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Structural Sources of Socioeconomic Segregation in Brazilian Metropolitan Areas[1]

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This article evaluates the impact of industrialization and urbanization on residential segregation by income among Brazilian metropolitan areas. Using data from the 1980 census of Brazil, the author finds that more-industrialized areas have lower segregation because they have lower income inequality. However, urbanization, particularly population size, explains most of the variation in segregation among metropolitan areas. The conclusion is that the extent of urbanization, which is independent of industrialization, is key to understanding socioeconomic spatial inequalities in the large and rapidly growing cities of less-developed countries, but that conclusions regarding the effects of industrialization through industrial location or investment in real estate have been overgeneralized.

On October 18, 1992, much of Rio de Janeiro's middle class felt besieged by the city's poor. Busloads of youths from poor communities in the "North Zone" paraded across Copacabana and Ipanema beaches in the "South Zone," startling the predominantly white, middle-class beachgoers into running away. In a few cases, the youths engaged in fistfights and in the petty theft of sandals, watches, and sunglasses, but the worst crime of all seemed to be their massive presence on the beach. The reactions to this event (*arrastão*) by South Zone residents revealed their prejudices and insecurities about the "poor, dark-skinned" residents of the North Zone and of the highly visible, but socially distant, *favelas* (housing on illegally occupied land) of nearby hillsides (*Veja* 1992; *Folha de São Paulo* 1992). The incident and the reaction to it manifested

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deep-seated class and racial prejudices among the middle class throughout Brazil as they came to realize that the social and spatial barriers that had long kept class and racial groups apart were actually quite fragile.

In addition to aggravating tension among social classes, as this event dramatizes, segregation affects access by the poor to schools, jobs, health services, and public utilities and impairs the capacity of cities to contribute to economic and social development (Yujnovsky 1975; Angiotti 1993). As evidence for the United States suggests (Mayer and Jencks 1989; Massey and Denton 1993; Brooks-Gunn et al. 1993), segregation is also likely to impair child development in Brazil and elsewhere because it concentrates poverty into particular neighborhoods. On the other hand, a positive aspect is that segregation may promote local control and facilitate political mobilization among the poor and the working class (Smith 1979; Caldeira 1992). In metropolitan areas like São Paulo, class segregation has strengthened working-class identities, allowing Worker's Party activists to build an organizational base that links neighborhood groups with labor unions (Bava 1994).

This study seeks to understand segregation in Brazilian urban areas in the context of industrial and urban demographic change. In Brazil and throughout Latin America, uneven industrialization and growing social inequality have characterized the regional pattern of development in recent decades (Geisse and Sabatini 1988; Portes 1989). As these countries become predominantly urban, industrialization's effect on urban socioeconomic and spatial inequalities becomes increasingly important for understanding social development. Brazil presents an excellent setting for examining the effect of industrialization on segregation because of its high levels of income inequality and because industrialization is quite uneven across metropolitan areas, ranging from highly industrialized ones like São Paulo to others that have grown without the benefit of industrialization and are consequently left with bloated urban informal sectors (Evans 1979; Merrick and Graham 1979). I also emphasize urbanization itself as important for understanding segregation in Brazil. The rapid growth of metropolitan areas from migration and the great variation in population size must be understood independent of industrialization and as critical factors in producing spatial inequalities.

THEORY AND HYPOTHESES

In this section, I first examine four groups of theories that relate industrialization to segregation. I then examine the relation between segregation and demographic factors (migration and population size), and finally, I discuss the special case of the Brasilia metropolitan area.

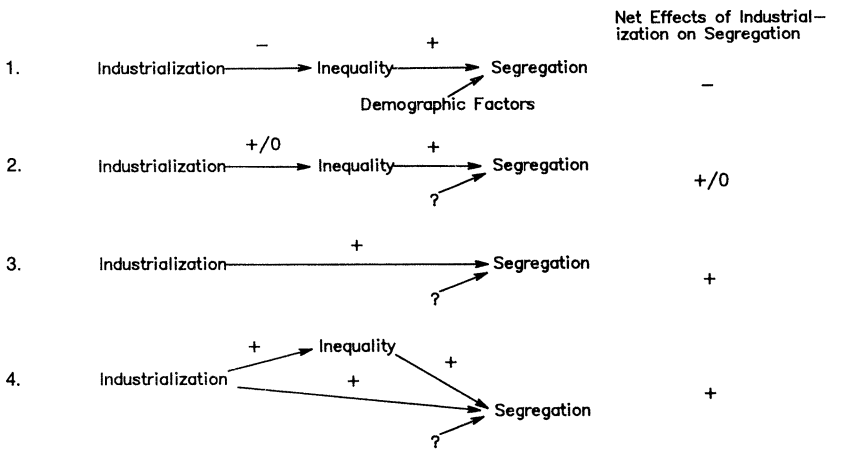

FIG. 1.—Hypothesized effects of industrialization on segregation

Industrialization, Inequality, and Residential Segregation

Several theories about how industrialization affects segregation have been proposed, although the specifics often are not clearly stated. I try specifying the major relationships suggested by these theories and summarize them under four perspectives and hypotheses that I call (1) neoclassical, (2) Marxist, (3) industrial location and accumulation, and (4) underdeveloped industrialization. Clearly, some theoretical elements are found in more than one perspective, but the four are intended to characterize the major relationships between industrialization, inequality, and segregation. In all the perspectives that consider income inequality, I hypothesize that greater income inequality leads to greater segregation. These hypotheses are illustrated in figure 1 and discussed in the following paragraphs.

Neoclassical perspective.—Since the industrial revolution, the consistent and often large gains in per capita incomes accruing to industrializing societies have made industrialization the dominant criterion for development (Gilles et al. 1992). Presumably industrialization produces positive benefits for society. Wages increase, at least in the aggregate, and an increasingly large share of the labor force is incorporated into productive and higher-paid industrial jobs. Poor countries, like Brazil, have often sought to diminish their reliance on manufactured imports and have made industrial development a central goal in their attempts to overcome poverty and raise living standards (Portes and Benton 1984). As cities industrialize, neoclassical theorists would expect residential segregation

to fall because of decreasing income inequality and because lower income inequality would likely diminish differences in access to property and housing.

Nationally, neoclassical economic theory predicts that, with industrialization, national inequality will increase at first, as urban incomes increase while rural incomes remain stagnant. Later, as increasing numbers of the rural population migrate to cities in search of the better wages from industrialization, inequality will begin to decline, as fewer residents will be in poverty (Kuznets 1955). Within an urban area though, industrialization should thus consistently reduce inequality. Finally, I contend that segregation may be affected by population size and growth in which segregation is likely to be greater in larger areas and in those experiencing greater migration, which I will discuss following the discussion of alternative hypotheses about the effects of industrialization.

Thus, in light of neoclassical theory, I hypothesize:

HYPOTHESIS 1.—*Industrialization reduces segregation but only indirectly by reducing income inequality. In turn, segregation is reduced, as it is a spatial manifestation of income inequality. These effects occur along with demographic effects.*

Marxist perspective.—Inspired by Marx, other analysts claim that the industrial revolution polarized the population into classes and increased the division of labor, presumably leading to greater geographical segregation within cities (Engels [1845] 1973; Smith 1979). Based on evidence for recently industrialized countries, including Brazil, some development analysts challenge the neoclassical theory that industrialization eventually reduces income inequality (Chenery 1980). Rather, such effects may be country-specific and depend on specific development patterns. According to these analysts, Brazil's growth-oriented pattern has tended to produce greater inequality nationally compared to the equity-oriented, low-growth pattern illustrated by Sri Lanka or the rapid growth with equity pattern of Taiwan and Korea (Chenery 1980). Specifically, the benefits of industrialization for the working class have been insignificant compared to the disproportionate shares that have gone to industrial and financial capitalists (Kowarick and Ant 1988; Singer 1985). Strong military governments between 1964 and 1985 colluded with capitalists in maintaining high levels of inequality by keeping the minimum wage at very low levels, an amount sometimes paid even to workers in modern industrial jobs (Souza 1980; Singer 1985).[2] Under this theory, housing

[2] Much debate surrounded the magnitude of change in inequality in Brazil from 1960 to 1980, a period of rapid industrial growth. However, a thorough and careful evaluation by the World Bank of the empirical literature concluded that the structure of inequality in Brazil remained roughly the same or increased slightly from 1960 to

markets would similarly be more stratified, leading to greater segregation. Thus, this discussion suggests a counterhypothesis:

HYPOTHESIS 2.—*Residential segregation is unrelated to or increases with industrialization because preindustrial levels of inequality persist or inequality increases with industrialization.*

Industrial location and accumulation perspective.—Industrialization may have direct effects on the spatial distribution of urban populations. Residences tended to be adjacent to or part of the workplace in old industrial cities (Angiotti 1993). In large and complex metroplitan areas, the agglomeration of large-scale industries in key urban locations may drive the elites and middle class out (Schnore 1965) but might also attract higher-paid industrial or specialized workers to such locations, leaving the poor behind or perhaps displacing the poor of those areas (Logan and Molotch 1987; Fales and Moses 1972). Despite disagreement about which class groups are most affected by industrial location, both of these hypotheses indicate greater intraclass agglomeration and therefore greater socioeconomic segregation. On the other hand, such direct effects from industrialization might have been more important when transportation was less developed and workers lived close to their workplaces. The fact that manufacturing was based on large-scale production in even the most industrialized of Brazilian urban areas in 1980 permits us to test the theories of industrial location that may be irrelevant for the small-scale and flexible forms of industrialization that increasingly characterize modern economies (Sassen 1991).

In large cities that are highly class differentiated, the elites may attempt to segregate themselves and the middle class from the poor, as has been the case for São Paulo throughout most of this century (Caldeira 1992). It is not clear whether such *intents* are universal or specific to particular cities. However, the *ability* of the urban elites and middle class to isolate themselves into income-homogeneous neighborhoods seems to depend on the capital that they can raise for building new housing tracts. Specifically, construction and real estate speculation may be intensified with greater capital accumulation drawn from industrial profits (Harvey 1985; Logan and Molotch 1987). This would lead to higher land prices, further stratifying residents spatially and raising the threshold of housing affordability for the poor. These theories tend to ignore the mediating effects that income distribution has on the relation between industrialization and segregation, and they would seem to support the following hypothesis:

1980, despite the growth (Pfefferman and Webb 1979). Wages in all sectors of the population increased during the period, although those at the very top increased the most. However, in the 1980s, a period of no growth, inequality increased though wages fell, to different degrees, at all levels (Bonelli and Sedlacek 1989).

HYPOTHESIS 3.—*Industrialization is directly related to greater residential segregation independent of its effects on inequality.*

Underdeveloped industrialization perspective.—Recently, some analysts have used the notion of "underdeveloped industrialization" to explain Brazil's pattern of social development, inequality, and segregation (Ribeiro 1992; Kowarick and Campanário 1988). This perspective claims that, despite industrialization, working wages have declined, increasing income inequality. As the price of land rises, housing stratification increases. Specifically, capitalist industrialization in Brazil brings about greater control over salaries, more work hours, and worsening labor conditions and, thus, greater profits for industrialists. Lacking other alternatives for investment, industrialists invest a large portion of these profits in real estate, leading to higher land prices and thus greater income segregation because greater shares of the poor cannot afford housing of any kind (Geisse and Sabatini 1988). The failure of the state to control such activity and provide for the housing or general welfare of the poor allows such a process to go unchecked. Thus, industrialization, under this theory, would seem to negatively increase segregation both directly and indirectly via inequality.

HYPOTHESIS 4.—*Industrialization leads to greater residential segregation indirectly by maintaining or increasing income inequality and directly by further stratifying real estate values.*

Demographic Factors and Segregation

Migration.—Cross-sectional country comparisons and the historical experience of the currently industrialized countries shows that industrialization and urbanization are often thought to move in tandem (Gilles et al. 1992). However, this relation does not hold in currently less-developed countries, including Brazil (Firebaugh 1979; Merrick and Graham 1979). Third World cities grow largely through natural increase, which far outpaces the growth of cities in industrialized countries during their peak growth periods, and migration is often more related to adverse conditions in rural areas than to the attraction of urban areas, as exemplified by the rapid growth of cities in the least-industrialized regions of Brazil (Martine and Camargo 1984). Also, social networks between an urban area and other areas, which may have started when an uran area was economically attractive to migrants, may continue to reinforce migration despite withering economic opportunities. Thus, demographic factors such as population size and migration should be analyzed separately from industrialization.

Population growth from migration may increase segregation by overburdening the formal housing market and increasing competition for cen-

tral land and housing. Also, since migrants tend to enter the urban labor market without financial capital and as low-wage and often informal-sector workers, they are often limited to poor housing. Their strong social networks further channel them into particular neighborhoods that are often populated with many other poor migrants, thus increasing economic residential segregation (Perlman 1976; Leeds 1974). Population growth forces new neighborhoods to be formed, whether these be shantytowns or middle-class settlements, and because these new neighborhoods are especially homogeneous in earlier stages, greater segregation is likely to accompany such growth. Finally, human ecologists have noted that population growth intensifies demand for central land and increases spatial differentiation, thus increasing segregation (Shevky and Bell 1955; Guest 1984). Thus

HYPOTHESIS 5.—*Higher migration rates or faster growth of metropolitan areas leads to greater segregation.*

Population size.—The major difference between urban areas today and in the past is size—contemporary large urban areas are far larger and more numerous than in the past. Currently, many less-developed countries feature giant or mega-cities (Angiotti 1993). Brazil currently has two mega-cities: São Paulo, with more than 12 million inhabitants in 1980, and Rio de Janeiro, with about 9 million residents.

Human ecologists have stressed the role of population size in increasing segregation (Schnore 1958). Population size allows for the development of greater social differentiation as well as greater differentiation of neighborhoods (Hawley 1950; Choldin 1984; White 1986*a*). Also, larger urban areas tend to have greater commuting distances and times, increasing demand for neighborhoods with better access to transportation routes and consumer and labor markets. This should lead to greater disparities in land values in larger areas, thus increasing segregation. Also, higher values overall would likely increase the chances of separate informal or illegal housing markets. This is clear in Brazil, as its rapid urban population growth in the 1970s often outpaced the housing supply. Thus

HYPOTHESIS 6.—*Larger urban areas tend to have greater residential segregation.*

The Special Case of Brasilia

Any analysis of segregation in Brazilian metropolitan areas should note the special case of Brasilia, which replaced Rio de Janeiro as the new national capital in 1960 and was to represent Brazil as a modern nation. Brasilia was designed, built, and administered by the state in the interest of, among other things, subverting the pernicious residential segregation and social class divisions that characterized typical Brazilian cities (Hol-

sten 1988). Brasilia's creators had a vision of a residentially egalitarian city with persons of distinct social classes living together in standardized apartment buildings, which themselves were intended to negate social divisions (Holsten 1988). However, its transformation to a free real estate market and the growth of the Brasilia metropolitan area beyond the limits of the planned city (Plano Piloto) has led to very apparent class segegation between primarily middle-class government bureaucrats, who can afford to live in Brasilia city, and the low-skilled manual workers, who must live in the satellite cities (Campos 1991).[3] Thus, the spatial rigidness imposed by the highly ordered housing zones may have instead exaggerated Brasilia's spatial segregation beyond that of older Brazilian cities. Thus, the final hypothesis:

HYPOTHESIS 7.—*Brasilia has significantly higher segregation than other Brazilian metropolitan areas.*

DATA AND VARIABLES

Data

Data are from the microlevel data files of the 1980 census of Brazil. All information on segregation is computed from the full 25% sample. Indexes of segregation were computed by the Instituto Brasileiro de Geografia e Estatistica (IBGE), under close supervision by the author. They are based on census tracts that have between 250 and 300 households, or an average of 1,150 persons.[4] Also, census tracts were designed in or prior to 1960 and new subdivisions are made according to physical criteria, thus diminishing the effects that variation in census tract design would have on measured social segregation across the metropolitan areas. The uniformity in the size of census tract parcels and fairly uniform criteria for their design make intranational comparisons viable. The units of analysis are the 40 Brazilian urban areas in 1980, as specified in an IBGE publication (Vetter 1988), with populations greater than 200,000.

Measures of Segregation

To measure segregation, I examine the extent of *evenness* in the distribution of household income groups across metropolitan areas. The concept

[3] Although the initial plan sought the integration of members of diverse classes, there was a clear differentiation of housing types between neighborhoods. Thus, when market forces were allowed to take over, sharp differences in housing values emerged among neighborhoods.

[4] By contrast, U.S. urban census tracts average about 5,000 persons. The larger size tends to reduce overall segregation values, as larger tracts are likely to be more heterogeneous.

of evenness refers to the extent to which social groups are differentially distributed across a metropolitan area. It is particularly suitable for capturing the amount of segregation found among the mosaics of households and neighborhoods that characterize the landscapes of Brazilian metropolitan areas. Much research on Latin American patterns of segregation have focused on *centralization* instead, largely because it describes an urban form derived from colonial (and even precolonial) times that is relatively easy to observe and, if measured, requires data for only two areas: the central city and the periphery. However, centralization fixes an a priori urban form that is both overly simplistic and often inappropriate for describing Brazil's spatially complex metropolitan areas.

The traditionally employed measure of evenness, and of residential segregation in general, is the widely used and intuitively interpretable index of dissimilarity (D) (Massey and Denton 1988; White 1986*b*). However, D is limited to the comparison of two groups. Because residential segregation by household income involves at least several categories, several pairwise comparisons must be made with D. To obtain a single citywide measure of segregation by social class, individual Ds must be aggregated as analysts have done in the past (Farley 1977; Denton and Massey 1988), or an index that can appropriately handle polytomous data must be chosen. Because D is sensitive to random fluctuations in the distribution of persons across census tracts, its aggregation to a single measure may be inaccurate. Several authors have suggested a rarely used entropy or information-based index known as the entropy measure of segregation or, simply, H (James and Taueber 1985; White 1986*b*; Massey and Denton 1988). Specifically, H measures departure from evenness by taking the weighted mean deviation of every census tract's entropy (E) from the entropy of the entire metropolitan area.

Metropolitan area–wide entropy, a summary measure of (income) composition, is computed as

$$E = -1 * \Sigma (P_k \log P_k),$$

and a census tract's entropy (E_i) is similarly

$$E_i = \Sigma (p_{ik} \log p_{ik}),$$

and finally, the entropy index of residential segregation (H) is

$$H = \Sigma (p_i(E - E_i)/EP) * 100,$$

where p_i and p_{ik} refer, respectively, to the census tract (i) population and the proportion of the population of each income group (k) in each census tract. The variables P and P_k similarly refer, respectively, to the total population of a metropolitan area and the proportion of the population of each income group among the total metropolitan area population.

TABLE 1

DISSIMILARITY INDEXES AMONG HOUSEHOLD INCOME GROUPS BY NUMBER OF MINIMUM WAGES IN FOUR METROPOLITAN AREAS OF BRAZIL: 1980

Metropolitan Area and Income Group	% of Total Population	% Nonwhite	20+	10–19.99	5–9.99	3–4.99	2–2.99	1–1.99
São Paulo:								
20+	7.3	2.9	. . .					
10–19.99	14.6	10.7	32.0	. . .				
5–9.99	28.1	22.2	32.9	20.7	. . .			
3–4.99	23.8	31.7	34.1	24.7	19.1	. . .		
2–2.99	13.2	37.6	39.5	35.6	30.6	21.1	. . .	
1–1.99	10.0	41.1	54.1	54.2	51.4	44.5	30.3	. . .
Less than 1	2.9	36.0	73.7	73.9	73.2	69.5	60.1	41.4
Rio de Janeiro:								
20+	6.7	5.1	. . .					
10–19.99	11.1	15.1	24.5	. . .				
5–9.99	21.2	31.0	27.8	18.4	. . .			
3–4.99	22.2	42.6	33.2	25.6	19.7	. . .		
2–2.99	16.1	48.3	46.8	42.3	36.5	26.0	. . .	
1–1.99	16.9	52.2	67.4	65.4	61.5	53.4	36.1	. . .
Less than 1	5.8	52.8	83.4	82.7	81.0	76.7	65.3	42.0
Salvador:								
20+	6.1	28.2	. . .					
10–19.99	10.4	48.0	22.5	. . .				
5–9.99	17.6	68.0	26.2	19.4	. . .			
3–4.99	18.4	79.7	31.2	27.6	21.3	. . .		
2–2.99	16.0	84.9	44.8	44.5	38.5	27.6	. . .	
1–1.99	19.7	87.6	65.7	67.4	63.4	55.7	38.0	. . .
Less than 1	11.8	89.1	81.4	83.6	82.0	77.2	65.6	42.5
Brasilia:								
20+	10.3	10.7	. . .					
10–19.99	12.8	24.5	27.8	. . .				
5–9.99	19.3	42.8	31.6	20.2	. . .			
3–4.99	19.8	55.1	38.0	28.6	20.8	. . .		
2–2.99	15.7	60.1	50.2	46.9	40.3	29.2	. . .	
1–1.99	17.2	62.9	68.7	70.9	67.5	59.6	38.8	. . .
Less than 1	4.8	64.9	83.0	86.2	85.7	82.9	72.7	48.5

In addition to H, I present three other indexes of overall segregation based on D. The main substantive difference between H and the measures based on D is that H measures the extent to which the income composition of census tracts deviates from the citywide composition, while the D measures are based on the extent to which paired groups deviate from each other in their distribution across census tracts. The first two indexes are aggregates of all pairs (as presented in table 1) but are weighted in different ways. "Standardized mean D" is weighted by

a standard or average population. I choose the metropolitan area of Juiz de Fora as the standard population since it very closely matches the mean income distribution of the 40 metropolitan areas. Thus, standardized mean *D* is the weighted mean dissimilarity of a metropolitan area if it had the income distribution of Juiz de Fora. The second index, "weighted mean *D*," is weighted by the own income composition of each metropolitan area. The third index, "*D* between extremes," is simply the dissimilarity index between the highest and lowest income groups.

Weighted mean *D*, because it mathematically incorporates income composition, captures a different conception of segregation than the other measures. Specifically, it reflects the idea that, even though the highest and lowest income groups may be similarly segregated from each other in two metropoltian areas, the fact that these groups represent a higher proportion of the population in city A than in city B should make for greater segregation in city A, assuming all other groups are equally segregated. Standardized mean *D*, though, would yield the same segregation levels between the two cities, and *H* would yield similar levels.

Independent Variables

To estimate relative levels of industrialization, I use the percentage of the total labor force employed in manufacturing. The Gini index of income inequality is estimated from the midpoint values of the lowest six ranked income intervals as shown in table 1 and from assigning a value of 25 for the highest, open-ended interval. Population size is logged to pull in large values, especially those of the two giant metropolitan areas. Percentage migrant refers to the total resident migrant population divided by the total population.

FINDINGS

Segregation in Four Metropolitan Areas

This section describes levels of segregation between paired household income groups in São Paulo, Rio de Janeiro, Salvador, and Brasilia. The use of dissimilarity indexes that pair all combinations of the income groups provides a sense of the nature and extent of segregation in various urban contexts. Table 1 shows that residential segregation follows the expected pattern of greater spatial distance with greater income differences.[5]

[5] Segregation indexes were also computed for broad occupational groups. Bivariate and multivariate results based on the aggregate indexes (*D* and *H*) for occupational groups were similar to those based on income. The greatest exception to the pattern expected from segregation by income was in the examination of the paired dissimilarity scores. Segregation of white-collar workers from personal-service workers was lower than from sales, skilled manual, and transport workers, even though the last three

Using a rule of thumb in which values of 70–100 indicate extreme segregation (Massey and Denton 1987), extreme segregation is found between households earning less than one minimum wage and (1) *five* income categories in Brasilia,[6] (2) *four* categories in Rio de Janeiro and Salvador, and (3) *three* categories in São Paulo. The second column shows that households earning less than one minimum wage represent only 2.9% of São Paulo's population, and aside from this very small group, extreme segregation among income groups is not found in that metropolitan area. By contrast, the proportion of Salvador's population earning less than one minimum wage is fully 11.8% and is extremely segregated from most of Salvador's remaining population—those earning over three minimum salaries. In addition to the lowest income category, extreme or nearly extreme levels are found in the next poorest, but substantially larger, income category (one to two minimum wages) in Rio de Janeiro, Salvador, and Brasilia. In Brasilia, the two lowest income groups, which together represent 22% of Brasilia's population, are extremely or almost extremely segregated (values of 67.5 and higher) from the 43% of the population that earns at least five minimum wages.[7] Thus, segregation of the middle class from the poor is moderate in highly industrialized São Paulo, substantially greater in Rio de Janeiro and Salvador, and clearly greatest in Brasilia.

Further analysis of segregation among proximate groups at high income levels reveals a different pattern. Among the three highest earning groups, São Paulo has the greatest segregation at this level. Thus, segregation between the upper and lower middle classes, in rough terms, is greatest in São Paulo and lowest in Rio de Janeiro, although segregation between the poor and the middle class is greater in Rio de Janeiro than in São Paulo.

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groups have higher incomes, on average, than personal-service workers. This may reflect the fact that personal-service workers include domestic workers, custodians, and security guards who often live on the premises of their employers.

[6] Numbers of minimum wages is a convenient way to collect and represent data in Brazil because of its high rates of inflation. In 1980, one minimum wage equaled about 75 U.S. dollars.

[7] The relatively low levels of segregation in São Paulo are reflected in D between those earning 10–20 minimum wages and those earning 1–2 minimum wages. This is an important comparison of middle-class and poor groups in all four areas because these income groups represent substantial portions of the population in all four areas. São Paulo, e.g., has a D in this case of 54.1, compared to 67.4 for Rio de Janeiro. Differences in segregation between the poor and middle classes in São Paulo and Rio de Janeiro are even greater if we consider that the poor groups represent a much larger portion of the population in Rio de Janeiro, so that a much larger portion of the population in Rio would have to exchange census tracts with the middle class to achieve evenness at this level.

Class and race are closely correlated in Brazil so that class issues, like segregation, often become racialized in many Brazilian cities. The wealthiest groups are often almost all white and the poor are disproportionately nonwhite, although racial composition and thus racial composition by class may vary widely across cities. The third column of table 1 shows the racial composition of income groups in the four metropolitan areas. In Salvador, where roughly 80% of the population identifies itself as nonwhite, nonwhites constitute 80%–90% of the lowest four income groups but less than 30% of the highest earning group. In São Paulo, nonwhites are a large minority of about 30%–40% among the poor, but they are virtually absent (only 2.9%) among the highest income group. Thus some racial segregation in Brazil is assured by the fact that nonwhites are disproportionately in lower socioeconomic groups, although moderate racial segregation also occurs among members of the same income category (Telles 1992).

Levels of Overall Segregation in 40 Metropolitan Areas

While the previous analysis has focused on segregation between paired income groups within metropolitan areas, the remaining analysis examines overall segregation in the 40 metropolitan areas. Table 2 shows levels of segregation as measured by the four indexes and levels of income inequality for the 40 largest metropolitan areas by region and then by order of population size. Levels of segregation tend to be highest in the least developed Northeast region, although the relation is not very strong. Consistent with greater spatial inequality, levels of income inequality among Northeast urban areas are invariably higher than those of urban areas in other regions, with the single exception of nearby Belem. In fact, the lowest levels of income inequality tend to be in São Paulo, the most industrialized state of Brazil. Finally, table 2 shows that segregation tends to decrease with population size.

Values of H are smaller than those of D, which tends to be true in general (White 1986*a*). Also, income segregation values using H are likely to be especially small because income groups are often continuous, resulting in some *mixing* across the boundaries of the categories.

Brasilia has the highest levels of income segregation under H (20.1) and standardized mean D (50.7), despite having about average levels of income inequality (Gini of 48.3). Thus, Brasilia's relatively high segregation seems to result from high levels of residential segregation between paired income groups (table 1) rather than from overall income inequality. Teresina scores the highest on the weighted dissimilarity index (54.5), apparently because it has the highest level of income inequality (Gini of 56.1) and income inequality is directly incorporated into this segregation

TABLE 2

INDEXES OF SEGREGATION AND GINI INDEX OF INCOME INEQUALITY FOR THE 40 LARGEST METROPOLITAN AREAS OF BRAZIL: 1980

REGION/STATE AND METROPOLITAN AREA	ENTROPY INDEX (H)	DISSIMILARITY (D)			GINI INDEX
		Standardized Mean*	Weighted Mean	Between Extremes†	
Northeast region:					
Recife	15.3	49.7	53.2	84.1	54.6
Salvador	15.6	47.5	48.4	81.4	51.3
Fortaleza	13.3	46.9	50.4	80.2	54.4
João Pessoa	14.9	50.0	53.9	85.7	55.3
Natal	14.8	48.9	51.5	80.5	53.4
Teresina	14.4	49.5	54.5	82.0	56.1
Maceio	13.0	47.3	51.2	81.6	55.0
Aracaju	12.2	44.5	46.8	78.0	52.9
São Luis	10.2	43.0	46.8	74.9	54.3
Feira de Santana	8.5	39.3	41.8	71.5	51.5
Campina Grande	10.9	44.7	49.4	76.4	55.8
Itabuna	12.3	45.5	48.7	80.9	54.1
Minas Gerais–Rio de Janeiro–Espiritu Santo states:					
Rio de Janeiro	14.8	46.7	45.4	83.4	47.3
Belo Horizonte	15.2	46.3	45.4	81.1	48.0
Vitoria	14.5	47.4	47.6	82.6	49.1
Barra Mansa–Volta Redonda	11.6	42.9	41.5	76.5	44.6
Juiz de Fora	11.0	41.7	41.7	77.0	48.6
Ipatinga	14.0	45.3	44.7	75.8	46.7
Uberlandia	9.5	39.4	38.7	68.0	46.5
Campos	9.6	40.4	41.5	72.6	49.9

São Paulo state:					
São Paulo	12.7	41.7	39.5	73.7	42.3
Santos	12.3	43.5	41.6	74.9	42.1
Campinas	12.7	42.2	40.3	71.0	43.1
São Jose dos Campos	10.7	39.1	37.2	69.4	43.5
Sorocaba	8.1	36.4	34.3	66.2	42.1
Ribeirão Preto	11.9	41.5	39.3	76.0	44.0
Jundiai	9.2	38.9	37.0	67.0	40.5
South region:					
Porto Alegre	13.1	44.7	43.0	77.4	45.1
Curitiba	12.2	43.3	42.0	73.3	46.2
Pelotas–Rio Grande	11.1	44.7	44.5	77.3	46.9
Florianópolis	12.3	41.8	41.0	74.5	47.8
Londrina	13.9	46.0	45.5	77.9	48.0
Joinville	8.9	40.3	38.2	64.6	41.3
Caxias do Sul	9.8	40.4	38.4	70.4	41.6
North and central west (frontier) regions:					
Brasilia	20.1	50.7	49.4	83.0	48.3
Belem	11.4	43.4	45.1	78.3	51.6
Goiania	11.8	42.2	42.7	75.6	49.9
Manaus	10.3	40.4	39.7	66.7	46.9
Campo Grande	11.2	40.2	39.7	67.9	48.5
Cuiaba	11.5	41.0	41.4	69.3	50.2
Mean	12.1	43.6	43.9	75.5	48.5

* Standard metropolitan area is Juiz de Fora.

† Extreme income groups: households earning 20 or more minimum wages and households earning less than 1 minimum wage.

TABLE 3

ZERO-ORDER CORRELATIONS AMONG RESIDENTIAL SEGREGATION MEASURES

Segregation Measures	1	2	3	4
1. Entropy index (H)	1.000			
2. Standardized mean D	.885	1.000		
3. Weighted mean D	.714	.934	1.000	
4. D between extremes	.828	.917	.865	1.000

NOTE.—$N = 40$. Values over .316 significant at the $P < .05$ level.

measure. In terms of D between extremes, only Recife (84.1) and Rio de Janeiro (83.4) have higher levels than Brasilia (83.0).

Brasilia, Recife, Salvador, João Pessoa, and Teresina score among the 10 most segregated metropolitan areas on all four measures. Aside from Brasilia, the other four areas are all in the underdeveloped Northeast region and are among the largest 50%. Places having among the 10 lowest levels of segregation on all four measures are São Jose dos Campos, Sorocaba, Jundiai, Uberlandia, Joinville, and Caxias do Sul, all of which are relatively small and in the more industrialized regions. These results suggest that size is positively associated and industrialization negatively associated with segregation.

For purposes of the multivariate analysis, I chose H to represent segregation, a decision consistent with previous prescriptions for its use (White 1986*b*; Massey and Denton 1988). The use of H rather than an aggregate D measure seems to be further justified by the fact that all four measures are empirically correlated, so that the choice of one over the other is not likely to greatly affect the findings. As table 3 shows, the four measures of segregation are highly correlated among themselves. Measure H is very consistent with standardized mean D ($r = .885$), reflecting their conceptual similarity. Measure H correlates the least with weighted mean D ($r = .714$) because local income inequality is mathematically built into the latter measure, an undesirable property in an analysis where income inequality is a covariate. Finally, D between extremes, although it strongly correlates with the aggregate measures, is selective of only the wealthiest and poorest sectors of the population.

Explaining Patterns of Segregation

To test how both industrialization and urbanization affect segregation, I regress H on the independent variables through four models. H is transformed into logits because of its limited range. The units of analysis are 39 of the 40 metropolitan areas. I exclude Brasilia from the analysis

TABLE 4

OLS Regression Results Predicting Entropy Measure of Residential Segregation (H)

Independent Variables	Model 1	2	3	4	Mean	SD
% in manufacturing	−.006**	−.003	−.007***	−.003	20.9	12.5
	(.002)	(.004)	(.004)	(.003)		
	[−.393]	[−.212]	[−.459]	[−.180]		
Gini index of inequality		.010		.016**	48.5	4.6
		(.010)		(.008)		
		[.238]		[.390]		
Population (logged)			.119***	.127***	13.2	1.0
			(.025)	(.024)		
			[.614]	[.653]		
% migrant			.004	.006*	23.3	8.1
			(.003)	(.003)		
			[.180]	[.252]		
Intercept	−1.871	−2.417	−3.683	−4.556		
R^2	.154	.178	.491	.551		
Adjusted R^2	.132	.132	.448	.498		

Note.—N = 39. Dependent variable transformed into logits; SEs are in parentheses, and standardized coefficients are in brackets.

* $P < .10$.

** $P < .05$.

*** $P < .01$.

because of its extreme segregation and statistical outlier status, as regression diagnostics indicated.

Regression results are shown in table 4. Model 1 shows that residential segregation decreases with industrialization, and model 3 shows an even stronger negative relationship when population size and migration are controlled. However, the addition of the income inequality variable in the simpler model (model 2) results in the loss of predictive power for industrialization, although inequality is not statistically significant in either. In the full model (model 4), industrialization is not significant, while inequality and both demographic variables are. Inequality is positively related to segregation, demonstrating that segregation directly reflects the extent of income inequality in an area of similar size and migration. This also reflects the modest correlation between industrialization and inequality, in which half of the variance between the two variables overlaps ($r = -.76$, in the appendix), indicating that greater industrialization tends to reduce inequality among metropolitan areas. Model 4 also shows that larger urban areas and those with larger proportions of migrants tend to be more segregated. The inclusion of demographic variables (models 3

TABLE 5

OLS REGRESSION RESULTS PREDICTING INCOME INEQUALITY

INDEPENDENT VARIABLES	MODEL 1	MODEL 2
% in manufacturing	−.283***	−.266***
	(.040)	(.041)
	[−.760]	[−.715]
Population (logged)		−.466
		(.515)
		[−.186]
% migrant		−.108
		(.066)
		[−.101]
Intercept	54.397	62.695
R^2	.578	.609
Adjusted R^2	.566	.576

NOTE.—N = 39. Dependent variable transformed into logits; SEs in parentheses, and standardized coefficients in brackets.

* $P < .10$.

** $P < .05$.

*** $P < .01$.

and 4) more than tripled the explanatory power (R^2) of the simpler models (1 and 2), so that about half of the variation in segregation was explained.[8]

The direct effect of industrialization on inequality is shown in table 5. Inequality is clearly reduced when greater proportions of the labor force are employed in manufacturing industries, and over half of the varia-

[8] Several other variables, such as those representing the housing market, were considered but later dropped because they tended to be less theoretically defensible than the included variables or had empirically insignificant effects. Housing turnover, which has been found to be related to class segregation (O'Loughlin 1983), is highly correlated with percentage migrant (r = .81), and homeownership has virtually no effect in any model ($t < 1$). Also, age has been shown to be an important predictor of segregation in the United States. However, a dummy variable for age, operationalized as whether the *municipio* population reached 100,000 by 1940 (the year of Brazil's first reliable census), had no independent effect on segregation ($t < 1$). Finally, indexes of racial segregation were unrelated to class segregation ($t < 1$), a finding similar to that for the United States (Elgie and Clark 1981). I was also concerned that high density in urban areas had distinct implications for segregation because the physical area of a census tract is smaller than in lower-density areas. The percentage in apartments is an indicator of density and varies from 0.4 in Teresina to 34.3 in Santos. However, a separate regression analysis that excluded the four urban areas with more than 15% of their population living in apartments (more than 1 SD above the mean) yielded results similar to the findings for the 39 areas.

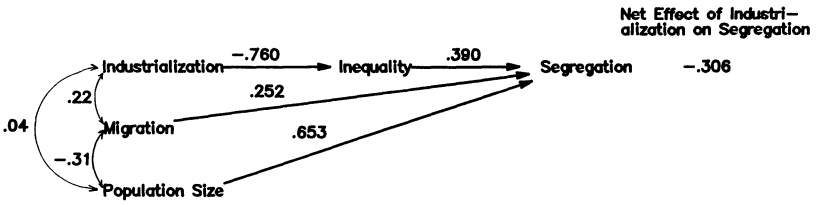

FIG. 2.—Path diagram showing effects of structural variables on segregation

tion in inequality is explained (model 1). Finally, the inclusion of demographic variables had virtually no effect on income inequality (model 2).

Thus, the results support hypothesis 1 that industrialization reduces segregation but only by reducing income inequality. Larger populations and a higher share of migrants also mean more segregation, supporting hypotheses 5 and 6. Furthermore, hypothesis 1 is supported only when the demographic effects are controlled. The relative effect of the variables is approximated with standardized coefficients shown in brackets in tables 4 and 5, and the final results are illustrated in the path diagram in figure 2. Population size clearly has the strongest direct effect on segregation (.653), followed by inequality (.390) and migration (.252). Industrialization has a relatively strong negative effect on inequality ($b = -.760$). Thus, the indirect effect of industrialization on segregation in this model is $-.306$ ($.390 \times -.760$), an effect that is substantially less than that of population size.

CONCLUSIONS

Industrialization is associated with lower segregation across Brazilian metropolitan areas, but its effect occurs only indirectly, via an area's income inequality. The cross-sectional finding of a strong negative relation between industrialization and income inequality thus supports neoclassical economic theory. It suggests that workers' wages in the aggregate are greater relative to the middle class in Brazil in places where a larger share of the labor force is incorporated into industrial jobs. Thus, more industrialized areas are likely to have lower income inequality than less industrialized places at any single point in time.

Industrialization has no discernible direct effects on segregation, as would be expected from theories claiming that industrial location geographically clusters workers (Schnore 1965; Fales and Moses 1972; Logan and Molotch 1987) or that industrial profits are invested into local real estate markets, thus heightening spatial stratification (Harvey 1978; Lo-

gan and Molotch 1987; Kowarick and Campanario 1988; Geisse and Sabatini 1988; Ribeiro 1992). Because proponents of these theories often draw their evidence from studies of a single case, they may be unable to discern the overriding effects of changing income inequality on segregation from these other effects.

More important than industrialization, urbanization explains much more of the variation in segregation than industrialization and inequality. In particular, population size is the best predictor of an area's segregation, making isolation of the poor and working classes most likely to be greatest in the largest cities. The importance of demographic variables in explaining segregation has been ignored or understated in many political economy discussions of the determinants of segregation, which focus on variables like industrialization and inequality. Urbanization is often assumed to move in tandem with industrialization, but the processes are often independent of each other in the currently less industrialized countries, and their effects on segregation may occur in opposite directions, as the case of Brazil shows. Industrialization decreases segregation, while urbanization increases it. Furthermore, the industrialization-inequality-segregation effect emerges only when population size and migration are controlled.

Given the strong relation between segregation and social well-being, slowed growth among the largest Brazilian metropolitan areas and greater growth among smaller ones in recent years therefore gives reason for some optimism. Debates over the effects of the large size of cities in the Third World focus on economic and health issues but tend to overlook social issues. The emerging "mega-cities" of the Third World are thus especially prone to a high degree of socieconomic segregation.

On the other hand, this pattern may not endure into the future. The transition from large-scale production to highly competitive, small-scale and flexible industrial production may mean greater income inequality, as the case of some global cities suggests (Sassen 1990), and thus greater segregation. Given substantial inequality in even the industrialized areas of countries like Brazil, new forms of industrialization may not affect inequality and may actually reduce the inequality and segregation of places that currently have little or no industrialization. Brazil is only beginning to enter this stage of industrialization, and thus how it will affect urban development, inequality, and segregation is still far from clear.

Income segregation in Brazil implies racial segregation because the two are correlated, although racial segregation is also created by moderate levels of segregation between similar socioeconomic groups (Telles 1992). Also, spatial factors may help explain why class identities are stronger than racial identities. In places like Rio de Janeiro and Brasilia, segrega-

tion between the poor and the middle class is extreme, while racial segregation is not. Furthermore, while nonwhites are more likely than whites to be poor, white-nonwhite segregation among the poor is especially low (Telles 1992).

The fact that metropolitan areas in the underdeveloped Northeast region have the highest levels of income inequality and segregation and that residents in that region are predominately nonwhite means that, not only are nonwhites more likely to suffer from poverty than whites, but they are also more disadvantaged by virtue of living in more unequal and segregated places. The Northeast's underdevelopment and the predominance of Afro-Brazilians in the Northeast are dual but related outcomes of the region's underdevelopment, historically rooted in a system of large landholdings for the development of a single export crop—usually sugar—which in turn depended on the brute labor of nonwhite workers.

Most of the variation in segregation among Brazilian metropolitan areas is explained in this analysis by industrialization and urbanization, although much of it may be further explained by the local management decisions and physical idiosyncrasies of particular cities and regions. Although housing and labor policies tend to be uniform throughout Brazil, differences in the enforcement of these may also help explain urban variation in segregation. Physical peculiarities like the mountainous terrain of Rio de Janeiro may help shape segregation, although Rio's segregation fits the modeled pattern based on all metropolitan areas.

The case of Brasilia offers an important lesson in urban planning. Its particularly high level of segregation originates in its unique development, which has overcome the constraints of industrialization and urbanization that predict segregation in other Brazilian urban areas. Segregation in Brasilia has been shaped by a highly ordered urban design, followed by conversion to a free real estate market and unanticipated population growth beyond the planned city limits. Ironically, Brasilia's planners had sought to build a new capitol free of the enormous class distances found in other Brazilian cities.

The direction of causality between industrialization, inequality, and segregation may also flow in reverse, although such effects are not likely to be observed at the metropolitan area level but at national or regional levels. Brazil's large income inequality, as well as that of other Latin American countries, may itself be an obstacle to development. According to some economists, the strong pressure in highly unequal societies for populist solutions has led to the avoidance of the currency devaluations that were necessary for Taiwan and Korea to attain export competitiveness and reach their current high levels of development (Sachs 1989; Mahon 1992). Similarly, high levels of segregation may impede develop-

ment as poor access to labor markets for many workers reduces their employability and lowers industrial efficiency. Also, inadequate access to good schools and other public services, as well as the psychological effect that segregation has on children and adolescents, limits the formation of human capital that is necessary for development.

Finally, given the complexity of residential form and segregation in the metropolitan areas of Third World countries, this study has demonstrated the need for indexes based on census tract data to measure levels of segregation. Such work could be extended to measure the social impact of segregation on the urban populations of these countries, particularly on the poor and on ethnic groups. Furthermore, because of the sensitivity of these measures to the size and design of census tract parcels, efforts should be made to create comparable tracts across countries. This would allow cross-national comparisons of cities, work that is currently hindered because of a general lack of uniformity at this level of aggregation. The choice of indexes has been shown to be important for accurately measuring segregation, as assumptions and limitations in their construction are not readily apparent.

APPENDIX

TABLE A1

ZERO-ORDER CORRELATIONS AMONG ALL INDEPENDENT VARIABLES USED IN THE REGRESSION ANALYSIS

Variable	1	2	3	4	5
1. Entropy index (H)	1.00				
2. % in manufacturing	−.39	1.00			
3. Gini index of inequality	.40	−.76	1.00		
4. Population (logged)	.54	.04	−.07	1.00	
5. % migrant	−.11	.22	−.31	−.31	1.00

NOTE.—$N = 39$. Values greater than .316 significant at the $P < .05$ level.

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