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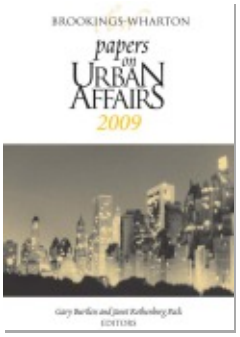

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Is Segregation Bad for Your Health? The Case of Low Birth Weight

This paper explores the relationship between racial segregation and racial disparities in the prevalence of low birth weight. The paper has two parallel motivations. First, the disparities between black and white mothers in birth outcomes are large and persistent. In 1996, 13 percent of infants born in the United States to black mothers weighed less than 2,500 grams (5.5 pounds, or low birth weight), compared with just 6.3 percent of all infants born to white mothers. And the consequences may be grave. Low birth weight is a major cause of infant mortality and is associated with greater childhood illness and such developmental disorders as cerebral palsy, deafness, blindness, epilepsy, chronic lung disease, learning disabilities, and attention deficit disorder.[1] Given the strong connection between race and residence in this country, it seems plausible that residential location may shape these differentials.

Second, while there is a growing literature on the costs of racial segregation, it has largely focused on economic outcomes such as education and employment. This paper aims to develop a fuller understanding of the costs of racial segregation by considering birth outcomes as well as such behaviors as tobacco and alcohol use among pregnant mothers. As Glaeser emphasizes (in his paper in this volume), information, ideas, and values are often transmitted through face-to-face interaction, and thus their transmission may be

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1. Paneth (1995).

blocked by segregation. This includes information related to job openings and may include information and norms related to behavior and care during pregnancy.

Adopting in large part the methodology of David Cutler and Edward L. Glaeser, the paper thus examines how levels of racial segregation affect the birth outcomes of black mothers.[2] It examines influences on both black and nonblack mothers in an attempt to identify the differential effect of segregation on black mothers.

Theory and Past Literature

This section summarizes what is known about the costs of segregation from prior research, discusses several alternative pathways through which segregation may influence outcomes, and reviews previous literature on the causes of low birth weight. Given this understanding, the section then explores how segregation might contribute to the lower birth weights of infants born to black mothers.

Costs of Racial Segregation

There is a growing body of work demonstrating a negative correlation between the degree of racial segregation in a metropolitan area and the economic success of its African American population.[3] Parallel to this work is a growing literature suggesting a link between racial segregation and the health of African Americans. In more segregated neighborhoods and metropolitan areas, African Americans have been found to suffer higher rates of homicide, suicide, infant mortality, and overall age-adjusted mortality.[4]

While these correlations are striking both in magnitude and significance, determining the direction of causality is naturally more difficult. It may be that greater disparities in economic status lead to greater residential segregation and not the reverse. And the link between segregation and health outcomes

2. Cutler and Glaeser (1997).

3. Galster (1987); Galster (1991); O'Regan and Quigley (1996); Cutler and Glaeser (1997).

4. Yankauer (1950); Polednak (1991); Potter (1991); LaVeist (1992); Krivo and Peterson (1993); LaVeist (1993); Shihadeh and Flynn (1996); LeClere, Rogers, and Peters (1997); Polednak (1997); Almgren and others (1998); Guest, Almgren, and Hussey (1998); Burr, Hartman, and Matteson (1999); Collins and Williams (1999).

may simply reveal that blacks who are more economically disadvantaged tend both to be at greater risk of poor health outcomes and to live in more segregated areas.

Despite this ambiguity, researchers considering health outcomes and segregation have paid scant attention to the issue of causality. They tend to rely strictly on aggregate, cross-sectional correlations, and thus it is difficult to interpret their results. The researchers concentrating on employment and education have focused a great deal more on causality and have made substantial strides.[5] Cutler and Glaeser make the most thorough attempt to discern causality.[6]

First, they study cross–metropolitan area differences in segregation. Many prior studies examining the effects of segregation have focused on a particular city or metropolitan area and compared the outcomes of blacks living in neighborhoods of varying racial compositions.[7] This approach may overstate the effects of segregation, however, since the more successful blacks may migrate to the more integrated neighborhoods. This approach may also lead one to understate the effects of segregation, since the degree of segregation in a metropolitan area may influence all minorities living there, even those living in largely white communities.[8]

When measuring segregation at the metropolitan level, such mobility concerns are naturally reduced. Moreover, Cutler and Glaeser focus on youth, for whom mobility should be less of a problem, and also examine the effects of segregation in the city of residence five years earlier.[9] Finally, to ensure that their measure of segregation is exogenous, Cutler and Glaeser use two different sets of variables to instrument for segregation across cities. In all cases, and with two different data sets, their results point to the same conclusion: segregation leads to poor outcomes for minorities and not the reverse.

Through What Channels Does Segregation Influence Outcomes?

Although the empirical evidence indicates that racial segregation reduces the educational attainment, wages, and likelihood of marriage among blacks, there is little evidence about which of several mechanisms is central. Past researchers have speculated about the ways in which segregation may under-

5. Galster (1987); O'Regan and Quigley (1996); Cutler and Glaeser (1997).

6. Cutler and Glaeser (1997).

7. Yankauer (1950); Holzer (1991); Borjas (1995); Krivo and Peterson (1996); LeClere, Rogers, and Peters (1997); Almgren and others (1998); Guest, Almgren, and Hussey (1998).

8. Ellwood (1986); Cutler and Glaeser (1997).

9. Cutler and Glaeser (1997).

mine the economic achievement of minorities. As John Kain first noted, segregation may result in a "spatial mismatch" between where blacks live and where the vast majority of appropriate job opportunities exist.[10] Katherine O'Regan and John Quigley instead stress the social isolation produced by segregation: the harm of segregation is that it creates a barrier that prevents information about job opportunities from flowing from white and more affluent populations to black and more economically deprived populations.[11]

Douglas S. Massey and Nancy Denton, meanwhile, argue that because of higher poverty rates among blacks, racial segregation means that blacks live in neighborhoods with higher poverty.[12] And as a growing literature suggests, neighborhoods with higher poverty may have powerful negative effects on the social and economic outcomes of residents, due perhaps to peer effects or social networks.[13] Others have emphasized the role of differential public services, while still others have emphasized the role that residential segregation may play in fueling, or at least maintaining, racial prejudice.[14]

Segregation might also benefit minorities. For example, it may provide greater political power, as well as improved services, to minority communities as a result. Racial segregation may also mean that black mothers live in communities where they enjoy stronger social networks and support.[15]

Birth Outcomes

The causes of low birth weight are surprisingly poorly understood.[16] Some medical risk factors are known—most important are the age and weight of the mother, and certain preexisting medical conditions. These are unlikely to be

10. Kain (1968).

11. O'Regan and Quigley (1996).

12. Massey and Denton (1993). Jargowsky (1997) finds that a one-standard-deviation increase in the level of segregation increases the average neighborhood poverty rate experienced by blacks by about one-fifth of a standard deviation.

13. For review, see Ellen and Turner (1997).

14. Galster (1991); Yinger (1995). One possible cause of differential services is discrimination on the part of public or private actors. Another possibility is that raised by Cutler, Elmendorf, and Zeckhauser (1993), who hypothesize that individuals may favor redistribution only to those living in their immediate area. If this is true, then separation of the races may result in less desire among whites to direct spending toward blacks.

15. Stack (1974).

16. Low birth weight is caused either by preterm delivery or by intrauterine growth retardation. Although it would be interesting to study preterm delivery and fetal growth retardation separately, data on gestational age are not very reliable, so the focus here is on birth weight. In general, the best evidence suggests that most of the racial disparity in the risk of low birth weight is driven by differences in preterm delivery. See Paneth (1995).

greatly shaped by the urban environment.[17] However, there are other known risk factors that are likely to be much more vulnerable to environmental threats. I group these into four categories of observed variables: socioeconomic status; behavior during pregnancy; stress; and exposure to various toxins.

In terms of socioeconomic status, numerous studies have shown that women with less education are far more likely to give birth to low-weight infants.[18] There is less consensus as to why this is the case. Less-educated women have lower incomes and are therefore less able to afford good pregnancy care. Alternatively, less-educated women may have inferior information about pregnancy care. Finally, the day-to-day stress of being poor may play a role as well. As will be discussed further below, there is some evidence that such stress leads to inferior birth outcomes.

Marital status is also strongly correlated with poor birth outcomes, perhaps because it too is a proxy for income. But marital status may also reflect social isolation. Prospective studies, which control for baseline health status, consistently show worse health outcomes for people with fewer social relationships.[19] Finally, marriage may be correlated with more desired, or at least more expected, pregnancies.

The second set of factors linked to poor birth outcomes are those relating to health-related behavior during pregnancy. These include tobacco use, alcohol use, drug use, nutrition, and the utilization of prenatal care. With varying degrees of certainty, all of these behaviors have been linked to poor birth outcomes.

The third factor related to poor birth outcomes is stress. Although the impact of stress on physical health is still poorly understood, there is growing evidence that psychological stress may place a toll over time on the body's immune system.[20] And there is at least some evidence that stress may specifically increase the risk of low birth weight and preterm delivery, and may do so independently of any influences on health-related behaviors.[21] Finally, there is some evidence that certain environmental conditions may contribute to poor

17. Although the age of the mother is potentially influenced by social conditions, the effects of age on birth weight appear to be nonlinear, and age only seems to matter once a mother gets beyond thirty or thirty-five years old. It seems less plausible that social norms will influence whether a mother chooses to have a baby after age thirty-five.

18. Rowley and others (1993).

19. House, Landis, and Umberson (1988).

20. Geronimus (1992).

21. McAnarney and Stevens (1990); Rowley and others (1993); Hoffman and Hatch (1996).

birth outcomes, perhaps because of oxygen flows to the fetus or exposure to particular toxins, such as lead.[22]

Is it plausible that the effects of residential segregation might operate through any of these channels? As mentioned already, there appears to be ample evidence that segregation leads to inferior social and economic outcomes on the part of minorities. Thus to the extent that segregation contributes to higher rates of out-of-wedlock birth and lower rates of educational attainment among black women, it may contribute in turn to elevated rates of low birth weight.

Second, it seems likely that the level of segregation could influence the health-related behaviors of pregnant mothers. In metropolitan areas that are more segregated, African Americans tend to live in neighborhoods with higher poverty rates, and the cost of undertaking or avoiding certain behaviors may be effectively higher in these areas. Resources such as health clinics and grocery stores may, for example, be less available. The quality of doctors serving minority and white communities may also vary. Similarly, the cultural gaps between blacks and whites may simply be larger in more segregated areas, which may hinder effective communication between black women and their typically white doctors. In such an environment, pregnant minority women may be less eager to visit their doctors. Moreover, minority neighborhoods in more segregated metropolitan areas may have higher crime rates and inferior access to transportation, which make it more difficult to reach such resources. One recent ethnographic study of heart patients in Harlem Hospital, for instance, suggests that worries about street-level safety may lead some mothers to avoid, or at least postpone, seeking medical care that is not immediately pressing.[23] Information networks about pregnancy care may also be more racially divided in more segregated cities. As mentioned above, some researchers argue that segregation creates a barrier that prevents information about job opportunities from flowing from white and more affluent populations to minority and more economically deprived populations. Perhaps segregation similarly constrains the flow of information about pregnancy.[24]

22. O'Campo and others (1997); Wang and others (1997); Chay and Greenstone (1999).

23. Blustein and others (1998).

24. Another possibility is that violent crime rates are generally higher in poorer areas. And it may be that people are more likely to undertake risky behavior in more-dangerous neighborhoods. If expected life spans are reduced, residents may have less to lose from less proximate health threats such as smoking, alcohol use, and delayed prenatal care. See Dow, Philipson, and Sala-i-Martin (1997); Ganz (1997).

Third, the day-to-day stresses experienced by black women in more segregated cities may be relatively higher due to crime, unemployment, or overall levels of racial tension. To cope with such stresses, pregnant women may turn to smoking and other behaviors that are temporarily comforting despite being unhealthy in the long term. Such stress may also in fact place a direct toll on the immune system.[25]

Finally, in more segregated metropolitan areas, blacks may be constrained to inferior physical environments and cut off from higher-quality public goods. This may occur because some combination of housing market discrimination, white household behavior, and income differences constrains blacks to communities that not only have a greater share of blacks but also possess older housing, more noxious factories, fewer safe places for outdoor recreation, and so forth.[26]

Although it is not possible to test all of these hypotheses, the results below do shed some light on the relationship between segregation and birth outcomes and provide some suggestive evidence about which of these various mechanisms are more plausible than others.

Data and Methods

The paper relies on the 1990 national linked birth and death files, which contain information about every infant born in the United States in 1990 and its mother. This data set includes background information about the mother (including race, age, education, and alcohol and tobacco use) and allows one to examine the individual determinants of birth weight and infant mortality. With the cooperation of the National Center on Health Statistics, this paper uses a unique version of the files that reveals the mother's metropolitan area of residence at the time of birth and thus enables measures of segregation and other metropolitan area characteristics to be linked to the file.

The sample is restricted to singleton births and to mothers living in metropolitan areas with at least 100,000 residents and at least 5,000 black residents. In total, the sample contains approximately 3 million births taking place in

25. Hoffman and Hatch (1996).

26. It is conceivable that black residents tend to choose different packages of public services. Few studies have explored this question, but Galster (1979) analyzes preferences for housing and finds few differences across racial groups.

Table 1. Summary Statistics of the Sample
Percent unless otherwise indicated

Variable	*Black mothers*	*Nonblack mothers*
Infants		
Low birth weight	12.0	4.7
Infant mortality rate	1.5	0.6
Mothers		
Mean age	24.6	27.1
First birth	38.0	42.8
With anemia	3.3	1.4
With hypertension	2.5	2.4
With diabetes	1.8	2.2
Not completing high school[a]	28.0	18.5
College graduates	7.4	23.1
Married	33.4	79.4
Using tobacco	16.5	17.9
Using alcohol	4.0	3.4
Receiving inadequate prenatal care[b]	30.1	14.7
N	563,539	2,479,624

Source: National Center on Health Statistics, 1990 Linked Birth and Death files. Sample is restricted to those women living in metropolitan areas with at least 100,000 total residents and 5,000 black residents. Low birth weight refers to an infant that weighs less than 2,500 grams (5.5 pounds).

a. Educational outcomes defined only for those at least 19 years of age.

b. Measured by the Adequacy of Prenatal Care Utilization (APNCU) Index; see footnote 34 for explanation.

261 metropolitan areas around the country.[27] Table 1 offers a brief summary. Approximately 18.5 percent of the infants are born to black mothers.[28] As shown, black mothers are more than two and one-half times more likely to give birth to low-weight infants. Their infants are also two and one-half times more likely to die within the first year. Some of this differential is due to economic status—black mothers are less educated and less likely to be married than their nonblack counterparts. And some of this difference may be due to differential utilization of prenatal care. But even after controlling for all of

27. Of these 261 metropolitan areas, nine are in fact counties in New England. In the case of mothers residing in New England, the NCHS data set identified the county of mother's residence rather than the metropolitan area. In certain cases, these counties spanned several metropolitan areas. In these cases, the share of the county population living in various metropolitan areas was calculated. A weighted mean of the characteristics of all of these metropolitan areas is then used. The mean is weighted by the number of county residents living in each metropolitan area.

28. It is important to point out that this paper considers births to black mothers, not black infants. Identification of the race of infants has been shown to be inaccurate, and the aim of this paper is to explore how mothers of different races are influenced by racial segregation.

these factors, black mothers remain about 2.1 times more likely to give birth to a low-birth-weight infant than nonblacks.[29]

Most of the analysis centers on logistic regressions of the probability of low birth weight.[30] The core equation is the following:

$$\log\left[\frac{P_i}{(1-P_i)}\right] = X'\beta + Z'\gamma + \gamma_1 segregation + \gamma_2 segregation * black,$$

where P is the probability that mother i has a low-birth-weight infant, X represents the matrix of individual level variables, and Z represents the matrix of metropolitan area–level variables. The coefficient γ_1 measures the effect of segregation on nonblacks, and the coefficient γ_2 measures the differential effect of segregation for blacks relative to nonblacks. Standard errors are adjusted for heteroskedasticity and clustering within a metropolitan area.[31]

To help to understand the effect of segregation and to identify which of the possible causal explanations above appears more valid, the individual variables are divided into four different categories. The first includes the race and ethnicity of the mother. The second group measures medical risk. These variables include the mother's age and medical conditions (hypertension, anemia, and diabetes), and a set of pregnancy variables representing birth order and interval.[32] The latter includes a variable indicating a first birth, since mothers giving birth for the first time are at higher risk; a variable indicating four or more previous births, since pregnancy risk increases after a large number of births; and a variable indicating a short interval (less than fourteen months) since the previous birth, because pregnancy outcomes tend to be worse when

29. Regression results are not shown. Other studies that use smaller samples including information about parental income find that the racial differential persists and remains approximately the same. See Hummer (1993).

30. I experimented with several different measures of birth outcomes, including infant mortality and actual birth weight. The core results were the same. The focus of this analysis is on birth weight because it is a better measure of a birth outcome per se. And the probability of low birth weight is analyzed since there is no reason to believe that differences in birth weight above this threshold are medically significant. Finally, the core results are also the same when a probit model is used.

31. The correction involves Huber standard errors that assume clustering at the level of the metropolitan area. See Rogers (1993).

32. Age of the mother is measured by two dummy variables (under 16 and at least 35). In one specification, age was represented by five age dummies (under 20; 20–24; 30–34; 35–39; and 40+), and the coefficients on the metropolitan variables were the same.

intervals between births are very short.[33] While all of these medical risk variables are potentially influenced by segregation, the link is weaker than those for health-related behavior and socioeconomic status.

The third set measures the mother's social status. These variables include the mother's education and marital status at the time of the birth. The final set of variables represents behaviors during pregnancy, including variables indicating the adequacy of prenatal care,[34] and tobacco and alcohol use during pregnancy.

The key metropolitan-area characteristic is the degree to which blacks are residentially segregated in the metropolitan area. I use two measures of housing segregation: the dissimilarity index and the relative centralization index. While often used interchangeably, these indexes examine different aspects of segregation and thus may help to clarify the ways in which racial segregation affects minority birth outcomes.

The dissimilarity index, or D, is the most commonly used measure of segregation. Derived from the Lorenz curve, D may be understood as an indicator of how far the population distribution is from a situation in which every neighborhood (or census tract) contains the same proportion of the minority group at hand—say, blacks. Varying between 0 and 1, the index may be interpreted as the share of blacks (or nonblacks) that would have to move to a different neighborhood for the city to be completely integrated.[35] The dissimilarity index reflects neighborhood-level separation and may be seen as capturing

33. This may be because a mother's body needs a chance to recover from the previous birth. Mothers giving birth after short intervals also may not discover that they are pregnant for a longer period of time and may therefore undertake more risky behavior.

34. The Adequacy of Prenatal Care Utilization (APNCU) Index is used, which categorizes the care received as "inadequate," "intermediate," "adequate," or "adequate plus." See Kotelchuck (1994). These categories separate women getting different levels of care according to guidelines established by the American College of Obstetricians and Gynecologists. These guidelines consider both the number and the timing of visits. Women receive "adequate plus" care primarily because of pregnancy complications and maternal health risks. It is therefore important to separate out these women so that prenatal care does not appear to be detrimental to birth outcomes.

35. This definition holds only if we assume that no majority group members move out of their neighborhoods to make room for the minorities. Given the durability of housing, it is more reasonable to consider the number of black and white households that would have to switch homes in order for a city to be totally integrated. Thus a more accurate (though much less common) interpretation is that D represents the ratio between the number of households that must move for the area to be completely integrated and the maximum number that would have to move, assuming that the population of every tract remains constant. See Winship (1977).

the degree to which blacks and whites are isolated from one another socially and the extent to which they face different social and economic environments.

The formula for the index is

$$\text{Dissimilarity Index} = \frac{\sum t_i \mid p_i - P \mid}{2TP(1-P)},$$

where p_i represents the proportion of blacks in neighborhood i, P the proportion of blacks in the overall metropolitan area, t_i the population in neighborhood i, and T the population of the overall metropolitan area.

The index of relative centralization measures the extent to which a group is spatially concentrated near the center of an urban area, and thus perhaps exposed to inferior physical environments—older housing, deteriorating infrastructures, and industrial hazards. To the extent that it suggests that minorities are located in a central city as opposed to a suburban jurisdiction, this index may also capture differing levels of public services.

The relative centralization index varies between 1 and –1, with positive values indicating a tendency for blacks to live in inner-city environments. More technically, the centralization index may be interpreted as indicating the proportion of blacks that would have to move to match the degree of centralization of nonblacks.[36] The formula is as follows:

$$\textit{Relative Centralization Index} = (\sum \textit{Black}_{i-1} * \textit{Nonblack}_i) - (\sum \textit{Black}_i * \textit{Nonblack}_{i-1}),$$

where $\textit{Black}_i$ and $\textit{Nonblack}_i$ are the respective cumulative proportions of blacks and nonblacks in tract i, and the n census tracts in the metropolitan area are ordered by increasing distance from the central business district.[37]

Regional dummy variables and additional contextual variables are also included in all regressions to control for other characteristics of metropolitan areas that may influence birth outcomes: population size, the proportion of blacks, and median household income. The log of population size and the log

36. Negative values are interpreted in the same way, but in this case blacks are less centralized than nonblacks, and they would have to move to become as centralized as nonblacks.

37. An alternative measure is the isolation index, which measures the extent to which blacks tend to live in largely black communities. Specifically, it represents the probability for a black resident of a given metropolitan area that a randomly picked resident of his or her census tract is also black. The regressions here were also estimated using the isolation index, but the results were highly similar to those using the dissimilarity index. Thus only the results for the dissimilarity index and the relative centralization index are shown. (The correlation between the dissimilarity index and the isolation index is 0.79.)

Table 2. Descriptive Statistics and Simple Correlation Matrix: Metropolitan-Area-Level Variables

Variable	*Dissimilarity index*	*Relative centralization*	*Log (MSA population)*	*Proportion black*	*Log (median income)*
Number of metro areas	252	220	252	252	252
Mean	0.584	0.358	12.96	0.123	10.31
Standard deviation	0.122	0.232	0.975	0.091	0.199
Minimum	0.206	–0.274	11.58	0.009	9.92
Maximum	0.873	0.752	16.0	0.457	10.97
Correlations					
Dissimilarity index	1.0				
Relative centralization index	0.407	1.0			
Log (MSA population)	0.312	0.015	1.0		
Proportion black	0.062	–0.000	0.007	1.0	
Ln(median income)	0.104	–0.010	0.425	–0.281	1.0

Source: For index of relative centralization, Harrison and Weinberg (1992). All other data, Cutler, Glaeser, and Vigdor (1999).

Table 3. Regional Differences in Levels of Segregation

	Northeast	*South*	*Midwest*	*West*
Dissimilarity index				
Mean	0.626	0.555	0.662	0.464
Standard deviation	0.085	0.115	0.109	0.102
Maximum	0.807	0.766	0.873	0.673
Minimum	0.354	0.206	0.355	0.322
N	58	105	57	32
Relative centralization index				
Mean	0.316	0.315	0.495	0.297
Standard deviation	0.250	0.194	0.194	0.182
Maximum	0.749	0.651	0.752	0.599
Minimum	–0.274	–0.153	–0.101	–0.232
N	40	95	55	30

of median household income are used in the regression. Since these characteristics might have different effects on mothers of different races, each of these variables is interacted with a dummy variable indicating whether a mother is black. Table 2 shows the simple correlation matrix for these metropolitan-area variables. The correlation between the two segregation measures is 0.407. The dissimilarity index is positively correlated with population size in the metropolitan area (and modestly positively correlated with the proportion black and the median income). Interestingly, the index of relative centralization is not correlated with any of these variables. Table 3 shows how segregation patterns differ across regions and reveals some sharp contrasts. The metropolitan areas located in the Midwest are significantly more segregated than those in other regions, while those in the West are significantly less segregated.

Results

Table 4 shows that 36.7 percent of low-birth-weight (LBW) babies are born to black mothers, whose babies make up only 18.5 percent of total births. Mothers of LBW infants also differ in other ways consistent with previous analyses. They are more likely, for instance, to have hypertension, to be a first-time mother, or to have at least four previous births. Class differences are perhaps most striking. LBW mothers are 40 percent more likely to be high school dropouts, 40 percent less likely to have graduated from college, and 27 percent less likely to be married. Finally, LBW mothers are also far more likely to use alcohol and tobacco during pregnancy and far more likely to receive inadequate prenatal care.

Table 4. Comparison of Mean Characteristics of Mothers Delivering Low-Birth-Weight Infants and Mothers Delivering Normal-Weight Infants
Percent unless otherwise noted

Variable	*Low-birth-weight infant*	*Normal-weight infant*
Black	36.7	17.3
Hispanic	14.4	16.8
Asian	3.9	4.2
Mother's age	25.9	26.7
First birth	46.1	41.6
Four or more births	5.5	3.8
Short birth interval	6.5	2.8
With hypertension	6.1	2.2
With anemia	2.5	1.6
With diabetes	2.0	2.1
Not completing high school	31.9	23.1
College graduates	11.8	19.5
Married	52.9	72.0
Using tobacco	30.0	16.8
Using alcohol	6.1	3.3
Receiving inadequate prenatal care	26.0	16.9

Basic Regression Results

Table 5 shows the estimated coefficients from some simple logistic regressions of low birth weight.[38] Two columns show the results when the dissimilarity index is used as a measure of racial segregation, and two columns present estimated coefficients from regressions using the index of relative centralization.[39] The table also shows predicted probabilities of low birth weight for black and nonblack mothers living in high- and low-segregation metropolitan areas. (In a high-segregation metropolitan area, the level of segregation is one standard deviation above the mean, while in a low-segregation metropolitan area, the level of segregation is one standard deviation below the mean.)

The probability of low birth weight for black mothers is predicted to be significantly higher in more segregated metropolitan areas. When the dissimilarity index is used, the probability of low birth weight is predicted to be 1 percentage point or 11 percent higher in high-segregation areas. When the index of relative centralization is used, the probability of low birth weight for

38. The results here and in later regressions are highly similar when a probit model is used.

39. The fact that the coefficient on the black race dummy variable becomes negative when metropolitan-area interaction terms are included does not suggest that the model has "explained" the black disadvantage. As shown in the predicted probabilities, over normal ranges, black mothers are still at a large disadvantage.

Table 5. Estimated Coefficients and Predicted Probabilities from Preliminary Logistic Regressions of Low Birth Weight[a]

	Dissimilarity index		*Relative centralization index*	
Variable[b]	*No controls*	*MSA controls*	*No controls*	*MSA controls*
Segregation	–0.039	–0.076	–0.091	–0.086
	(0.086)	(0.110)	(0.063)	(0.044)
Segregation*black	0.514	0.438	0.313	0.313
	(0.103)	(0.094)	(0.054)	(0.054)
Black	0.675	–3.39	0.891	–3.45
	(0.062)	(0.709)	(0.022)	(0.590)
Asian		0.279		0.277
		(0.029)		(0.289)
Hispanic		0.140		0.140
		(0.025)		(0.025)
Hispanic origin missing		0.141		0.133
		(0.051)		(0.052)
Northeast		0.029		0.024
		(0.017)		(0.156)
South		–0.012		–0.028
		(0.021)		(0.017)
West		–0.033		–0.035
		(0.044)		(0.030)
Log population		–0.008		–0.006
		(0.012)		(0.009)
Log population*black		0.016		0.021
		(0.020)		(0.012)
Proportion black		0.219		0.196
		(0.124)		(0.122)
Proportion black*black		0.124		0.226
		(0.153)		(0.135)
Log median income		–0.404		–0.440
		(0.043)		(0.045)
Log median income*black		0.374		0.387
		(0.083)		(0.064)
Intercept	–2.98	1.29	–2.97	1.63
	(0.052)	(0.389)	(0.326)	(0.420)
N	3,043,163	3,043,163	2,847,986	2,847,986
Predicted probability of low birth weight (percent)				
Black mothers				
Low segregation[c]	11.0	11.4	11.4	11.5
High segregation	12.2*	12.3*	12.5*	12.6*
Nonblack mothers				
Low segregation[c]	4.7	4.8	4.8	4.8
High segregation	4.7	4.7	4.6	4.6

*Predicted differences between high- and low-segregation metropolitan areas are statistically significant.

a. The analysis using the dissimilarity index covers 252 metropolitan areas. The analysis using the index of relative centralization covers 220 metropolitan areas. Standard errors are reported in parentheses and, here and throughout the paper, are adjusted for heteroskedasticity and clustering within a metropolitan area.

b. With the exception of segregation, all variables are evaluated at the sample means.

c. A low-segregation metropolitan area is one in which the level of segregation is one standard deviation below the mean. A high-segregation metropolitan area is one in which the level of segregation is one standard deviation above the mean.

black mothers is predicted to be 1.1 percentage points or 9.6 percent higher. According to these results, if segregation levels fell to zero in all metropolitan areas, the model predicts that the probability of low birth weight for black mothers would fall to 9.1 percent, meaning that black mothers in 1990 would have been 1.9 times more likely to have low-birth-weight infants than would white mothers. The actual probabilities in the sample show that black mothers were in fact 2.6 times more likely to have low-birth-weight infants in 1990 (see table 1).

As shown in the second and fourth columns in table 5, these differentials persist after controlling for the ethnicity of the mother and other metropolitan-area characteristics. They shrink somewhat in the case of the dissimilarity index, but they are unchanged when the index of relative centralization is used.

By contrast, there is little difference between the predicted birth outcomes of infants born to nonblack women in these two types of metropolitan areas. In all four regressions, the coefficient on the racial segregation variable is negative, but in only one regression does it reach statistical significance. In other words, there is at most weak evidence that racial segregation affects the birth outcomes of nonblack mothers, and if anything, segregation is related to improved birth outcomes among these mothers.

Exploring the Pathways: Controlling for Other Individual Characteristics

Table 6 shows results from three sets of regressions that control for other individual characteristics. The first set—the columns marked (1)—includes the individual factors considered to be relatively independent of racial segregation (age, race, and ethnicity of mother; birth order and interval; and medical conditions).[40] The individual-level coefficients (not shown) provide few surprises. A woman is more likely to give birth to a low-weight infant if she is black, Asian, or Hispanic, if she is older, or if she has hypertension or anemia. She is also at greater risk of low birth weight if it is her first birth, if she has already had at least four children, or if the interval since her last birth is less than fourteen months.

The estimated coefficients for all metropolitan-area variables are shown. When these additional variables are included, the coefficients on the black

40. The three medical conditions were in fact considered as a separate category—one that might be more influenced by environmental conditions. However, including these medical variables had virtually no effect on the racial segregation coefficients. Therefore the regression that includes age, race, ethnicity, and pregnancy variables (but not medical conditions) as independent variables is not shown.

Table 6. Estimated Coefficients from Regression of Low Birth Weight

Metropolitan area variable	*Dissimilarity index*			*Index of relative centralization*		
	(1)[a]	*(2)*[b]	*(3)*[c]	*(1)*[a]	*(2)*[b]	*(3)*[c]
Segregation	–0.072	–0.081	–0.079	–0.088	–0.097	–0.051
	(0.109)	(0.112)	(0.108)	(0.038)	(0.039)	(0.046)
Segregation*black	0.364	0.130	–0.013	0.300	0.235	0.106
	(.099)	(0.083)	(0.097)	(0.055)	(0.045)	(0.063)
Log population	–0.013	–0.013	–0.000	–0.011	–0.012	–0.004
	(0.010)	(0.010)	(0.012)	(0.008)	(0.009)	(0.011)
Log population*black	0.020	0.030	0.029	0.021	0.023	0.022
	(0.020)	(0.019)	(0.022)	(0.013)	(0.012)	(0.019)
Proportion black	0.214	0.303	0.287	0.189	0.290	0.241
	(0.114)	(0.115)	(0.133)	(0.112)	(0.113)	(0.143)
Proportion black*black	0.172	0.004	0.201	0.252	0.032	0.205
	(0.150)	(0.139)	(0.151)	(0.127)	(0.117)	(0.151)
Log median income	–0.399	–0.282	–0.294	–0.427	–0.307	–0.284
	(0.037)	(0.040)	(0.059)	(0.038)	(0.042)	(0.059)
Log median income*black	0.347	0.322	0.161	0.366	0.352	0.168
	(0.083)	(0.074)	(0.077)	(0.064)	(0.059)	(0.075)
N	3,043,163	3,043,163	3,043,163	2,847,986	2,847,986	2,847,986

a. Regression 1 includes demographic information about the mother such as age, ethnicity, and race. It also includes information on medical conditions—specifically, anemia, hypertension, and diabetes, all of which influence birth weight—as well as variables to indicate birth order and interval—specifically, whether this is a mother's first birth, whether she has already had at least four children, and whether the mother gave birth in the previous 14 months. Finally, regional dummies are included as well.

b. Regression 2 includes the same variables in model 1 plus measures of education and marital status. Specifically, variables are added that indicate whether or not the mother is married and whether or not she has completed high school or college.

c. Regression 3 includes the same variables in model 2 plus measures of behavior during pregnancy. Variables are added that indicate whether the mother used tobacco during pregnancy or whether she used alcohol. In addition, an index of prenatal care utilization is included that reflects the number and timing of prenatal visits. Dummy variables are included here to note if the information is missing. Both the coefficients for "missing tobacco" information and "missing prenatal care" information are positive and statistically significant. This may reflect the fact that these women in fact received inferior care, or that lower-status women (who are more likely to have low-birth-weight infants) have less complete medical records.

dummy*racial segregation interaction terms are changed very little and remain highly significant, suggesting that black mothers living in more segregated metropolitan areas are indeed more likely to give birth to low-birth-weight babies, even after controlling for birth order, age, and selected medical conditions.

In the columns marked (2), estimated coefficients are shown for a regression that also controls for the education and marital status of the mother.[41] The coefficient on the segregation*black term falls substantially when these variables are included. It falls by 64 percent compared with the first specification when the dissimilarity index is used and by 22 percent when the index of relative centralization is used. This suggests that much of the apparent effect of segregation operates through the educational attainment and marital status of the mother.

In the columns marked (3), estimated coefficients are shown for a regression that also controls for tobacco and alcohol use during pregnancy and the utilization of prenatal care. Including these variables reduces the magnitude of the coefficient still further. It falls to effectively zero in the case of the dissimilarity index and falls by 55 percent compared with the second specification when the index of relative centralization is used.[42] (It remains statistically significant at the 10 percent level of significance.)

Summarizing these various results, table 7 shows the differences in the predicted probabilities of low birth weight for black and nonblack mothers living in a high- as compared to a low-segregation metropolitan area. Again, the segregation level in a high-segregation area is one standard deviation above the mean, and segregation in a low-segregation area is one standard deviation below the mean. The table shows the absolute percentage point difference. In percentage terms, these differences are naturally far larger, since the mean probability of low birth weight for black and nonblack mothers is 12 and 4.7 percent respectively.

In contrast to the results for the segregation*black term, the coefficient on racial segregation is consistently negative, relatively small in magnitude, and in all but two cases, statistically insignificant. Thus there is little reason to believe that segregation per se is proxying for some other metropolitan-area attribute that is related to low birth weight. In the case of centralization, the

41. Again, the coefficients on the individual-level variables are as expected—mothers who are high-school dropouts are more likely to deliver low-birth-weight infants, while those who are married and college graduates are less likely to.

42. When including behaviors and not class, the effects of segregation do not disappear. The coefficient on the segregation*black variable suggests an effect very similar in magnitude to that effect predicted when class variables are included and behavior is omitted.

Table 7. Predicted Difference in Probability of Low-Birth-Weight Babies for Black and Nonblack Mothers, High- versus Low-Segregation Areas[a]
Percentage points

	Black mothers		*Nonblack mothers*	
Control variables	*Dissimilarity index*	*Index of relative centralization*	*Dissimilarity index*	*Index of relative centralization*
Race of mother	1.2*	1.1*	0.0	–0.2
+ Ethnicity and MSA controls	0.9*	1.1*	–0.1	–0.2
+ Age, medical conditions, birth order	0.7*	1.0*	–0.1	–0.2*
+ Education, marital status	0.3	0.7*	–0.1	–0.2*
+ Tobacco, alcohol, and prenatal care	0.0	0.2	–0.1	–0.2

*Statistically significant difference between high- and low-segregation areas.
a. A low-segregation metropolitan area is one in which the level of segregation is exactly one standard deviation below the mean. A high-segregation metropolitan area is one in which the level of segregation is one standard deviation above the mean.

coefficient on racial segregation is negative and statistically significant in two regressions, providing some evidence that nonblack women may benefit somewhat when blacks are relatively concentrated in the center of the city, and when nonblacks are therefore more concentrated in outlying areas.

With the exception of income, the other metropolitan characteristics included in these six regressions do not seem to have much effect on low birth weight, either for black or nonblack mothers. Income at the metropolitan-area level does have an effect, which is not surprising. Wealthier cities are generally likely to have better hospitals, better doctors, and better public services. Yet the coefficients on median income interacted with the black dummy variable suggest that these benefits are a great deal smaller for blacks.

In an additional regression (not shown), both measures of racial segregation were included. With both included, the coefficient on the dissimilarity index falls substantially and is not statistically significant in any of the three regressions. The coefficient and standard error for the index of relative centralization, meanwhile, are unchanged.

In summary, these regressions suggest that the aspect of segregation most related to birth outcomes is the degree to which black mothers are concentrated near the central city, and thus perhaps exposed to differing social services and physical environments. The importance of the centralization index may also reflect the fact that it measures the extent to which blacks are clustered not only in individual neighborhoods but also in larger geographic areas (that is, black neighborhoods next to black neighborhoods). A second key result is that most of the apparent effect of racial segregation on black mothers appears to operate either through its effects on the social status of the mother or through influences on her behavior during pregnancy.

Instrumental Variables Estimation

There are some potential problems with these estimates. Most fundamental, both segregation and disparities in birth outcomes might be the result of poor economic outcomes of minorities. In an attempt to address this issue, an instrumental variables approach is used. Following Cutler and Glaeser, I instrument for segregation using the natural log of the number of local governments in the metropolitan area and the share of local revenue that comes from intergovernmental sources.[43] Both of these variables measure the extent to which the government structure of a metropolitan area encourages residential sorting. With more governments and less aid, there is a greater incentive for households to segregate. In both cases, the 1962 values of these fiscal variables are used to ensure that they are unrelated to birth outcomes in 1990. These figures are available for only a subset of the metropolitan areas, so the sample size falls to 215 in this analysis.

As expected, the dissimilarity index is positively correlated with the number of governments and negatively correlated with the share of revenue that comes from intergovernmental sources. Specifically, a regression of the dissimilarity index on these two variables yields the following estimates:

$$\begin{aligned} \textit{Dissimilarity Index} &= 0.501 \\ &\quad (0.038) \\ &+ 0.047*\text{Log}(\textit{number of governments}) \\ &\quad (0.006) \\ &- 0.192*\textit{Transfer share}, \\ &\quad (0.096) \end{aligned}$$

with $N = 215$, $R^2 = 0.252$.

Unfortunately, these fiscal factors explain much less of the variation in the index of relative centralization ($R^2 = 0.08$), so the instrumental variables estimation is performed only in the case of the dissimilarity index. Because of the difficulty of performing instrumental variables with a logistic regression, a linear probability model is used here, and the instrumental variables results are therefore compared to ordinary-least-squares (OLS) estimates of low birth weight.[44] Consistent with Cutler and Glaeser,[45] the results are largely unchanged when instrumenting with these fiscal variables—both the coeffi-

43. Cutler and Glaeser (1997).

44. The ordinary-least-squares estimates (not shown) of the effect of segregation on black birth weight are quite similar to those in table 6, although they suggest a slightly larger effect, at least for regressions (1) and (2).

45. Cutler and Glaeser (1997).

cients and the standard errors of the segregation variables increase somewhat. Naturally, this is not a perfect correction, but this does provide some modest support for the hypothesis that greater segregation leads to worse birth outcomes for black mothers.

How Does Segregation Affect Birth Outcomes? Further Evidence

This section explores two ways of further probing the relationship between segregation and birth outcomes. First, it examines the relationship between our two different measures of racial segregation and various intermediate outcomes. Second, it considers other measures of black-white disparity in metropolitan areas.

Intermediate Outcomes

Table 8 examines the relationship between racial segregation and characteristics of the mother and her pregnancy (marital status, education, tobacco and alcohol use during pregnancy, and inadequate prenatal care), controlling for the same metropolitan-area characteristics used above and for selected individual variables. Two sets of regressions were estimated, one using the dissimilarity index and the other using the index of relative centralization.

The coefficient on segregation*black is negative and statistically significant in both regressions of the probability of being married. Black women giving birth, in other words, are less likely to be married in more segregated metropolitan areas. The effect is larger when the dissimilarity index is used. The educational attainment of black mothers appears strongly related to segregation, but only when the dissimilarity index is used.

Alcohol and tobacco use during pregnancy are also related to segregation, but here the effect is only apparent when the index of relative centralization is used. In brief, black mothers are more likely to drink and smoke during pregnancy when they live in metropolitan areas where blacks are more residentially concentrated in the central city. Perhaps surprisingly, all mothers are less likely to receive inadequate prenatal care in more segregated metropolitan areas. Perhaps this is because there are a greater number of doctors in these more segregated areas. But this does raise doubts about whether the effect is really due to segregation as opposed to some other omitted factor.

Causality is of course in question here, but these simple regressions do demonstrate that segregation is related to a variety of poor outcomes on the

Table 8. Estimated Coefficients on Segregation Variables in Regressions of Various Intermediate Variables

	Dependent variable					
Segregation index	*Marital status*[a]	*High school drop-out*[a]	*College graduate*[a]	*Tobacco use*[b]	*Alcohol use*[b]	*Inadequate prenatal care*[b]
Dissimilarity						
Segregation	–0.240	0.010	–0.140	0.21	–0.299	–1.14
	(0.247)	(0.351)	(0.308)	(0.296)	(0.815)	(0.378)
Segregation*black	–1.61	1.75	–1.01	0.281	0.416	0.425
	(0.308)	(0.396)	(0.236)	(0.296)	(0.665)	(0.271)
N	3,047,035	2,478,880	2,478,880	2,057,224	2,102,596	2,216,661
Relative centralization						
Segregation	0.047	0.407	–0.137	–0.389	–0.577	–0.452
	(0.124)	(0.185)	(0.098)	(0.122)	(0.271)	(0.163)
Segregation*black	–0.645	–0.452	0.003	0.733	1.01	0.057
	(0.205)	(0.331)	(0.138)	(0.169)	(0.333)	(0.116)
N	2,851,512	2,313,592	2,313,592	1,878,211	1,920,522	2,076,059

a. Regression also controls for race, ethnicity, and age of mother (five-year dummies), and other metropolitan-area controls.
b. Regression controls for these same variables plus education and marital status of mother, birth order, and whether or not the previous birth (if any) occurred within the last fourteen months.

part of black mothers that may in turn be detrimental to birth outcomes.[46] These results also show that the two measures of segregation capture very different aspects of residential separation. The neighborhood-level separation measured by the dissimilarity index may be critical to spillover effects on educational attainment and out-of-wedlock birth. But differences in physical location—and proximity to the central city—may be critical in determining the extent to which black women engage in unhealthy behaviors during pregnancy. This is somewhat of a puzzle. The concentration of blacks in large central areas may allow for geographically targeted advertising campaigns, or tobacco and alcohol may be more readily available in downtown central-city areas. Alternatively, peer effects may be stronger when minority neighborhoods are located next to other minority neighborhoods.

Controlling for Black Exposure in Metropolitan Areas

A second approach is through constructing variables that actually measure the extent to which blacks and nonblacks are exposed to different sorts of environments. Two hypotheses in particular are explored. The first posits that black mothers fare worse in more segregated metropolitan areas because they are exposed to less-educated neighbors and therefore receive less useful information about prenatal care, appropriate behavior during pregnancy, risks, and so on. To the extent that less-educated mothers also tend to smoke during pregnancy, exposure to less-educated neighbors may also mean greater exposure to these behavioral influences as well.[47] To test this hypothesis, I use an index constructed by Cutler and Glaeser that measures the extent to which blacks disproportionately live in neighborhoods with residents having some amount of college education.[48] The formula is as follows:

46. Instrumental variable analysis, again using 1962 fiscal variables as instruments for segregation, supports a causal link between segregation and out-of-wedlock birth and worse educational outcomes on the part of blacks.

47. High-school dropouts are more likely to use alcohol during pregnancy than women who have completed high school and perhaps attended some college. Interestingly, college graduates are also more likely to use alcohol during pregnancy than are high-school graduates.

48. Cutler and Glaeser (1997).

$$\text{Black Education Exposure Index} = \sum \frac{Black_i}{Black} * \frac{Educated\ persons_i}{Total\ persons_i} - \frac{Educated\ persons}{Total\ persons}.$$

Note that this index effectively states the average black exposure to college-educated neighbors minus the overall proportion of college-educated residents in the metropolitan area. Thus the index measures the extent to which blacks differentially live in census tracts with college-educated residents.

A similar index is constructed to measure the extent to which blacks are disproportionately exposed to older housing in a metropolitan area. The formula for this index is as follows:

$$\text{Black Old Housing Exposure Index} = \sum \frac{Black_i}{Black} * \frac{Old\ housing\ units_i}{Total\ housing\ units_i} - \frac{Old\ housing\ units}{Total\ housing\ units},$$

where old housing units are those that were at least forty years old in 1990. The risks of older housing might include lead paint, dust, inadequate ventilation, inadequate heating, and older water pipes. Old housing may also serve as a proxy for conditions in older neighborhoods.

Both measures of racial segregation are highly correlated with the old-housing-exposure index. They are also negatively correlated with the education-exposure index, though less so, especially in the case of the index of relative centralization. In other words, blacks in segregated metropolitan areas do appear to be confined to inferior neighborhoods.

Table 9 shows the results of regressions of low birth weight that include the black education-exposure index, the black old-housing-exposure index, and each index interacted with a black dummy variable. Again, only the coefficients on metropolitan-area variables are shown.[49] Since the aim is to explain

49. The inclusion of these additional variables generates virtually no change in the individual-level coefficients.

Table 9. Effects of Relative Black Exposure to Educated Neighbors and Old Housing Estimated Coefficients from Regression of Low Birth Weight[a]

	Dissimilarity index		*Index of relative centralization*	
Metropolitan area variable	*(1)*[b]	*(2)*[c]	*(1)*[b]	*(2)*[c]
Segregation	0.042	0.074	–0.067	–0.064
	(0.125)	(0.127)	(0.044)	(0.044)
Segregation*black	0.033	–0.138	0.199	0.194
	(0.107)	(0.102)	(0.048)	(0.047)
Log population	–0.015	–0.016	–0.011	–0.011
	(0.010)	(0.011)	(0.008)	(0.009)
Log population*black	0.033	0.039	0.023	0.023
	(0.012)	(0.013)	(0.011)	(0.011)
Proportion black	0.168	0.217	0.190	0.251
	(0.106)	(0.107)	(0.115)	(0.116)
Proportion black*black	0.354	0.217	0.312	0.119
	(0.115)	(0.113)	(0.118)	(0.118)
Log median income	–0.397	–0.278	–0.418	–0.300
	(0.045)	(0.047)	(0.045)	(0.049)
Log median income*black	0.303	0.334	0.328	0.371
	(0.063)	(0.060)	(0.061)	(0.060)
Education exposure	0.104	0.127	0.087	0.099
	(0.243)	(0.226)	(0.233)	(0.218)
Education exposure*black	–0.173	0.282	–0.261	0.280
	(0.291)	(0.252)	(0.277)	(0.246)
Old–housing exposure	–0.344	–0.438	–0.141	–0.221
	(0.148)	(0.150)	(0.165)	(0.175)
Old–housing exposure*black	0.847	0.736	0.489	0.266
	(0.183)	(0.170)	(0.161)	(0.154)
N	2,935,885	2,935,885	2,763,311	2,763,311

a. The education-exposure index is defined for only 217 metropolitan areas, and thus the sample used in these regressions is somewhat smaller than that used in table 6. However, the changes apparent here (in comparison with table 6) are not the effect of a changed sample. The results in table 6 are largely identical when this smaller sample is utilized for both sets of regressions.

b. Regression 1 includes demographic information about the mother such as age, ethnicity, and race. It also includes information on medical conditions—specifically, anemia, hypertension, and diabetes, all of which influence birth weight—as well as variables to indicate birth order and interval, specifically whether this is a mother's first birth, whether she has already had at least four children, and whether the mother gave birth in the previous 14 months. Finally, regional dummies are included as well.

c. Regression 2 includes the same variables in Model 1 plus measures of education and marital status. Specifically, variables are added that indicate whether or not the mother is married and whether or not she has completed high school or college.

the apparent effect of segregation and thus to test if the coefficient on the black*segregation variable diminishes, the analysis here is limited to regressions (1) and (2).

In the regressions using the dissimilarity index, the inclusion of these indexes in the regressions renders the coefficient on racial segregation*black insignificant. Notably, the coefficient on the racial segregation*black variable actually becomes *negative* in the second regression. This at least hints that after controlling for these potentially negative influences of segregation (that

is, greater exposure to older housing and less-educated neighbors), the presence of a greater number of black neighbors may bring some benefits to black women, such as enhanced social networks and political power.[50]

When the index of relative centralization is used instead, the coefficient on segregation*black remains statistically significant in all of the models, even after the inclusion of these exposure indexes, though the magnitude of the coefficients is generally diminished. The persistence of the effect of the relative centralization measure suggests that there are other aspects of central-city residence, beyond the existence of older housing, that may be detrimental to birth outcomes. One possibility is inferior city services.

Surprisingly, perhaps, there is little evidence that exposure to educated neighbors matters in shaping birth outcomes. In terms of older housing, black women are more likely to give birth to a low-weight infant when living in metropolitan areas in which blacks disproportionately live in older neighborhoods. Nonblacks in these metropolitan areas are meanwhile less likely to give birth to low-weight infants. In the case of the relative centralization index, the effect of older housing exposure is weaker, perhaps because the proximity to the central city is the better measure of environmental risk. Older housing may indeed simply serve as a proxy for central-city residence.

Conclusion

This analysis yields three main conclusions. First, there does appear to be a link between racial segregation and low-birth-weight outcomes among black women, and there is some evidence here that greater segregation in fact leads to worse birth outcomes. It still may be true that segregation has positive influences as well, but on net the influence appears to be negative. By contrast, there is little evidence that segregation has an effect on the birth weight of nonblack infants.

Second, much of the apparently harmful effect of segregation may be traced to its effect on the long-term social status of the mother as well as on behaviors during pregnancy.

Third, this study suggests that the concentration of blacks in central-city environments, and to a lesser extent their concentration in neighborhoods with older housing, is more damaging than the neighborhood-level racial separa-

50. In a regression that includes behavioral variables as well, the coefficient remains negative and becomes marginally significant.

tion that is measured by the dissimilarity index. Generally, these results reveal important differences between distinct measures of racial segregation, differences that future researchers studying the consequences of segregation should bear in mind.

In sum, while further research should be done to define more precisely the nature of the link between segregation and poor birth outcomes, these results imply that an increase in residential integration in U.S. metropolitan areas would help to diminish our troubling and persistent racial disparities in birth outcomes. More generally, this research also suggests that this country's stubbornly high levels of racial segregation—and in particular, the high concentration of minorities in central-city areas—may have serious consequences far beyond the economic outcomes that researchers have typically explored.

Comments

David M. Cutler: Ingrid Gould Ellen has written a fascinating paper on the impact of segregation on birth outcomes. Ellen shows clearly and convincingly that blacks living in more segregated cities have worse birth outcomes than do blacks living in less segregated cities. This is not true for whites. She also shows that the causality runs from segregation to outcomes and not the reverse.

The methodology that Ellen uses is similar to the one that Edward Glaeser and I employed in our study of the impact of segregation on economic outcomes for blacks.[1] Thus it is no surprise that I find it persuasive. Ellen's paper explores a new dimension of outcomes, however, and makes substantial headway. I take her finding to be true and robust: segregation is harmful to the health of black babies.

The central question raised by these results is why this is the case. The question is posed in the paper and speculated about, but it is never really resolved. Ellen shows that segregation matters because it is correlated with behavioral decisions that women make—both socioeconomic behaviors (education, marital status) and health behaviors (smoking, drinking). This finding echoes that of Ellen Meara, who has shown in a recent paper that less-educated women smoke more than more-educated women, and this explains a significant share of why low-birth-weight infants are more common among less educated women.[2]

But why does segregation matter for these behaviors? The paper is unable to answer this question with the data available. I'd like to raise a few theories and discuss how they might be tested.

Income theory. The first theory is that segregation affects health because higher-income women can afford better health behaviors. Less-educated women may not be able to buy necessary food, medical care, and other ser-

1. Cutler and Glaeser (1997).
2. Meara (1999).

vices, and this may adversely affect fetal development. This theory would not explain why segregation leads to increased smoking and drinking, but it could explain the effect of segregation through changes in educational attainment.

One way to test this theory is to examine the consumption patterns of women by income or education, matched with data on where they live. This has not been done, but other evidence suggests that this theory is not the complete explanation. National data show that the incidence of low birth weight among most Hispanic and Asian women is very similar to that of non-Hispanic whites, despite much lower income among these groups. In fact, the incidence is slightly lower for Mexican and Chinese mothers.[3] Thus it is clear that income by itself is not the explanatory factor.

Peer effects. A second theory is that segregation matters for birth outcomes because in more-segregated areas some women have worse behaviors and this is imitated by other women in a contagious way. Such peer effects may be bad (smoking, drinking) or good (vitamin intake, prenatal care).

I do not have a strong sense about whether this view is correct. Behaviors certainly do differ by racial group (although not always negatively—black women smoke less than white women). But whether this results from peer effects or from other factors that similarly influence women from different racial groups is unknown. I consider this a major research question.

Time allocation. The third theory is that segregation matters for health because women in more segregated areas have to spend more time on basic aspects of living and have less time for appropriate medical or nonmedical inputs to health. Depictions of life for poor mothers frequently stress the great complications of seemingly simple tasks. Taking the children to day care may involve a half hour or hour each way. Commuting to work or shopping, which are often not near the home, may involve similar amounts of time. With such a large time allocation devoted to these activities, it may be difficult for women to find time for doctors' visits or to ensure adequate rest and nutrition.

This theory would explain why centralization in particular affects health. Women who are isolated in central-city neighborhoods without much link to wealthier neighborhoods may find the time costs of good behaviors particularly high. The additional hardship of basic life may also lead women to engage in other unhealthy activities, such as smoking and drinking, as compensation for an already difficult life.

3. Table 11 in National Center for Health Statistics (1999).

Testing this theory requires two additional pieces of information: time diaries and neighborhood characteristics on the availability of different services. If supermarkets are less plentiful in segregated areas but fast food is more plentiful, that may explain different dietary patterns among women living in segregated environments. I do not know of any data sets that have this information, but I would place a high priority on obtaining it.

Allostatic load. The final theory is that segregation affects health because it is associated with greater long-term stress, which has a cumulative adverse impact on women's health. This has been termed the theory of "allostatic load."[4] Increased stress may result simply from living in a segregated neighborhood, or may be a consequence of specific time pressures or other constraints faced by women living in these areas. To date, most of the research on allostatics and health has focused on diseases that occur later in life, such as cardiovascular disease, but such theories could be applied to younger women as well. Indeed, research suggests that maternal stress during gestation predicts certain components of fetal development.[5]

Allostatic load can be measured in one of two ways. Case histories can be used to measure the degree of stress encountered in daily life and in particularly difficult circumstances. Allostatic load is often measured clinically by monitoring levels of cortisol or other hormones. Measurement of both of these factors is feasible and could be used to test this theory.

In sum, Ingrid Gould Ellen's paper makes a striking case for the importance of segregation in influencing birth outcomes. But it leaves open the mechanisms through which these effects occur. Understanding such mechanisms should be the next step in this very important line of research.

William Dickens: Ingrid Ellen makes a good case for her main thesis—that segregation or centralization has negative consequences for black birth outcomes. However, the paper misses several opportunities to make its case stronger and to shed light on the mechanism by which segregation or centralization affects birth outcomes.

Although the paper uses individual data on birth weight, most results are driven by differences in the independent variables between metropolitan areas. It is very hard to make a convincing case for causality on the basis of cross-section correlations at the metropolitan level. The main reason for this is that

4. McEwen (1998).
5. Hobel and others (1999).

one cannot be sure which way causation flows—did A cause B, B cause A, or did some other factor C cause both? The paper's main strength is in finding multiple contrasts across metropolitan areas that strain the credulity of alternative interpretations of the primary result. In particular, the contrast between the coefficient on segregation for whites and for blacks in a logistic regression of low birth weight on individual and metropolitan-area characteristics is compelling. If this showed that segregation was associated with bad birth outcomes for both blacks and whites, the interpretation of the result would be highly suspect. It would seem most likely that some other characteristic of the city, one not controlled for in the regression, was a common cause of birth outcomes and segregation. However, segregation is seen to have virtually no relation to birth outcomes for whites, while it has a substantial relation to birth outcomes for blacks.

This is not the case for some other variables. In table 5, for example, city size has no relation to birth outcomes for either blacks or whites. If there were many unobserved city characteristics that were affecting birth outcomes, it would be surprising that none are correlated with city size (or that their correlations with city size lead to effects on those coefficients that are exactly offsetting). In cities with higher median incomes, whites do have fewer low-birth-weight babies, but this is not the case for blacks. Were these results nonsensical, or if they mimicked the pattern for the two segregation measures, this would raise a question about the meaning of the correlation between segregation and birth outcome in the black population. But the results are not nonsensical, and they do not mimic the other patterns, so this lends credence to the method of contrasting outcomes for blacks and whites.

By this argument, the positive relation between proportion black in a metropolitan area and the likelihood of a low-birth-weight baby being born to a white is troubling. This suggests that there are some ignored metropolitan-area characteristics that are influencing the results. But the size effect is very small. A one-standard-deviation increase in proportion black increases the probability of a low-weight birth to an average white mother by no more than 0.13 percentage point. In contrast, the size effect of concentration on the probability of a low-weight birth to a black mother is more than five times as large. Even though the results for whites for this variable are statistically significant, they do not suggest a major problem with unobserved third-factor causes.

Taken together, the results strongly suggest that something about the environment in segregated cities is leading to a higher probability of low birth weight in black babies. But is segregation the *cause*, so that integration would

be a cure? There are two ways that we might think about answering this question. The first would be to try to find city characteristics that lead to segregation but are not themselves likely to have been caused by some other city characteristic that could also be related to poor birth outcomes. We could then look to see if variation in segregation caused by differences in these antecedents was related to birth outcomes. If that were the case, we would have strong evidence that segregation is the cause. This is the method of instrumental variables. A second approach would be to try to identify the way in which segregation affects outcomes. If this could be done convincingly, then again we would know whether integration could be a tool for improving black birth outcomes. Further, the process might allow us to identify other ways in which we might intervene to improve outcomes. The paper tries both approaches.

Following David M. Cutler and Edward L. Glaeser, Ellen relates segregation to two possible antecedents: the number of governments in a metropolitan area and the share of local revenue that comes from intergovernmental sources.[1] Segregation is understandably higher in cities with more governments and lower in those in which a higher percentage of revenue is shared. When these variables are used as instruments for the dissimilarity index, the results are largely the same as in the OLS case. This would add considerably to the credibility of the claim that segregation causes bad birth outcomes were it not for the author's selective reporting of results. The regressions are run for the dissimilarity index but not for the centralization index. Worse, these are not the most convincing instruments. It is not inconceivable that preexisting patterns of segregation have affected the number of governments in a region and the extent of revenue sharing within it. Cutler and Glaeser had another instrument that they used in their paper—the number of rivers dividing a metropolitan area. This factor is naturally related to segregation, and it is much more believable that this variable is a cause and not a result of segregation. But Ellen does not even mention it. If some objective criterion has been used to decide in which circumstances to use which instruments, it should be motivated and reported. Without this, the reader cannot help but worry that the results that are being reported are not representative of all that could be obtained.

There is another problem with the instrumental variables analysis. It is done using OLS rather than logit. This makes it hard to compare the results of the IV analysis to the earlier work. This problem could have been avoided if the

1. Cutler and Glaeser (1997).

author had used a continuous measure of birth weight throughout the paper. Ellen never justifies her use of a dichotomous variable for birth weight.

Turning to the second mode of demonstrating causality, the paper misses a golden opportunity to narrow the range of suspects for causal paths. In the discussion Ellen suggests that centralization is more the cause of the problem than segregation per se. Although she presents the dissimilarity index and centralization index as measures of the same concept—segregation— it is in fact clear from their correlation (.4) that they are measuring different things. Therefore there is no reason that they could not both have been included in all regressions. We would then know whether it is segregation or centralization that is causally related to birth outcomes—or whether both are related to the outcomes.

I find the results presented in table 6 interesting and indicative of the mechanisms relating segregation to low birth weight. They further confirm the causal nature of the relation. Here the author introduces, in sequence, controls for the mother's social status and some behaviors during pregnancy. The introduction of these controls significantly reduces the impact on blacks of living in a segregated city, suggesting that either segregation or some other aspect of segregated cities is leading black women to be less educated and less likely to marry and that these factors influence their birth outcomes. Introducing controls for behaviors such as drinking and smoking during pregnancy completely eliminates the effect of segregation in at least some specifications. Again, this fits well with the story that the author is telling and adds to its plausibility.

What I find far less interesting is the material contained in tables 7 through 10. Here the author attempts to account for difference in marital status and to explore for other causal routes. The results are disappointing. It seems all too easy to read into the findings other explanations than those the author prefers. In particular, the often counterintuitive coefficients on segregation for whites suggest that many unobserved factors are at work in creating these outcomes and confounding the interpretation of the results.

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