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Metropolitan Growth, Inequality, and Neighborhood Segregation by Income

Over the last three decades, residential segregation by income has become an increasingly important feature of the U.S. metropolitan landscape. From 1970 to 2000, income sorting grew in large cities. In the 1980s almost all American metropolitan areas experienced a rise in segregation of the rich from the poor, though these changes were slightly offset by modest declines in segregation during the 1990s. More than 85 percent of the U.S. metropolitan population lived in an area that was more segregated by income in 2000 than in 1970. The time trend in residential segregation by income hints that income inequality may play an explanatory role. Mayer (2001) uses a panel of states to provide evidence that rising income inequality is associated with rising residential segregation by income.[1] Income inequality at the top of the income distribution is associated with residential isolation of the rich, while income inequality at the bottom of the distribution is associated with residential isolation of the poor.

It is perhaps unsurprising that the metropolitan areas with the largest growth in segregation include a number of distressed cities in industrial decline, such as Buffalo, New York, and Flint, Michigan. These metropolitan areas had large

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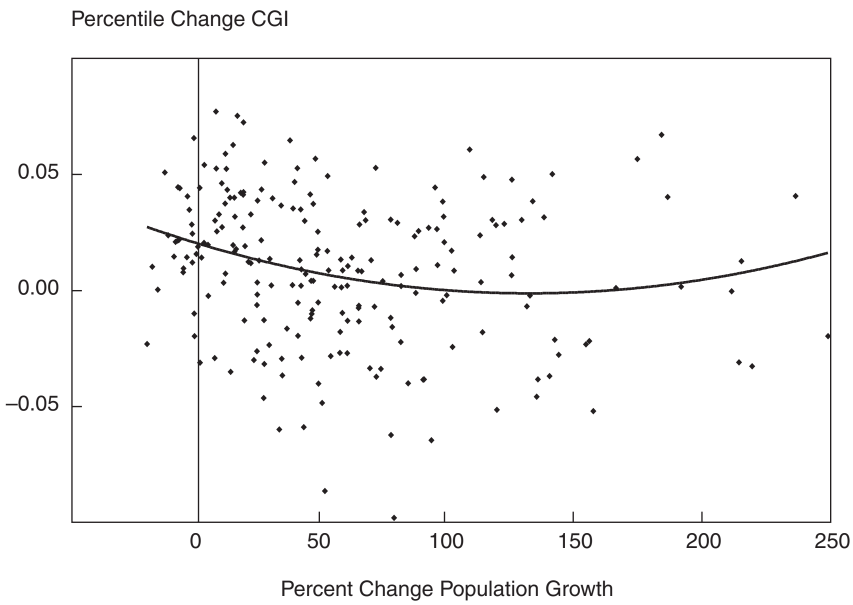
1. In a companion piece to this paper, I obtain similar results using a panel of metropolitan areas and an alternative measure of income sorting. See Watson (2006).

Figure 1. Relationship between Changes in Family Centile Gap Index, 1970–2000, and Metropolitan Area Population Growth, 1970–2000, Relative to 1970 Population[a]



a. Three outliers with more than a 250 percent population growth omitted from graph.

increases in income inequality associated with the demise of their manufacturing sectors. There is a sizable literature examining the flight of white, middle-class residents from the central cities of distressed metropolitan areas and the consequent residential isolation of the minority poor.[2] The implications of this change for housing construction have received less attention. Interestingly, a number of old manufacturing centers, such as Buffalo and Flint, witnessed a fair amount of new housing construction despite population declines.

Income segregation also rose in a subset of booming metropolitan areas. Tucson, Arizona, and Reno, Nevada, for example, saw increases in income segregation over the past three decades that were comparable in magnitude to those in Buffalo and Flint. The relationship between growth in segregation and growth in population is U-shaped, with both rapidly growing and stagnating metropolitan areas experiencing rising income segregation (see figure 1).

2. For example, Wilson (1987).

This paper, which investigates how income inequality and metropolitan growth interact to generate changes in residential segregation by income, proposes a simple model suggesting that rising income inequality creates pressure for income sorting in residential markets. In rapidly growing metropolitan areas, changing preferences are quickly reflected in the housing stock and level of segregation. In slowly growing metropolitan areas, however, the housing stock reflects the preferences of previous generations of residents. If existing housing costs less than the price of new construction or retrofitting, there is little incentive to change the housing stock. Rising segregation occurs in slow growth areas only if the change in market pressure for segregation is sufficient to overcome the costs of new construction or retrofitting. A key feature of the model is that changes to the housing stock are necessary to allow the resorting of income groups.

Why does economic segregation matter? Income sorting affects the distribution of role models, peers, and social networks. Sociologists hypothesize that the lack of neighborhood exposure to mainstream middle-class role models and social networks is a major contributor to urban joblessness and social problems.[3] A number of empirical papers also suggest that the characteristics of one's neighbors and peers in school affect social and economic prospects,[4] though the issue is far from settled.[5] If households sort into different political jurisdictions, economic segregation affects the degree of fiscal redistribution among income groups.[6] Even within political units, neighborhood-level sorting may influence the average level and variance of school quality and other local public goods. Finally, the factors that motivate households to segregate by income also shape the spatial relationship between jobs and homes, in turn affecting commuting patterns and labor-market decisions.

Each of these factors is amplified by the political process because economic segregation itself shapes the context in which policy decisions are made. Bjorvatn and Cappelen (2003) present a model in which income inequality generates residential sorting by income. Residential segregation, they hypothesize, reduces social attachment between groups, and rich children who grow up in segregated neighborhoods are less willing to favor redistribution as adults. In this way, income sorting may have consequences reaching beyond the current generation.

3. For example, Wilson (1987).
4. Case and Katz (1991); Cutler and Glaeser (1997); Hoxby (2000).
5. For example, Oreopoulos (2003); Kling, Liebman, and Katz (2007).
6. Glaeser, Kahn, and Rappaport (2000).

Theoretical Background

The simple framework presented in this paper is based on the notion that income inequality creates divergence in willingness to pay for neighborhood attributes, thereby inducing market pressure for segregation by income. Because income groups have different preferences over the physical characteristics of housing, income resorting requires a change in the housing stock. The observed change in segregation resulting from a given change in inequality depends on the cost of adjustment.

Market Pressure for Residential Segregation by Income

One tradition of modeling residential location decisions starts with a classic paper by Tiebout (1956), which suggests that household location decisions can be viewed as choices over bundles of local public goods. Households sort by income at the level of political district because income is correlated with willingness to pay for public goods. Analogously, households might sort across school districts or neighborhoods because income is correlated with willingness to pay for school or neighborhood quality. Sorting by income at the neighborhood level stems from divergence in willingness to pay for neighborhood attributes, including both attributes that vary across political jurisdictions (those emphasized by Tiebout) and attributes that vary within a political jurisdiction. Even within political boundaries, neighborhoods differ in their access to governmentally provided local public goods, such as proximity to public transit or reliability of trash collection, and differ in their nongovernmental local public goods, such as nice neighbors or a good view.

If households of different income levels are willing to pay different amounts to live in a given neighborhood, market forces tend to generate residential segregation by income. Individual households need not prefer segregated neighborhoods *per se.* Rather, differences in the willingness to pay for various neighborhood attributes across income groups attract these groups to different neighborhoods.[7] In a frictionless housing market, market pressure for segregation is observed as actual segregation, that is, rich and poor households living in different neighborhoods.

7. If rich neighbors are themselves an amenity for which high-income households are willing to pay more than low-income households, the market pressure for income sorting is further enhanced. For simplicity, I imagine the amenity to be a nongovernmentally provided public good, such as a nice view.

The simplest form of a Tiebout model implies that residential segregation by income should be complete. If all households have the same underlying tastes, the rich always pay more to live in high-quality neighborhoods and complete residential segregation by income occurs.[8] The model has been extended by Epple and Platt (1998) to allow variation in both tastes for neighborhood quality and income. For a given level of tastes, rich households in the model always choose to live in a higher-quality neighborhood than poor households. Similarly, at a given income level, households with stronger preferences for neighborhood quality always live in higher-quality neighborhoods than those with weaker preferences. Because both income and tastes vary across households, the willingness to pay for neighborhood quality is imperfectly correlated with income. In equilibrium, neighborhoods are partially, but incompletely, sorted by income. The prediction of Epple and Platt's model accords well with the observed patterns of residential location in American metropolitan areas.

Epple and Platt's framework suggests that observed economic segregation in American metropolitan areas depends on household preferences and the income distribution. Income inequality affects the relative willingness to pay of households at different income levels. There are two distinct ways in which the income sorting predicted by a Tiebout-style model could be affected by inequality. First, there is a direct effect of income inequality on willingness to pay. As inequality increases, it becomes less likely that rich and poor households are willing to pay similar amounts to live in a given neighborhood. In this sense, income inequality is a primary determinant of the market pressure for segregation.

In addition, the income distribution may affect residential sorting by differentially changing neighborhood quality and thereby changing the relative price of a high-quality neighborhood. For example, if less-skilled men disproportionately reside in low-quality neighborhoods and idle men are undesirable neighbors, then the attractiveness of low-quality neighborhoods is likely to fall as the labor market for less-skilled men weakens.[9] High-income families might be willing to pay more than low-income families to avoid these very low-quality neighborhoods. This change may also push the market toward a segregated equilibrium.

A thought experiment helps to clarify the meaning of market pressure for segregation as it is used in this paper. Consider two identical metropolitan

8. Ellickson (1971).

9. Less-skilled workers are defined as those with a high-school diploma or less. Idle men are defined as men who are not employed and not in school.

areas, each with a fixed group of families that are heterogeneous in income and tastes for neighborhood attributes. Residential markets in the two cities are in a competitive equilibrium and identical to each other. Thus the observed level of income segregation is the same in the two cities. At some point, an exogenous force widens the distribution of income in only one city, the so-called *treatment city,* by changing the amount of income associated with each family income percentile but preserving each family's rank in the metropolitan area income distribution. If no family moves in response to the change in the income distribution, income segregation is unchanged.

Given the scenario described above, one might ask what level of income segregation would emerge if the supply of housing were perfectly elastic in the treatment city. The income segregation level under this hypothetical costless competitive equilibrium is the result of market pressure for segregation. In other words, even if no family cares explicitly about the incomes of its neighbors, factors such as income inequality affect the willingness of different income groups to pay for various attributes of neighborhoods. Divergence in the valuation of neighborhood attributes across income groups leads to competitive pressure for income segregation. The difference in equilibrium segregation levels in the treatment and control cities in the absence of adjustment costs is the effect of inequality on the market pressure for segregation.

Adjustment Costs

In practice, adjustment costs in the housing market are likely to be quite important. Glaeser and Gyourko (2005) develop a "bricks-and-mortar" model of metropolitan growth and decline. Population is slow to fall in economically distressed metropolitan areas because the housing stock remains after employment disappears. Housing prices often fall below the price of new construction, attracting some residents to the area despite labor-market conditions. Adjustments to labor demand shocks across metropolitan areas are likely to be slow because housing is durable.

Similarly, the durable nature of housing prevents an immediate market response to changes in relative willingness to pay for neighborhood amenities within metropolitan areas. The financial and regulatory costs of retrofitting or building new housing imply that it may take many years to respond to a demand-side shock in the housing market. Indeed, if the residential market evolves sufficiently slowly, there may be coordination failures that preclude the hypothetical costless equilibrium from ever being realized.

Rapidly and slowly growing metropolitan areas differ in their adjustment costs and, therefore, in their responsiveness to housing market pressures. Glaeser and Gyourko (2005) report that existing housing stock is priced lower than new construction in many declining cities, making it relatively costly to develop new neighborhoods. Similarly, regulatory or zoning barriers may make the supply of housing inelastic. As Gyourko, Mayer, and Sinai (2006) point out, some highly desirable "superstar" cities have very inelastic supply responses to increases in demand over recent decades. Within metropolitan areas, there may be superstar suburbs or neighborhoods as well. In supply-constrained metropolitan areas, demand-side forces generate rapid house price appreciation with little population growth or new construction. In both distressed and supply-constrained metropolitan areas, slow population growth is associated with high costs of adjustment in the housing market.

Americans frequently move from one house to another, suggesting that the financial costs of moving are not prohibitive.[10] The adjustment costs described here are the bricks-and-mortar costs of constructing and retrofitting housing. These costs are likely to be substantial in a city with a preexisting housing stock.

In rapidly growing cities, on the other hand, newly constructed housing can easily respond to current consumer preferences. Developers of new neighborhoods can also overcome coordination problems that might persist in cities with a preexisting housing stock. Thus for a comparable shock affecting demand for different types of housing in different neighborhoods, the transition to a new equilibrium occurs more quickly and cheaply in a rapidly growing metropolitan area.

In sum, an empirically observed change in the level of segregation represents the effect of a change in market pressure toward segregation, tempered by incomplete adjustment. Holding other factors constant, it is expected that income segregation in rapidly growing cities has greater sensitivity to changes in inequality because the housing stock in growing cities adjusts more quickly to changing consumer preferences.

Simple Model

A simple model formalizes the intuition described above. This is not meant to be a complete model of residential location choice, but rather a starting

10. In 1970 about 48 percent of metropolitan household heads reported having lived in a different house five years earlier. In 2000 the number was about 45 percent (IPUMS 2004).

point for the empirical analysis that follows. The model abstracts from many of the complex features of urban housing markets.[11]

Suppose that there are two neighborhoods, G and B. The good neighborhood, G, is more desirable because residency includes access to an unspecified local public good such as a good view, but the two neighborhoods are otherwise identical. As the city is built, the housing supply in each neighborhood is upward-sloping, reflecting the fact that it is more expensive to build on some lots in the neighborhood. Let $S_q(p_q)$ describe the supply of housing in neighborhood of quality $q \in \{G,B\}$. Assume $S'_q(p_q) > 0$ and the supply function S_q is the same in both neighborhoods.

The willingness to pay for housing in each neighborhood is described by $D_q(p_q)$, where $D'_q(p_q) < 0$. In neighborhood G this includes the valuation of the local public good. In equilibrium:

$$D_b(p_b) = S_b(p_b),$$
$$D_g(p_g) = S_g(p_g), \text{ and}$$
$$p_g = p_b + a^*,$$

where $a^* > 0$ represents the valuation that the marginal resident assigns to the local public good. Note that in equilibrium it must be the case that $p_g > p_b$.

Suppose a fraction r of the metropolitan area residents are rich, while $1 - r$ are poor. Residents each live on a plot of land of a fixed size, but rich residents always build a high-amenity house and poor residents always build a low-amenity house. Rich and poor residents have different distributions of willingness to pay to live in the good neighborhood, represented by $f_r(a)$ and $f_p(a)$, respectively. The distribution $f_r(a)$ stochastically dominates the distribution $f_p(a)$.

Let a^* be the equilibrium difference in prices between the two neighborhoods, as described above. The fraction of rich residents with valuations $a > a^*$ in equilibrium is $1 - F_r(a^*)$. This is, therefore, the fraction of rich residents who live in neighborhood G. The fraction of poor residents with valuations $a > a^*$ in equilibrium is $1 - F_p(a^*)$. Assume, as in the Epple and Platt model,

11. For example, the model does not consider distance to the city center, elasticity of demand for land, crime, racial segregation, discrimination in housing markets, transportation costs, filtering down of old housing, or local public finance. It also abstracts from the question of what drives demand for housing across metropolitan areas, and considers only the effect of these demand shocks on metropolitan area housing prices and population.

some residents of each type have valuations above and below a^*, so $0 < (1 - F_p(a^*)) < (1 - F_r(a^*)) < 1$. It follows that both neighborhoods contain both rich and poor residents, but rich residents are disproportionately represented in neighborhood G and poor residents are disproportionately represented in neighborhood B. The housing in each neighborhood is constructed as a mix of high-amenity and low-amenity houses, reflecting the incomes of residents.

It is instructive to consider the effect of inequality on the distribution of residents across neighborhoods as the metropolitan area is built. Suppose the income of the rich is higher while the income of the poor is unchanged. The distribution of the willingness of the rich to pay for the local public good, $f_r(a)$, shifts upward, while the distribution of the willingness to pay of the poor, $f_p(a)$, remains the same. Let a^{**} represent the marginal valuation of the public good in this new scenario. In the new equilibrium $a^{**} > a^*$, $(1 - F_p(a^{**})) < (1 - F_p(a^*))$, and $(1 - F_r(a^{**})) > (1 - F_r(a^*))$. That is, with rising inequality, poor residents are less likely to live in the good neighborhood and rich residents are more likely to live in the good neighborhood. Because rich residents become increasingly concentrated in the good neighborhood, residential segregation by income increases relative to a situation in which income is distributed equally (see figure 2).

A similar result is obtained if inequality rises at the bottom of the distribution. Poor residents are willing to pay less to live in the good neighborhood. The relative valuation of the rich rises. As a result, rich residents disproportionately construct their homes in the good neighborhood and segregation increases.

Model Applied to Three Types of Metropolitan Areas

Suppose a city is built at a time of relative equality and neighborhoods are characterized by moderate segregation, with a mix of high- and low-amenity houses in each neighborhood. In equilibrium,

$$p_{hg} = p_{hb} + a_r^*, \text{ and}$$

$$p_{lg} = p_{lb} + a_p^*,$$

where h and l represent high-amenity and low-amenity houses, respectively, and a_r^* and a_p^* represent the marginal willingness to pay for the local public good of each type of resident. If the metropolitan area is growing, $a_r^* = a_p^*$ because both groups are simultaneously bidding on empty lots.

Fig 2a. Hypothetical Distributions *f*(*a*) under Relative Equality

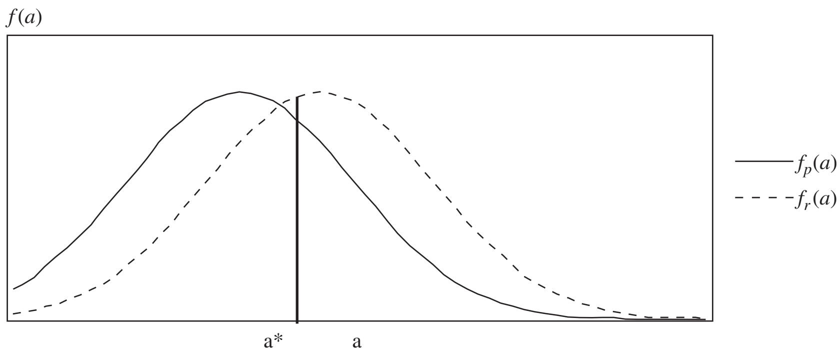
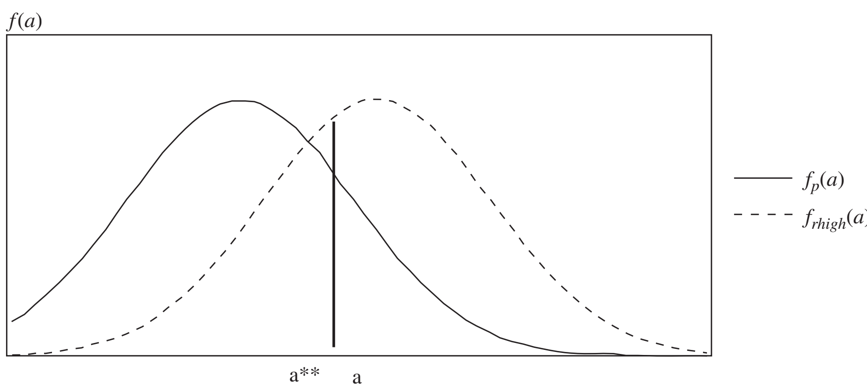


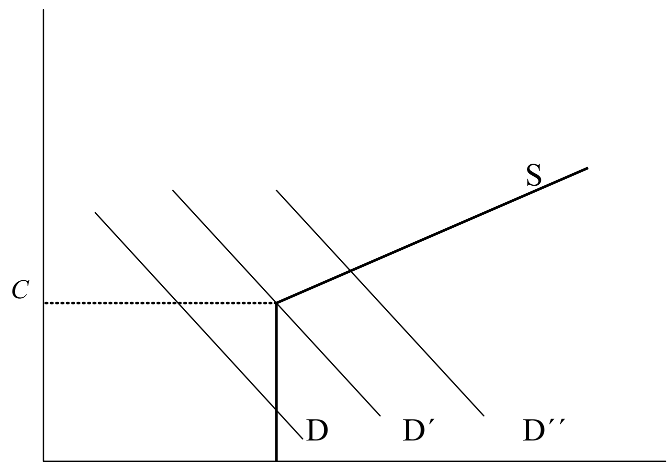
Fig 2b. Hypothetical Distributions *f*(*a*) under Relative Inequality



Given this set of initial conditions, consider three types of metropolitan areas. First, consider cities that peak at a time of relative equality and then fall into economic decline with stagnant or falling population and housing prices. Second, consider cities that continue to experience rising demand for housing overall, but supply is restricted due to natural or regulatory barriers, or both. Third, consider metropolitan areas that continue to grow rapidly with an elastic housing supply.

A metropolitan area's economic decline makes it less attractive to potential migrants. The demand for housing in the metropolitan area falls, housing prices drop, and population stagnates or declines. As noted by Glaeser and Gyourko (2005), the housing supply curve is inelastic for prices below the cost of

Figure 3. Housing Market with Kinked Supply Curve



Source: Glaeser and Gyourko (2005).
C = cost of new construction; *D* = demand for housing; *S* = supply of housing.

new construction and upward sloping above the cost of new construction (see figure 3).

What is the impact of rising inequality in a declining metropolitan area? As a first case, imagine that inequality increases at the top of the distribution. An exogenous force raises incomes of the rich in the declining metropolitan area. This change increases the willingness to pay of rich residents, but not poor residents. In the new equilibrium,

$$p_{hg} = p_{hb} + a_r^{***},$$

where $a_r^{***} > a_r^{*}$ represents the marginal valuation of the public good of the new marginal resident. The market pressure for segregation has increased because rich residents are willing to pay more to live in the good neighborhood. However, if the new price $p_{hg} < c_h$ (the cost of new construction for a high-amenity house), then no new high-amenity houses are built in neighborhood *G*. Similarly, if the new price p_{hg} is sufficiently low relative to the fixed cost of retrofitting, low-amenity homes are not converted into high-amenity homes. The inequality shock raises the demand for high-amenity houses in neighborhood *G,* but the housing supply remains fixed at its historical level. Because the housing stock is tied to the income levels of residents, no rich residents move into the good neighborhood, and segregation remains constant.

On the other hand, if $p_{hg} > c_h$, then new high-amenity houses in neighborhood *G* are built and rich residents move into neighborhood *G*.[12] Thus a sufficiently large demand shock induces new housing construction even in a stagnant metropolitan area, and leads to higher levels of residential segregation by income.

A shock to inequality at the bottom of the distribution (that is, the poor residents become poorer) could also generate increased segregation in a declining metropolitan area. The price of low-amenity houses in the good neighborhood falls, reflecting the decline in willingness to pay for the public good of poor residents. If the price of the low-amenity homes in the good neighborhood is sufficiently low, rich residents who value the local good purchase these homes, and incur the cost of retrofitting them. Poor residents move into high-amenity homes vacated by rich residents in the bad neighborhood. In this scenario, increased segregation occurs as the existing housing stock is retrofitted or replaced to accommodate the rising market pressure for segregation.

Alternatively, an increase in poverty may make neighborhood *B* a less attractive place to live. The good neighborhood becomes more desirable, especially for rich residents if they are particularly averse to living in a very low-quality neighborhood. Depending on underlying preferences, rich residents may be willing to pay to finance new construction or retrofitting in the good neighborhood. A sufficiently large change in the quality of the bad neighborhood could induce new housing construction and lead to higher levels of residential segregation by income.

To summarize, a distressed metropolitan area is characterized by economic decline, stagnant or negative population growth, and housing prices below the cost of new construction. The durable nature of housing combined with the low market price for housing implies that the supply is fixed in the absence of a large shock. If there is a moderate increase in inequality, the relative prices of high-amenity and low-amenity houses in the good neighborhood change. However, the change is not sufficient to generate retrofitting or new construction. The distribution of rich and poor residents across neighborhoods remains constant and the observed level of income segregation remains unchanged.

12. According to a strict interpretation of the model, in which it is assumed poor residents only live in small houses, rich residents leave vacant large homes in the bad neighborhood. More realistically, some poor residents would move into those vacated properties, leaving small homes vacant in neighborhood *B*.

On the other hand, the economic decline may be accompanied by a very large shift in relative demand for high-amenity houses in the good neighborhood. If the demand shock is sufficiently large, the market price of high-amenity houses exceeds the cost of new construction or retrofitting, and high-amenity houses are built in the good neighborhood. The fraction of rich residents living in the good neighborhood rises and segregation increases. In sum, a declining metropolitan area experiences an increase in segregation and new housing construction (or retrofitting) only if the underlying demand for housing in particular neighborhoods is very high. According to the model, an increase in segregation is not observed without a contemporaneous change in the housing stock.

As a second case consider the implications of the model for supply-constrained, economically vibrant cities. Like the superstar cities in Gyourko, Mayer, and Sinai (2006), these metropolitan areas experience high overall demand for housing, coupled with natural or regulatory supply constraints in the housing market. Rising inequality in a supply-constrained metropolitan area raises the relative valuation of high-amenity houses in the good neighborhood. If construction is very expensive due to natural boundaries or zoning, only a substantial change in the willingness of the rich to pay for the good neighborhood induces a supply response. If supply constraints are severe, little new construction or population growth is expected. In constrained, economically vibrant cities, rising inequality induces rising segregation through retrofitting or replacement of existing housing stock.

In contrast to the two types of slowly growing areas described above, consider a hypothetical, rapidly growing metropolitan area. Rapid population growth typically implies that new homes are priced above the cost of construction. Housing supply is somewhat elastic for both high- and low-amenity houses. If income inequality remains constant as the number of residents grows, market forces yield a distribution of new houses that is similar to the initial distribution of houses. New homes are built, but segregation remains at a constant level in this case.

The housing market in a booming metropolitan area is very responsive to changes in inequality. If inequality is rising as the population expands, the increased demand for high-amenity houses in the good neighborhood is easily accommodated. New construction reflects the contemporary market pressure for segregation. Thus even a minor increase in inequality translates into homogeneous neighborhoods and rising segregation levels in a rapidly growing metropolitan area.

This simple model suggests that it is the interaction between the change in inequality and population growth of a city that determines a metropolitan area's segregation level. In a rapidly growing city, the housing stock and observed

Table 1. Theoretical Predictions Regarding Relationship between Metropolitan Area Growth and Segregation

	Metropolitan area	
Inequality	*Rapid growth*	*Slow growth*
Rising	Increase in observed segregation. New housing construction as predicted by population growth.	Increase in observed segregation only if inequality shock is sufficient to induce higher-than-expected housing construction or retrofitting.
Not rising	No increase in observed segregation. New housing construction as predicted by population growth.	No increase in observed segregation. Little or no new housing construction.

segregation reflect residents' current preferences. In a slowly growing metropolitan area, observed segregation reflects residents' historical preferences, unless the inequality shock is sufficient to induce the construction of new housing or retrofitting that would not have occurred otherwise.

The model generates several predictions, which are summarized in table 1:

—Factors raising the relative willingness of the rich to pay to live in a good neighborhood, such as income inequality, tend to raise residential sorting by income in metropolitan areas.

—The extent to which observed levels of segregation reflect changes in inequality depends on a metropolitan area's population growth.

—Rising segregation is accompanied by higher than expected levels of new housing construction in distressed cities, but not in economically vibrant cities.

—New housing in a metropolitan area reflects the market pressure for segregation at the time it is built. Because the housing stock is durable, market forces generating economic segregation have persistent effects on segregation levels even after the forces themselves have disappeared. Segregation levels are more persistent in cities with a slowly evolving housing stock.

The final prediction is somewhat analogous to Glaeser and Gyourko's (2005) bricks-and-mortar view of metropolitan growth and decline, applied to residential choice within metropolitan areas. Neighborhoods are developed to reflect the heterogeneity of their expected residents in terms of desired housing attributes. Because housing is durable, segregation by income tends to reflect the market pressure for segregation at the time housing is built in a metropolitan area. In slowly growing metropolitan areas, segregation rises only if the market pressure for segregation is sufficient to induce retrofitting or new housing construction that would not otherwise be expected. Changes in the housing stock enable the resorting of income groups across neighborhoods.

Measurement of Income Segregation

The consensus of the empirical literature is that neighborhood income segregation rose between 1970 and 2000. Jargowsky (1996a) reports that economic segregation within racial groups increased in both the 1970s and 1980s. Mayer (2001) finds a slight decline in overall tract-level segregation over the 1970s and a substantial rise in the 1980s, while Massey and Fischer (2003) report an increase in the concentration of poverty between 1970 and 2000 in large metropolitan areas, with a large rise in the 1980s and a decline in the 1990s.[13] Using a measure of income sorting developed in Watson (2006), this paper also documents an increase in economic segregation between 1970 and 2000.

The empirical analysis presented here is based on census tract-level family income data from the 1970, 1980, 1990, and 2000 U.S. censuses.[14] Tract-level data on household income are not available for 1970, so information on family income is used throughout the analysis.[15]As is common in the literature, this

13. Jargowsky (1995, 1996a) reports that economic segregation within racial groups increased during both the 1970s and 1980s. Mayer (2001) finds a slight decline in overall tract-level segregation during the 1970s and a substantial rise in the 1980s. Both Jargowsky and Mayer use the Neighborhood Sorting Index, a measure of overall economic segregation developed by Jargowsky. The index is the square root of the ratio of the between-tract income variance to the total income variance. Massey and Fischer (2003) also measure the concentration of affluence and find rising residential segregation of the rich between 1970 and 2000. Affluence is defined as four times the poverty line. Concentration of affluence declined in the 1970s and 1990s, but rose in the 1980s. When Massey and Fischer instead use the top-income quintile as a measure of affluence, there is no overall change between 1970 and 2000.

14. The tract-level family income data are provided by the census in fifteen income bins for 1970, seventeen for 1980, twenty-five for 1990, and sixteen for 2000. The implications of this fact are discussed at length in appendix A. Information on family income (rather than household income) is used to construct measures of inequality and segregation. Tract-level data on household income are not available for 1970.

15. Families are defined by the census as two or more individuals related by blood or marriage, and they constitute about three-quarters of all households. Families have slightly higher segregation levels than all households in years when both can be observed, but follow similar trends in segregation. The measure of family income is not adjusted for household size or family structure and reflects reported total income, which for most respondents is pretax income. The data do not reflect permanent or lifetime income. Therefore measured family income inequality may not accurately reflect differences in well-being. Similarly, measured segregation is a measure sorting by income rather than a measure of sorting by well-being.

paper uses the census tract (an area of roughly 4,000 people defined by the Census Bureau) as the definition of a *neighborhood*.[16] Information at the tract level is aggregated to construct indicators of income segregation and income inequality at the metropolitan area level, and to calculate several other metropolitan area variables. The tract-level information is supplemented with data collected by the census at the county level, county data in the City and County Data Books, and national industrial employment trends in the Integrated Public Use Microdata Series (IPUMS 2004).[17] The metropolitan areas are based on the 2003 U.S. Census county-based metropolitan area definitions, so they represent a constant geographic area over time to the extent that the counties were tracted in 1970. The sample includes 216 of the 217 metropolitan areas that had at least one tracted county in 1970.[18]

Table 2 presents some basic facts about the sample. On average, the 216 metropolitan areas experienced substantial increases in population, income, and income inequality. Land area increased, reflecting the fact that counties became tracted over the 1970–2000 period. New housing construction slowed in the 1980–2000 period relative to the 1960–80 period. Racial segregation fell between 1970 and 2000, as has been documented elsewhere.[19]

To analyze the changes in residential segregation by income over time, Watson (2006) introduces an index of segregation that is not directly related to the shape of income distribution in a metropolitan area. The Centile Gap Index (CGI) estimates how far the average family income within a tract deviates in percentile terms from the median family income in the tract, compared to how far it would deviate under perfect integration. Because the CGI is based on income percentiles, it is theoretically sensitive to rank-preserving spreads in the income distribution.[20] In other words, if the income distribution widens but families do not move, measured segregation is unchanged. This feature

16. The primary disadvantage to defining a neighborhood as a census tract is that a neighborhood is a much smaller geographic unit in a dense urban area than in a sprawling suburb. It is likely that much of the true segregation in suburban areas is due to within-tract sorting and is not picked up by a tract-based measure. Because both the physical proximity and nearest neighbors matter (for example, a neighbor living a quarter mile away has less relevance in a dense urban area than in a suburb), the ideal measure of neighborhood segregation is unclear.

17. Available at www.ipums.org.

18. Gainesville, Florida, is excluded from the analysis due to missing data. The definition of metropolitan areas is discussed in appendix B.

19. For example, Cutler, Glaeser, and Vigdor (1999).

20. In practice, income percentiles must be estimated using the income bins reported by the census, so that measured CGI may change slightly if the income distribution changes. An extensive discussion of this issue can be found in Watson (2006).

Table 2. Sample Means of Metropolitan Area Characteristics: Population, Income, and Income Inequality, 1970–2000[a]

Characteristic	1970	1980	1990	2000	Change 1970–2000
Metropolitan area					
Number of families	164,878	188,255	219,737	244,766	79,888
Number of tracts	151	171	196	220	69
Population (000s)	661	754	851	967	306
Family income last year (in 2000 dollars)					
Mean	50,604	54,330	57,750	63,940	13,336
Median	44,789	47,597	48,188	51,659	6,870
Family income ratio					
80-20	2.83	3.10	3.34	3.39	0.55
90-50	1.94	2.00	2.13	2.23	0.28
50-10	2.99	3.10	3.32	3.21	0.21
Predicted employment					
Relative to 1970	1.00	1.28	1.54	1.73	0.73
Of less-skilled men relative to 1970 total employment	0.44	0.43	0.38	0.38	–0.06
Predicted central city share of employment	0.57	0.52	0.52	0.48	–0.09
Race, education, and age					
Fraction black	0.10	0.10	0.11	0.12	0.02
Fraction Hispanic	0.05	0.06	0.07	0.10	0.05
Fraction foreign-born	0.03	0.04	0.05	0.07	0.04
Fraction aged 25 and older who are high school graduates[b]	0.55	0.68	0.71	0.85	0.30
Fraction aged 25 and older who are college graduates[c]	0.11	0.16	0.20	0.24	0.12
Fraction under age 18	0.35	0.29	0.26	0.25	–0.10
Fraction under age 65	0.91	0.90	0.86	0.88	–0.03
Racial segregation index[d]	0.38	0.32	0.28	0.22	–0.16
Land area (square miles)	1,894	2,469	2,844	2,843	949
New housing construction[e]	0.40	0.41	0.27	0.22	–0.18

Source: Tract-level and county-level census data from the U.S. Census Bureau, Census CD; Urban Institute Underclass Database; IPUMS; and author's calculations.

a. Means of 216 metropolitan areas (unweighted). Median family income and family income ratios are estimated. Inflation adjustment based on CPI-U, 1982–84 base year. Predicted variables based on 1970 industry mix interacted with national trends. For some cities 1970 black and Hispanic populations are imputed.

b. High school graduates include GED graduates in 1990 and 2000.

c. College graduates include those with four or more years of college in 1970 and 1980.

d. Racial segregation refers to the isolation of blacks from whites, adjusting for group populations.

e. New housing construction is the percentage of homes built within the last ten years relative to the percentage built ten or more years ago.

distinguishes the CGI from other measures of income sorting used in the literature.[21] The CGI is particularly well-suited to studying the relationship between income inequality and residential choice.

The family income data at the census tract level are presented using fifteen to twenty-five income bins defined by the U.S. Census Bureau. The information can be aggregated to the metropolitan area level and, to the extent that income is accurately reported, one can determine the actual range of family income percentiles in a metropolitan area represented by each income bin. This strategy eliminates the need for any assumptions about the income distribution in a metropolitan area and thereby overcomes a potential source of bias.[22] Family income groups within a census tract are known to be within a narrow range of income percentiles, but the exact income ranks are not known. To estimate the likelihood that a family is in a given percentile within the narrow range, this paper assumes that families in a particular income bin in a particular tract are uniformly distributed among the percentiles represented by the bin.[23]

The formula for the Centile Gap Index of metropolitan area *m* is

$$CGI_m = \left(0.25 - \left(1/J_m\right)\sum_j \left|P_j - P_{medtj}\right|\right)/0.25,$$

where

CGI_m : CGI in metropolitan area *m,*
J_m : number of families in metropolitan area *m,*
P_j : estimated percentile in the metropolitan area *m* income distribution of family *j,*
and P_{medtj} : estimated income percentile of median family in the tract of family *j.*

That is, the term $\left|P_j - P_{medtj}\right|$ represents the estimated income percentile distance of a given family from the median family in their tract. If a metropolitan area were fully integrated by income, each census tract would contain the full income distribution (defined from 0 to 1). In this case, the median family in the tract would be in the 50th percentile of the metropolitan area income distribution and the average centile difference between a family and

21. The Neighborhood Sorting Index, developed by Jargowsky (1995, 1996a), is a commonly used measure of income sorting that is not invariant to rank-preserving spreads in the income distribution. See Watson (2006) for details.

22. For more information about measurement of the income distribution, see Watson (2006).

23. Watson (2006) uses simulation to demonstrate that the bias introduced by the uniformity assumption is likely to be small with fifteen or more income bins.

the median family in the tract would be 0.25. Therefore, under perfect integration, the CGI equals zero. In contrast, a completely segregated city would consist of homogeneous neighborhoods. The average percentile difference between a family and the median family in the tract would be zero, yielding a CGI of 1 under perfect segregation.[24]

Conceptually, it is worth distinguishing between two different notions of neighborhood income segregation. The neighborhood distribution of income is plausibly important to outcomes. The isolation of the poor, a measure of segregation used in some studies, focuses on the income distribution of a typical poor family's neighborhood. In contrast, the CGI is a measure of the distribution of income rank groups across neighborhoods, not of the distribution of income across neighborhoods. Thus if neighborhoods are segregated and fixed, a rise in income inequality could make the poor worse off because average neighborhood income might fall. This effect is not captured by the CGI. Rather, a rank-preserving spread of the income distribution induces a systematic change in the CGI only if it induces a change in the residential location choices of different income groups. Because this study investigates the relationship between income inequality and residential choice, the CGI is an appropriate measure to use.

This paper uses an additional percentile-based segregation measure to examine segregation at different parts of the income distribution. The families in each metropolitan area are divided into five income quintiles. The exposure of quintile x to quintile y is the fraction of quintile y families in a typical quintile x family's census tract.[25] For example, the exposure of the bottom quintile to the top quintile represents the fraction of top-quintile families in a typical bottom-quintile family's census tract. The exposure of an income group to itself is referred to as the *isolation* of that income quintile.

Trends in Segregation by Income

As shown in table 3, economic segregation in metropolitan areas increased between 1970 and 2000. The average CGI rose from 0.110 to 0.120 over the period, decreasing slightly over the 1970s and the 1990s, and rising substantially over the 1980s. Income segregation grew earlier and more substantially in

24. With a finite number of income bins, perfect segregation cannot be observed. See Watson (2006) for a discussion.
25. The formula for the Exposure Index is reported in appendix A.

Table 3. Sample Means of Metropolitan Area Characteristics: Economic Segregation, 1970–2000

Measure	*1970*	*1980*	*1990*	*2000*	*Change 1970–2000*[a]
Family income segregation					
CGI	0.110	0.106	0.123	0.120	0.009
Isolation of bottom quintile	0.263	0.267	0.281	0.276	0.013
Isolation of top quintile	0.275	0.271	0.286	0.283	0.007
Family suburbanization (210 metropolitan areas)					
Fraction of all families in central city	n.a.	0.464	0.425	0.439	–0.026
Fraction of bottom quintile in central city	n.a.	0.528	0.499	0.519	–0.008
Fraction of top quintile in central city	n.a.	0.439	0.399	0.408	–0.031
Fraction of central city in bottom quintile	n.a.	0.239	0.249	0.253	0.015
Fraction of central city in top quintile	n.a.	0.184	0.182	0.178	–0.006
Within central city versus suburb segregation (210 metropolitan areas)					
CGI within central city	n.a.	0.125	0.147	0.138	0.013
Isolation of bottom quintile in central city	n.a.	0.390	0.444	0.445	0.055
Isolation of top quintile in central city	n.a.	0.253	0.268	0.254	0.001
CGI within suburbs	n.a.	0.067	0.082	0.079	0.012
Isolation of bottom quintile in suburbs	n.a.	0.191	0.195	0.187	–0.004
Isolation of top quintile in suburbs	n.a.	0.276	0.286	0.286	0.010

Source: Tract-level census data, U.S. Census Bureau, Census CD; Urban Institute Underclass Database; and author's calculations.
n.a. Not available.
CGI = centile gap index.
a. Change reflects 1980–2000 changes when 1970 information is unavailable.

larger cities. Sorting declined in southern metropolitan areas, but increased in other regions. Trends in the CGI for different types of metropolitan areas are shown in table 4.[26]

Is the change in the CGI large or small? To get a sense of this, consider a hypothetical metropolitan area with many neighborhoods of equal population. If each neighborhood is representative of the metropolitan income distribution, the CGI is zero. Suppose some neighborhoods become moderately segregated. They contain 20 percent of their population from each of the three middle-income quintiles, and the remaining 40 percent of their population from either just the top- or bottom-income quintile. If 69 percent of neighborhoods are segregated as described and 31 percent of neighborhoods are representative of the whole population, the CGI is about 0.110, the sample mean CGI

26. The Neighborhood Sorting Index also shows an increase in income segregation between 1970 and 2000, but the index rose in all three decades. See Watson (2006) for a discussion of the differences between alternative measures of income sorting.

Table 4. CGI by Metropolitan Area Characteristics, 1970–2000

	CGI				
Category	*1970*	*1980*	*1990*	*2000*	*Change 1970–2000*
All metropolitan areas (216)	0.110	0.106	0.123	0.120	0.009
All metropolitan areas (weighted by 2000 population, $N = 216$)	0.130	0.137	0.157	0.158	0.028
By region					
East (33)	0.082	0.091	0.106	0.115	0.033
Midwest (63)	0.090	0.097	0.118	0.110	0.020
South (83)	0.139	0.119	0.130	0.123	–0.016
West (37)	0.104	0.109	0.128	0.131	0.027
By growth in inequality (80-20 family income ratio)					
Slowest (72)	0.118	0.104	0.113	0.109	–0.010
Moderate (72)	0.111	0.106	0.124	0.121	0.010
Fastest (72)	0.101	0.110	0.131	0.129	0.028
By population growth					
Slowest (72)	0.088	0.095	0.114	0.111	0.023
Moderate (72)	0.117	0.110	0.125	0.120	0.003
Fastest (72)	0.125	0.114	0.129	0.128	0.002
By growth in inequality (80-20 family income ratio), in slow population growth areas					
Slowest (24)	0.083	0.097	0.098	0.087	0.004
Moderate (24)	0.075	0.084	0.103	0.098	0.023
Fastest (24)	0.103	0.119	0.142	0.146	0.043
By growth in inequality (80-20 family income ratio), in rapid population growth areas					
Slowest (24)	0.124	0.108	0.117	0.112	–0.012
Moderate (24)	0.118	0.110	0.121	0.122	0.004
Fastest (24)	0.133	0.125	0.157	0.148	0.015
By 2000 population					
< 250,000 (66)	0.094	0.086	0.098	0.091	–0.003
250,000–499,000 (64)	0.105	0.100	0.114	0.111	0.006
500,000–1 million (37)	0.118	0.114	0.132	0.132	0.014
>1 million (49)	0.133	0.136	0.160	0.161	0.028
By predicted employment growth					
Slowest (72)	0.080	0.084	0.101	0.098	0.018
Moderate (72)	0.128	0.118	0.134	0.131	0.003
Fastest (72)	0.123	0.118	0.132	0.129	0.007

Source: Tract-level census data, U.S. Census Bureau, Census CD; Urban Institute Underclass Database; and author's calculations.
CGI = centile gap index.

value for 1970. If 75 percent of neighborhoods are segregated as described and 25 percent of neighborhoods are representative of the whole population, the CGI is about 0.120, the sample mean for 2000.

Average segregation levels peaked in 1990. A CGI of 0.123, the sample mean in 1990, would be generated if 77 percent of neighborhoods are segregated as described above and 23 percent of neighborhoods are representative. Indeed, in 1990 a quarter of the metropolitan areas in the sample had CGIs exceeding 0.160, a statistic that would be generated if 100 percent of neighborhoods were segregated as described above. Thus the change in segregation over time is economically meaningful.

Nevertheless, changes in segregation over time are not particularly large compared to variation across metropolitan areas. The metropolitan area with the median CGI in 1990 would have placed at the 64th percentile of segregation in 1970. The 1990 mean CGI is 0.3 of a standard deviation higher than the 1970 mean CGI (using the 1970 standard deviation).

To get a better sense of neighborhood composition, it is helpful to examine the typical experience of family income quintile groups. The top and bottom income groups were more isolated in 2000 than 1970. Families in the bottom quintile of their metropolitan area family income distribution had neighborhoods that were 26.3 percent bottom quintile in 1970 and 27.6 percent bottom quintile in 2000. Top-quintile families also became more likely to live with other top-income quintile families. In 2000 the typical family in the bottom quintile lived in a neighborhood that was about 28 percent bottom-quintile residents and 14 percent top-quintile residents, while the proportions were roughly reversed for top-quintile families.

This paper focuses on income segregation at the neighborhood level. However, there is a mechanical relationship between central city-suburb sorting and neighborhood sorting. The 1970–2000 period was characterized by disproportionate suburbanization of the rich. Empirically, however, income sorting between the central city and suburbs does not explain the bulk of neighborhood income segregation. The growth in neighborhood income segregation is not primarily due to differential suburbanization rates, but rather sorting both within the suburbs and central city.

Trends by Metropolitan Area Growth

Slowly growing metropolitan areas are those in the bottom third of population growth. These include economically distressed cities as well as some economically vibrant cities (such as Boston and New York) with housing supply constraints. Rapidly growing metropolitan areas are those in the top third of the population growth distribution. Table 4 shows trends in income segregation by population growth rates.[27] The most slowly growing metropolitan areas had the largest changes in segregation.

Table 5 summarizes the changes that took place in slowly growing cities between 1970 and 2000. About a third of slow-growth metropolitan areas lost population between 1970 and 2000. Slow growth areas also experienced large increases in inequality. These areas faced a strong trend toward suburbanization of the rich and middle class. Residential segregation by income also increased within central cities and suburbs. The net result was a large increase in the concentration of bottom-quintile families in the central city. By 2000 a typical bottom-quintile central-city family in a slow-growth metropolitan area lived in a neighborhood that was composed of 55 percent bottom-quintile family residents.

The pattern in booming metropolitan areas, also shown in table 5, was quite different. Growth in inequality was relatively modest, and average segregation levels were nearly flat over the period. There was also greater variation in segregation trends in these areas. More than 40 percent of rapid-growth metropolitan areas had declining segregation, while a number of other areas had large increases in segregation. Unlike slow-growth areas, high-growth areas were not characterized by disproportionate suburbanization of the rich, even among those with rising segregation. Rising segregation in booming metropolitan areas, where it occurred, was driven by the fact that the rich were becoming increasingly isolated within the suburbs and central cities. It was the growing isolation of the rich that drove segregation in a subset of rapidly growing metropolitan areas.

Testing the Model's Implications

The CGI is well suited to investigating the relationship between inequality and residential choice. This section presents empirical evidence regarding the implications of the model using a panel of 216 metropolitan areas over four decennial censuses spanning thirty years.

27. Table 4 also shows segregation trends by predicted employment growth rates. Predicted employment is based on 1970 industrial composition interacted with national industry-specific employment trends. The variable is discussed later in this paper. Predicted employment growth serves as a proxy for economic growth.

Table 5. Sample Characteristics for Slowly and Rapidly Growing Metropolitan Areas, 1970–2000[a]

	Metropolitan areas					
	Slow growth[b]			*Rapid growth[c]*		
Characteristic	*1970*	*2000*	*Fraction positive change*	*1970*	*2000*	*Fraction positive change*
Metropolitan area						
Population (000s)	995	1,083	0.67	436	998	1.00
Family income ratio						
80-20	2.58	3.31	1.00	3.04	3.48	0.96
90-50	1.86	2.17	1.00	2.02	2.29	1.00
50-10	2.80	3.18	0.89	3.12	3.25	0.71
Racial segregation index	0.389	0.310	0.29	0.353	0.137	0.18
Land area (square miles)	1,558	1,866	0.49	2,529	4,159	0.78
New housing construction	0.25	0.13	0.01	0.55	0.32	0.09
Family income segregation measures						
CGI	0.088	0.111	0.83	0.125	0.128	0.57
Isolation of bottom quintile	0.253	0.281	0.92	0.268	0.272	0.61
Isolation of top quintile	0.259	0.271	0.71	0.289	0.293	0.61
Family suburbanization measures (210 metropolitan areas, 1980–2000)						
Fraction of all families in central city	0.412	0.373	0.19	0.473	0.458	0.39
Fraction of bottom quintile in central city	0.511	0.502	0.43	0.513	0.503	0.44
Fraction of top quintile in central city	0.357	0.298	0.15	0.472	0.463	0.36
Fraction of central city in bottom quintile	0.262	0.288	0.89	0.225	0.230	0.65
Fraction of central city in top quintile	0.166	0.150	0.21	0.197	0.198	0.49
Within central city versus suburb segregation (210 metropolitan areas, 1980–2000)						
CGI within central city[d]	0.107	0.121	0.81	0.139	0.151	0.67
Isolation of bottom quintile in central city	0.449	0.548	0.88	0.355	0.373	0.69
Isolation of top quintile in central city	0.199	0.178	0.28	0.293	0.310	0.58
CGI within suburbs[d]	0.057	0.067	0.72	0.075	0.091	0.74
Isolation of bottom quintile in suburbs	0.166	0.154	0.31	0.209	0.218	0.53
Isolation of top quintile in suburbs	0.286	0.314	0.92	0.267	0.261	0.67

Source: Tract-level census data, U.S. Census Bureau, Census CD; Urban Institute Underclass Database; and author's calculations. CGI = centile gap index.

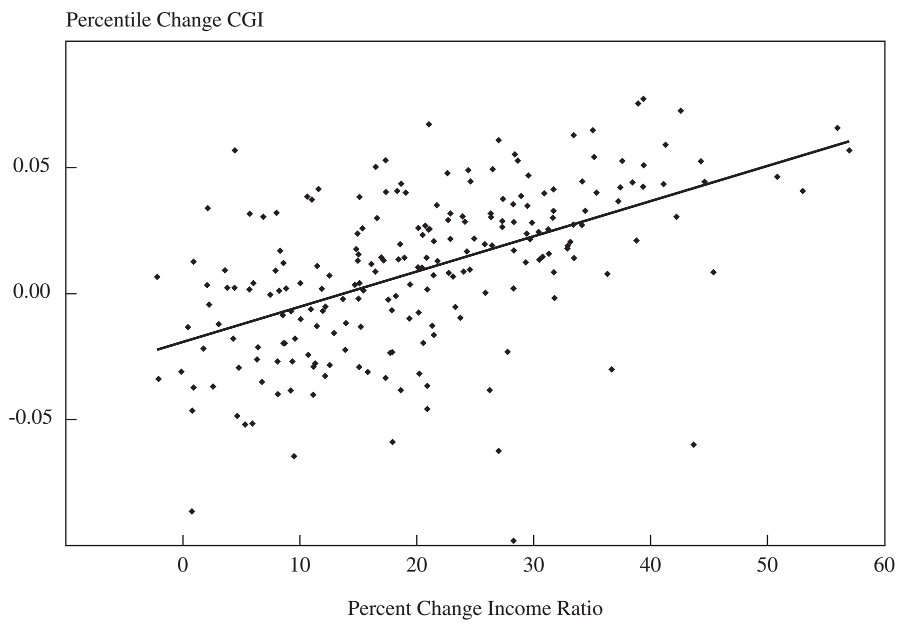
a. Suburbanization measures reported for 1980 rather than 1970; suburbanization variables not available for 1970. Changes for population, number of families, and land area reported in percentage terms. See text and appendix A for description of segregation measures.

b. Bottom third of the population growth rate distribution.

c. Top third of the population growth rate distribution.

d. Computed using city or suburb income percentiles.

Figure 4. Relationship between Changes in Family CGI and Family Income Ratio (80-20), 1970–2000



Inequality and Segregation

The model's first implication is that factors that raise the relative willingness of the rich to pay to live in a good neighborhood tend to increase a metropolitan area's income segregation. Though a number of factors are likely to contribute to market pressure for segregation, this paper focuses on rising income inequality. As suggested by the model, rising inequality is likely to affect the relative willingness of high- and low-income families to pay for certain neighborhood attributes.

The data show a strong relationship between income inequality and segregation by income percentile. A one standard deviation increase in inequality raises income segregation by 0.4 standard deviations. This result is foreshadowed by figure 4, which plots the relationship between growth in income segregation and growth in income inequality between 1970 and 2000.

A fixed effects specification using four decennial censuses (1970–2000) controls for any unobserved attributes of metropolitan areas that do not change over time and that could be correlated with both inequality and segregation levels. I estimate the following reduced form model:

$$\begin{aligned} \text{Segregation}_{mt} = {} & \beta_1 * \text{Inequality}_{mt} + \beta_2 * \text{Predicted Employment}_{mt} \\ & + \beta_3 * \text{Predicted Employment for Less-Skilled Men}_{mt} \\ & + \beta_4 * \text{Predicted Central-City Employment Share}_{mt} \\ & + \text{other MSA characteristics}_{mt} * \beta_5 + \alpha_m + \delta_t + \mu_{mt}. \end{aligned}$$

Three industrial composition variables—predicted employment, predicted employment for less-skilled men, and predicted central-city employment share—are constructed using 1970 industrial shares in each metropolitan area interacted with national industry trends.[28] It is important to control for the industrial composition variables because metropolitan areas with different economic bases are likely to have differentially changing residential patterns independent of differential changes in the income distribution.

Metropolitan areas may have long-standing differences in residential patterns that are correlated with the income distribution in those areas. Metropolitan area fixed effects, α_m, are included in the model to control for time-invariant differences across metropolitan areas. Year fixed effects, δ_t, control for national trends in preferences common to all metropolitan areas that could influence segregation levels. Additional time-varying metropolitan area characteristics are included as well.[29]

Results of the fixed effects model are shown in table 6. In the table's first column, a baseline model is presented in which the log of the 80-20 ratio is the measure of inequality and the CGI is the measure of segregation. As predicted by theory, income inequality is highly correlated with observed income segregation. After the model has controlled for the effects of industrial composition and a number of other factors, the coefficient on inequality is 0.108. This number implies that a 1 standard deviation increase in income inequality raises income segregation by 0.4 standard deviations.

To put the effect's size into perspective, recall the hypothetical metropolitan area discussed above. Some neighborhoods are representative of the metropolitan area population. Others are moderately segregated, with 20 percent

28. The construction of these variables is described in appendix B.

29. Time-varying metropolitan area characteristics include log of population, racial and ethnic composition variables, educational composition variables, age composition variables, and land area. Land area changes if a county eventually included in a metropolitan area was not tracted in 1970.

of their population from each of the three middle-income quintiles, and the remaining 40 percent of their population from either just the top- or bottom-income quintile. The mean CGI for 1970 (0.110) is consistent with a hypothetical metropolitan area in which 69 percent of neighborhoods are segregated as described and 31 percent of neighborhoods are representative of the whole population. Between 1970 and 2000, the increase in the average of the log 80-20 ratio was 0.18. According to the regression model, this change predicts an increase in the CGI of 0.020. The resulting level of segregation would be achieved if 81 percent of neighborhoods were segregated as described and 19 percent were representative of the population. The estimated effect of rising inequality more than fully accounts for the observed growth in income segregation between 1970 and 2000.

Differences in family income across income quintile groups are associated with different neighborhood choices by those groups. For example, inequality at the top of the income distribution is associated with residential isolation of the top quintile. An increase in the log 90-50 ratio equivalent to the change in the sample mean between 1970 and 2000 predicts an increase in isolation of the rich of 0.022. In 2000, holding all else equal, the typical top-quintile family is predicted to live in a neighborhood consisting of an additional 2.2 per 100 top-quintile families (from a base of 27.5 per 100 in 1970).

Similarly, inequality at the bottom of the income distribution is associated with isolation of the bottom quintile. The coefficient on the isolation of the poor and the actual change in inequality are both smaller than for the top quintile, so that the predicted increase in isolation of the bottom quintile is a modest 0.003. In 2000 the typical bottom-quintile family is predicted to live in a neighborhood consisting of an additional 0.3 per 100 top-quintile families (from a base of 26.3 per 100 in 1970), holding industrial composition and other factors fixed.

Some of the effect of inequality at the bottom on residential sorting is likely captured by the industrial mix variables. The data indicate a strong negative relationship between predicted employment demand for less-skilled men and segregation, after the model has controlled for employment decentralization and overall employment levels. In particular, declining employment for less-skilled men is associated with rising isolation of families in the bottom-income quintile. This is suggestive evidence that manufacturing job loss may cause a change in the relative desirability of high- and low-quality neighborhoods, leading all but the lowest-income groups to exit low-quality neighborhoods. Also, fewer jobs for less-skilled men may affect variation in permanent incomes, in which case measured income inequality does not fully capture the differences in economic well-being that affect residential choices.

Table 6. Fixed Effects Analysis of Income Segregation, 1970–2000[a]

			Isolation			
	CGI		*Of bottom quintile*		*Of top quintile*	
Dependent variable	*I*	*II*	*III*	*IV*	*V*	*VI*
Log (80-20 family income ratio)	0.108**		0.060**		0.084**	
	(0.020)		(0.015)		(0.015)	
Log (90-50 family income ratio)		0.115**		0.010		0.163**
		(0.028)		(0.026)		(0.025)
Log (50-10 family income ratio)		0.040**		0.055**		0.007
		(0.013)		(0.011)		(0.009)
Predicted employment	0.197**	0.200**	0.188**	0.178**	0.086	0.100*
	(0.073)	(0.071)	(0.062)	(0.062)	(0.055)	(0.053)
Predicted employment of less-skilled men	–0.894**	–0.927**	–0.812**	–0.801**	–0.321	–0.378*
	(0.281)	(0.281)	(0.238)	(0.238)	(0.199)	(0.194)
Predicted central city employment	–1.082**	–1.127**	–0.803**	–0.847**	–0.593**	–0.593**
	(0.364)	(0.350)	(0.327)	(0.327)	(0.215)	(0.202)
Log (population)	0.018*	0.016*	0.007	0.006	0.008	0.007
	(0.010)	(0.010)	(0.007)	(0.007)	(0.007)	(0.006)
Fraction black	0.083	0.107	0.133**	0.117*	0.047	0.083
	(0.079)	(0.080)	(0.063)	(0.062)	(0.055)	(0.054)
Fraction Hispanic	0.013	0.037	0.000	–0.002	0.041	0.061*
	(0.057)	(0.057)	(0.050)	(0.050)	(0.036)	(0.031)
Fraction foreign-born	–0.051	–0.063	–0.079*	–0.069	0.038	–0.003
	(0.053)	(0.052)	(0.047)	(0.049)	(0.037)	(0.032)

Log (mean family income in 2000 dollars)	–0.036**	–0.054**	–0.012	–0.014	–0.029*	–0.043**
	(0.016)	(0.016)	(0.014)	(0.013)	(0.015)	(0.015)
Fraction aged 25 and older who are	–0.033**	–0.030**	–0.007	–0.010	–0.029**	–0.026**
high school graduates	(0.014)	(0.014)	(0.012)	(0.012)	(0.010)	(0.010)
Fraction aged 25 and older who are	0.194**	0.223**	0.071	0.086*	0.214**	0.219**
college graduates	(0.056)	(0.056)	(0.046)	(0.045)	(0.050)	(0.050)
Fraction under age 18	0.194**	0.171**	0.193**	0.180**	0.012	–0.012
	(0.082)	(0.084)	(0.077)	(0.079)	(0.066)	(0.065)
Fraction under age 65	0.199**	0.219**	0.091	0.070	0.102	0.170**
	(0.096)	(0.100)	(0.079)	(0.080)	(0.071)	(0.073)
Log (square miles)	–0.015**	–0.014**	–0.014**	–0.013**	–0.005*	–0.005*
	(0.005)	(0.005)	(0.003)	(0.004)	(0.003)	(0.003)
Year fixed effects	yes	yes	yes	yes	yes	yes
MSA fixed effects	yes	yes	yes	yes	yes	yes
Observations	864	864	864	864	864	864
Number of metropolitan areas	216	216	216	216	216	216
R-squared	0.93	0.93	0.91	0.91	0.92	0.92

Source: Author's calculations based on U.S. Census data.

CGI = centile gap index; MSA = metropolitan statistical area.

*Significant at the 10 percent level; **significant at the 5 percent level.

a. Analysis is unweighted. Standard errors clustered on metropolitan area are in parentheses. See notes in table 2 and text for variable descriptions.

Overall, the evidence is consistent with a model in which income inequality affects the relative willingness to pay for neighborhood attributes across income groups.[30] It is worth noting that an exogenous change in residential patterns could lead to inequality in educational or labor-market opportunities. A change in educational opportunities would likely be reflected in family income inequality with a substantial lag, but a change in labor-market opportunities could generate an immediate effect on the income distribution. Although there is no way to definitively reject the possibility of reverse causality, the effects are assumed to be small relative to the direct effect of income on residential choice.

Segregation and Growth

The model's second prediction is that the extent to which observed levels of segregation respond to a similar inequality shock depends on the population growth of a metropolitan area. That is, a comparable change in inequality should have a larger impact on observed segregation in a growing metropolitan area than in a stagnant metropolitan area. Rapidly growing metropolitan areas without supply constraints in the housing market can easily accommodate changing demand for different types of housing. Slowly growing metropolitan areas, on the other hand, require a large shock to induce retrofitting of existing housing or new construction.

The fixed effects analysis described above is repeated separately for three groups of cities categorized by population growth. Table 7 shows these regressions for both the most rapidly and most slowly growing cities. The empirical evidence supports the hypothesis for the effect of inequality at the top of the distribution, but not at the bottom of the distribution. That is, slow-growth metropolitan areas have larger responses to a given change in the 50-10 family income ratio, while rapid-growth metropolitan areas are more responsive to a given change in the 90-50 family income. It may be the case that the economic prospects of the poor affect demand for segregation differentially in stagnating cities, where a given observed change in inequality may be associated with a variety of social ills.[31]

30. Decentralization of employment also contributes to rising segregation. Several other metropolitan area characteristics are also important. See Watson (2006) for a further discussion.

31. Results categorizing metropolitan areas by predicted employment growth rather than population growth support this interpretation. The pattern of coefficients is qualitatively similar, but the coefficient on the log of the 50-10 ratio on isolation of the bottom quintile is 0.119. This suggests that there is a particularly large effect of inequality at the bottom in economically depressed metropolitan areas.

If a given change in the 90-50 ratio represents a similar demand shock across different types of cities, then the larger coefficient for rapidly growing cities is consistent with the model. The estimated coefficients imply that a 1.00 standard deviation change in the log of the 90-50 ratio is associated with a 0.21 standard deviation increase in isolation of the top quintile in a slow-growth city, but a 0.70 standard deviation increase in isolation in a rapid-growth metropolitan area. The difference is statistically significant.

The results suggest that residential patterns in rapidly growing areas are particularly sensitive to the expanding right tail of the income distribution. The growth in the average log 90-50 ratio was smaller in rapidly growing cities than in slowly growing cities between 1970 and 2000 (0.125 compared to 0.153). However, because rapidly growing metropolitan areas are more sensitive to any given change in inequality, a smaller change in inequality yields a substantially larger predicted change in the isolation of the rich, holding other factors constant. In a booming metropolitan area, the typical top-quintile family in 2000 is predicted to live in a neighborhood consisting of an extra 3.0 per 100 top-quintile families (from a base of 25.9 per 100 in 1970), holding all else equal. In contrast, despite greater inequality growth in the slowest-growing cities, the typical top-quintile family is predicted to live in a neighborhood consisting of an extra 1.1 per 100 top-quintile families (from a base of 25.3 per 100 in 1970). The evidence is consistent with the notion that rapidly growing cities quickly develop neighborhoods of homogeneous, high-amenity housing when inequality rises. It is more costly for slowly growing cities to adjust their housing stocks to meet changing demand induced by a comparable change in inequality.

If rapid growth areas are sensitive to rising inequality, why did they experience modest increases in segregation, on average, over the period? The answer is that a number of rapidly growing areas had negligible changes in income inequality. Indeed, a quarter of rapidly growing areas experienced net declines in the 50-10 ratio between 1970 and 2000, and these areas experienced average declines in segregation as well (analysis not shown). Furthermore, the expanding land area of rapidly growing areas tends to reduce measured income segregation.[32] Nevertheless, a subset of rapidly growing areas did experience sizable increases in inequality, especially at the top of the income distribution. In those areas, such as Tucson and Reno, where the market pressure for segregation rose, the flexible housing market allowed substantial increases in residential sorting by income.

32. A census tract represents a larger land area in a low-density metropolitan area. In general there is more heterogeneity in these geographically larger tracts.

Table 7. Fixed Effects Analysis by Metropolitan Area Population Growth Rate, 1970–2000[a]

	Metropolitan areas					
	Slow growth[b]			*Rapid growth*[c]		
Dependent variable	*CGI*	*Isolation bottom quintile*	*Isolation top quintile*	*CGI*	*Isolation bottom quintile*	*Isolation top quintile*
Log (90-50 family income ratio)	0.050	0.028	0.073**	0.142**	–0.019	0.239**
	(0.039)	(0.030)	(0.036)	(0.053)	(0.049)	(0.045)
Log (50-10 family income ratio)	0.038**	0.062**	0.006	–0.012	0.001	–0.014
	(0.015)	(0.013)	(0.013)	(0.029)	(0.022)	(0.019)
Predicted employment	0.254**	0.229**	0.262**	0.185	0.139	0.088
	(0.099)	(0.083)	(0.103)	(0.111)	(0.086)	(0.079)
Predicted employment of less-skilled men	–1.409**	–1.114**	–1.200**	–0.695	–0.457	–0.348
	(0.397)	(0.345)	(0.402)	(0.458)	(0.352)	(0.290)
Predicted central city employment	–1.283**	–0.937**	–1.092**	–0.847	–0.460	–0.513*
	(0.336)	(0.274)	(0.341)	(0.558)	(0.508)	(0.291)
Log (population)	–0.010	–0.012	–0.006	0.018	0.005	0.019*
	(0.020)	(0.023)	(0.016)	(0.016)	(0.014)	(0.011)
Fraction black	0.169*	0.285**	0.104**	0.067	0.107	0.028
	(0.085)	(0.095)	(0.052)	(0.122)	(0.088)	(0.079)
Fraction Hispanic	0.049	–0.000	0.026	–0.082	–0.057	–0.042
	(0.060)	(0.102)	(0.066)	(0.109)	(0.088)	(0.067)
Fraction foreign-born	–0.161*	–0.194**	–0.060	0.166	0.106	0.081
	(0.081)	(0.094)	(0.089)	(0.130)	(0.115)	(0.081)

Log (mean family income in	–0.046**	–0.014	–0.047**	–0.064**	–0.040	–0.021
2000 dollars)	(0.020)	(0.017)	(0.017)	(0.031)	(0.030)	(0.038)
Fraction aged 25 and older who	0.022	0.016	0.005	–0.039*	–0.016	–0.033**
are high school graduates	(0.025)	(0.020)	(0.020)	(0.021)	(0.018)	(0.017)
Fraction aged 25 and older who	0.326**	0.101	0.292**	0.162	0.134*	0.067
are college graduates	(0.065)	(0.066)	(0.057)	(0.103)	(0.071)	(0.102)
Fraction under age 18	0.051	–0.014	0.045	0.229	0.263*	–0.016
	(0.098)	(0.088)	(0.078)	(0.148)	(0.137)	(0.115)
Fraction under age 65	0.340**	0.309*	0.248**	0.260	0.089	0.262*
	(0.134)	(0.165)	(0.115)	(0.188)	(0.123)	(0.136)
Log (square miles)	–0.009	–0.004	0.000	–0.009	–0.006	–0.005
	(0.007)	(0.009)	(0.006)	(0.007)	(0.004)	(0.004)
Year fixed effects	yes	yes	yes	yes	yes	yes
MSA fixed effects	yes	yes	yes	yes	yes	yes
Observations	288	288	288	288	288	288
Number of metropolitan areas	72	72	72	72	72	72
R-squared	0.97	0.96	0.96	0.90	0.88	0.90

Source: Author's calculations based on U.S. Census data.
CGI = centile gap index; MSA = metropolitan statistical area.
*Significant at the 10 percent level; **significant at the 5 percent level.
a. Analysis is unweighted. Standard errors clustered on metropolitan area are in parentheses. Growth rates are defined by metropolitan area population growth rate 1970–2000. See notes in table 2 and text for variable descriptions.
b. Bottom third of growth
c. Top third of growth.

New Housing Construction

The model predicts that rising segregation is accompanied by higher than expected levels of new housing construction and retrofitting in economically declining cities. Because of the durable nature of housing, the housing supply does not adjust immediately to changing preferences. In distressed metropolitan areas, rising segregation is observed if the market pressure for segregation is sufficient to induce the construction of new housing or the retrofitting of old housing. Economically vibrant cities with binding supply constraints are likely to respond to inequality shocks by retrofitting existing housing. In growing cities, population growth induces housing construction regardless of whether inequality is rising or falling.

To test the model's prediction, a fixed effects analysis investigates the relationship between the date of housing construction and economic segregation across different types of metropolitan areas.[33] The dependent variable is the new construction relative to the previously existing housing stock—that is, housing units built in the previous ten years divided by housing units built ten or more years ago. I control for the previous ten-year population growth rate and its square, as well as metropolitan area fixed effects and year effects. The key independent variable of interest is the CGI interacted with categories of metropolitan area predicted employment growth (a proxy for economic growth). The theory predicts that, after the model has controlled for flexibly for population growth, segregation should be positively correlated with new housing construction in economically stagnating areas but not in economically vibrant areas.

The empirical evidence presented in table 8 is consistent with the hypothesis. Slow-growth metropolitan areas show a significant positive relationship between segregation and new construction. A one standard deviation increase in the CGI is associated with an extra 5 percentage points in new construction in an economically distressed metropolitan area. As expected, rapidly growing metropolitan areas show no significant positive relationship between segregation and housing construction. Indeed, the correlation is weakly negative. The difference in coefficients across economic growth categories is statistically significant. In sum, slowly growing metropolitan areas have a positive association between segregation and excessive housing construction, while rapidly growing areas do not.

One concern with the above analysis is that an unobserved third factor might be influencing the housing market such that both segregation and construction

33. Retrofitting cannot be inferred from the census data unless it changes the reported date of construction of the dwelling.

Table 8. New Construction and Segregation[a]

Dependent variable: New construction (previous ten years) relative to old construction

	By predicted employment growth category		*By population growth category*	
Variable	*OLS*	*2SLS*	*OLS*	*2SLS*
CGI	1.192**		1.209**	
	(0.288)		(0.270)	
CGI × intermediate growth	–0.732		–0.570	
	(0.473)		(0.551)	
CGI × rapid growth	–1.943**		–1.909**	
	(0.629)		(0.545)	
CGI (predicted)		1.623**		1.882**
		(0.411)		(0.374)
CGI (predicted) × intermediate growth		–0.805		–0.991*
		(0.599)		(0.590)
CGI (predicted) × rapid growth		–3.479**		–2.779**
		(0.776)		(0.825)
Previous ten-year population growth rate	0.555**	0.573**	0.551**	0.574**
	(0.084)	(0.083)	(0.080)	(0.080)
Previous ten-year population growth rate squared	–0.041	–0.079	–0.044	–0.076
	(0.125)	(0.124)	(0.120)	(0.118)
Year fixed effects	yes	yes	yes	yes
MSA fixed effects	yes	yes	yes	yes
Observations	864	864	864	864
Number of metropolitan areas	216	216	216	216
R-squared	0.88	—	0.88	—

Source: Author's calculations based on U.S. Census data.

CGI = centile growth index; MSA = metropolitan statistical area; OLS = ordinary least squares model; 2SLS = two-stage least squares model.

*Significant at the 10 percent level; **significant at the 5 percent level.

a. Analysis is unweighted. Standard errors clustered on metropolitan area are in parentheses. Intermediate growth is a dummy indicating the metropolitan area is in the middle third of thirty-year population growth rates; rapid growth is a dummy indicating the metropolitan area is in the top third of thirty-year predicted employment growth or population growth rates. In the two-stage least squares model, the CGI is predicted using the following variables: log of 90-50 family income ratio, log of 50-10 family income ratio, predicted employment, predicted demand for less-skilled men, predicted central-city employment, percentage black, percentage Hispanic, percentage foreign-born, log mean family income, percentage high school, percentage college, percentage under age 18, and fraction under 65, all interacted with the growth category dummy variables.

rise in some cities. Therefore a two-stage least squares analysis is considered. In the first stage, segregation is predicted by a number of demand-side factors including inequality, industrial composition, and other metropolitan area characteristics. In the second stage, the predicted level of segregation is interacted with categories of economic growth. The results are quite similar; predicted market pressure for segregation is positively correlated with unexpectedly high levels of new construction in distressed metropolitan areas but not in economically healthy areas. Metropolitan areas with almost no economic growth appear to construct new housing in response to market pressure for segregation.

The analysis is repeated using categories of population growth rather than predicted employment growth. Results are qualitatively similar. Metropolitan areas with slow population growth and competitive pressure for segregation have higher than expected rates of new construction. The small differences between the categorizations based on predicted employment versus population stem in part from supply-constrained, economically healthy metropolitan areas. Areas with severe supply constraints are likely to respond to market pressure by retrofitting existing housing rather than constructing new housing. As expected, segregation and new construction are particularly correlated in economically distressed areas.

The relationship between new construction and segregation in distressed cities suggests that resorting of income groups across neighborhoods may require adjustments to the housing stock. Americans are highly mobile, but the neighborhoods in which different income groups reside are somewhat determined by the housing stock. In metropolitan areas with population growth too meager to induce housing construction, a sufficient level of market pressure for income resorting may itself drive new housing.

Persistence of Segregation by Income

The model suggests that the housing stock of a metropolitan area tends to reflect the underlying demand for segregation at the time it was built. Thus market forces that generate economic segregation, such as inequality, have persistent effects on segregation levels even after the forces themselves have disappeared. This is particularly true in slowly growing cities; the model suggests that levels of segregation are more persistent if the housing stock is older.

Segregation appears to be quite persistent in the sample. The raw correlation between the CGI in 1970 and 2000 is 0.69 across metropolitan areas. The cross-sectional regressions in the first two columns of table 9 show a sizable and statistically significant effect of the 1970 segregation level on 2000 segregation levels. The 1970 income segregation level can explain about half of the variation in segregation even after controlling for 2000 inequality and a large number of other factors likely to affect 2000 segregation levels.

The third and fourth columns of table 9 test the hypothesis that the persistence of segregation is related to the durability of housing. In a cross-section of metropolitan areas in 2000, a variable indicating the fraction of homes built before 1970 is included and interacted with the 1970 segregation index. As expected, the predictive power of the 1970 segregation level rises with a higher fraction of homes built before 1970. In metropolitan areas with a large fraction

Table 9. Persistence of Segregation[a]

Dependent variable: 2000 CGI

Variable	*I*	*II*	*III*	*IV*
1970 CGI	0.668**	0.449**	0.072	0.168
	(0.047)	(0.054)	(0.183)	(0.210)
Fraction of housing units built before 1970			–0.106**	0.420
			(0.042)	(1.570)
1970 CGI × fraction of units built before 1970			1.374**	0.625
			(0.370)	(0.465)
2000 log (80-20 family income ratio)		0.079**		0.058
		(0.021)		(0.088)
2000 log (80-20 family income ratio) × fraction built before 1970				0.011
				(0.174)
Other 2000 metropolitan area characteristics	no	yes	no	yes
Other 2000 metropolitan area characteristics × fraction built before 1970	no	no	no	yes
Observations	216	216	216	216
Number of metropolitan areas	216	216	216	216
R-squared	0.49	0.53	0.82	0.87

Source: Author's calculations using U.S. Census data.
CGI = centile growth index.
*Significant at the 10 percent level; **significant at the 5 percent level.
a. Analysis is unweighted. Standard errors clustered on metropolitan area are in parentheses. Control variables include all variables in table 6, column I for 2000.

of their housing built since 1970, the 1970 segregation level is less correlated with the 2000 segregation level. When all control variables and interactions are included, the coefficient on the interaction term is statistically significant only at the 20 percent level, but the pattern of coefficients is similar.

The evidence is largely consistent with a bricks-and-mortar view of segregation in metropolitan areas. That is, segregation (or integration) persists in part because the housing stock reflects consumer preferences at the time it is built. It is costly to change the housing stock once the infrastructure of a metropolitan area has been developed, inducing hysteresis in the residential patterns of income groups. When residential patterns do change in an older city, it is because there are large shocks to inequality and other forces creating market pressure for resorting of income groups. Extreme market pressure is sufficient to induce retrofitting or to induce new construction in areas without population growth. Changes to the housing stock enable the desired resorting of income groups across neighborhoods to take place.

Racial Segregation and Income Segregation

A discussion of residential segregation in metropolitan areas is incomplete without mention of racial segregation. Racial segregation has been declining since its peak in 1970.[34] The paper's main results are qualitatively unaffected by controlling for racial segregation in the analysis (results not shown).

Although the model does not explicitly consider racial segregation, the framework may have some relevance for sorting by race. In the context of the model, market pressure for racial segregation could be viewed as stemming from racial differences in the willingness to pay for various neighborhood attributes, which could include the neighborhood's racial composition. The housing market in rapidly growing metropolitan areas may be responsive to changing preferences with regard to racial segregation.

The three metropolitan area population growth categories had similar levels of racial segregation in 1970, as measured by the exposure of blacks to nonblacks.[35] By 2000, however, rapid-growth metropolitan areas had witnessed much larger drops in racial segregation, as shown in table 5. Furthermore, racial and economic segregation are positively correlated in slowly growing metropolitan areas, but not in rapidly growing areas (analysis not shown). This is consistent with the notion that some metropolitan areas may be moving more quickly than others to a new equilibrium—one in which racial segregation is replaced by economic segregation. The relationship between income and race is complicated and a full analysis is beyond this paper's scope.

Conclusion

Divergence in the valuation of neighborhood attributes across income groups leads to competitive pressure for segregation. Although individuals are highly mobile, the housing stock is expensive to change once it is built. It may take years for residential markets to fully respond to changes in demand for segregation. Observed segregation depends both on the underlying pressure for segregation and the adjustment costs associated with changing the housing stock. Rapidly growing metropolitan areas have low adjustment costs and accommodate changing preferences easily, but slowly growing metropolitan areas witness rising segregation only if market pressure is sufficient to induce retrofitting or new construction.

34. Cutler, Glaeser, and Vigdor (1999).

35. The exposure index used here adjusts for relative group size. See Cutler, Glaeser, and Vigdor (1999) for details.

The empirical findings are generally consistent with the model. First, higher levels of income inequality are associated with higher levels of residential segregation by income. Second, inequality at the top of the distribution (though not the bottom of the distribution) has a bigger effect on segregation in rapidly growing areas than in slowly growing areas. Third, among slowly growing metropolitan areas, large increases in segregation are coupled with higher than expected housing construction. This is not the case in rapidly growing areas. Finally, segregation levels are persistent. The 1970 level of segregation affects current segregation even after one has controlled for contemporaneous factors likely to affect segregation. The persistence is more pronounced in cities with older housing stocks.

The bricks-and-mortar framework explains the U-shaped relationship between a metropolitan area's population growth and its growth in income segregation. In cities facing industrial decline, the market pressure for income segregation rose between 1970 and 2000 because of growth in inequality and falling labor-market demand for less-skilled men. Despite the fact that existing housing was cheap, middle-class and rich residents were willing to pay to construct new housing in good suburban neighborhoods. Thus economically distressed metropolitan areas witnessed rising segregation and higher than expected new housing construction.

Economically vibrant, supply-constrained superstar cities also witnessed growth in segregation. These areas experienced large increases in inequality.[36] New construction and population growth were muted by regulatory constraints in these areas, but segregation did rise, presumably through the retrofitting of existing housing.

Rapidly growing metropolitan areas as a group did not face the same growth in inequality as other areas. Indeed, a number of booming areas experienced declines in the 50-10 family income ratio over the time period, and these areas also tended to experience declines in segregation. On the other hand, some rapidly growing cities did experience growth in inequality. These boom towns had cheap adjustment costs—the housing market was able to adapt quickly to changing consumer preferences. In rapidly growing areas, the isolation of the rich is very responsive to inequality at the top of the distribution. Thus a subset of rapidly growing areas with moderate to large increases in inequality had substantial growth in segregation.

The work presented here has implications for redistributive policy. Family income inequality generates residential segregation by income within American

36. Discussed in Gyourko, Mayer, and Sinai (2006).

metropolitan areas. To the extent that income sorting adversely affects the outcomes of those families at the bottom of the economic ladder, it follows that relative income matters to absolute outcomes. Furthermore the results suggest that a short period of high inequality could affect the shape of American metropolitan areas in the long run. Neighborhoods are built to reflect contemporary preferences for residential sorting by income. The housing stock built during high-inequality periods will tend to reflect market pressures for segregation. Because housing is durable, neighborhoods with low-amenity (or high-amenity) housing will continue to attract low-income (or high-income) families unless market forces are sufficient to drive retrofitting or new housing construction. Thus the legacy of income inequality could persist into the next generation even if inequality itself fades.

APPENDIX A

Income Segregation Measures

The centile gap index (CGI) estimates how far the average family income within a tract deviates in percentile terms from the median tract family income, compared to how far it would deviate under perfect integration.[37]

As noted in the text, the formula for CGI is:

$$CGI_m = \left(0.25 - \left(1/J_m\right)\sum_j \left|P_j - P_{medtj}\right|\right)/0.25,$$

where

CGI_m : centile gap index in metropolitan area *m,*
J_m : number of families in metropolitan area *m,*
P_j : estimated percentile in the metropolitan area *m* income distribution of family *j,*
and P_{medtj} : estimated income percentile of median family in the tract of family *j.*

That is, the term $\left|P_j - P_{medtj}\right|$ represents the estimated income percentile distance of a given family from the median family in its tract. Note that although this paper refers to income percentiles for clarity, it does not divide families

37. See Watson (2006) for details and comparisons to measures of income sorting used elsewhere in the literature.

into 100 discrete groups. Rather, the ranking is continuous on a scale from 0 to 1. In principle, the CGI goes from 0 to 1, with 1 meaning perfect segregation. In practice, perfect segregation could never be observed with a finite number of income bins.

The formula for an exposure index of quintile x to quintile y in metropolitan area m is

$$\text{Exposure}_{xym} = \sum_t \left(X_t / X_m\right) * \left(Y_t / J_t\right),$$

where

X_t : number of quintile X families in tract t,
X_m : number of quintile X families in metro area m,
Y_t : number of quintile Y families in tract t,
and J_t : number of families in tract t.

The exposure of quintile x to quintile y can be interpreted as the average fraction of quintile y families in the typical quintile x family's census tract.[38]

In the present analysis, no adjustment is necessary for group size since all family income quintiles are the same size. Exposure indexes were developed to study segregation between discrete racial groups and are not ideal for analyzing segregation along a continuous dimension such as income. Nevertheless, they are useful as a supplement to overall income segregation measure.

Note that none of the income segregation measures used here are explicitly spatial. That is, this paper does not use geographic information about proximity of neighborhoods to one another.

APPENDIX B

Data and Other Variables

Definitions of terms and measures used in this paper are listed below.

Data Description

Tract-level census data for 1980, 1990, and 2000 are taken from Census CDs. For 1970 they are taken from the Urban Institute Underclass Database. This paper also uses county-level information from the Census CDs and City

38. See also Cutler, Glaeser, and Vigdor (1999).

and County Data Books. The IPUMS data are used to estimate national trends in industrial mix and job centralization. The income data for families in the tract-level data sets is the number of families in different income bins in the year previous to the census year. There are fifteen income bins in the 1970 data, seventeen in the 1980 data, twenty-five in the 1990 data, and sixteen in the 2000 data.

Gainesville, Florida, is excluded from the analysis due to missing data. There are 216 metropolitan areas in the analysis.

Metropolitan Area Definitions

The boundaries of metropolitan areas change over time and a researcher must decide how to deal with this fact in the analysis. One values consistency, but at the same time wants to capture genuine changes in the area of the residential market. This paper pursues an intermediate approach, using the consolidated metropolitan areas defined by the Census Bureau as of 2003, including all of the counties that were tracted in a particular year. Therefore, the boundaries of about half of the metropolitan areas in the sample change over time. The analysis excludes metropolitan areas that had no tracted counties in 1970. For New England, the county-based metropolitan area definitions developed by the Census (New England County Metropolitan Areas) are used, rather than the standard town-based definitions. Metropolitan areas outside of New England are based on counties or county-equivalents as usual.

Families versus Households

Data for families are used because they are available for all four Census years. Families, which are households in which at least two residents are related by blood or marriage, make up a large fraction (ranging from 68 percent in 2000 to 75 percent in 1980) of households. In the 1980–2000 period, families had higher segregation levels than all households. Comparing the baseline regression relating family segregation and family income inequality for 1980–2000 to the analogous model using households, the main results are very similar and highly significant.

Industrial Mix Variables

Ten initial metropolitan area industry shares are interacted with national industry changes over time to predict the level of total employment relative to 1970 total employment, the level of employment of less-skilled men relative to 1970 total employment, and the fraction of metropolitan employment in the central city. Less-skilled workers are defined as those with a high-school diploma or less education. The national trends for centralization and skill level are computed using IPUMS data on eighteen- to sixty-five-year olds in metropolitan areas who worked at least fifteen hours in the previous week. Predicted variables are used rather than direct measures of employment growth, demand for less-skilled men, and job centralization because these characteristics may be endogenous to segregation. Therefore the industrial mix variables in some sense undercontrol because they do not capture the effect of idiosyncratic changes in industrial composition.

The formula for Predicted Employment is

$$PredEmp_{mt} = \sum_i \left(Emp_{im70} / Emp_{m70}\right) * \left(NatEmp_{it} / NatEmp_{i70}\right),$$

where

$PredEmp_{mt}$: predicted employment level in metropolitan area *m* at time *t,*
Emp_{im70} : employment in metropolitan area *m* in 1970 in industry *i* (from aggregated county-level data),
Emp_{m70} : total employment in metropolitan area *m* in 1970 (from aggregated county-level data),
$NatEmp_{it}$: total employment in all metropolitan areas in industry *i* at time *t* (from aggregated county-level data),
and $NatEmp_{i70}$: total employment in all metropolitan areas in industry *i* in 1970 (from aggregated county-level data).

It is clear from the formula that all metropolitan areas have a predicted employment of 1 in 1970.

The formula for Predicted Employment of less-skilled men is:

$$PredEmpLSM_{mt} = \sum_i \left(Emp_{im70} / Emp_{m70}\right) * \left(Nat2LSM_{it} / Nat2Emp_{it}\right) * \left(NatEmp_{it} / NatEmp_{i70}\right),$$

where

$PredEmpLSM_{mt}$: predicted employment of less-skilled men in metropolitan area *m* at time *t,*
$Nat2LSM_{it}$: employment of less-skilled men in all metropolitan areas at time *t* in industry *i* (from the PUMS),
$Nat2Emp_{it}$: total employment of less-skilled men in all metropolitan areas at time *t* (from the PUMS), and other variables are as above.

The variable is a prediction of employment of less-skilled men in year t relative to total metropolitan area employment in 1970.

The formula for Predicted Job Centralization is

$$PredCent_{mt} = \sum_i \left(PredFrac_{imt}\right) * \left(Nat2CC_{it} / Nat2Emp_{it}\right),$$

where

$PredCent_{mt}$: predicted fraction of employment in the central city,
$Nat2CC_{it}$: employment in industry i at time t in all central cities (from the PUMS),
$Nat2Emp_{it}$: employment in industry i at time t in all metropolitan areas (from the PUMS),
and $PredFrac_{imt}$: predicted fraction of employment in industry i in metropolitan area m at time t and is defined by:

$$PredFrac_{imt} = Emp_{im70} * \left(Nat2Emp_{it} / Nat2Emp_{i70}\right) \Big/ \sum_i \left[Emp_{im70} * \left(Nat2Emp_{it} / Nat2Emp_{i70}\right)\right].$$

In the formula, Emp_{im70} is the employment in industry i in metropolitan area m in 1970 (from aggregated county-level data), $Nat2Emp_{i70}$ is the employment in industry i in 1970 in all metropolitan areas (from the IPUMS), and other variables are defined as above.

Racial Segregation Measures

The measure of racial segregation used in the paper is a person-based measure (rather than family-based), similar to that used by Cutler, Glaeser, and Vigdor (1999). It is an exposure (isolation) index of black residents to other black residents, adjusted for the exposure that would be expected given the number of black residents and white residents in the metropolitan area.[39] Note, however, that they consider isolation of black residents from all other residents while this paper considers the isolation of black residents from white residents.

Hispanic families may be of any race. Some of the rise in exposure of black residents to white residents may be due to an increase in exposure to white Hispanic residents.

39. For details, see Cutler, Glaeser, and Vigdor (1999, p. 459).

Measurement of Metropolitan Area Income Inequality

The construction of metropolitan area income inequality measures is based on a methodology described and tested in Jargowsky (1995). In particular, metropolitan area income is assumed to be distributed with a linear distribution below the mean and a Pareto distribution above the mean.[40]

Central City and Suburbs

Central cities are those places identified by the U.S. Census Bureau as such in 2003 based on metropolitan area residential and commuting patterns, and represent a consistent geographic area over time. There may be more than one central city in a metropolitan area; these are combined for the purpose of the analysis. The suburbs include all remaining tracted portions of the metropolitan area in a given year. Suburbs are also combined for the purpose of the analysis. Census tracts in the 1980–2000 period are matched to places, which in turn are matched to central cities. For cases in which a census tract includes both central city and suburban places, it is considered part of the central city if at least half of the tract area is within the central city. In 1970 neither central cities nor places are identified in the data.

New Construction

New construction is defined as newly constructed housing relative to previously existing housing. The variable in any given year is the number of housing units built in the past ten years divided by the number of housing units built more than ten years ago.

40. See Watson (2006) for more details.

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