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LAND POLICIES AND THEIR OUTCOMES

Edited by Gregory K. Ingram and Yu-Hung Hong

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CONTENTS

15

Brazil's Urban Land and Housing Markets: How Well Are They Working?

David E. Dowall

This chapter uses a macro, national-level perspective to assess urban land and housing market outcomes across Brazil. It is based on available empirical data from Instituto Brasileiro de Geografica e Estatística (IBGE), field studies, the Fundação João Pinheiro (FJP), and other sources. The chapter begins by posing and answering the following questions: What are the characteristics of well-functioning urban land and housing markets? How well are Brazil's urban land and housing markets performing relative to those of other countries? It then provides an assessment of urban land and housing market outcomes in Brazilian cities. The chapter concludes by exploring a range of opportunities for enhancing urban land and housing market outcomes.

This chapter argues that because the historical and current performances of Brazil's urban land and housing markets are below their potential, Brazil's urban land and housing policies should be reformed. Urban land and housing markets in Brazil are not providing sufficient housing opportunities for low- and middle-income families and are contributing to a growing housing deficit and widespread housing informality (Fundação João Pinheiro 2002, 2005). Although dwelling unit production is satisfactory relative to household formation, the provision of infrastructure and urban services is unsatisfactory.

The author would like to thank Pedro Peterson for his research assistance to support the preparation of this chapter. Valuable comments and suggestions were provided by Mila Freire, Edesio Fernandes, Paul Avila, and Fernanda Furtado and from participants at a World Bank–Lincoln Institute Seminar in Brasília on March 6, 2006. Gregory K. Ingram, Martim O. Smolka, and Yu-Hung Hong of the Lincoln Institute of Land Policy provided detailed comments on the chapter. Any errors that remain are the responsibility of the author.

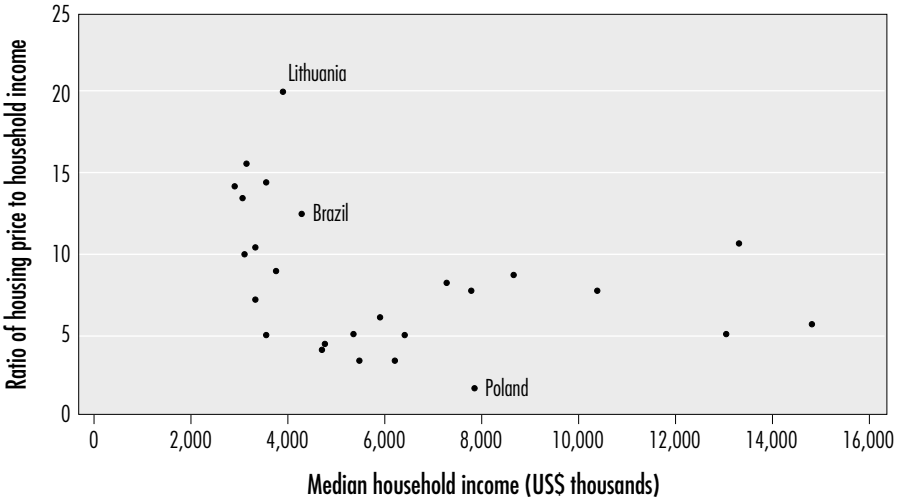
Two important caveats are in order, however. First, this chapter begins by taking an integrated approach to evaluating Brazil's urban land and housing markets. It looks at the entire spectrum of housing units, both formal and informal, including dwelling units located in fully approved housing projects—subdivisions and apartment complexes—as well as *favelas* (shantytowns) and irregular and illegal settlements. This approach is broad and incorporates a wide range of housing conditions, and it has the advantage of allowing a macro-level assessment of overall housing supply and demand. How many total units are produced in Brazil over a year? How many new households are formed each year? How many units have to be replaced because of deterioration, demolition, or change of use? Overall, as explained below, total housing production of both formal and informal dwelling units is slightly less than new household formation (World Bank 2002).

The second caveat relates to the definition of informality. A review of the literature on housing informality indicates that it is based on three distinct but interdependent factors: (1) type of land tenure; (2) access to infrastructure; and (3) the physical characteristics of settlements and dwelling units. As is common in many countries, census data on informal housing stocks are highly inaccurate. Some countries ignore informal housing altogether; others grossly undercount it. Brazil is no exception, and data from the IBGE are problematic. To maintain the empirical mode of analysis, informal housing is defined here on the basis of the most inclusive single measure—access to infrastructure services. This definition allows widespread measurement of stock and flow trends for municipalities and metropolitan areas over time. However, it may understate informality by excluding cases in which urban services are available, but in which households lack secure and legal land title or the subdivisions in which the housing units are located are poorly planned and executed. Within these caveats, the next sections of this chapter present a broad assessment of Brazil's urban land and housing markets.

Characteristics of Well-Functioning Urban Land and Housing Markets

Urban land and housing markets should efficiently allocate land and housing resources between suppliers and demanders. Housing supply should reasonably match the housing demands of households in terms of price, location, and quality attributes. In most market economies, private production (from large merchant builders to self-built housing to informally provided housing in *favelas* and irregular settlements) is the predominant mode of housing production. Except for a few countries such as Singapore, the public provision of housing is miniscule relative to overall production. The full range of housing supply, including both new and existing units, should provide households with affordable options for purchase as well as rental. Depending on household incomes and housing prices, the private real estate markets typically produce housing that is affordable for households in the 30th to 40th percentiles of the income distribution (Dowall 1989, 1992b). Households with lower incomes typically rent accommodations, share housing with extended families, or postpone forming households. Some are fortunate to receive housing assistance from government sources.

Figure 15.1
Median Housing Price and Median Household Income: Middle-Income Countries, 1998



Source: World Bank (2000).

To be well-functioning, housing markets must produce housing that is priced between three and six times the total household income. Middle- and low-middle-income households should be able to afford such units by saving money for down payments and taking out mortgages from housing lenders. Unfortunately, however, housing supplies are frequently constrained, and housing prices are much higher in relation to income. This situation stems mainly from the lack of public sector investment in basic infrastructure to serve residential development projects as well as from restrictive land use regulations, complex land titling and registration, and limitations on the availability of construction and borrower financing.

In middle-income developing countries, housing price to income ratios vary considerably. As household incomes rise, the variation in the ratio diminishes as housing and real estate markets mature and broaden their range of housing products (and prices). Where formal housing production is constrained, house price to income ratios increase. Figure 15.1 illustrates the relationship between housing price and household income for 27 middle-income countries.[1] The figure is based on tabulations of the World Bank's housing indicators program. The data were collected in 1998 from a sample of large cities in each country (World Bank 2000). The ratio of median housing price to median household income ranges from a low of 1.7 for Poland to 20.0 for Lithuania. Brazil's ratio of 12.5 is higher than those

1. Middle-income countries, as defined by the World Bank, have per capita gross national incomes (GNIs) ranging from $826 to $10,065 (in 2004 dollars). The countries are further divided into low-middle-income countries ($826–$3,255) and upper-middle-income countries ($3,256–$10,065).

of all Central and Latin American countries included in the data series. Only five countries have higher ratios than Brazil—Panama, Serbia and Montenegro, Latvia, the Ivory Coast, and Lithuania. By contrast, 11 of the 27 countries have ratios below 6.0, suggesting good performance.

Is There a Brazilian Paradox?

Brazil's urban housing market seems to suffer from a paradox—housing is expensive relative to income (see figure 15.1), and yet Brazil lacks infrastructure services and secure land tenure. The private sector is capable of producing satisfactory numbers of dwelling units, despite the fact that the public sector is not capable of producing enough infrastructure services or planning and approving enough residential subdivisions to support housing development. The result is an urban land and housing market paradox—expensive housing that lacks water and sanitation, and secure land tenure,[2] adequate circulation, and common areas for schools and parks. Table 15.1, by comparing the housing characteristics of Brazilian cities with those of other countries,[3] lends some credence to the paradox. In Brazilian cities, 93 percent of the housing stock is classified as permanent—a rate significantly higher than the comparable rate, 86 percent, for low-middle-income countries. On the other hand, Brazil does poorly with respect to the percentage of housing units with piped water connections—64 percent versus 74 percent for cities in low-middle-income countries.[4] At the same time, its portion of unauthorized housing units, 23 percent, is well below levels found in other low-middle-income countries, 36 percent. Thus, the overall scorecard for Brazil is again a paradox that is both good—a relatively low rate of unauthorized housing and a high portion of permanent structures—and bad—a relatively low level of access to water supply (UNECLAC 2004).[5]

Performance of Brazil's Urban Land and Housing Markets

At the country level, Brazil has undergone a massive shift in the spatial patterns of its population. Between 1950 and 2000, the country added 117.6 million persons, approximately 2.4 million per year. More dramatically, the spatial structure of the population shifted from being predominantly rural to urban. As this section illustrates, the most challenging period of rapid urbanization has passed. In the 1990s, population and household growth slowed as Brazil passed through its urban transition. Using IBGE census data, figures 15.2 and 15.3 illustrate that in 1950 about

2. According to the World Bank's Doing Business survey, Brazil ranks eighth out of nine developing countries on ease of property registration (World Bank 2005).

3. The World Bank classifies Brazil as a low-middle-income country.

4. Alternatives to piped water supply in high-density urban areas are limited to tanker truck vendors. But such service delivery turns out to be relatively expensive and subject to contamination.

5. The percentages in table 15.1 have limitations: they are based on binary definitions of service access and do not reflect poor quality of service, such as water supply limits of three to four hours per day.

Table 15.1
How Brazilian Cities Compare with Cities in Other Countries, 1990s

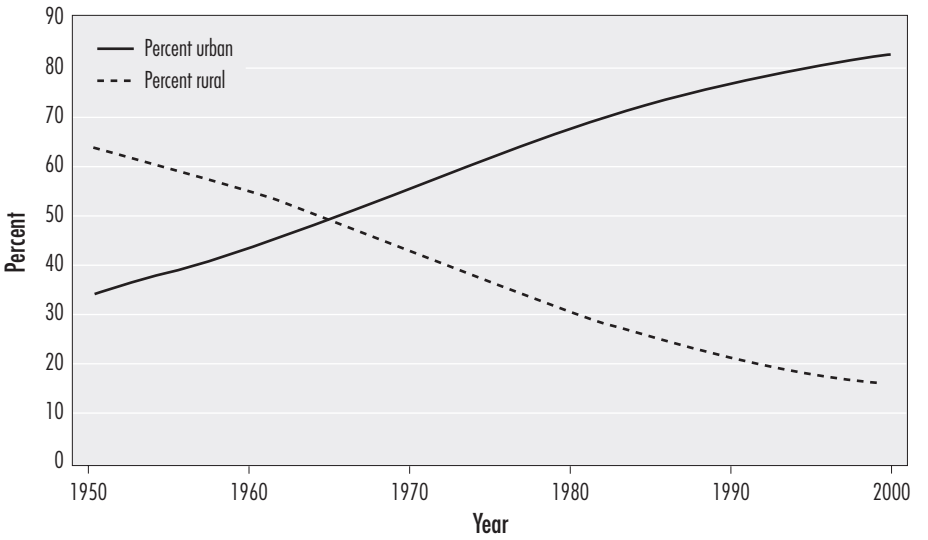
Cities in	Percentage of Housing Units That Are Permanent Structures	Percentage of Housing Units with Piped Water	Percentage of Unauthorized Housing Units	Average per Capita GNI, 2004 (US$)
Low-income countries	67	56	64	$507
Low-middle-income countries	86	74	36	1,686
Brazilian cities	93	64	23	3,000
Middle-income countries	94	94	20	4,769
Middle-high-income countries	99	99	3	16,046
High-income countries	100	100	0	32,112

GNI = gross national income.

Source: UNCHS (1996).

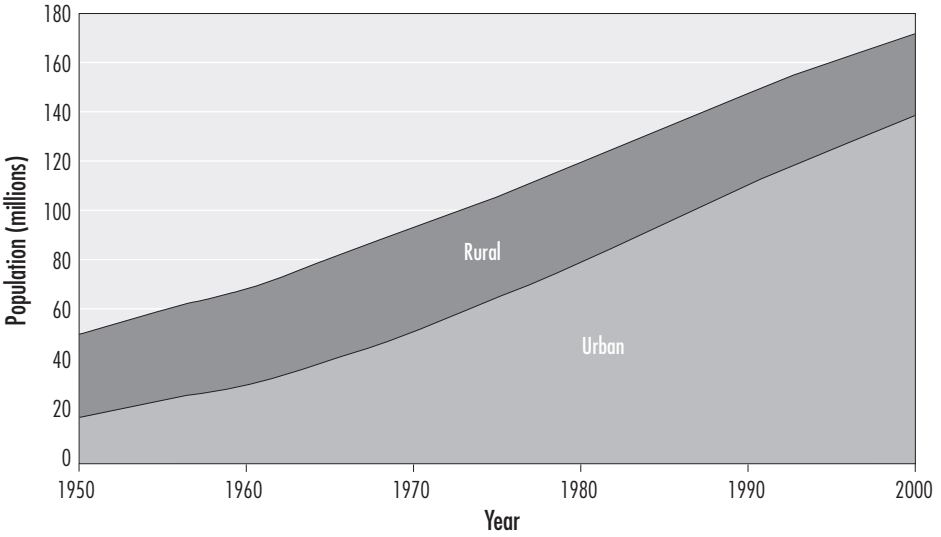
64 percent of Brazil's population was located in rural areas and 36 percent was located in urban areas. By 1980 the pattern was completely reversed—32 percent rural and 68 percent urban. Since then, urban population dominance has increased; by 2000 about 81 percent of Brazil's population lived in cities and 19 percent lived in rural areas.

Figure 15.2
Percentage Distribution of Urban and Rural Populations: Brazil, 1950–2000



Source: IBGE (1991, 2000).

Figure 15.3
Urban and Rural Population Trends: Brazil, 1950–2000 (millions)



Source: IBGE (1991, 2000).

In absolute terms, the increase in urban population has been enormous. Table 15.2 shows that between 1950 and 2000, the country's urban population increased by 118.9 million, while its rural population slightly decreased by 1.3 million. Although some of these changes reflect alterations of administrative boundaries and definitions of what constitutes an urban place, they overwhelmingly reflect massive rural to urban migration—on average, cities in Brazil added 2.4 million persons a year between 1950 and 2000.

In Brazil, rural-urban migration was particularly strong in the 1950s and 1960s, reflecting the country's emerging economic growth and social transformation. During the 1970s, 1980s, and 1990s, this migration slowed, and, as a consequence, urban population growth slowed as well. In percentage terms, annual urban population growth ranged from a high of 3.0 percent during the 1950s to a low of 1.4 percent during the 1990s. This decline in the percentage rate of growth is common throughout Latin America as rural areas depopulate and as overall rates of natural population increase slow. However, in absolute terms annual urban population growth continued until the 1990s and will continue in the future, but it will be driven mainly by natural population increase and less by rural-urban migration.

Rural areas of Brazil have actually been losing population since the 1970s (they contained about 10 million fewer persons in 2000 than in 1970), while urban areas have been growing rapidly since the 1950s—increasing by 119 million between 1950 and 2000. Annual urban population growth ranged from about 1.25 million during the 1950s to a peak of 3 million during the 1980s. During the 1990s, the annual rate of growth slightly declined to 2.7 million persons.

Table 15.2
Urban and Rural Populations: Brazil, 1950–1960 to 1991–2000

	Population Change			Annual Percentage Change		
	Total	Urban	Rural	Total	Urban	Rural
1950–1960	18,126,060	12,520,143	5,605,917	3.0	5.2	1.6
1960–1970	23,068,580	20,781,950	2,286,630	2.9	5.2	0.6
1970–1980	25,863,669	28,351,425	–2,487,756	2.5	4.4	–0.6
1980–1991	27,822,769	30,554,581	–2,731,812	2.1	3.3	–0.7
1991–2000	22,718,968	26,706,449	–3,987,481	1.4	2.2	–1.2
1950–2000	117,600,046	118,914,548	–1,314,502	2.4	4.1	–0.1

Source: IBGE (2000).

URBANIZATION OF BRAZIL'S 15 LARGEST METROPOLITAN REGIONS

Urbanization trends can be disaggregated to examine population growth in Brazil's 15 largest metropolitan areas (table 15.3). Over the 50-year period from 1950 to 2000 shown in the table, these cities accounted for a decreasing share of total urban population, falling from 54.8 percent of total urban population in 1950 to 42.8 percent in 2000, indicating a deconcentration of urban population.

However, despite the declining share, absolute population change has been significant. Table 15.4 presents population increases for the 15 metropolitan areas by decade from 1950–1960 to 1991–2000. Population growth in the 15 metropolitan areas was the greatest during 1970–1980 when the areas added a total of 12.6 million persons. Since then, the absolute decadal increases have declined, and during 1991–2000 they stood at 9.2 million. This decline is consistent with their decreasing share of total urban population; these 15 metropolitan areas accounted for a relatively declining share of countrywide increases in urban population, falling from 52.1 percent of the total increase during the 1950s to 34.6 percent during the 1990s. These trends reveal that over the 50 years urbanization gradually slowed in Brazil's 15 largest metropolitan areas. Two factors account for this finding: (1) urban growth is shifting to areas outside the boundaries of the 15 metropolitan areas; and (2) second-tier metropolitan areas are accounting for an increasing share of population increase.

HOUSING DEMAND AND HOUSING PRODUCTION IN URBAN BRAZIL

Housing demand is determined by population growth, household formation, income, and requirements to replace both old, dilapidated housing stock and housing units removed from the stock. Housing production trends in Brazilian cities have largely followed trends in urbanization, and overall production of formal and informal housing has reasonably paced increases in household growth.

Table 15.5 presents trends in housing units by metropolitan region for census years 1970–2000 for Brazil's 15 largest metropolitan areas. During the 30-year period, informal and formal housing stock increased from 5.4 million units to 16.5 million units—a gross increase of 11.1 million units or 370,000 units a year. For all urban areas in Brazil, the total housing stock increased from 10.5 million

Table 15.3
Population Trends: Brazil's 15 Largest Metropolitan Regions, 1950–2000

Metropolitan Region	Total Population					
	1950	1960	1970	1980	1991	2000
Belém	268,252	422,648	669,768	1,021,473	1,401,305	1,795,536
Belo Horizonte	565,970	990,055	1,719,490	2,676,352	3,515,542	4,349,425
Brasília	—	141,742	537,492	1,176,908	1,601,094	2,051,146
Curitiba	333,138	554,515	875,269	1,497,352	2,061,531	2,726,556
Fortaleza	464,507	699,262	1,091,117	1,651,744	2,401,878	2,984,689
Goiânia	82,826	196,596	442,790	827,446	1,230,445	1,639,516
Grande São Luís	119,785	180,747	302,609	498,958	820,137	1,070,688
Grande Vitória	123,281	213,449	410,103	744,744	1,126,638	1,425,587
Maceió	178,705	240,733	357,514	522,173	786,643	989,182
Natal	169,293	245,303	373,754	554,223	826,208	1,043,321
Porto Alegre	842,390	1,263,401	1,751,889	2,468,028	3,230,732	3,718,778
Recife	843,409	1,275,125	1,827,173	2,386,453	2,919,979	3,337,565
Rio de Janeiro	3,178,310	4,869,103	6,891,521	8,772,277	9,814,574	10,894,156
Salvador	463,545	739,799	1,147,821	1,766,724	2,496,521	3,021,572
São Paulo	2,662,776	4,791,245	8,139,705	12,588,745	15,444,941	17,878,703
Total, 15 metropolitan regions	10,296,187	16,823,723	26,538,015	39,153,600	49,678,168	58,926,420
Total, Brazil's urban population	18,782,891	31,303,034	52,084,984	80,436,409	110,990,990	137,697,439
15 metropolitan regions as percentage of total urban population	54.8	53.7	51.0	48.7	44.8	42.8

Note: Brasília was not established until the 1960s.

Source: IBGE (2000).

Table 15.4
Urban Population Change: Brazil's 15 Largest Metropolitan Regions, 1950–1960 to 1991–2000

Metropolitan Region	Change in Population				
	1950–1960	1960–1970	1970–1980	1980–1991	1991–2000
Belém	154,396	247,120	351,705	379,832	394,231
Belo Horizonte	424,085	729,435	956,862	839,190	833,883
Brasília	141,742	395,750	639,416	424,186	450,052
Curitiba	221,377	320,754	622,083	564,179	665,025
Fortaleza	234,755	391,855	560,627	750,134	582,811
Goiânia	113,770	246,194	384,656	402,999	409,071
Grande São Luís	60,962	121,862	196,349	321,179	250,551
Grande Vitória	90,168	196,654	334,641	381,894	298,949
Maceió	62,028	116,781	164,659	264,470	202,539
Natal	76,010	128,451	180,469	271,985	217,113
Porto Alegre	421,011	488,488	716,139	762,704	488,046
Recife	431,716	552,048	559,280	533,526	417,586
Rio de Janeiro	1,690,793	2,022,418	1,880,756	1,042,297	1,079,582
Salvador	276,254	408,022	618,903	729,797	525,051
São Paulo	2,128,469	3,348,460	4,449,040	2,856,196	2,433,762
Total, 15 metropolitan regions	6,527,536	9,714,292	12,615,585	10,524,568	9,248,252
Total, Brazil's urban population change	12,520,143	20,781,950	28,351,425	30,554,581	26,706,449
15 metropolitan regions as percentage of total urban population change	52.1	46.7	44.5	34.4	34.6

Source: IBGE (2000).

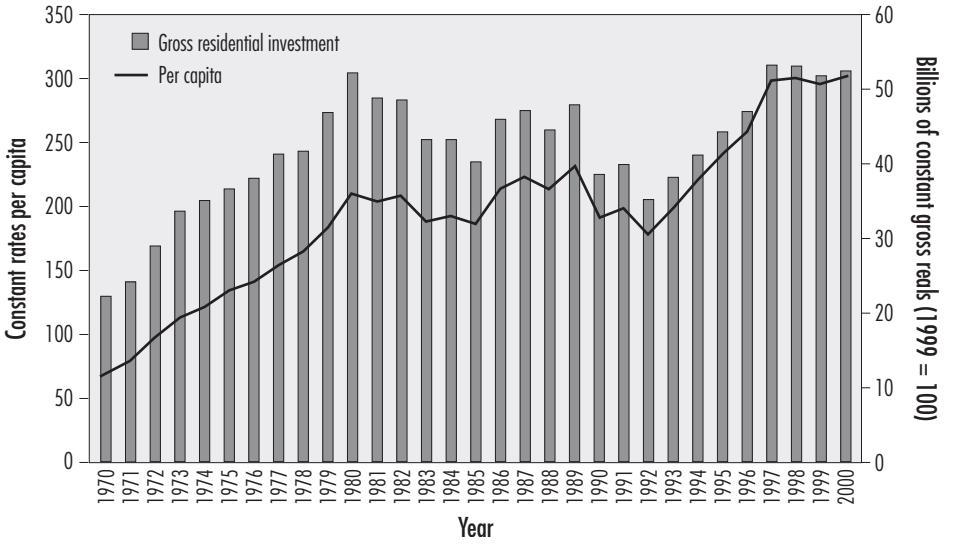
Table 15.5
Permanent Dwelling Units: Brazil's 15 Largest Metropolitan Regions, 1970–2000

Metropolitan Region	Number of Dwelling Units			
	1970	1980	1991	2000
Belém	105,675	184,364	292,218	419,791
Belo Horizonte	319,386	568,116	858,303	1,189,609
Brasília	99,303	253,950	386,396	556,762
Curitiba	178,338	342,427	543,032	790,982
Fortaleza	188,412	320,663	523,219	731,278
Goiânia	83,514	180,810	312,228	467,227
Grande São Luís	49,228	90,563	167,174	249,682
Grande Vitória	74,579	161,041	279,674	401,091
Maceió	66,028	104,667	176,051	247,536
Natal	65,023	109,867	183,440	260,220
Porto Alegre	380,128	630,867	936,221	1,153,274
Recife	332,871	481,456	678,819	873,407
Rio de Janeiro	1,489,189	2,152,226	2,743,178	3,302,119
Salvador	205,588	353,789	581,080	807,352
São Paulo	1,721,964	2,999,178	4,083,306	5,079,188
Total, 15 metropolitan regions	5,359,226	8,933,984	12,744,339	16,529,518
Persons per dwelling unit	5.0	4.4	3.9	3.6
Total, Brazil's urban population	10,501,000	18,364,477	28,532,388	38,678,933

Metropolitan Region	Change in Number of Dwelling Units			
	1970–1980	1980–1991	1991–2000	1970–2000
Belém	78,689	107,854	127,573	314,116
Belo Horizonte	248,730	290,187	331,306	870,223
Brasília	154,647	132,446	170,366	457,459
Curitiba	164,089	200,605	247,950	612,644
Fortaleza	132,251	202,556	208,059	542,866
Goiânia	97,296	131,418	154,999	383,713
Grande São Luís	41,335	76,611	82,508	200,454
Grande Vitória	86,462	118,633	121,417	326,512
Maceió	38,639	71,384	71,485	181,508
Natal	44,844	73,573	76,780	195,197
Porto Alegre	250,739	305,354	217,053	773,146
Recife	148,585	197,363	194,588	540,536
Rio de Janeiro	663,037	590,952	558,941	1,812,930
Salvador	148,201	227,291	226,272	601,764
São Paulo	1,277,214	1,084,128	995,882	3,357,224
Total, 15 metropolitan regions	3,574,758	3,810,355	3,785,179	11,170,292
Total, Brazil's urban population	7,863,477	10,167,911	10,146,545	28,177,933

Source: IBGE (2000).

Figure 15.4
Private Investment in Housing: Brazil, 1970–2000



Sources: Suzigan (1986); Abreu and Verner (1997); IBGE, Diretoria de Pesquisas, Departamento de Contas Nacionais.

to 38.7 million between 1970 and 2000, or about 940,000 units a year. Overall, this level of residential construction and investment is remarkable, although, as explained later, much of it is produced through informal channels and is not supplied with adequate infrastructure and secure land titling. It is also significant that persons per household declined dramatically over the 30-year period, falling from 5.0 persons per unit to 3.6 persons per unit, or by 28 percent.

Regardless of whether these units are located in legal or illegal residential subdivisions or *favelas*, the increases in housing stock are impressive. They represent the significant financial accomplishments of households, especially low- and moderate-income households. Figure 15.4 illustrates countrywide (urban and rural) private gross residential capital outlays and per capita outlays in constant 1999 reals (IBGE 2000).[6] The figure shows that spending has been robust and increased in per capita real terms from 131.4 reals in 1970 to 310.0 reals in 2000. Despite the ups and downs of the Brazilian economy during the 1980s, private investment in housing has increased on a decade-by-decade basis. In constant reals, private residential investment increased 4.3 times between 1970 and 2000.

How adequate has this spending been in terms of providing sufficient housing stock for new households? The question can be partially answered by comparing the relationship between housing production and increases in households. Table 15.6

6. The figures pertain to fixed capital only and do not include land and operating or maintenance costs.

Table 15.6
Trends in Household Formation: Brazil's 15 Largest Metropolitan Regions, 1970–2000

Metropolitan Region	Number of Households			
	1970	1980	1991	2000
Belém	128,063	219,200	332,063	477,536
Belo Horizonte	328,774	574,324	833,067	1,156,762
Brasília	102,771	252,555	379,406	545,518
Curitiba	167,355	321,320	488,514	725,148
Fortaleza	208,627	354,452	569,165	793,800
Goiânia	84,663	177,564	291,575	436,041
Grande São Luís	57,860	107,073	194,345	284,757
Grande Vitória	78,414	159,816	266,976	379,145
Maceió	68,358	112,054	186,408	263,080
Natal	71,463	118,932	195,784	277,479
Porto Alegre	334,969	529,620	765,576	989,037
Recife	349,364	512,114	691,938	887,650
Rio de Janeiro	1,317,690	1,882,463	2,325,728	2,897,382
Salvador	219,469	379,125	591,593	803,610
São Paulo	1,556,349	2,701,447	3,659,939	4,754,974
Total, 15 metropolitan regions	5,074,190	8,402,060	11,772,078	15,671,920
Dwelling units/households	1.056	1.063	1.083	1.055
Total, Brazil's urban population	17,610,993	25,156,482	37,843,782	44,857,290

Metropolitan Region	Household Change			
	1970–1980	1980–1991	1991–2000	1970–2000
Belém	91,137	112,863	145,473	349,473
Belo Horizonte	245,550	258,742	323,695	827,988
Brasília	149,784	126,851	166,111	442,747
Curitiba	153,965	167,194	236,633	557,792
Fortaleza	145,825	214,714	224,635	585,174
Goiânia	92,900	114,011	144,467	351,378
Grande São Luís	49,212	87,273	90,412	226,897
Grande Vitória	81,403	107,160	112,170	300,732
Maceió	43,696	74,354	76,672	194,722
Natal	47,468	76,852	81,695	206,016
Porto Alegre	194,651	235,957	223,460	654,067
Recife	162,751	179,824	195,712	538,286
Rio de Janeiro	564,772	443,266	571,653	1,579,691
Salvador	159,657	212,467	212,017	584,141
São Paulo	1,145,098	958,491	1,095,036	3,198,625
Total, 15 metropolitan regions	3,327,870	3,370,018	3,899,842	10,597,730
Total, Brazil's urban population	7,545,489	12,687,300	7,013,508	27,246,297

Source: IBGE (2000).

Table 15.7
Ratio of Change in Permanent Dwelling Units to Change in the Number of Households: Brazil's 15 Major Metropolitan Regions, 1970–1980 to 1991–2000

Metropolitan Region	Change in Permanent Dwelling Units/Change in Households			
	1970–1980	1980–1991	1991–2000	1970–2000
Belém	0.86	0.96	0.88	0.90
Belo Horizonte	1.01	1.12	1.02	1.05
Brasília	1.03	1.04	1.03	1.03
Curitiba	1.07	1.20	1.05	1.10
Fortaleza	0.91	0.94	0.93	0.93
Goiânia	1.05	1.15	1.07	1.09
Grande São Luís	0.84	0.88	0.91	0.88
Grande Vitória	1.06	1.11	1.08	1.09
Maceió	0.88	0.96	0.93	0.93
Natal	0.94	0.96	0.94	0.95
Porto Alegre	1.29	1.29	0.97	1.18
Recife	0.91	1.10	0.99	1.00
Rio de Janeiro	1.17	1.33	0.98	1.15
Salvador	0.93	1.07	1.07	1.03
São Paulo	1.12	1.13	0.91	1.05
Total, 15 metropolitan regions	1.07	1.13	0.97	1.05
Total, Brazil's urban population	1.04	0.80	1.45	1.03

Sources: Tables 15.5 and 15.6.

presents estimates of increases in household formation for the 15 major metropolitan regions from 1970 to 2000. The table reveals that household formation was robust in the 15 metropolitan areas; between 1970 and 2000 they added about 10.6 million households. In total, the number of households in all urban areas of Brazil increased by 27.2 million over the 30-year period, or about 900,000 households a year. As pointed out earlier, an important factor in increased household formation is the reduction in the number of persons per household. Fewer persons per dwelling unit (and by extension persons per household) means that the number of households per 1,000 persons will increase. The 28 percent decline in persons per dwelling unit reflects a flexible response in housing supply to accommodate more households per 1,000 persons.[7]

Table 15.7 compares the housing stock increases shown in table 15.5 with the increases in households presented in table 15.6. In the 15 largest metropolitan areas, the 11.2 million increase in housing stock between 1970 and 2000

7. If housing supplies were tightly constrained, one would expect to see a stable or an increasing number of persons per dwelling unit as people delayed household formation or doubled up with other households or extended families.

closely tracked the 10.6 million increase in households. The overall ratio of housing stock increase to household increase for the 15 metropolitan areas is 1.1, suggesting that 1.1 housing units were added to the stock of the 15 metropolitan areas for every one additional household. Closer inspection of the ratio across the metropolitan areas reveals that 10 of the 15 metropolitan regions are producing relatively more housing units per increase in households. But housing markets in the metropolitan regions of Belém, Fortaleza, Grande São Luis, Maceió, and Natal are not producing enough units to accommodate new household formation.

These ratios are very impressive in view of the fact that they incorporate housing stock demolitions and removals. The net increase in the stock has, with the exception of the 1980s, kept pace with strong household formation, driven by both population increases and smaller average household size.

This evaluation of Brazil's housing market indicates that Brazil has a strong private (informal and formal) sector and that housing production is substantial. Private gross fixed capital formation in the housing sector has increased by more than fourfold in constant terms. On a per capita basis, the real constant investment in housing increased by almost two and a half times between 1970 and 2000. But as we shall see, most of the housing stock increases are in informal settlements that have limited infrastructure services.

How Large Is Brazil's Informal Housing Sector?

The previous section outlined the overall performance of Brazil's urban land and housing market, looking at both the formal and informal sectors of housing production and consumption. This section explores the role and performance of the informal sector in producing housing in Brazilian cities.

As noted in the introduction to this chapter, defining and systematically exploring informal housing are problematic (Pontual 2005; Pontual and Serra 2005). For Brazil, estimates of housing informality vary widely in terms of both the size of the informal housing stock and the rate at which informal housing units are added to the supply of housing.

What defines informality? Informal housing can be defined along three main conceptual lines: (1) security of land tenure; (2) access to infrastructure services; and (3) the physical characteristics of the settlement and the housing structures in it. Informal land subdivisions are a predominant component of informal housing. Brazil has two types of informal land subdivisions: illegal subdivisions and clandestine subdivisions.

Illegal subdivisions are produced by a landowner or the landowner's agent. A parcel typically is subdivided without government permission (approval of the subdivision plan) and a legal physical cadastre identifying plots. Incomplete infrastructure is provided. Purchasers of such lots will usually build housing over a two- to five-year period and, because of the lack of legal status, will construct housing without obtaining building permits and inspections.

Clandestine subdivisions refer to settlements produced on land not owned by a developer or real estate agent. These subdivisions may even be located on government land. Houses in clandestine subdivisions usually do not have secure tenure or

complete urban infrastructure services.[8] *Favelas* are also invasions of land, but the subdivision of the land is typically unorganized and does not follow a plan. Plots in *favelas* do not have legal title, nor do they have access to services.

The physical characteristics of informal settlements vary considerably. In clandestine subdivisions and *favelas*, housing construction can range from very poor temporary arrangements to reasonably good conditions—brick walls, concrete floors, and tin roofs. Condition depends on the age of the settlement—newer ones are more precarious, whereas more established settlements have better housing conditions. Over time, virtually all settlements go through an incremental process of upgrading. Some of this upgrading is self-organized, and some is based on government programs in which government agencies work with residents of informal settlements to provide secure tenure and make infrastructure investments in water, wastewater collection and treatment, drainage, electricity, and solid waste collection. These programs also include assistance to homeowners to make improvements to their houses. Even when governments do not support or sanction upgrading, community-based efforts are organized to improve conditions through self-help activities. The overall result is that in most metropolitan regions the stock of informal housing is constantly changing through additions, resettlements, and upgrading efforts.

Figure 15.5 illustrates how the three dimensions of informality can be combined to sort housing settlements and housing production into formal and informal classifications. Unfortunately, Brazilian statistics on informal housing stock are incomplete and at times misleading. Census data from IBGE on housing units combine informal and formal units and do not provide any basis for distinguishing between the two types. The work of the Fundação João Pinheiro (2002, 2005) also does not shed much light on this matter. Although its extensive research on Brazil's housing deficit provides specific tabulations of inadequate housing, overcrowding, lack of access to infrastructure, and excessive rental payments, these figures cannot be aggregated into overall estimates of informal housing stocks.

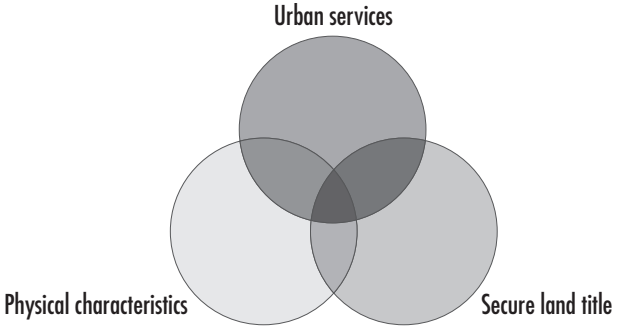
IBGE does, however, collect information on whether housing units have access to infrastructure services and on the physical conditions of each dwelling unit, as well as tabulations of the number of households in which the occupant has legal right to the structure, but not the land. But here again the tabulations cannot be aggregated without the risk of significant double counting (IBGE 2000).

As figure 15.5 shows, housing informality can be caused by a lack of infrastructure, a lack of secure land title, or poor physical condition of housing and an irregular settlement layout. Because the IBGE does not have data on land tenure, only three of the four variables needed to measure informality are used here.

Reliance on access to services and physical conditions while forgoing information on land tenure is likely to result in undercounting the stock of informal dwelling units in Brazil's urban areas. Unfortunately, it is not known how serious the

8. For example, some *favelas* in Rio de Janeiro (such as Favela da Rochinha) have most services, but still lack formal title. Also, as mentioned earlier, classifying settlements as either having or not having infrastructure services is problematic, because this binary treatment does not capture the variable quality of infrastructure services.

Figure 15.5
Informal Housing: A Definition



underestimation might be. If the incidence of dwelling units with infrastructure, good physical conditions, and lack of secure land tenure is low, then the underestimation will be low. If substantial numbers of units in cities lack secure land title but have infrastructure and are in good physical condition, then the underestimation will be large.

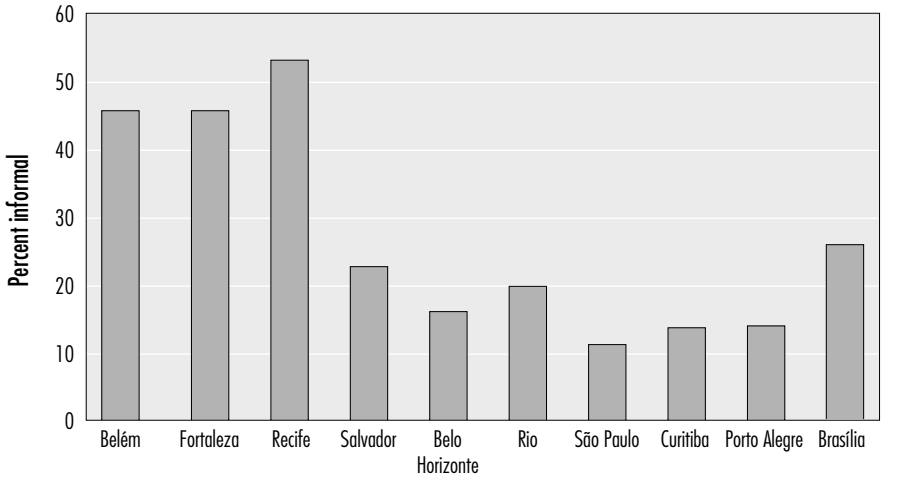
Discussions with housing and land tenure experts in Brazil indicate that the range of underestimation probably varies from city to city, with it higher in the north and northeast, where land titling and registration are less common (Edesio Fernandes, personal communication, March 6, 2006). In addition, many housing experts have noted that the IBGE data on access to infrastructure and on physical conditions are inaccurate and that they frequently undercount informal housing. Because of the lack of consensus on the precise definition of informal housing, a conceptually clear indicator of deficiency in housing services—lack of access to infrastructure—is used in the analysis described in this chapter, allowing clarity and transparency in the empirical measure of housing deficiency presented.

Figure 15.6 provides a tabulation of the percentage of housing units without urban infrastructure services by major metropolitan region in Brazil, based on the 2000 census. The figures range from more than 10 percent for São Paulo to nearly 55 percent for Recife.

Figure 15.7 depicts the changes in the informal housing stock in Rio de Janeiro. Informal housing increased from virtually zero in 1900 to over 225,000 units in 1991. Since the 1960s, the rate of growth has slowed, but it is still increasing and overspilling into outlying areas (O'Hare and Barke 2003). As a result, the proportion of Rio's housing stock located in *favelas* is declining. In 1970 about 13.5 percent of the housing stock was located in *favelas*, whereas by 1991 the portion had declined slightly, to 12 percent, which is roughly consistent with the percentage indicated in figure 15.6.

Table 15.8 enumerates both formal and informal housing stock (based on access to adequate infrastructure) for 1991 and 2000 for the 10 largest metropolitan areas in Brazil and other urban areas and estimates the net flow of formal and informal dwelling units. The overall portion of informal units has increased from 13 percent to 23 percent. In some cities—Brazília, Belém, and Recife—the portion

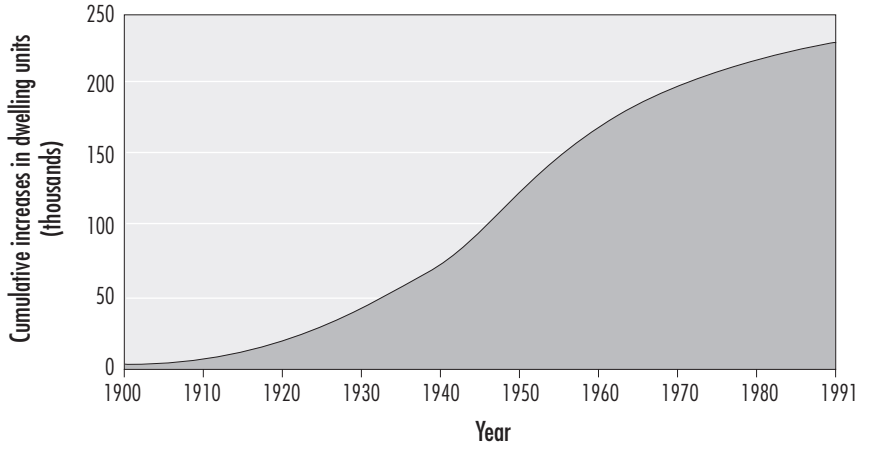
Figure 15.6
Level of Infrastructure Access: Brazil, 2000



Source: Fundação João Pinheiro (2005).

of informal units has doubled. In others—Curitiba, Salvador, and São Paulo—it has remained constant. However, experts familiar with Salvador indicate that the ratio of unserviced informal housing is grossly underestimated (Ivo Imparato, personal communication, March 6, 2006).

Figure 15.7
Number of *Favela* Dwelling Units: Rio de Janeiro, 1900–1991 (thousands)



Source: Development Planning Unit (2003).

Table 15.8
Total Dwelling Units and Those Lacking Adequate Infrastructure (informal): 10 Metropolitan Regions, 1991 and 2000

Metropolitan Region	1991			2000			Informal Increase as % of Total Increase
	Total Permanent Dwellings[a]	Informal Dwelling Units[b]	Percent of Total	Total Permanent Dwellings[a]	Informal Dwelling Units[c]	Percent of Total	
Belém	274,186	38,386	14.0	416,176	193,271	46.4	109.1
Fortaleza	479,852	146,355	30.5	723,197	333,262	46.1	76.8
Recife	605,880	181,764	30.0	859,574	459,352	53.4	109.4
Salvador	547,678	124,323	22.7	796,200	180,904	22.7	22.8
Belo Horizonte	822,147	229,379	27.9	1,295,824	214,114	16.5	–3.2
Rio de Janiero	2,753,543	273,669	9.9	3,252,659	654,324	20.1	76.3
São Paulo	3,967,579	273,669	6.9	4,992,570	571,466	11.4	29.1
Curitiba	508,699	72,744	14.3	776,060	108,938	14.0	13.5
Porto Alegre	840,660	81,544	9.7	1,112,752	162,856	14.6	29.9
Brasília	363,222	6,538	1.8	777,473	205,787	26.5	48.1
Total, metropolitan regions	11,163,447	1,428,371	12.8	15,002,485	3,084,274	20.6	43.1
Other metropolitan regions	23,571,268	3,224,240	13.7	29,774,255	7,176,802	24.1	63.7
Total, Brazil's urban population	34,734,715	4,652,611	13.4	44,776,740	10,261,076	22.9	55.8

[a] Permanent dwellings, 1991 and 2000: census table 2432.
[b] Informal dwellings, 1991: Fundação João Pinheiro (2002, table 4).
[c] Informal dwellings, 2000: Fundação João Pinheiro (2005).

These data provide a rough estimate of the relative contribution of formal and informal housing production to Brazil's urban areas between 1991 and 2000. The most important result of the tabulations presented in table 15.8 is that the informal sector accounted for over half—56 percent—of the increase in Brazil's urban housing stock between 1991 and 2000. Out of the total increase in permanent dwelling units of 10 million units between 1991 and 2000, informal production accounted for 5.6 million units.

Table 15.8 also suggests that informality is now more prevalent outside the 10 largest metropolitan areas. In 1991 informal housing accounted for 13.7 percent of the total housing stock outside the 10 largest metropolitan areas in Brazil. In 2000 the figure increased to 24.1 percent. By 2000, 22.9 percent of the urban housing stock in Brazil could be classified as informal (lacking access to infrastructure).

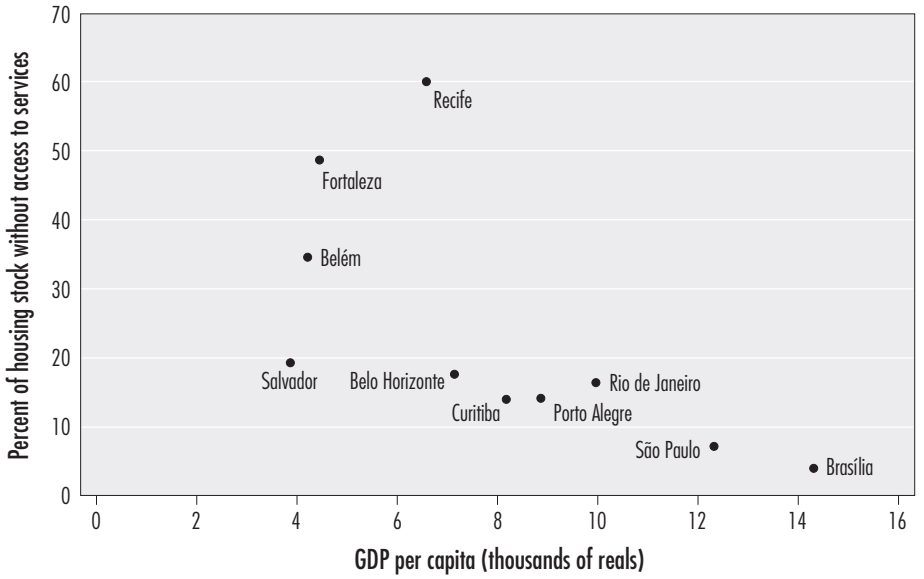
As for the net flow of unserviced housing production between 1991 and 2000 in the 10 largest metropolitan areas, changes in the number of informal units accounted for 43.1 percent of the total increase. Put another way, between 1991 and 2000 four out of every 10 units developed in the 10 metropolitan areas were without access to infrastructure. In Brazil's smaller metropolitan areas and cities, informal production accounted for 63.7 percent of total net housing production. This finding indicates that informality is growing rapidly in small and medium-size cities—between 1991 and 2000 the portion of housing units lacking infrastructure increased from 14 percent to 26 percent. In 2000 Brazil's urban housing stock totaled 44.8 million units. Of these, 10.3 million units were informal, lacking access to infrastructure.

Compared with other Latin American countries, Brazil ranks poorly in terms of access to infrastructure. According to a survey by the UN Economic Commission for Latin America and the Caribbean (UNECLAC 2004), it ranked eighth out of 13 countries in the percentage of dwelling units with access to piped water, eleventh out of 13 in sewerage collection and treatment connections, and fifth out of 14 in access to electricity.[9] These are not impressive standings, and they reflect the limited options open to low- and medium-income households to secure shelter.

Despite high levels of private investment in residential construction, urban housing production in Brazil relies predominantly on informal housing construction. Based on the available data, more than half—56 percent—of the housing stock increase between 1991 and 2000 was provided informally (see table 15.8). This situation is largely a reflection of the failure of formal urban housing and land markets to generate sufficient supply at affordable prices. However, informality is not simply a manifestation of low incomes. As figure 15.8 illustrates, levels of informality are not highly correlated with incomes. Informality varies considerably within a narrow range of metropolitan areas with a gross domestic product (GDP) of between 4,000 and 6,000 reals.

9. With a per capita GNI of $3,000, Brazil ranks below Mexico, Argentina, Chile, and Uruguay, and these countries score higher on infrastructure access. However, some lower-income countries such as Honduras and Guatemala, El Salvador, and Nicaragua score higher than Brazil on water and sanitation.

Figure 15.8
Housing Stock Without Access to Services: Brazil, 2000



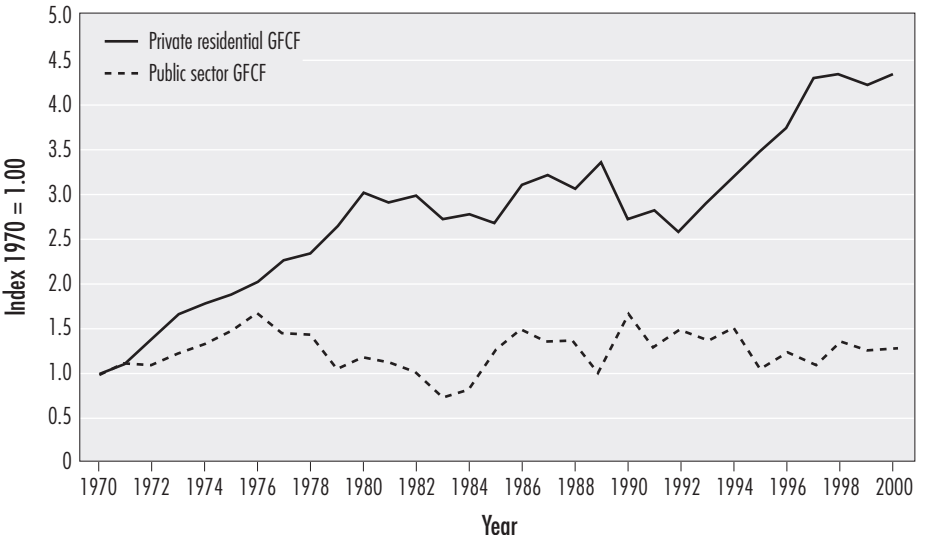
Source: Fundação João Pinheiro (2005).

The most important obstacles to increased supply are lack of serviced subdivided land. Public infrastructure services are not expanding fast enough to meet housing production, and so over 10 million units do not have access to adequate infrastructure. Figure 15.9 illustrates that public sector investment in infrastructure has not kept pace with housing production; public sector gross fixed capital formation has lagged behind. As a result, much of Brazil's housing production is delivered without the support of public infrastructure services.

If present trends continue, Brazil's urban housing stock will become increasingly dominated by informal production. Even though some modest increase in slum upgrading and regularization will move informal units into the formal category, it is quite likely that the overall proportion of informal urban dwelling units in Brazil will increase over the next several decades. In fact, if the trends in informal and formal housing production between 1991 and 2000 continue, Brazil's urban informal housing stock can be expected to increase to 35 percent overall by 2030.

One of the most significant consequences of urbanization and housing construction is the spatial development of cities. As cities grow and expand over time, their spatial structure changes (Angel, Sheppard, and Civco 2005). Motorization and the increasing use of automobiles are now one of the principal factors driving low-density metropolitan development. As the next section illustrates, Brazilian cities are decentralizing and consuming more land per person added.

Figure 15.9
Trends in Public Sector Gross Fixed Capital Formation (GFCF) and Private Residential GFCF, 1970–2000



Sources: Suzigan (1986); Abreu and Verner (1997); IBGE, Diretoria de Pesquisas, Departamento de Contas Nacionais.

The Effects of Urbanization on Urban Land Use

Brazil's rapid urbanization has profoundly shaped the physical development of its cities and metropolitan areas. Because urban population growth must be supported by urban land, as cities grow their urban (built-up) areas increase in size. Table 15.9 summarizes the built-up areas and population densities of selected Brazilian and Latin American cities. As the table illustrates, gross population densities in Latin American cities range from 23.7 persons per hectare in Curitiba to a high of 101.0 persons per hectare in Rio de Janeiro.

The urban development challenges posed by urban population growth are substantial. Additional population requires additional housing stock, water supply and wastewater treatment, solid waste collection, schools, health facilities, streets, transport, and employment opportunities. All require land to support such development. In fact, the supply of serviced land is one of the principal determinants of urban land market performance. When the supply of serviced land is limited, urban land prices are typically high relative to income and economic activity, thereby making housing and nonresidential real estate more expensive. Figure 15.10 provides a tabulation of land prices relative to GDP per capita in three Brazilian cities: Brasília, Curitiba, and Recife. As it illustrates, in all three cities the price of 100 square meters of serviced residential land roughly equals the per capita GDP of the metropolitan area.

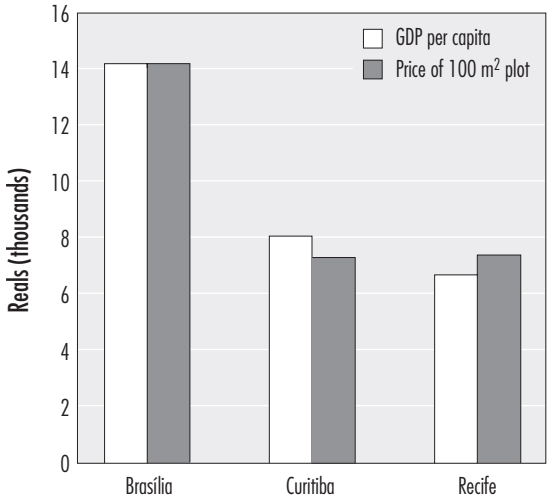
Households earning incomes below the GDP average are forced out of the formal market and must seek shelter in informal settlements. They then generate overcrowding as households share dwellings. It is no coincidence that informal

Table 15.9
Population, Urban Land Use, and Gross Population Density: Selected Latin American Cities, 1990 and 2000

City	Year	Population (millions)	Urban Land Use (hectares)	Gross Population Density	Source
Bogotá	1990	5.484	158,700	34.6	Brinkhoff
Brasília	2000	2.403	61,648	39.0	Serra et al. (2005)
Buenos Aires	1990	7.974	115,700	68.9	Bertaud
Caracas	1990	1.822	43,300	42.1	Brinkhoff
Curitiba	2000	2.594	109,629	23.7	Serra et al. (2005)
Mexico City	1990	8.235	149,900	54.9	Brinkhoff
Recife	2000	3.339	37,669	88.6	Serra et al. (2005)
Rio de Janeiro	1990	5.480	54,265	101.0	Bertaud
Santiago	1990	4.518	55,700	81.1	Simmonds and Hack (2000)
São Paulo	1990	15.416	203,800	75.6	Simmonds and Hack (2000)

Sources: A. Bertaud, http://alain-bertaud.com/; T. Brinkhoff, http://www.citypopulation.de/index.html; Serra et al. (2005); Simmonds and Hack (2000).

Figure 15.10
Prices of Residential Land and Gross Domestic Product per Capita, Selected Brazilian Cities



Source: Serra et al. (2005).

housing production, despite rigorous enforcement in the center of Brasília, is higher in Brasília than in Curitiba. As for Recife, the very high rates of informality stem from both affordability gaps and limited land for residential development (Serra et al. 2005).

Recent research on land markets in Brasília, Curitiba, Recife, and São Paulo gives some indication of the relationship between population growth and urban land development (see table 15.10). Using population and land use data from 1991 and 2000, the table illustrates the clear and direct relationship between population growth and urban land development. Depending on the metropolitan region, each additional 1,000 increase in population required the development of between 6 and 37 hectares of land. The amount of land needed depended on a range of factors such as the population per household, the density of residential development (houses per hectare), the extent to which new population was accommodated through the urban redevelopment of older buildings; and the additional demand for urban development generated by nonresidential uses such as commercial and industrial activities. In both Recife and São Paulo, development took place at higher population densities, most likely because of the denser residential development, whether formal or informal. However, over time the overall density of metropolitan areas declined.

This section examines the spatial structure of the three cities—Brasília, Curitiba, and Recife—looking at the distribution of population and the compactness of urban land development. This examination of the spatial distribution of population in the three cities provides an opportunity to compare and contrast the overall compactness of urban development. Compactness is measured by calculating the cumulative percentage of total population located within specific radii of the city center. Compactness changes over time, depending on the spatial distribution of residential development taking place between 1991 and 2000.

Figure 15.11 arrays the spatial distribution of population change for the three cities between 1991 and 2000 according to seven distance bands, expressed in terms of distance (kilometers) from the city center. To foster comparison, the bands are defined to reflect the overall spatial distribution of the three cities.

Changes in population between 1991 and 2000 reveal several interesting results. The first and most dramatic finding is that Brasília's population is distributed quite differently than Curitiba's and Recife's—that is, most of its population is concentrated far from the city center. In 1991 over half (53.6 percent) of Brasília's metropolitan population was located more than 25 kilometers from the city. By 2000 the percentage had declined somewhat, to 50 percent, but remained distinctly different from the spatial patterns in the other two cities. The percentage of population located within 10 kilometers of Brasília's center averaged about 8 percent for both 1991 and 2000.

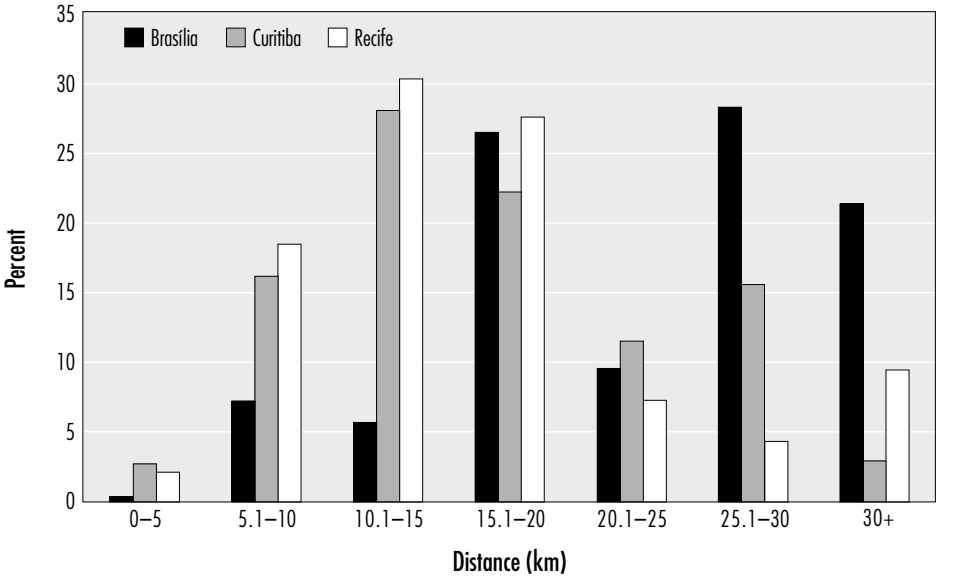
In sharp contrast, in 1991 nearly 70 percent of Curitiba's population resided within 10 kilometers of the city center. By 2000 Curitiba's population had begun to decentralize, and 58.5 percent of the total metropolitan population was located within 10 kilometers of the center. The peripheral population in Curitiba was low in comparison with that in Brasília—less than 6 percent in 1991 and less than 9 percent in 2000 of the total population residing more than 25 kilometers from the central city.

Table 15.10
Trends in Population and Built-up Areas: Selected Brazilian Cities, 1991 and 2000

Metropolitan Region	1991 Population	2000 Population	1991 Built-up Area (hectares)	2000 Built-up Area (hectares)	Change in Population	Change in Built-up Area (hectares)	Hectares per 1,000 Population Increase
Brasília	1,592,000	2,403,000	40,213	61,648	811,000	21,435	26.4
Curitiba	2,051,000	2,594,000	89,659	109,629	543,000	19,970	36.8
Recife	2,917,000	3,339,000	31,559	37,669	422,000	6,110	14.5
São Paulo	10,730,000	15,416,000	126,350	155,430	4,686,000	29,076	6.2
Total/average	17,290,000	23,752,000	287,781	364,376	6,462,000	76,591	11.9

Source: Serra et al. (2005).

Figure 15.11
Spatial Distribution of Population Change: Selected Brazilian Cities, 1991–2000



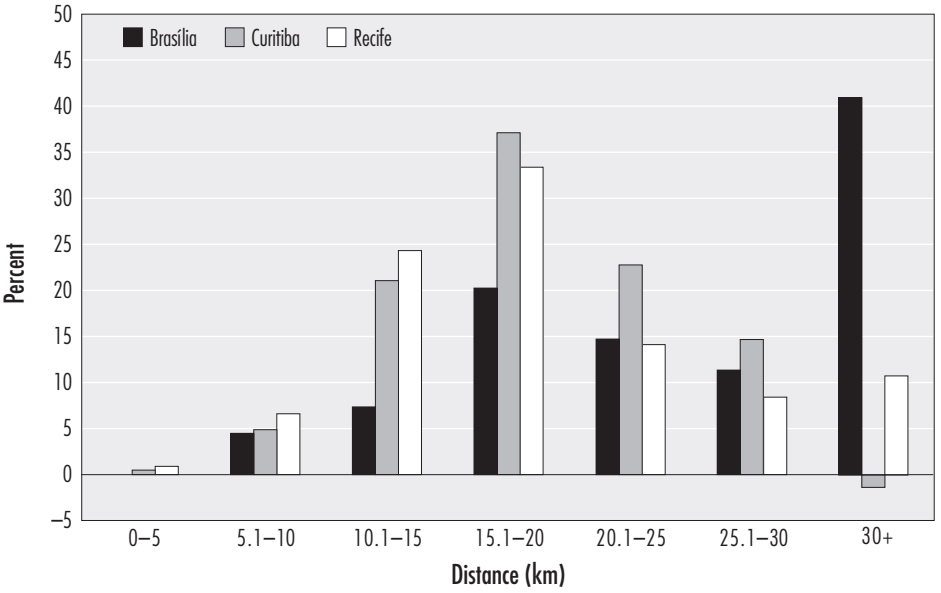
Source: Serra et al. (2005).

The patterns for Recife are similar to those for Curitiba. In 1991 over 48 percent of the population resided within 10 kilometers of the city center. In 2000 the portion was 44 percent. Recife's peripheral population was about the same as Curitiba's and well below that of Brasília. In 1991, 8.5 percent lived more than 25 kilometers from the city center. In 2000 the figure increased to 9.2 percent.

The spatial distribution of population in the three cities between 1991 and 2000 largely reflected the baseline spatial structure of 1991. In Brasília, about half of the population growth took place in areas more than 25 kilometers from the center. About 28 percent of the population change took place in the distance band of 25.1–30 kilometers, reflecting the growth in the area northeast of the city center. This decentralized, sprawling pattern of population change in Brasília suggests that planning restrictions and government ownership of land introduces profound distortions into Brasília's urban land market. Because development is blocked in areas adjacent to the city center, residential growth is forced to the periphery.

An interesting contrast is that between the situation in Brasília and those in both Curitiba and Recife, where land use regulations are far less stringent. In Curitiba, population growth moved out beyond 10 kilometers from the city center. Between 1991 and 2000, nearly half of the increase took place in areas between 10.1 and 20 kilometers from the city, suggesting that Curitiba has been relatively successful in achieving compact development by channeling growth into areas that are contiguous to existing urban areas. Compact development is not necessarily high-density.

Figure 15.12
Spatial Distribution of Change in Urban Land Development: Selected Brazilian Cities, 1991–1997/2000



Source: Serra et al. (2005).

In Curitiba, the city used 37 hectares of land for each additional 1,000 persons—or much more land than Brasília, which used 26 hectares.

In Recife, about 58 percent of the increase in population between 1991 and 2000 took place between 10.1 and 20 kilometers from the city center. Like Curitiba's, Recife's growth has been compact, moving out beyond the densely developed core. But unlike Curitiba, Recife is developing at a much higher density—it used about 15 hectares per 1,000 increase in the population.

Figure 15.12 illustrates the change in urban developed land between 1991 and 1997/2000 for the three cities. In the core of Brasília (within five kilometers), less than 10 percent of the total urban land area is developed.[10] By contrast, over 90 percent of the land in the core of Curitiba is developed. In Recife, about 80 percent of its developable core is urbanized. In Brasília, net new urban development in the core—conversion of vacant land to urban uses—is effectively zero (one hectare). In Curitiba, net urban development in the core increased by 14 hectares, in contrast to that in Recife—48 hectares.

As for urban land development beyond the core, Curitiba's and Recife's urban development is concentrated in the 10.1–20 kilometer bands. Between 1991 and 2000, 81 percent of Curitiba's change in developed, urbanized land was located in the 10.1–25 kilometer bands. In Recife, 73 percent was similarly located. By

10. The total area of the core is 7,850 hectares—$\Pi * \text{radius}^2$.

contrast, in Brasília less than 50 percent was located within 10.1–25 kilometers. In fact, about 53 percent of urban land development in Brasília between 1991 and 1997 took place beyond 25 kilometers of the city center—suggesting that Brasília is sprawling.

What are the implications of these alternative forms of urban land development in the three cities? Three important issues emerge from this comparison. First, cities that sprawl, such as Brasília, consume more land per person than those that develop compactly. Brasília developed 21,435 hectares of land to accommodate 811,000 persons—26.4 hectares per 1,000 additional persons (see table 15.10). By contrast, Recife developed 6,110 hectares of land to accommodate 422,000 additional persons—14.5 hectares of land per 1,000 persons. Curitiba, however, developed 19,970 hectares of land to accommodate 543,000 additional persons—36.8 hectares of land per 1,000 additional persons—suggesting that Curitiba experienced substantial low-density development.

A second issue is the welfare implications of forcing population to travel greater distances to the center of the city. As Bertaud, Buckley, and Owens (2003) have suggested for India, low-density urban sprawl burdens residents with significant transportation costs. A good comparative measure of compactness is the average per capita distance from the city center (Bertaud 2001). This distance is calculated as the weighted average distance of each population in each zone. In 2001 the average per capita distance for Brasília was 24.3 kilometers, for Curitiba 11.2 kilometers, and for Recife 13.1 kilometers. In all cases, the average per capita distance to the city center increased between 1991 and 2001. In 1991 Brasília's average was 22.5 kilometers, Curitiba's 9.75 kilometers, and Recife's 12.62 kilometers. In a 2003 paper, Bertaud and Brueckner demonstrate that cities with restrictive development controls take up more space and have higher commuting costs. Because distances are about twice as great in Brasília as in Curitiba or Recife, there is clearly a compelling case for assessing the welfare implications of the capital's dispersed spatial structure.[11]

The third issue is that more compact development economizes on urban infrastructure costs, whereas low-density sprawling development typically requires higher infrastructure costs per capita (see Burchell et al. 2002).

The experiences in Curitiba and Recife are consistent with empirical research on patterns of population density in Latin America and worldwide. These patterns reveal that over time population densities decline. As Ingram (1998, 1021–1022) points out, "Over time, a universal finding is that metropolitan populations have become more decentralized (population density gradients become flatter)—due to the effects of increases in income (promoting housing consumption) and improvements in transport performance (higher speeds and lower costs relative to incomes). Population growth in large cities usually does not increase the population density of high density areas, but promotes densification of less-developed areas and expansion at the urban fringe."

11. In fact, average distance per capita figures for other national capitals—such as Moscow, 10.57 kilometers; Paris, 10.24 kilometers; and London, 12.63 kilometers—are less than half of Brasília's, despite the fact that they have larger populations.

Density gradients measure the relationship between population density and distance from the city center. Normally, as cities expand, population density gradients "flatten out" as people move to suburban rings of the metropolitan area to find housing (Mills 1972). This flattening out is the result of two changes in the gradient: first, the population at the center declines, and, second, the rate at which population density falls with distance from the city center declines. Empirical research has shown that a simple exponential function provides a reasonable basis for describing the pattern of declining population density in metropolitan areas. That function is $D_x = D_0 e^{-gx}$, where D_x is the population density at x kilometers from the city center; D_0 is the population density at the center of the city; and g is a population density gradient parameter to be estimated from the data.

Table 15.11 presents the results of separate regression models estimating the population density gradients for a range of Brazilian cities. Intercept data and gradients are presented for two time periods. In all cases, the gradients "flatten out" over time. With the exception of Recife, the intercept population density (the estimated population density in the city center) decreases over time, suggesting that residential occupancy decreases in the center, perhaps signaling conversion to nonresidential uses or residential population shifts to newer outlying areas. The increase in central city population in Recife, although modest, may suggest that the preservation of high-density *favelas* in ZEIS areas near the city center is an effective means of preserving residential areas in central cities.

Table 15.11
Population Density Gradients: Selected Brazilian Cities, 1991 and 2000

City	Year	Intercept (D_0)[a]	Gradient (g)	Source
Belo Horizonte	1991	122	–0.082	Avila and Mandell
	2000	113	–0.052	(2005)
Curitiba	1991	140	–0.201	Serra et al.
	2000	124	–0.166	(2005)
Fortaleza	1991	206	–0.166	Avila and Mandell
	2000	171	–0.108	(2005)
Porto Alegre	1991	166	–0.187	Avila and Mandell
	2000	158	–0.168	(2005)
Recife	1991	165	–0.076	Serra et al.
	2000	179	–0.073	(2005)
Rio de Janeiro	1991	169	–0.040	Avila and Mandell
	2000	148	–0.029	(2005)
Salvador	1991	219	–0.146	Avila and Mandell
	2001	198	–0.100	(2005)
São Paulo	1991	200	–0.073	Avila and Mandell
	2000	154	–0.049	(2005)

[a] Density is persons per hectare.

Sources: Serra et al. (2005); Avila and Mandell (2005).

The flattening out of population density gradients has important implications for urban land management. As cities grow, the amount of land supply needed per person will increase. Therefore, looking toward the future, cities in Brazil will expand spatially as densities decrease. This increase in urban population will generate considerable demand for urban land and infrastructure services.

Sprawl also poses a major challenge for metropolitan management and planning institutions. If the population growth of Brazil's largest metropolitan areas is spilling over into outlying municipalities, central city governments such as those of Rio de Janeiro and São Paulo will lose their control of spatial development policies and infrastructure investment decisions.

Looking Forward

Projections of future urban population growth for Brazil suggest robust growth (UNECLAC 2004). As illustrated in table 15.12, Brazil's total population is projected to increase by 65.96 million between 2000 and 2030, reaching 235.5 million. All of this increase will occur in urban areas, because rural hinterlands are expected to continue losing population. Total urban population will increase from 138 million in 2000 to 215 million in 2030, an increase of 77 million—the equivalent of adding seven Rio de Janeiros to Brazil over the 30-year period. On an annual basis, the increase in urban population will average over 2.5 million persons a year, which is almost equivalent to adding a Curitiba each year. These huge numbers imply massive challenges for city planning and public sector capital investment programming.

Table 15.12
Projections of Brazil's Total, Urban, and Rural Populations: 2000–2030

Year	Population (millions)		
	Total	Urban	Rural
2000	169.544	137.697	31.847
2005	186.405	157.041	29.364
2010	198.497	171.904	26.593
2015	209.401	185.052	24.349
2020	219.193	196.573	22.620
2025	227.930	206.557	21.373
2030	235.505	214.940	20.565
Year	**Annual Percentage Change**		
	Total	**Urban**	**Rural**
2000–2005	2.0	2.8	–1.6
2005–2010	1.3	1.9	–1.9
2010–2015	1.1	1.5	–1.7
2015–2020	0.9	1.2	–1.4
2020–2025	0.8	1.0	–1.1
2025–2030	0.7	0.8	–0.8

Source: UNECLAC (2004).

How much urban land will be needed to accommodate future urban population growth in Brazil? Based on combinations of tables 15.10 and 15.12 and using the overall average 11.9 hectares of built-up area to support a 1,000-person increase in urban population, the total urban land requirements to accommodate 77 million persons is approximately 916,300 hectares or 9,163 square kilometers. Put another way, accommodating the urban population growth will require a built-up area equivalent to seven São Paulos.

This estimate is, however, speculative. It may be possible to accommodate the population growth at higher densities by redeveloping inner-city areas with housing and by increasing the density of suburban development (Dowall and Treffeisen 1991). Shifting away from single-family dwelling units (in both formal and informal settlements) to midrise condominiums and more compact low-rise residential development will reduce per capita urban land requirements (Burchell et al. 2002). For example, if the urban land supply requirements per 1,000 persons could be reduced by about 25 percent, only nine hectares of urban land would be required for each 1,000 persons (111 persons per hectare). This approach would reduce the aggregate land supply requirement to 693,000 hectares or 6,930 square kilometers. However, increasing density will make it more difficult for the informal sector to operate, because higher-density multifamily units will be needed. For this approach to work, such housing must be affordable to low- and moderate-income households, which suggests that the government should concentrate its efforts on providing urban infrastructure to land suitable for development.

What Can Be Done to Improve Urban Land and Housing Market Outcomes?

The government of Brazil, in partnership with local governments, nongovernmental organizations, and the private sector, could do much to foster increased production of affordable housing. This section outlines what such a strategy might look like.

First and foremost, the urban land and housing strategy should be multifaceted and similar to policy models used by public health professionals—that is, it should include both "curative" and "preventive" programs. The curative aspects of the strategy would focus on upgrading and improving housing conditions in informal areas. Preventive strategies should be implemented to reduce the growth of informal areas, which would require opening up more land for residential development, providing public infrastructure and facilities, and creating incentives for the provision of low- and moderate-income housing. Both approaches are needed. On its own, the curative approach will not succeed. Although existing *favelas* and irregular settlements could be upgraded, this approach does not prevent the formation of new informal settlements—they will continue to expand as long as urban land and housing markets fail to produce affordable housing.

Effective upgrading programs should include community participation, provide secure land tenure, and give access to critical residential infrastructure—water, wastewater collection and treatment, drainage, electricity, schools, and clinics, as well as parks and recreational facilities. Large-scale programs such as São Paulo's Guarapiranga project have been largely successful and provide useful models for replication (City of São Paulo 2000). However, because of their complexity such

projects are difficult to implement and replicate (Cohen 1983), which suggests that more work is needed to design more efficient and simpler procedures as well as to generate more professional expertise about upgrading.

Preventing the continued expansion of informal housing requires that Brazil's urban land and housing markets begin to produce more housing and provide more affordable housing located within reasonable commuting distances to jobs. If this can be accomplished, then the demand for informal housing should decline as households shift to less expensive formal housing.

What would it take to achieve such a result? First, cities and metropolitan areas need to better understand how their land and housing markets operate. Urban planners, housing specialists, and policy makers need better empirical data on urban land and housing markets—both current demand and supply information on land and housing prices and projections of future housing and urban land requirements to accommodate demographic and economic growth (Dowall and Clarke 1991).

Second, these data and projections should be used to prepare master plans for cities and metropolitan areas. The plans should ensure that adequate supplies of serviced urban land are available to support residential demand. This goal will require pro-poor land use plans and zoning regulations (United Nations–Habitat 2004). Lands should be targeted for residential development, and tax incentives should be used to encourage owners to bring land to the market for residential development. Governments should provide the funding for infrastructure provision, so that developers will be encouraged to construct housing.

Third, massive investments in private infrastructure are needed to foster residential subdivision development. The government of Brazil and state and local governments must develop more fiscal resources to finance infrastructure. This goal can be accomplished through a range of policy interventions, including levying user and beneficiary charges and implementing value capture programs as outlined by Furtado and Jorgensen (2006).

Fourth, land subdivision and building regulations should be reviewed to assess their impacts on housing costs. Subdivision standards frequently impose excessive standards on developers—large minimum lot sizes, high land dedication requirements, and investments in nonessential infrastructure (Avila 2006). Building codes often prove costly and impose too much of a burden on low- and moderate-income households (Dowall 1992a). One interesting model is Colombia's "minimum norms" for low-income settlements (Carroll 1980). Another possibility is to create a zoning classification that permits the development of sites and services projects. Such a classification would, in effect, legalize irregular settlements if they meet basic standards for circulation, plot size, and layout (United Nations–Habitat 2004).

Fifth, the government needs to develop cost-effective and replicable models for land titling and registration. These issues and policy reforms are outlined comprehensively by Fernandes (2006).

Taken together as a package, these five initiatives could foster increased affordable land and housing production. To launch this effort, the central government needs to articulate a policy framework and then to collaborate with local governments to design and implement plans and programs. Over time, the framework as well as specific programs should be evaluated and modifications made as necessary.

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