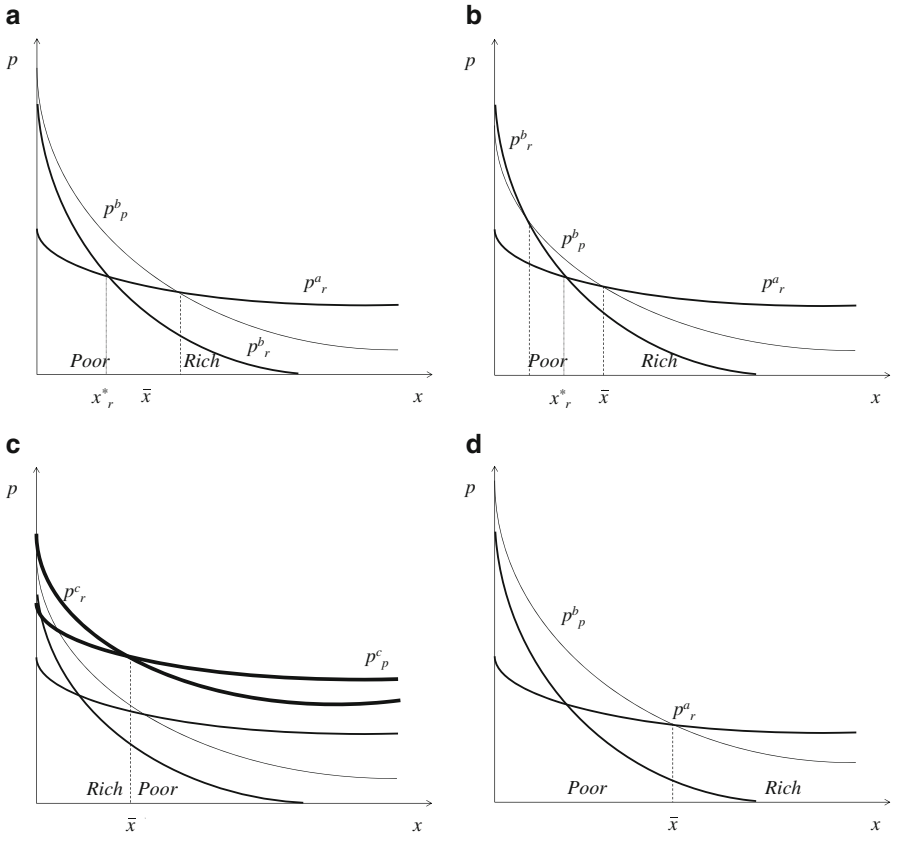

Fig. 8 Effect of transport interventions. *Source* Author's calculations

3.4 Public transport policies

We now consider how two alternative policy interventions affect the sorting of the groups in the city and the consumption of housing services. We show that making public transport more efficient (e.g., by introducing a faster means of transport such as a subway/train or rapid bus transport, or by lowering the price of the bus) can induce the poor to live further from the central business district and therefore have access to better housing services.

3.4.1 Introducing a more efficient public means of transport

Suppose we are in a situation in which the poor live in the city center and use public transport, whereas the rich live in the suburban area and use cars. Consider a government intervention that introduces a new means of transport such as a subway or rapid bus transport system (represented by c in Fig. 8c) that is both cheaper and more efficient than both the standard bus system and the car. In this case, both rich and poor will use the same means of transport. If Eq. (9) holds—that is, the elasticity of demand for housing services is less than the elasticity of the marginal cost of transportation—the rich will relocate to the city center, whereas the poor will live in suburban areas. This is due to the comparative advantage the rich hold because of their higher opportunity costs.

3.4.2 Decreasing the cost of public transport

Consider again the situation in which the poor live in the city center and use the bus only, whereas the rich live in suburban areas and use the car only. Lowering the cost of the bus, will increase the distance x_R^* that makes it worthwhile for the rich to use the car, whereas the poor will still take the bus for any distance. Reducing commuting costs for the poor will, ceteris paribus, lead to an increase in the demand for housing services from the poor, as this is a normal good (and lowering the transport cost for the poor is analogous to increasing their income). Consider then the poor living at the boundary with the rich. Having a higher income and a higher demand will increase the price bid for housing services at this location and thus the poor will outbid the rich. This is true for some area around the boundary. As a response, the rich at the boundary will be urged to move outward, thereby increasing the price at these locations. There are then two possible outcomes of this change: either the rich get concentrated in a smaller area of suburbia and suffer a utility loss whereas the poor's locations extend further from the center (Fig. 8d),[14] or some of the rich decide to relocate to the city center. Which of these two possibilities obtains depends on the magnitude of the decrease of bus transport costs.

[14] See Wheaton (1974) for a general equilibrium analysis of this possibility.

4 Policy priorities

Following the framework of the previous section, when the expected income in urban areas is higher than in rural areas, there will be an increase in the urban population and the equilibrium of housing supply and demand will be distorted. Excess demand for housing services will increase prices, which will in turn incentivize builders to expand the housing supply to reach a new equilibrium in a larger city.

There are market failures in the formal housing market for the poor that in reality prevent or delay this adjustment. The proliferation of slums in LAC after the rapid and unplanned urbanization of recent decades shows that there is a serious problem in access to formal housing by low-income segments of the population. Thus, formalization of the urban poor is the first policy priority studied.

The model presented clearly shows the trade-off between the price of housing services and transport costs. We also examined the importance of public transport policies in shaping the spatial sorting of income groups and affecting their consumption of housing services. If the public transit system is more efficient and/or affordable for the poor, according to the framework presented, we expect a decentralization of this group that would increase their capacity to consume housing services. Therefore, the second policy priority studied is improving transport networks to achieve a more sustainable and equitable transport system.

Enhancing access to formal housing and improving public transport for the poor can potentially avoid the formation of new slums and attenuate the growth of existing ones. However, there are still millions of people living in slums, so the third policy priority studied is slum upgrading to improve the living standard of people living in informal settlements.

4.1 Housing

4.1.1 Access to formal housing

When the formal housing market cannot cope with a rapid increase in demand, many poor migrants look for housing solutions in the informal market, including owning or renting a house or subdivision of a dwelling built illegally on irregularly developed land, or occupying land or dwellings in irregular places (usually in slums or squatter settlements).

To understand why the poor cannot access the formal housing market, supply and demand problems need to be considered. On the supply side, the private sector may not respond if it lacks incentives to go down-market, either because it is less profitable than serving wealthier markets, and access to credit and capital is scarce, or because there is unfair competition from informal land developers and from people who build their own homes. In addition, there may be constraints on scale, technology, or inputs (such as land availability), or regulation costs and taxes may affect the ability to produce housing units below a certain cost threshold.

On the demand side, the three main barriers are (1) insufficient purchasing power to transform demand for housing into effective demand, (2) the lack of satisfactory guarantees to qualify for mortgage loans, and (3) the lack of documentation to prove permanent earnings given that many low-income families work in the informal sector.

Bouillon et al. (2012) study the demand side in a sample of cities in LAC. They classify the affordability gap according to several constraints: low income, poverty induced if buying a house, high interest rate of mortgages, lack of documents to prove income, or high housing prices. They detect an overall gap of 43 % of households in 41 LAC cities. Insufficient income is the most common factor preventing households from affording a house in the formal market. In the most expensive cities, the main problem is the inability to document income and the high prices of private sector dwellings. The interest rate does not seem to be an important factor contributing to the affordability gap. Bouillon et al. (2012) show that the cities with the highest affordability gap are Caracas, Lima, Buenos Aires, São Paulo, Santo Domingo, San Pedro Sula, Managua, Rio de Janeiro, Curitiba, and La Paz.

Policies promoting income growth and redistribution policies in cities with high inequality are needed to mitigate the affordability constraint. Other solutions are supply-side programs, such as public housing and subsidies, or demand-side programs, such as housing allowances or cash transfers. Another alternative is to promote the rental market, which is far less popular in LAC than in the OECD countries.

The next section reviews the main policies applied to formalize low-income households.

4.1.2 Land titling and property rights

A common characteristic of slum dwellers is that they live in houses with unsecure property rights or they lack a title altogether. In the model, a house that has insecure property rights is represented by a q lower than q_s, where q_s is the housing services threshold below which a dwelling is considered substandard. This is a consequence of the lack of planning for urban growth together with the inability of land and mortgage markets to reach these populations. Besley and Ghatak (2009) classify property rights into two types: *use rights* (the owner's right to use a good or asset for consumption and income generation, and *transfer rights* (the owner's right to transfer a good or asset to another party as a sale, gift, or bequest). When property rights are effective, it means mainly that the ownership structures are well-defined.

There are two main channels through which effective property rights can affect economic development (De Soto 2001). The first is by encouraging private housing investments, as insecure property rights usually weaken the incentive for owners to make long-term capital investments or to plan for the future. Also, secured tenure is sometimes a precursor to public investment, since government agencies are more likely to invest in extending public services (e.g., water, drainage, or sewerage networks) once the dwellers regularize their temporary or illegal situation (Gulyani and Talukdar 2008). The second channel is related to the income-generation interpretation of the "use rights." Property rights enable owners to use their

property as collateral to secure loans. In turn, this credit can be invested as capital in productive projects, increasing labor productivity and income, or in further housing upgrades. The lack of property rights makes investments in untitled parcels highly illiquid. Moreover, it prevents poor families from the possibility of having a valuable insurance and savings tool that could provide protection during bad times and retirement, forcing them instead to rely on extended family members and offspring as insurance mechanisms (Galiani and Schargrodsky 2010).

In recent years, many governments throughout the developing world have undertaken land-titling programs that mainly involved titling public (or sometimes private) tracts of land to their current occupants (Galiani and Schargrodsky 2011). The evaluation of the causal effects of property rights, however, is a difficult task, as their allocation is typically endogenous. Usually, the allocation of property rights is not random but based on wealth, family characteristics, individual effort, previous investment levels, or other mechanisms that make the groups that acquire those rights different than those that do not. There is already a group of papers that overcome this identification problem by exploiting different quasi-experimental designs or natural experiments that provide exogenous sources of variation in land titles.

Galiani and Schargrodsky (2010) exploit a natural experiment in the allocation of land titles in Argentina. In 1981, squatters occupied a piece of land in a poor suburban area of Buenos Aires. In 1984, a law was passed expropriating the former owners' land in order to title the occupants. While some original owners accepted the government compensation, others opted to dispute the compensation payment in the Argentine courts, which are extremely slow. Both groups share the same household pretreatment characteristics, live next to each other, and inhabit identical parcels. Since the decision of the original owners to accept or dispute the expropriation payment was uncorrelated to the squatter characteristics, these different decisions by the former owners generated an exogenous allocation of property rights across squatters.

The authors find that families that received a title substantially increased housing investments (for example, the constructed surface increased by 12 %, while an overall index of housing quality rose by 37 %). Land titling also reduced household size to an average of 5.11 members compared to 6.06 members for families still living on untitled parcels. This was due to the fact that the titled households were more nuclear families (less presence of extended family members), and because of reduced fertility of the household heads. In addition, the children from the households that reduced fertility show significantly better educational achievement, with an average of 0.69 more years of schooling and twice the completion rate of secondary education (53 versus 26 %). No significant impact on labor market outcomes was found.

Regarding the impact of land titles on the credit market, the study found no effects on access to credit cards and banking accounts or to nonmortgage formal credit. Indeed, families in this area had very little access to formal credit (less than 10 % had access). Access to credit was higher for informal credit from relatives, colleagues, neighbors, and friends (41 %). However, titling status showed no effect

on access to these informal sources of credit and very modest effect on mortgage credits (only 4 % of the treated households had ever received a mortgage loan).

Another study of the effects of land titles using a quasi-experimental design is by Field (2005), who exploited the variation in ownership status induced by a nationwide titling program in Peru in which 1.2 million property titles were distributed to urban squatters on public land between 1996 and 2003. Making use of differences across regions induced by the timing of the program and differences across target populations in the level of pre-program ownership rights, Field performed a difference-in-differences analysis comparing the change in housing investment before and after the program among participating households with the change among nonparticipants. Field constructed a panel using cross-sectional data with retrospective questions. The results indicate that strengthening property rights in urban slums had a significant effect on residential investment: the rate of housing renovation rose by more than two-thirds of the baseline level.

As in the case of Galiani and Schargrodsky (2010), Field (2005) found that the greater incentives to invest were not associated with an improvement in credit access due to the titling program, but rather to a reduced threat of eviction. In particular, there was a significant increase in renovations financed out of pocket and in total investment among nonborrowing households.

Field and Torero (2003) relied on matching methods for their identification strategy using a survey of households in Peru with detailed credit information (they exploited the same Peruvian land titling program as Field). They found very small effects of titles on the credit market, with property titles associated with approval rates 12 % higher when titles were requested in public banks for construction material loans, and no relationship between titles and approval decisions otherwise. However, the authors could not rule out that this small effect was due to other unobservable characteristics affecting the creditworthiness of titled and untitled applicants.

Once again, exploiting the same quasi-experimental setting in Peru, Field (2007) examined the effect of land titles on the labor market. She found that households with no legal claim to property spent an average of 13.4 h per week maintaining informal tenure security, reflecting a 14 % reduction in household labor supply. Household members were also 40 % more likely to work inside of their homes. Field claims that the positive effect on employment was due to the reduced need to stay at home to informally secure it (home security demands), a need faced by the untitled. Galiani and Schargrodsky (2011) claim that the labor market context is important in interpreting the effect of titles on employment, since in the setting studied in Argentina the unemployment rate was very high, which could be the reason why they did not find an effect of titling on employment. Field (2003) also interprets her finding of a smaller household size for the titled as demanding less security. Another interpretation of smaller household size for the titled is that when there are no formal property rights, it is easier to keep informal property rights in case of divorce or death when the extended family lives in the dwelling. Also, households with secure rights can use the house as insurance for the future, whereas insurance for untitled households is provided through higher fertility and non-nuclear family members.

In summary, there is evidence that land titling programs have positive effects on housing investments, negative effects on household size, and positive effects on child education. Effects on the labor market are not conclusive. There is weak support for the hypothesis that land titling can have positive effects on capital investment because the dwelling can be used as collateral. The reason could be due to the very limited access of slum dwellers to the credit market. Another reason could be that the high legal costs of eviction and executing a mortgage might preclude mortgaged credit (Galiani and Schargrodsky 2011).

There are different types of land titling, and we still do not know which one is optimal for each case. More studies are needed to study the effect of different types of land titles and the degree of titling. UN-Habitat (2007), for example, advocates various interim occupancy rights such as granting nontransferable short-term leases, collective property rights, use of community land trusts, and protection against eviction. Galiani and Schargrodsky (2011) point out that the main decision should be in terms of individual recording or registration. Arruñada and Garoupa (2005) studied the relative efficiency of these two systems and found evidence that, at least in developed countries, registration is more efficient (with efficiency increasing with the frequency of land transactions).

4.1.3 Promoting home ownership for the poor

There has been a battery of supply-side policies to make housing affordable for low-income households in LAC. Unlike the case of land titling, however, there are scant evaluations on the effect of supply-side policies. The basic policy is to give the poor a new house at a subsidized price either where they live in substandard conditions or relocate them. This policy can be seen as an attempt to solve the housing problem through direct intervention in the form of a capital housing subsidy (UN-Habitat 2003).

These initiatives usually take the form of relocation programs in which households are allocated completely new, prebuilt dwellings at a small cost or for free. As such, these programs simultaneously incorporate a number of the elements of slum upgrading. In the 1970s it was the State in charge of building the housing, but in 1977 Chile pioneered an innovative program to give incentives to the private sector to build those houses and at the same time promote demand by providing subsidies to low-income households to buy them. The subsidy was allocated to families that were both poor and prepared to help themselves. The test of the latter was their willingness to accumulate savings; the longer their savings record and the greater their savings, the more likely they were to get a subsidy. Major elements of the Chilean housing subsidy model spread to other LAC countries, notably Colombia, Costa Rica, Ecuador, and Panama (Held 2000; Pérez-Iñigo 1999). In 1994, South Africa adopted a similar kind of policy (the Reconstruction and Development Programme) that provided nearly 2 million houses.

In Chile there was a massive investment in subsidized housing through which more than a million Chileans moved out of slum neighborhoods and become property owners (Salcedo 2011). Marcano and Ruprah (2008) performed an evaluation of the Chilean Progressive Housing Program, a public housing initiative that facilitates the purchase of a new home for low-income slum dwellers. The

evaluation found that the program's design (savings requirement, voucher, and mortgage) was inappropriate to target the poor. In addition, they found that although the program had significant positive effects on housing conditions (access to water, sewerage, and electricity), it had a negative effect on overcrowding, and had no discernible effects on welfare indicators (poverty, school attendance, occupation ratio, etc.). This could be due to high residential segregation, as the public housing was in remote locations very far from job opportunities. Following the analytical framework in Sect. 3, the poor would not move further out because they usually cannot afford the transport cost to go to work. Salcedo (2011) pointed to positive effects from this policy in terms of living conditions, but also noted concerns about stigmatization and social cohesion.

Another example of a relocation experience can be found in Cattaneo et al. (2006), who analyzed the performance of the Mexican We Start Your Home (*Iniciamos Tu Casa*) Program. This program involved providing new houses to poor inhabitants, but the houses were located far from the city center. A year after the program started, a large proportion of the participants had abandoned the houses; moreover, those who remained said that, although housing conditions were better, the new neighborhoods had poor access to public goods and general infrastructure.

Promoting home ownership is very expensive if the State has to subsidize the total value of the dwelling. An option usually available for medium- and high-income segments is a mortgage, which in the case of the poor can be partly subsidized. The problem is that the penetration of financial services among low-income groups remains very limited: the mortgage-debt-to-GDP ratio is 3 % in Brazil, 5 % in India, and 10 % in Mexico. In contrast, the ratio is 72 % in the United States (Magowan 2008). Among low-income groups it is more common to finance housing through informal channels, such as cash from relatives and friends or resources from cooperatives.

Some countries have implemented government-supported liquidity facilities, such as the Cagamas program in Malaysia, Sociedad Hipotecaria Federal in Mexico, and the Mortgage Refinance Company in Egypt (Hoek-Smit 2009). There are no rigorous evaluations of these programs, but the qualitative evidence available shows that these solutions might help solve housing problems, though they do not seem to work for the very poor either.[15]

We conclude that promoting house ownership should be in situ or close to the central business district. Incentives to the private sector to build cheap houses in scale would help increase the supply of housing for low-income families. The location of the new houses is key for the success of the program. Still, access to the financial market is very limited for the poor, so liquidity facilities are of little help for this population segment.

4.1.4 Promoting the rental market

Historically, governments in LAC have focused on home ownership. The reason for this can be based on a perception that home ownership brings about greater

[15] See Gonzalez Arrieta (1999) for more examples.

satisfaction with life, more housing investment, more neighborhood cohesion, and ultimately better labor outcomes. However, there is no conclusive empirical evidence of this. As detailed in Sect. 2, the rate of home ownership is very high on average in LAC in comparison with other regions (UN-Habitat 2003). The rental sector in most LAC countries is small—typically less than one-fifth of all households rent (IDB 2012).

To promote the rental market, there should first be units available for rent for poorer population segments. In the developed world there have been programs that built public housing to rent to low-income families. Those dwellings are usually managed by local authorities and the rents are capped to a certain percentage of the income of the household. In the United States this has been a popular and by all accounts successful policy (Sinai and Waldfogel 2005). However, some authors point to the deterioration of this type of accommodation over time, as the dwellings are sometimes poorly managed and located in disadvantaged neighborhoods (O'Sullivan 2009).

Another supply-side policy used in the United States has been preferential tax treatment for the construction of low-cost rental units. A very popular US program has been the Low-Income Housing Tax Credit (LIHTC), which was introduced in 1986 and has since expanded. The LIHTC is an indirect federal subsidy that gives tax incentives for investors in affordable housing by reducing upfront costs. The program has created 75,000 new apartments annually in recent years and is considered one of the most successful rental supply programs (NAHB 2011). European countries have used other programs to encourage private investment in affordable housing, such as preferred interest rates or direct grants.

On the demand side, OECD countries have used two strategies: rent supplements and housing allowances (Andrews et al. 2011). Rent supplements top up the remaining cost of the rent after exceeding 30 % of the household income (Bouillon 2012). Housing allowances are vouchers that can be used in any place and do not require any direct contract with a landlord. It is possible to have minimal condition or size standards to ensure the program is not supporting poor quality housing. The subsidy payment similarly uses a percentage of income, such as 30 %, but adds another element, which is a "percentage of gap" between the 30 % level and actual market rent. Usually both strategies coexist.

An interesting rental voucher program was Moving to Opportunity (MTO), launched in 1994 by the US Department of Housing and Urban Development. Its goal was to make housing in better neighborhoods affordable to low-income households. Even though its focus was not on access to housing, it is worth reviewing this program given its design and results. The idea was to improve the employment, education, and health of low-income families living in poor neighborhoods with poverty rates of 40 % or more by providing them with residential mobility. Over 3 years, roughly 4200 families from five major cities—Baltimore, Boston, Chicago, Los Angeles, and New York—were recruited to participate. MTO allocated vouchers to occupy houses in better locations (with less than 10 % of poverty incidence). The winners of vouchers (treatment group) were compared to families that did not win the lottery (control group).

Results from MTO were mixed. Katz et al. (2001) showed that those offered vouchers experienced improvements in multiple measures of well-being relative to the control group, including safety, health, and behavioral problems among boys. There were no significant short-run effects of vouchers on the employment, earnings, or welfare receipt of household heads. Katz et al. (2005) found mixed effects on crime while Katz et al. (2007) found that 4–7 years after the lottery, families offered vouchers lived in safer neighborhoods than families not offered vouchers. The program also improved the mental health of adults and young women but no change in economic self-sufficiency was identified.

Galiani et al. (2012) analyzed the MTO program by combining the experimental data with a structural model to estimate a location choice model. The authors used the random variation in the rents of households to estimate the model. They performed interesting policy exercises to investigate whether more stringent location restrictions are successful in changing exposure to certain neighborhood characteristics, such as a low poverty rate in the neighborhood of residence. In the case of the MTO program, the poverty rate for the receiving neighborhoods was less than 10 % and take-up was around 50 %. Galiani et al. (2012) estimate that only 13 % of households would use the subsidy under a more stringent restriction that limits subsidy use to neighborhoods with a poverty rate under 5 %. An important implication of this is that more stringent location constraints designed with the goal of exposing the target population to lower neighborhood poverty rates could end up reducing the take-up of the program and the average poverty rate to which the treated group is exposed to (due to less take-up).

The aim of the MTO program was to expose households in poor neighborhoods to a better environment, rather than improve the housing infrastructure. In practice, a program like this is very unlikely to be carried out in LAC. Mixing the population from "good" and "bad" neighborhoods would indeed decrease the segregation measures and negative neighborhood effects. However, for relocation interventions to be sustainable, slum dwellers would need to have incentives to stay in the new location (such as economic opportunities and better urban services). In the developing world there have been no experiences of moving households to low-poverty neighborhoods (like the MTO program), but as described before, in some circumstances efforts were made to move entire slum populations to a safer area. Such experiences have proven costly in social and financial terms.

4.2 Transport systems

Transportation is a pillar of economic development and affects the productivity and spatial patterns of cities in many dimensions. First, following the analytical framework of Sect. 3, transport costs together with the price of housing services determine the location of households in cities. As stated earlier, there is a trade-off between the price of housing services and transport costs.

Second, the process of rapid urbanization has resulted in an increase in transportation demands (Gilles and Turner 2012). Problems with road congestion and pollution have come up, and these problems are more severe in LAC than in other regions that did not experience exponential motorization. The framework of

Sect. 3 took into account the individual cost of transport (in terms of money and opportunity cost of time). However, when one person more commutes by car, there is a negative congestion externality, as traffic is slowed down. Thus, in the model, the private cost of commuting is lower than the social cost. (See Brueckner et al. 2011 for an extension of the model to the theoretical include congestion.)

We detail different ways of correcting the market failure brought about by congestion. Regarding the first impact of transport systems, we review alternatives to eliminate the urban divide and improve the links from poor suburbs to city centers, as well as policies that improve transport infrastructure.

4.2.1 Sustainable urban transport

First let us consider all the transportation options available in cities. There are four types of urban modes of transport: (1) motorized private transport, typically cars; (2) nonmotorized transport, including nonemission modes of transport such as bicycles, rickshaws, and walking; (3) formal public transport, which encompasses services available to the public that run on pre-set routes and timetables with set fares, and that include buses, tramways, metros, suburban rail, and waterborne transport (ferries, boats); and (4) informal (motorized) transport, including privately owned vehicles whose operators often lack necessary permits or do not meet requirements for vehicle size, insurance coverage, or driver standards.

The current level of motorized private transport use is not sustainable because it generates pollution and congestion and hinders human and economic development in cities. In particular, in LAC vehicle ownership has increased hugely as a consequence of economic growth and social progress. The average number of motor vehicles per capita in 1990 was 0.09; by 2008, it had risen to 0.20, which increased traffic and slowed down commuting speeds (Freeman et al. 2013).

The approach to transport has traditionally been focused on mobility. To attain a sustainable transport system there should be a paradigm shift to favor access rather than mobility, focus on efficient and fluent modes of transport, and promote low-carbon and clean vehicles and fuels (Hidalgo and Huizenga 2013). This paradigm involves three types of actions: avoiding long and unnecessary motorized travel, shifting the movement of goods and people to the most efficient modes of transport, and improving the technology and operational management of transport services (Dalkmann and Brannigan 2007).

Following the framework in Sect. 3 we can see that intervention in the transport system is needed to internalize the social cost of congestion in the private cost of transport considered in the model. Some governments have either implemented travel demand management policies or have considered ways of directly reducing the number of vehicles in congested areas.

To date, travel demand management measures in LAC have been mainly vehicular restrictions and the promotion of public transport modes. The types of administrative restrictions applied have consisted mostly of monitoring license plate numbers. These experiences have proven unsustainable in the medium and long term or have had negative effects (Ide Carvallo and Lizana 2011). Examples of such policies have been the plate restriction mechanism imposed in Mexico City's No

Driving Today (*Hoy no Circula*) Program, which has actually increased air pollution and increased the hours worked by the huge taxi fleet to replace car trips (Davis 2007); the No Car Day (*Dia sin Carro*) in Bogota, which has resulted in a significant social loss for car users (Cantillo and Ortúzar 2011) and has not reduced pollution given the poor quality of public transport (Ide Carvallo and Lizana 2011); the Vehicle Restriction (*Restriccion Vehicular*) Program in Santiago, which reduced traffic by one-fifth of the expected effect (De Grange and Troncoso 2010); and the *Estadual Rodizio* Program in São Paulo, which increased the car fleet (Biezus and Oliveira Rocha 1999). The Vehicle Restriction (*Restriccion Vehicular*) Program in San Jose, Costa Rica and the Peak and Plate (*Pico y Placa*) Program in Medellin are similar examples that have not been successful (Ide Carvallo and Lizana 2011). *Pico y Pala* in Quito has had mixed results.[16]

On the other hand, examples of travel demand management policies in developed cities can be found, for example, in Singapore (vehicle registration caps and dynamic congestion pricing), London (congestion pricing), Milan (air pollution pricing), and San Francisco (parking controls with dynamic pricing). While in LAC travel demand management policies have mainly involved road rationing through "command-and-control," in the developed world incentive-based policies are more common.

Congestion pricing is a very popular travel demand management measure that encompasses a set of strategies and techniques aimed at imposing charges that effectively discourage motorists from entering a congested area during certain periods of high traffic congestion (Hau 1992; Vickrey 1969). The concept behind congestion pricing is to charge those using private cars with the negative externality they produce by slowing down the traffic and producing more pollution. It is assumed that people would make socially efficient decisions if they fully consider the social costs and benefits. The optimal congestion tax is the marginal external cost at the point where the marginal social cost is equal to the marginal social benefit (Button 1993). In practice, an analysis of pricing schemes ensures that congestion taxes are appropriately set.

Multiple forms of congestion pricing have been implemented, including schemes covering the inner city (as in London), a significant part of the metropolitan area (as in Singapore), or a wider perimeter area (as in Oslo). These strategies have been effective in reducing congestion and pollution. For example, the congestion charge in London reduced the number of private cars, vans, and trucks coming into central London between 2002 (year of introduction) and 2003 by 27 %. There was a drop by 33 % in inbound car traffic (65,000–70,000 trips that are no longer made),[17] a decrease in traffic congestion, and an increase in the mean speed in the inner city (Leape 2006). It is important to highlight that in London there are very fast and accessible alternatives to private cars, such as the metro (tube) or a wide coverage of buses.

[16] See Carrillo et al. (2014) for positive findings about *Pico y Pala*; see also Ide Carvallo and Lizana (2011).

[17] In 2003, London imposed a daily charge for driving or parking a vehicle on public roads within central London. Today the congestion charge is £10 daily between 7:00 a.m. and 6:00 p.m. on weekdays to enter the congestion price zone.

Although incentive-based travel demand management seems to have been successful in reducing congestion and pollution, there are barriers that currently prevent it from being widely adopted in LAC. These include implementation of a sophisticated tracking system to enforce it and the development of efficient alternatives to private motorized transport (Rogat et al. 2009).

In the past decade, the development of sustainable transportation programs based on public transport has become popular in LAC. There are no rigorous studies, but the descriptive evidence shows that such programs have had positive results in reducing pollution and traffic in some Latin American cities, such as Bogota, Mexico City, and Santiago. Among these programs, the two main types are initiatives for mass transit using rapid transit bus systems and the use of bikes. For example, Brazil and Colombia implemented major transport policies based on cycling promotion that integrated cycling lanes into the public transport network (Bicycle Brazil, and *Ciclorutas* in Colombia), and rapid bus transport. Chile has focused on improvements of public transport with rapid bus transport within the Transantiago Plan.

Countries included in the Sustainable Transport Forum (*Foro de Transporte Sostenible*—FTS) survey carried out by the United Nations Centre for Regional Development and the Inter-American Development Bank reported 42 cities with mass transit (rail and rapid bus transport) and 327 cities with bike lanes (85 % in Brazil) (UNCRD-IDB 2011). In terms of total kilometers, the largest mass transit availability is in Brazil, with 829 km of suburban railway, 278 km of metro, and 80 km of rapid bus transport in 16 cities. Argentina has the largest suburban rail network (830 km). The largest extension of rapid bus transport corridors is in Colombia (386 km in six cities). Availability of mass transit ranges between 2.2 and 41.6 km per million urban inhabitants (Peru and Chile, respectively) to no mass transit. Availability of bike lanes ranges from 2 to 15 km per million urban inhabitants (Mexico and Brazil, respectively). While the length of metro and suburban rail systems has not grown substantially in the past decade in LAC, both rapid bus transport and bike lanes have grown explosively.

Bocarejo and Oviedo (2013) analyze the rapid bus transport network, Transmilenio, in Bogota. While urban sprawl has been the general growth pattern in most developing cities worldwide, Bogota has undergone a process of densification in specific areas in the past decade. Using a differences-in-differences methodology, Bocarejo and Oviedo (2013) show that the Transmilenio, built during that period, is one of the variables that account for this higher density. Areas served by Transmilenio, especially those in the periphery that have been provided with feeder bus routes, have higher growth than zones without access to this system.

There are descriptive studies on other rapid bus transport systems in LAC that have had mixed results. The evaluation of Metrobus in Mexico City by Global Mass Transit Research (2009) showed that the operation of Lines 1 and 2 of the Metrobus has produced an important decrease in pollution (less emissions). In addition, both lines have brought commuter time savings of 30 %. On the other hand, reports on Metrobus-Q in Quito and Transmilenio in Santiago show mixed results (Ide Carvallo and Lizana 2011).

4.2.2 Integration of the urban poor through transport

Geographical segregation is a major problem affecting the income opportunities of slum dwellers. Slums are usually "bad" neighborhoods with deficient services (urban infrastructure, health, education, etc.), social and economic violence, and limited working opportunities. Usually the jobs available are unstable, informal, and have low productivity. Wealthier neighborhoods of the city, on the other hand, have more economic opportunities but are hard to reach for some low-income households. Sometimes the transport links are deficient or nonexistent; other times the slums are located in areas far from the city center. The social stigma of slum dwellers because they live in deficient housing is also a factor reducing their possibilities in the city. Geographical segregation is just one aspect of social (and, in some countries, racial) segregation endured by slum dwellers. For example, Perlman (2003) provides evidence from slums in Rio de Janeiro suggesting that the stigma of having a residential address in a squatter settlement has adverse consequences on the probability of getting a job.

Public transit has a key role in socially and physically integrating the urban poor into the formal city. Mobility is one of the main factors that reduce social exclusion (Vella-Brodrick et al. 2011). In recent years large infrastructure projects have been undertaken in LAC cities to reduce the immense divide between prosperous areas and slums. An example is the inauguration in December 2011 of the giant outdoor escalator to Medellin's slum, Comuna 13. The 1260-foot escalator, built at a cost of US$6.7 million, has shortened the 35-min hike on foot up the hillside to get to Comuna 13 to a 6-min ride. The Metrocable in Medellin and the Transmilenio in Bogota are aimed at similar purposes. In Rio de Janeiro, a six-station cable car line inaugurated in 2011 runs above a collection of favelas known as the Complexo do Alemao and carries an estimated 30,000 people a day along a 2.1-mile route. This US$74 million urban gondola line has transformed what used to be an hour-and-a-half journey into a 16-min sky ride. The extent to which geographical segregation was alleviated by these innovations, and their effect on housing and other socioeconomic outcomes has yet to be studied.

Apart from these large infrastructure projects, other reforms in public transit can shape the spatial patterns of a city and the housing choices of the urban poor. First, the trend to demotorize large cities can help the poor if it increases cycling and walking space in city centers and promotes affordable public means of transport (such as rapid bus transport). To integrate the poor via transport, a very careful diagnostic study should first be performed to assess whether the current transport network is in fact inaccessible (does not reach poor areas) or unaffordable.

As shown in Sect. 2, public transport in LAC is relatively more expensive than in the developed world in terms of its proportion of the minimum wage. In many African cities, commuting by public transit costs between 26 and 50 % of the poor household's income (Cervero 2011). In the United States, Roberto (2008), using data from 2000, found that the 10 % poorest spent twice as much share of their income on commuting to work than the 10 % richest (6.1 versus 3.8 %).

The relevant question is which share of income is reasonable to be spent in transport costs. Cervero (2011) concludes that there is a consensus around the

acceptable levels proposed by Armstrong-Wright (1986): no more than 15 % of annual income should be spent on transport. Transport fares worldwide are subsidized, but for the poor the burden is still too high. Targeted subsidies seem to be an appropriate policy to reach the right groups and increase access to jobs. For example, South Africa uses highly subsidized weekly coupons—each for 10 journeys between black townships and industrial development areas—to connect low-income groups to jobs. Brazil requires formal sector employers to provide transit tickets to employees through a system called *Vale Transporte* (VT). Firms then deduct the VT expenditures from taxable income. The VT system effectively spreads the cost of transport subsidies between employers and the government, though it only affects those employed in the formal sector.

Mass transport (rapid bus transport, rails, subways, trams), when adequately planned and implemented, has the potential to alleviate congestion and pollution, and can particularly benefit the poor, who rely most on these means of transport to commute to work. Accessible and affordable transport can have a wide range of positive effects. For example, Stanley et al. (2011) show that mobility improves well-being. The effects of such transport on the consumption of housing services and access to the labor market are of particular interest, but those effects have not been widely studied. The effect of public transport expansion on employment has been studied in the United States, with evidence showing that improving access to jobs reduces the probability of asking for public assistance and increases the likelihood of getting a paid job for unemployed adults and welfare recipients (Sandoval et al. 2010). Kawabata (2003) shows a positive effect of access to transport on being employed among low-skilled workers in San Francisco. In sum, mass public transit is key to shaping the spatial sorting of citizens, and has the potential to improve housing and labor market outcomes. Therefore it should certainly be promoted in LAC.

4.2.3 Transport infrastructure

The improvement of transport infrastructure, such as repairs of roads and highways, is a common supply-side policy to upgrade the transport system. In an urban context, street paving has multiple functions: it facilitates vehicle, pedestrian, and cyclist movement and access, provides accessible space for vehicle parking, allows commercial vehicles to deliver goods, and has a significant impact on the visual appearance of the area. However, it can also lead to congestion.

Gonzalez-Navarro and Quintana-Domeque (2010) studied a randomized field experiment in Acayucan, Mexico, in which the city expanded its pavement grid over time via street asphalting projects. Given that the municipal administration could afford to pay for only 28 of the 56 projects in 2006, it was agreed to select the 28 streets to be paved at random. The follow-up was conducted almost a year after the intervention and focused on households that were present both before and after the intervention. They found that street paving led to a doubling in the average number of home improvements in which a household engaged over the previous 6 months (from 0.4 to 0.8 improvements). Furthermore, there was a 50 % increase in the likelihood that the family had purchased materials for home improvements in the

previous 6 months and an increase in the number of durable goods and motor vehicles acquired. The rise in motor vehicle acquisition can also be explained by complementarities with street paving. However, street paving has no statistically significant effect on monthly per capita expenditure (nondurable consumption). Street paving increased home prices, though these estimates do not adjust for the improvements in the house driven by the intervention itself. Street paving also increased the percentage of individuals who used collateral-based credit from about 2 % among the control group to nearly 5 % among the treated group.

4.3 Housing infrastructure

In light of the growth perspectives of LAC cities, promoting access to the formal housing market and improving mass public transit for the poor could eventually prevent the formation of new slums and perhaps help reduce the size of existing ones. However, some slums may persist if the poor prefer locations that are closer to the city center.[18] Also, slums may continue to grow because poverty traps impede migrants from moving to a better location, despite the intention of the poor when they move to the city to live in a slum only temporarily (Marx et al. 2013).

Following the framework of Sect. 3, families moving to the city that choose to live close to the central business district will have a level of housing services below q_s. An important part of the compound variable q is housing infrastructure. The urban poor live in housing with inadequate services, which poses a risk to their health, security, and socioeconomic development. Low living standards pose hazards to development.

To start with, adequate housing protects households from the negative effects of the environment: proper roofs and walls shelter household members from rain and cold (Galiani et al. 2013). Safe water and sanitation facilities, as well as nondirt floors, are important to protect dwellers against parasitic infestations and infections. Deficient facilities contribute to acute respiratory diseases and diarrhea, among other infectious waterborne diseases (e.g., tuberculosis, hepatitis, dengue, pneumonia, cholera, and malaria) (Luby et al. 2004). In addition to these health issues, overcrowding increases the possibility that contagious diseases will spread within the household when one member falls ill.

Children are the most affected by inadequate housing facilities. Galiani et al. (2005), for example, show that safe water reduces child mortality. The damage from childhood diseases and malnutrition can be irreversible. Children often miss school due to illness, and anemia can make them permanently lag behind in their cognitive development (Cattaneo et al. 2009). Adequate housing also provides security against crime, a major problem in slum areas. Proper housing can enable families to accumulate assets and free up their time from protecting assets in order to engage in more productive activities (Field 2007).

For all these reasons, adequate housing is critical for health, child development, and household productivity, which in turn contribute to a better quality of life. Moreover, proper housing can induce a sense of dignity. Thus, housing quality has a

[18] See Galiani et al. (2013) for empirical evidence on the heterogeneity of preferences among the poor.

strong impact on life satisfaction, which can be broadly defined as a person's level of happiness with all aspects of life. It is natural that the houses and neighborhoods where people live are major factors influencing their life satisfaction. Surveys and studies reveal that in LAC, people's satisfaction with the homes and cities where they live is a main determinant of their overall life satisfaction (Lora et al. 2010).

Several approaches have been tried to address the problem of slums. The first has been the "eradication" strategy, which has proven expensive (assuming governments can provide homes for the displaced population) and socially disruptive. Then, in the 1970s a popular approach was "site-and-services," which provided urbanized lots for families to build their homes progressively away from slum areas. This approach has also been criticized for being incomplete and leaving families worse off as they lost their social capital, than they were when they lived in the original slum area. Since the 1980s, local and central governments have increasingly undertaken in situ slum upgrading based on the notion that it is both socially and economically more desirable. In situ upgrading and improvement programs have the goal of integrating low-income communities into the formal city and the housing market. The main advantage of in situ slum upgrading is that it maintains the social networks of the dwellers and the cohesiveness of the community because residents remain in the same location, but under better living conditions (Abdenur 2009). This approach has led to the implementation of a variety of programs, from those that deal with land tenure to fully integrated programs.[19] The next section analyzes different types of programs to improve the housing services of the urban poor.

4.3.1 In situ housing infrastructure upgrading

To improve the living standards of the poor, there is consensus that upgrading infrastructure for water, sanitation, and hygiene should be the priority because of the health issues involved, especially for children. Diarrhea is closely related to poor living conditions and is estimated to be the cause of 21 % of deaths of children under 5 years of age in developing countries, accounting for 2.5 million deaths per year (Kosek et al. 2003). Unsafe water supply and the lack of proper sanitation facilities, together with poor hygiene practices, cause approximately 88 % of all diarrhea infections worldwide (Evans 2005). This problem is more severe in slums, as they are densely populated environments in which where infections propagate easily.

Galiani et al. (2005) found that improving the quality of water through the privatization of water supply decreased child mortality in Argentina. Also, the promotion of safe hygiene practices and improved sanitation are effective in improving child health (Luby et al. 2004; Hutton and Haller 2004). Luby et al. (2006) found positive results for reducing diarrhea from the effects of combining drinking water treatment and hand washing for prevention.

Access to infrastructure is usually a principal component of comprehensive slum upgrading programs. Making infrastructure work for the poor requires promoting access and ensuring that consumption is affordable. Better access can involve

[19] See Jaitman (2012) for a comprehensive review of slum upgrading programs.

reducing connection costs, increasing the number and types of suppliers, and requiring operators to promote access. Affordability can involve reducing actual bills and service costs and facilitating easier payments. There is evidence of low demand for some services due to a lack of information regarding the positive effects of better facilities, or because the use of those services involves changes in habits (Banerjee and Duflo 2011). In addition, the lack of formal land tenure is often cited as a cause for not investing in housing upgrades, as untenured households fear eviction (Galiani and Schargrodsky 2010). There is also a growing literature on the willingness to pay for such services in Asia and Africa. Ashraf et al. (2010) and Kremer et al. (2009) conducted randomized experiments in Zambia and Kenya, respectively, and found low willingness—in terms of money spent on chlorine or time spent on collecting water—to pay for improved water quality.

More studies are needed to increase access to better services and promote the uptake of new technologies that can have positive direct effects on health. The problem is complex because the provision of these services also involves collective action problems, as there are usually positive or negative externalities of individual take-up in the community that influence willingness to pay and other factors. For example, to implement a program that extends sewage or water connections, a minimum amount of households need to be willing to adopt the service. Duflo et al. (2012) describe the barriers to adoption of water, sanitation, and hygiene interventions, especially in Africa and Asia.

There are a set of papers that study the impact of housing improvements on a wide range of outcomes and that exploit experimental or quasi-experimental. They include Galiani et al. (2013) on the effect of prefabricated housing interventions, Cattaneo et al. (2009) on the effect of replacing dirt floors with cement floors, and Devoto et al. (2012) on the effects of piped water connection.

Galiani et al. (2013) assess the impact of providing better houses in situ to slum dwellers in El Salvador, Mexico, and Uruguay. The authors experimentally evaluated the impact of an initiative called A Roof for My Country (*Un Techo Para Mi País—UTPMP*), a youth-led program that provides basic prefabricated houses to extremely poor populations in LAC. UTPMP budget and personnel constraints limit the number of housing units that can be upgraded at any one time, so beneficiaries are selected through a lottery system. Galiani et al. (2013) rely on a randomized controlled experiment to evaluate the effect of upgrading houses in slums, thus reporting internally valid. In addition, as the same experiment was replicated in three different countries with very similar results, it can give us a hint of the external validity of its estimates.

UTPMP houses are made of wood (Mexico and Uruguay) or aluminum (El Salvador).[20] A typical house is 18 meters squared and is built by teams of youth volunteers working alongside the beneficiary household. UTPMP dwellings offer significant improvements for the poor population targeted in terms of flooring, roof, and walls, but it should be borne in mind that the homes do not come with water and

[20] The UTPMP works in 18 Latin American countries. The evaluation performed by Galiani et al. (2013) examined the programs in El Salvador (2007–2008), Mexico (2010), and Uruguay (2007–2008).

sanitation connections or bathroom or kitchen or amenities such as plumbing, drinking water, or gas.

As expected, the program substantially improves the quality of floors, walls, and roofs, as well as the share of rooms in the house with windows. Living in a better house can on itself be a source of satisfaction, dignity, and pride, aside from other dimensions such as health, education, or labor outcomes. Galiani et al. (2013) found that families reported being significantly happier with their houses and their lives. The gains were substantially larger in El Salvador, where houses were in worse conditions before the treatment, than in Uruguay and Mexico. However, the study also found that families did not further improve their houses as a response to the improvements made under the program. In particular, there were no significant effects on access to water, electricity, sanitation, or the possession of assets.

The estimates show that in El Salvador all self-reported measures of security increased substantially—the increase in the index for security inside the house was around 30 % and that for whether it is safe to leave children alone was about 90 %. On the other hand, no effect was detected in Uruguay or Mexico. The authors did not find an effect of the program on victimization rates in any country.

Galiani et al. (2013) examined whether a better house could directly or indirectly stimulate labor supply and earnings and did not detect significant effects on any labor market outcomes. They did find positive effects on child health measured by reduced diarrhea prevalence in El Salvador and Mexico. This could be due to having a cleaner and better ventilated dwelling provided by the program.

In summary, it seems that better houses in situ for slum dwellers in El Salvador, Mexico, and Uruguay improve satisfaction with the quality of life. Perceptions of security changed for the better in El Salvador, and there seems to have been a positive effect on child health in El Salvador and Mexico. However, the program had no significant effect either on the possession of assets or on labor outcomes.

Cattaneo et al. (2009) investigated the impact of a large-scale program, called Solid Ground (*Piso Firme*), undertaken by the Mexican government to replace dirt floors up to 50 m^2 with cement floors. Dirt floors are a threat to health because they provide a vector for parasites to infest people, especially young children, since fecal matter tends to remain on the floor (difficult to spot and clean). To identify the effects of this intervention the authors took advantage of the geographic variability in implementation of the program that started in 2000 some states were treated but neighboring states were not. The treatment areas were high-density, low-income urban neighborhoods, and eligible households had to have dirt floors and be able prove home ownership prior to participating in the program. The households already had water and sanitation facilities. The program covered the cost of the cement, while households supplied the labor input needed to prepare and install the floor.

The study found that replacing dirt floors with cement floors interrupts the transmission of parasitic infestations and reduces the incidence of both diarrhea and anemia. Reduction in anemia is expected to have positive effects on cognitive development. In fact, the study found that children in treated households performed significantly better on child development tests. However, an alternative pathway could have been through the program's effect on economic resources. *Piso Firme* provides a benefit amounting to approximately US$150, which is equivalent to

about half a month's income. If a beneficiary household had already decided to save and invest in cement floors, it could have used the resources freed up by this in-kind transfer to increase consumption or to make other kinds of investments, such as additional housing investments that could affect health outcomes or in microenterprises that might increase household income. The authors rule out this channel, as they show that the program is not associated with the value of houses (treatment households did not consider their houses to be more valuable than control households did), with changes in income, or with total consumption. Also, the program did not have the effect of encouraging households to make additional improvements to their houses.

A main result of the *Piso Firme* intervention, as described in Cattaneo et al. (2009), is that following implementation of the program adults were substantially happier, as measured by their degree of satisfaction with their housing and quality of life, and had significantly lower scores on depression and perceived stress. The reasons adults were happier may have to do with the fact that they were living in a better environment and their children were healthier. These results indicate that housing has a significant effect on welfare.

Devoto et al. (2012) studied the welfare effects of a program that increases access to piped water in low-income households in Tangiers, Morocco. Many poor urban households in Tangiers were located in neighborhoods connectable to the water system, but could not afford the connection fee. These households had free access to public taps installed in their neighborhood, and also had sanitation facilities at home. The program provided a subsidized interest-free loan to install a water connection. The loan was to be repaid in regular installments with the water bill over 3 to 7 years. The loan did not cover the cost of installing the connection or the cost of water consumed. To pilot-test the program, a door-to-door awareness campaign was conducted in early 2008 among 434 households, randomly chosen from the 845 that needed a connection.

The authors found with this randomized experiment that households are willing to pay a substantial amount of money to gain access to a private tap at home. Within a year, 69 % of households in the treatment group had purchased a connection (against 10 % in the control group), and as a result their average monthly water bill more than doubled from US$9 to US$24 a month (the previous cost came from households that used water from their neighbors). The quality of water was unchanged, since public taps are also maintained and the water comes from the same source. The study found no change in the incidence of water-borne diseases, such as child diarrhea. The connection generated important time gains, but it did not lead to increases in labor market participation, income, or schooling attainment. The extra time seems to have been used for leisure and socializing. The private connection program did reduce the risk of conflict or ill-feelings between neighbors. Overall, consistent with Cattaneo et al. (2009), Devoto et al. (2012) noted that that households' psychological well-being improves substantially when they upgrade their housing facilities.

It is important to note that the intervention studied by Devoto et al. (2012) provided a loan rather than an in-kind subsidy. Their conclusions are useful in terms of the barriers that households face to improve housing. In this case it was credit

constraints, because households were willing to pay for the water connection once offered the loan. Thus, initiatives like that in Morocco, for which there is willingness to pay, can involve relatively low costs for the state yet improve the welfare of poor urban families through investments in better housing.

In summary, the findings of these papers, which have an internally valid design, suggest that limited in situ improvements in housing are not sufficient to bring about significant changes in living conditions of the urban poor. Providing better housing and housing facilities improves slum dwellers' well-being and satisfaction with life, but does not reduce the various ailments they suffer as a result of living in slums. What might be necessary, then, is to carry out broader slum upgrading programs that combine housing improvements with broader interventions that address other major problems affecting slum dwellers.

4.3.2 Integral urban upgrading

Among the several forms of urban development interventions, slum upgrading offers an incomparable opportunity to affect many neighborhood outcomes that can reshape the environment of a human settlement. Integral upgrading programs have the ability to mobilize many different actors in diverse policy areas at various levels. These programs can give momentum to the idea that improving a neighborhood involves all dimensions of its life, including the freedom of citizens from or risk of injury, public safety, welfare, satisfaction with life, education, employment, and access to services, among others.

There is scant rigorous evidence on the effectiveness of such programs. There is only one randomized evaluation by McIntosh et al. (2013), who studied a major federal infrastructure spending program in poor neighborhoods in Mexico from 2009 to 2011. The intervention analyzed is a phase of the *Hábitat* program of the Social Development Secretariat (SEDESOL). The program, which has made US$68 million in infrastructure investments, targets the urban poor and focuses on neighborhood upgrading through urban infrastructure (roads, water, sewerage, lighting, and sidewalks) as well as community centers, parks, sports facilities, and skill upgrading such as job training for the unemployed and health and nutrition training for young mothers.

SEDESOL's *Hábitat* Program randomly selects a "polygon" (a specific neighborhood) within each participating municipality for the upgrading program. In order to be eligible for the program, a polygon needs to have a state and municipal government willing to cooperate with the program's cost-sharing rules, which require local government to provide 50 % of project costs. In the projects studied, the municipalities provided 40 % of those costs, the states provided 8 %, and the beneficiaries provided 2 %. Also, according to the study, to be eligible the populations in those polygons needed to be settled in marginalized urban areas with concentrations of asset poverty greater than 50 %, located in cities of 15,000 inhabitants or more, with a deficit of infrastructure and urban services, and with at least 80 % of the lots having no active conflict over property rights.

McIntosh et al. (2013) studied the effect of the program across a wide range of indicators, including property prices using household and block-level data. They

found no significant strategic response of municipal governments to federal spending and little evidence of strong spillover effects of the program. They also analyzed the effect of the program and found that some infrastructure variables improved, satisfaction with neighborhood infrastructure did not change significantly, private investment in housing stock improved, and the value of a square meter of land in treatment neighborhoods increased by more than US$2 for every US$1 invested by the program. The study is significant because it is the first to evaluate a randomized integral program, but the authors did not conduct an in-depth analysis to determine which components of the program are driving the effects.

There is also descriptive evidence of integral slum upgrading programs by UN-Habitat under the Safer Cities Program. These integral interventions focus on reducing crime through integral slum upgrading. They are an example of crime prevention through environmental design, which is a policy that tries to reshape the geographical space to reduce crime and enhance socioeconomic development. The fundamental concept is that the physical environment affects criminal behavior and can be changed in a way that will reduce the incidence and fear of crime (Cooke 2003).

UN-Habitat considers four key factors in these programs: the degree of social cohesion, the extent of urban inequalities, the risks of the built environment, and the scope of inclusiveness in urban governance. The factors are derived from six case studies from UN-Habitat's Safer Cities Program in Dhaka, Bangladesh, Doula, Cameroon, Medellin, Colombia, Nairobi, Kenya, Port Moresby, Papua New Guinea, and Rio de Janeiro, Brazil. The evaluations of these programs were not performed employing experimental or quasi-experimental designs that allow for attribution of causality to the program for the changes observed in outcomes. The methods used were analysis of the project and national documents, together with field visits, interviews, and focus groups with community leaders. This qualitative evaluation is also a valuable source of information about associations between variables. However, a lack of counterfactuals implies that there is no benchmark against which to compare the progress of the variables. For example, it might have been the case that there was also some positive evolution in outcomes of untreated slums due to the favorable economic situation.

One of the case studies reviewed in UN-Habitat (2011) within the Safer Cities Program was of the Integral Urban Program (*Programa Urbano Integral*—PUI), which was implemented by the city of Medellin starting in 2002. Two components were at the core of the PUI: first, the promotion of public spaces for citizens of all economic and social levels to enjoy; and second, the promotion of public education and culture, conceived as tools for the development of the city and society, and key elements for inclusion and equity. The PUI was implemented in areas of the city with low human development indexes and accentuated problems of violence and social conflicts.

The most salient effects of the PUI, according to the descriptive evidence available, were economic and social (UN-Habitat 2011). First, the integral plan promoted economic activity in the beneficiary area. At the individual level, the PUI had positive effects on employment and income, since 92 % of the workforce employed in the program was made up of residents from the intervention area

(which had an unemployment rate of 40 %). Private investment and economic activities also rose dramatically in the area: there was a 300 % increase in trade, and with the creation of a commercial boulevard the number of businesses along the boulevard increased from 18 to 239. The relatively high investment in social and cultural programs was four times more than expenditure on construction of the Metrocable (the city's main investment in physical infrastructure). Finally, social outcomes also improved, according to the qualitative review of the PUI. Surveys showed a significant reduction in rates of violence and insecurity, mainly in intra-familiar violence and burglary. There was also evidence of new community leadership, strengthening of social and community organizations, and increasing levels of citizen participation.

Another important intervention in the region is the *Favela-Bairro* Program in Rio, Brazil. This program started in 1994 and is now in its third phase. The first phase focused on urban upgrading programs implemented in 38 favelas and on improvements in other informal settlements. The second phase began in 2000 and introduced activities in education, health and training, community development, and property rights recognition. The third phase, which is ongoing, is designed to help communities with between 500 and 2500 households. The objective is to improve the living conditions of the urban poor through a comprehensive package of interventions including social infrastructure, land tenure, and social development. The program also includes specific objectives such as reducing the risk of geological and environmental accidents (mostly landslides and floods), increasing transit access, reducing the incidence of vector-borne disease, and increasing use of public services. The basic infrastructure component includes installing water supply facilities, gutters, sewerage, and lighting, as well as making road and garbage collection improvements. The social component includes construction of early child care centers, community activity programs, and training community development workers. The social components were mainly available in the second phase, except for the training program. Land titling interventions, though initially planned for the first phase, started to be implemented in the second phase. The completion rate of the program has been high: 284 public works and other projects were executed, accounting for over 90 % or the programmed activities. In all, interventions were carried out in 38 of the 54 targeted favelas.

Soares and Soares (2005) performed an ex-post evaluation of the Brazil project employing quasi-experimental design, and re-creating a matched control group from different sources of information to circumvent the problems of not having a baseline pre-intervention survey. The authors report positive results of the program, especially related to an increase in the coverage of water and garbage collection in favelas that outpaced the comparison groups identified. The impact on sewerage was the most significant at the aggregate level, and an analysis by income quartile revealed that the poorest quartiles benefited more from sewerage interventions than the richest quartiles. This heterogeneous impact was also seen with respect to water, garbage collection, and illiteracy. The authors did not find significant effects on reducing mortality due to poor sanitation conditions or homicides. Neither were any effects on housing values detected, although that could be due to data and methodological limitations. The results also do not suggest that the program was

successful in generating improvements in income. The authors recommend that a planned evaluation with the timely data collection processes be performed on future phases of the program in order to better assess its effects. More studies are needed to assess the benefits of integral upgrading programs in general and to understand which interventions should be included in them.

5 Conclusions

The countries of Latin America and the Caribbean have strikingly high urbanization rates in comparison with other developing regions and even with many OECD countries. In 2010, 79 % of the LAC population was living in cities and by 2050 it is expected that 90 % of the population will be urban. As a consequence of this process of massive urbanization, many citizens live in informal neighborhoods with substandard housing and urban services, as cities have not been able to meet the needs of their fast-growing populations. More than 100 million people live in slums, in informal settlements with unsecure tenure, and/or in dwellings with deficient urban services.

According to Bouillon (2012), closing the current housing gap in LAC will require an investment of at least US$310 billion, or 7.8 % of the region's GDP. At the moment LAC devotes 1 % of GDP, on average, to public programs for housing and urban development issues (Bouillon 2012). Meeting future housing demands will require a coordinated effort by all stakeholders—slum dwellers, local governments, and financial institutions—along with massive annual investments estimated at US$70 billion.

To guide these investments and design the associated programs targeted at improving living standards, it is important to understand the incentives that drive housing choices of new city migrants. Toward this end, this chapter has presented a theoretical model that provides a key insight: city migrants face a trade-off between the affordability of services and transport costs. Using this trade-off as a starting point, the chapter analyzed three types of urban policies: access to housing, transport policies, and slum upgrading.

Urbanization in the region will continue, thus filling the knowledge gap on the best way to integrate transit and land use to develop more sustainable and accessible urban spaces. When transit and land development are integrated, there is less dependence on private motorization, which in turn has positive effects on equity, congestion, and the environment (Cervero 1998). To the best of our knowledge, however, there is scant rigorous evidence on which to base policies to support this process. To reverse the cycle of urbanization of poverty, more research is needed on how to prevent the formation of slums by way of formal access to housing coordinated with public transit policies.

Regarding access to housing, a popular policy in LAC has been land titling to formalize those living in informal settlements. There is a good body of literature with sound identification strategies studying such programs. Land titling has positive effects on housing investments, negative effects on household size (less fertility and more nuclear families), and positive effects on children's education. No

conclusive evidence is found on the effects of land titling on labor market outcomes. There is weak support for the hypothesis that land titling can have positive effects on capital investment because the dwelling can be used as collateral. One reason may be because the access of slum dwellers to the credit market is very limited. Also, the high legal costs associated with eviction and with obtaining a mortgage execution might preclude mortgage credit (Galiani and Schargrodsky 2011). It is important to assess the long-term effects of land titling to ensure that regulatory policies enable its sustainability. It is still not clear how to incorporate the regularized properties into formal renting and housing markets. Finally, more research is needed on the best type of titling, registration or recording, both of which seem to be efficient options in the developed world.

The housing affordability gap in LAC is mainly driven by the low income of poor households. Supply- and demand-side polices to close this gap have not been thoroughly studied. There are still open questions as to the best types of subsidies or financial instruments to enhance home ownership among the poor and how to promote the rental market for this segment. Policies that involve private–public partnerships to increase the supply of affordable units are very important to expand the supply of housing for low-income citizens. The policy response to housing problems in LAC in terms of quality and affordability has, in most cases, ignored rental housing as a vehicle to provide adequate housing solutions for low-income families. The development of the rental market for low-income segments is an even less explored area. Rigorous evaluations should be encouraged when new housing programs are implemented to compare the cost-effectiveness of different options.

As explained in this paper, the process of rapid urbanization in LAC has resulted in an increase in transportation demands. Better public transport links can alleviate the housing gap because they enable the poor to move to the suburbs where land and housing services are cheaper. Problems with road congestion and pollution are also becoming severe in the bigger cities of LAC, where private motorization has increased exponentially. However, to date, transport in general, and public transit for the poor in particular, has been an understudied topic. One reason might be because enhancing mobility has not been stated as an explicit priority in the United Nation's Millennium Development Goals. Another reason is the lack of systematic statistics. Travel surveys like the ones performed in more advanced countries can be a starting point to identify the constraints faced by low-income commuters (affordability, accessibility, etc.).

A wide range of travel demand management policies have been applied in different countries, ranging from vehicular restrictions to public transport improvements, but there remains a gap in the knowledge of what works in travel demand management in the region. Anecdotal data and descriptive statistics show that sustainable transport reforms based on rapid bus transport have been successful in better connecting cities and reducing pollution. The promotion of cycling through the expansion of cycling lanes and bike-sharing facilities is becoming more common in the region, though the take-up of such programs is still limited (IDB 2013) and there are no evaluations of their effect so far. Nor is there any experimental design to assess the effect of different alternatives to make public transport more affordable to low-income households (such as the travel vouchers as

used in South Africa, or a proportion of transport costs paid by employers, as in the *Vale Transporte* program in Brazil).

Expanding public transit can have an important effect on sorting income groups in cities and has the potential to encourage the decentralization of the urban poor from inner-city slums and improve access to the labor market of the urban poor in the suburbs. LAC scores low in mobility indexes, and thus a serious assessment of transport demand to reshape cities is a very important avenue for future research.

Slums can be viewed as the first location of rural migrants when they arrive in a city, the place from which they explore labor opportunities. This often means being close to the city center and living in deficient housing. The problem is that in LAC many slums have turned into a permanent and burgeoning phenomenon due to poverty traps. In light of anticipated future urbanization, as mentioned earlier, the integration of formal housing supply and transport systems is key to meet the demands of new low-income migrants. Even so, slum dwellers in some cases may choose to stay in the slums given their strong preference for the location or because of social and economic bonds.

This paper has also examined policies to upgrade the living standards of slum dwellers. What seems not to work is relocating entire slum areas to remote locations or providing social housing far from the original marginal neighborhoods. Evidence from a randomized experiment in the United States (the Moving to Opportunity Program) and from quasi-experiments in Chile and Mexico suggests that the benefits of better housing services under such initiatives are outweighed by social disintegration, stigmatization, and loss of work opportunities because beneficiaries cannot get to their existing workplaces and have difficulties finding new jobs closer to their new location. In situ upgrading, when possible, is a better option than relocation. This is consistent with the evidence presented in Baker et al. (2005) for Mumbai. That study used a residential location model to assess the welfare of both an in situ slum upgrading program and a relocation program. It concluded that for households relocated further away, the increased commuting distances wiped out the housing benefits of the program and that beneficiaries were better off with the more limited housing improvement provided by the in situ intervention.

There is also already a body of knowledge on the effects of in situ housing infrastructure upgrades. Providing better housing and housing services improves slum dwellers' well-being and satisfaction with life. Some interventions, like improved water quality and improved flooring or walls, have positive effects on child health. Upgrading the walls and roof of a home can also improve a household's perception of security. However, these limited in situ improvements in housing are not sufficient to achieve significant changes in the living conditions of the urban poor and to significantly reduce the various ailments they suffer as slum dwellers.

What might be necessary, then, is to carry out wider slum upgrading programs that combine housing improvements with broader interventions addressing other major problems affecting slum dwellers. There are few evaluations of slum upgrading interventions that exploit experimental or quasi-experimental designs, although randomized evaluations are feasible and can be implemented in many more contexts within housing improvements (Field and Kremer 2005). There is a

gap in the literature in terms of rigorous evaluation of integral slum upgrading programs.

Given the multiple challenges and the dimension of the problems in slum areas, large-scale coordinated programs to reshape the overall environment would seem better suited than small-scale interventions. Integral upgrading programs have the ability to mobilize many different actors in diverse policy areas at various levels. These programs can give momentum to the idea that improving a neighborhood involves addressing all the dimensions of life there, including freedom from risk of injury, public safety, welfare, satisfaction with life, education, employment, access to services, and effective transport networks.

However, causal investigations have been carried out for most of the integral programs undertaken in LAC. It is critical to incorporate evaluation of integral programs into the region's research agenda to assess the best set of interventions. To date, little is known about complementarities and economies of scale in delivering urbanization programs. For example, water and sanitation could be coupled with community strengthening to enhance social cohesion, which in turn could have positive effects on other individual as well as community outcomes. Also, transport interventions together with housing upgrades could improve living conditions and increase the disposable incomes of slum dwellers.

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