Some Microfoundations for the Great Gatsby Curve

Steven N. Durlauf
University of Wisconsin

Ananth Seshadri
University of Wisconsin

August 13, 2016

Work in Progress
Please do not Circulate

We thank Joel Han, Arik Roginsky, Irinia Shaorshadze, Kegon Tan, and Nicholas Tenev for spectacular research assistance.

Some Microfoundations for the Great Gatsby Curve

Abstract

The Great Gatsby Curve is a description of the observation that for OECD countries, greater cross-section income inequality is associated with lower mobility. Analogous findings for locations within the United States. This paper presents a theoretical model for which the Gatsby Curve constitutes an equilibrium description of income dynamics. Cross-section income inequality determines levels of residential income segregation, which in turns controls levels of disparities in the socioeconomic outcomes of children. The model illustrates how growing economies exhibit very different inequality dynamics from stationary ones.

Steven N. Durlauf
Department of Economics
University of Wisconsin
1180 Observatory Drive
Madison WI, 53706
durlauf@gmail.com

Ananth Seshadri
Department of Economics
University of Wisconsin
1180 Observatory Drive
Madison WI, 53706
aseshadr@ssc.wisc.edu

> …changes have taken place in ghetto neighborhoods, and the groups that have been left behind are collectively different than those that lived in these neighborhoods in earlier years. It is true that long-term welfare families and street criminals are distinct groups, but they live and interact in the same depressed community and they are part of the population that has, with the exodus of the more stable working- and middle-class segments, become increasingly isolated socially from mainstream patterns and norms of behavior
>
> William Julius Wilson, *The Truly Disadvantaged*

1. Introduction

This paper describes a theoretical framework which links cross-sectional inequality to intergenerational mobility, with the explicit object of demonstrating how increased inequality can act to reduce mobility. The underlying mechanism which generates this relationship is the interplay of income inequality and the level of income segregation across residential neighborhoods. As such, our analysis focuses on social explanations for the level of mobility.

The basic ideas underlying our analysis are quite intuitive. Increases in cross-section inequality increase the magnitudes of the differences in the characteristics of the neighborhoods in which children and adolescents develop. This is so both because increased cross section inequality implies greater differences in neighborhood quality between relative rich and relatively poor neighborhoods, relative to an initial income distribution, but also because the degree of income segregation is itself a function of the level of cross- sectional income inequality and so can increase. Greater neighborhood disparities, because of their association with parental income, in turn increase the intergenerational persistence of socioeconomic status.

Within economics, theoretical models of social determinants of persistent inequality emerged in the middle 1990's (Benabou (1996a,b), Durlauf (1996a,b), Fernandez and Rogerson (1996,1997)), which focused on the role of communities in forming human capital and determining member productivity.[1] This work, among other things, represented a good faith effort to couple substantive sociological idea with the formal economic reasoning[2]. In addition to continuing theoretical work, a substantial body of empirical studies has emerged in the last two decades which have uncovered a plethora of dimensions along which neighborhoods affect socioeconomic outcomes— see Durlauf (2004) and Topa and Zenou (2015) for a range of empirical findings. Somewhat separately, the last two decades have seen the emergence of a new "social economics" which explores a broad set of contexts in which sociological, social psychological, and cultural mechanisms have been integrated economic analyses. Benhabib, Bisin, and Jackson (2011) provides a comprehensive overview of the field. Most relevant for this paper, much research in social economics has documented the presence of different types of peer influences in education; Epple and Romano (2011) survey the state of the literature.

Our analysis is strongly motivated by and related to these literatures. More generally, the model we develop constitutes an example of what Durlauf (1996c, 2006) titled the "memberships theory on inequality": a perspective that identifies segregation as an essential determinant of inequality within and across generations. We regard this perspective as a potentially important complement to the important developments over the last decade involving the study cognitive and socioemotional skill formation in childhood and adolescence; see Heckman and Mosso (2014) for a synthesis which focuses on the skills formation/mobility relationship and Lee and Seshadri (2015) for a recent analysis.

The microeconomic structure for this environment focuses on the incentives that determine the residential location decisions of families. Local public finance of education combines with social interactions to induce equilibrium segregation of neighborhoods by income. While neighborhoods are always stratified, the degree of segregation is a

[1]Of course, the idea that there are social determinants of behavior had appeared many times previously; see Becker (1974) for a seminal early contribution as well as discussion of social factors in the history of economic thought. Loury (1977) is particularly closely related to the work in the 1990's.

[2]The renaissance of neighborhoods research in sociology, for example Wilson (1987) was very influential in economics.

function of the income distribution-greater income dispersion induces greater segregation. Segregation, in turn, translates parental income into offspring income, generating intergenerational persistence. This relationship is the Great Gatsby Curve. Intergenerational income inequality is further shown to be potentially permanent, i.e. contemporary family differences may be irreversible. This will be the case when families incomes exhibit long term growth. The model we use in this draft is a stripped down version of Durlauf (1996a,b).

Section 2 describes the empirical background which motivates our analysis. Section 3 describes the environment that we study. Section 4 characterizes neighborhood structure. Section 5 analyses intergenerational income dynamics. Section 6 provides summary and conclusions.

2. Empirical Background

Our analysis is motivated a set of four general stylized facts on inequality and intergenerational mobility. The first fact, responsible for the title of the paper, is the existence of a positive correlation between measures of wage or income inequality and measures of intergenerational correlation of incomes among OECD countries. This relation was first identified by Miles Corak, (see Corak (2013), for a description). This relationship was dubbed The Great Gatsby Curve by Krueger (2012), based on Corak's data, and that name has stuck. Figure 1 illustrates the relationship. The curve has had political traction in the US, in particular, because it suggests that high inequality of outcomes is not, as thought by conventional wisdom, offset by higher equality of opportunity.[3]

[3]One advantage of a general equilibrium formulation, such as we develop, is that it allows one to focus on particular mechanisms. Ethical theories conclude that equality of opportunity is fundamental to distributive justice; for example, the arguments developed by John Roemer (Roemer (1998) is a clear description) define equality of opportunity with reference to the characteristics of the mechanisms that determine socioeconomic outcomes. Roemer's approach focuses on the injustice of mechanisms which generate inequalities for which an individual should not be held responsible. Neighborhoods are an obvious example of a mechanism of this type — see Durlauf (1996,2006) for an

Substantive interpretation of the international Gatsby Curve is naturally problematic because of the heterogeneity of the countries described, despite their common OECD membership. Our focus is somewhat different as we are interested in the presence of an intertemporal Gatsby Curve within the United States. By intertemporal, we mean that inequality within one generation determines the level of mobility of its children, so that the two measures are asynchronous.

Our second stylized fact speaks to the existence of an intertemporal Gatsby curve: across locations, inequality and mobility are negatively associated. The evidence for this claim is both direct and indirect.

Direct evidence of an intertemporal Gatsby Curve derives from explicit calculations of time-specific inequality and mobility measures, which explores covariation between the measures. Identification of a relationship might appear, at least for the US case, to be a nonstarter since the intergenerational elasticity of income (IGE) between parents and children has not changed much over the last 40 years, despite substantial increases in conventional cross-section inequality measures. However, as argued recently by Kearney and Levine (2015), the invariance of the standard measure may reflect its relative lack of insensitivity to changes in mobility for the offspring of very advantaged and very disadvantaged parents[4]. They go on to argue that the 50/10 and 90/50 income ratios are better measures of the effects of inequality on tail mobility. Their approach (and findings) echo earlier work by Aaronson and Mazumder (2008). We reproduce results from Aaronson and Mazumder and Kearney and Levine in Figures 2a and 2b. Of particular interest, in our judgment, is the relationship Aaronson and Mazumder find between the college wage premium and the IGE. This is suggestive of the general mechanism we study: the role of inequality in producing educational inequalities that matter in labor force outcomes.

---

elaboration of arguments on the implications of social determinants of inequality for distributive justice arguments.

[4]This insensitivity can be understood as derivative from the linear nature of the IGE. The analogous limitation earlier appeared in the economic growth literature, when evidence of convergence (which is equivalent to 1 minus the IGE) was misinterpreted to argue that there are no national poverty traps. See Durlauf, Johnson, and Temple (2009) for elaboration.

Indirect evidence for our second stylized fact comes from studies of location and inequality. One aspect of this relationship comes from Chetty et al (2014), who find substantial regional variation in intergenerational mobility[5]. Their now-famous graphic for US commuting zones is reproduced in Figure 3. This study also finds an interspatial association between higher inequality and lower mobility. Kearney and Levine (2015) move beyond general correlation between inequality and mobility to inequality and education, arguing that metropolitan statistical areas with higher inequality are associated with more unequal education outcomes, notably lower high school graduation among the disadvantaged. Their findings are shown in Figure 4.

Our third stylized fact is the existence of pervasive segregation by income across locations. This is, abstractly, an uncontroversial claim. One dimension for which this holds is the spatial concentration of poverty, which is illustrated in Figure 5 at the country-level. Similar segregation exists at lower levels of aggregation. Figure 6 reproduces poverty rates across Chicago neighborhoods. Another facet of this stylized fact is the increasing stratification of neighborhoods by income, with some attendant reduction in racial segregation. Reardon and Bischoff (2011) and Reardon, Fox, and Townsend (2014) provide evidence of this phenomenon. Some of these findings are summarized in Figure 7.

Beyond spatial segregation by income, there is substantial spatial variation in factors that matter for education, which we regard as a distinct stylized fact. One mechanism which produces locational disparity is local public finance in education. Figure 8 illustrates these differences while Figure 9 illustrates these differences in the context of Texas. Of course, differences in per capita student expenditures do not necessarily entail differences in human capital formation, which is the natural object of interest. Many studies of financial resources and cognitive outcomes have failed to identify significant positive covariation (Hanushek (2006)). That said, there is a general consensus that certain consequences of expenditures, for example classroom size, have nontrivial

[5]We note that Bloome (2015) does not find that state Gini coefficients help predict offspring income in parent offspring regressions. This finding does not directly contradict the claim that the parent child IGE is functionally dependent on mobility, which is the stylized fact in which we are interested.

influences (see e.g. Dustmann, Rajah, and van Soest (2003) and Krueger (2003)). We therefore consider this mechanism important, with the natural caveat that the impact of expenditures depends on where they are applied. We also note that evidence of the effects of expenditures on future outcomes is stronger than for cognitive skills. Despite evidence that the effects of small class size on test scores fade out by eighth grade (Krueger and Whitmore (2001)), for example, Chetty et al (2011), find that kindergarten classroom quality affects adult earnings.

A distinct mechanism involves social interactions. Conceptually, these can range from primitive psychological tendencies to conform to others, to information-based influences of observed patterns of behaviors and consequences on individual cost-benefit calculations, to more complex notions of culture. Again we emphasize spatial variation. Figure 10 gives one example: spatial variation in exposure to violent crime across the US. Figure 11 gives a related figure for homicides in Chicago. Exposure to violence has been linked to stress among children and lower educational attainment, e.g. Burdick-Will (2013). One of the robust findings from the Moving to Opportunity Demonstration was the positive effects on stress-levels among individuals who moved to lower poverty neighborhoods, e.g. Katz, Kling and Liebman (2007) and Gennetian et al (2012).

These stylized facts provide the background for our theoretical model.

3. Model

This section outlines the basic environment in which incomes evolve across generations. The model is based on Durlauf (1996a,b) which developed a social analogue to the class family investment model of intergenerational mobility developed by Becker and Tomes (1979) and Loury (1981).

a. demography

The population possesses a standard overlapping generations structure. There is a countable population of family types, indexed by i, which we refer to as dynasties Each family type consists of many identical “small” families. This is a technical “cheat” to avoid adults considering the effect of their presence in a neighborhood on the income distribution. It can be relaxed without affecting any qualitative results.

Each agent lives two periods. Agent it is the adult member of dynasty i, and so is born at time $t-1$.[6] In period 1 of life, an agent is born and receives human capital investment from the neighborhood in which she grows up. In period 2, adulthood, the agent receives income, becomes a member of neighborhood, has one child, consumes and pays taxes.

b. preferences

The utility of adult it is determined in adulthood and depends on consumption C_{it} and income of her offspring, Y_{it+1}. Offspring income is not known at t, so each agent is assumed to maximize expected utility, which has a Cobb-Douglas specification.

$$EU_{it} = \pi_1 \log(C_{it}) + \pi_2 E\left(\log(Y_{it+1}) \middle| F_t\right) \qquad (1)$$

where F_t denotes the parent’s information set.

The assumption that parental preferences are a function of the income of their offspring differs from the formulations which follow Becker and Tomes (1979), which makes offspring human capital the argument in parental utility, as well as those which follow Loury (1981) in assuming that parents are affected by the lifetime utility of offspring. Our formulation retains the analytical convenience of Becker and Tomes, by ruling out the need for a parent to form beliefs about dynasty income beyond $t+1$, i.e. their immediate offspring. We prefer the income formulation as it captures our intuition that parents have preferences over the opportunity sets of their children, as opposed to education per se, so in this sense our assumption is more in the spirit of Loury. This all

[6]For variables, the time index t refers to the period in which a variable is realized.

said, we do not believe that there is a principled basis for distinguishing these different preference formulations.

The Cobb-Douglas function plays an important role in our analysis. By eliminating heterogeneity in the desired fraction of income that is spent on consumption, the political economy of the model becomes trivial. More general formulations could be pursued following Durlauf (1996a). The potential problem with more general specifications of preferences is the identification of general conditions that are sufficient for the existence of equilibrium neighborhood configurations. The Cobb-Douglas is not unique in terms of ensuring existence, but is very convenient.

c. income and human capital

Adult it 's income is determined by two factors. First, each adult possesses a level of human capital that is determined in childhood, H_{nt-1},. Human capital is determined at the neighborhood rather than the family level. This is the essential difference between this model and the approach initiated by Becker and Tomes (1979) and Loury (1981)-human capital is socially rather than privately (with respect to a family dynasty) produced. Income is also affected by shock experienced in adulthood ξ_{it}. We do not interpret these shocks, which may be regarded as luck. The adult shock has both a neighborhood-specific component υ_{nt} and an individual-specific component γ_{it}.

$$\xi_{it} = \upsilon_{nt}\gamma_{it} \tag{2}$$

which allows for unobserved heterogeneity to affect income beyond human capital at both the family and the social levels. ξ_{it} is assumed to be independent of information available at time $t-1$ and to be independent and identically distributed across dynasties. The iid assumptions rules out a heritable component to the shock (eg genetic factors); inclusion of dynastic correlations would lower mobility without changing qualitative results. We also assume that ξ_{it} has a bounded support[7]. The substantive value of the assumption is that it delimits the probability that a shock can overcome the effects of income disparities between parents on their offspring, if the parental incomes are far enough apart.[8]

We assume a multiplicative functional form for the income generation process.

$$Y_{it} = \phi H_{nt-1} \xi_{it} \tag{3}$$

This functional form matters as it will allow the model to generate endogenous long term growth in dynasty-specific income. Eq. (3) is an example of the AK technology studied in the growth literature.[9] We employ this technology in order to understanding inequality between dynasties in growing economies.

d. family expenditures

A parent's income decomposes between consumption and taxes.

$$Y_{it} = C_{it} + T_{it} \tag{4}$$

Introduction of separate parental investments, from the public provision of education will be done in the next version of the model. This generalization will be interesting because of the interaction between private investments and neighborhood characteristics. Wodtke, Elwert, and Harding (2016) find complementarity between neighborhood quality and parental investment, suggesting that this extension will exacerbate the potential for segregation to reduce intergenerational mobility, although this intuition does not account for the effects of the complementarity on equilibrium sorting.

[7]One can relax the identical distribution assumption if the support of the shocks is still uniformly bounded.
[8]Replacement of the bounded support assumption with finite second moments has no qualitative effect but renders proofs more cumbersome.
[9]See Jones and Manuelli (1990) for infinite horizon growth models and Jones and Manuelli for overlapping generations models with AK-type structures.

e. educational expenditure and educational investment in children

Taxes are linear in income and are neighborhood- and time-specific

$$\forall i \in N_{nt},\ T_{it} = \tau_{nt} Y_{it} \ . \qquad (5)$$

These are determined by a political process described below.

The total expenditure available for education in neighborhood n at t is

$$TE_{nt} = \sum_{j \in n_t} T_{jt} \qquad (6)$$

and so constitutes the resources available for educational investment.

The translation of these resources into per capita educational investment (which will constitute a school's direct contribution of human capital) will depend on the size of the population of children who are educated. We assume that the education process exhibits nonconvexities with respect to population size, i.e. there exist exists a type of returns to scale (with respect to student population size) in the educational process. Let $p(n,t)$ denotes the population size of n at time t. The educational investment provided by the neighborhood to each child, $ED_{n,t}$ (equivalent to educational quality), requires total expenditures such that

$$TE_{nt} = \left(\lambda_1 + \lambda_2 p(n,t)\right) ED_{nt} \qquad (7)$$

The parameters λ_1 and λ_2 scale the relative costs of fixed and proportional components of educational investment. We do not claim that the specification (7) is empirically compelling. The advantage of the assumption is that it allows the number of neighborhoods and their sizes to be endogenously without any a priori restrictions on either. Standard models of neighborhood formation and neighborhood effects typically fix the number and size of neighborhoods. This builds in an exogenous sources of segregation. Since the core logic of the model is so closely tied to the consequences of inequality for segregation, we do not want any level of segregation to be imposed a priori. In other words, we want the possibility to exist that all families are combined in a common neighborhood.

From the perspective of parents, the inversion of (7)

$$ED_{nt} = \frac{TE_{nt}}{\lambda_1 + \lambda_2 p(n,t)} \tag{8}$$

is of course, the way in which neighborhood characteristics determine educational quality and so provides the way parents will compare neighborhoods with reference to the political economy of human capital.

f. human capital

The human capital of a child is determined by two factors: the child's entry (at school) skill level s_{it} and the educational investment level ED_{nt}

$$H_{it} = \theta(s_{it}) ED_{nt}, \tag{9}$$

where $\theta(\cdot)$ is of course positive and increasing. The linear structure of (9) is extremely important as it will allow dynasty income to grow over time. Together, eq. (3) and eq. (9) produces an AK-type growth structure relating educational investment and human capital, which can lead family dynasties to exhibit income growth because of increasing investment over time.

Entry level skills are determined by an interplay of family and neighborhood characteristics

$$s_{it} = \xi\left(\overline{Y}_{-i}\right) \quad (10)$$

where ξ is increasing in all arguments. This general structure is easy to motivate from social interactions models[10]Equations (9) and (10) express the fact that the income distribution in a neighborhood generates distinct political economy and social interaction effects. In our context, social interaction effects constitute a distinct mechanism by which a neighborhood income distribution determines offspring development beyond the public finance of education. These dual channels for neighborhood income will interact in determining the properties of the dynastic income processes and hence differences between them, i.e. inequality dynamics.

g. neighborhood formation

Neighborhood reform every period, i.e. there is no housing stock. As such, neighborhoods are like clubs. Neighborhoods are groupings of families, i.e. all families who wish to form a common neighborhood and set a minimum income threshold for membership. This is a strong assumption. That said, we would emphasize that zoning restrictions matter in neighborhood stratification, so the core assumption should not be regarded as obviously inferior to a neighborhood formation rule based on prices.[11]

h. political economy

[10]While the distinction between $\theta(\cdot)$ and $\xi(\cdot)$ matters for empirical work, but not for the behavior of this version of the model.

[11]In the next version of the paper we explore whether prices can support the equilibrium neighborhood configurations produced by the minimum income level rule. Benabou (1996) and Becker and Murphy (2000) illustrate how social interactions are not sufficient to generate equilibrium neighborhood segregation; intuitively willingness to pay needs to be increasing in family income. Previous work and initial calculations suggest that this is the case for this framework, but we have not yet proven it.

The equilibrium tax rate in a neighborhood is one such that there does not exist an alternative one preferred by a majority of the neighborhood. The Cobb-Douglas preference assumption renders this standard requirement trivial there because will be never disagreement on the preferred tax rate. The reason for this is that conditional on neighborhood composition, tax rates determine budget shares, which under private consumption and Cobb-Douglas preferences are of course fixed. Families differ in the implicit prices by which offspring income trades off against consumption, because of different influences as embodied in $\phi(\cdot)$, but this is irrelevant with respect to desired budget share allocation.

i. borrowing constraints

Neither families nor neighborhoods can borrow. This extends the standard borrowing constraints in models of this type. With respect to families, we adopt Loury (1981) idea that parents cannot borrow against future offspring income. Unlike his case, the borrowing constraint matters for neighborhood membership, not because of direct family investment. In addition, in our analysis, communities cannot entail children who grow up as members to pay off debts accrued for their education. Both assumptions follow follow legal standards, and so are not controversial.

4. Neighborhood equilibria

In this section we characterize neighborhood equilibria. To do this, observe that the expected utility of adult it given a neighborhood is

$$\begin{aligned}
&\pi_1 \log\left((1-\tau)Y_{it}\right)+\pi_2 E\left(\log\left(\phi H_{nt}(\tau)\xi_{it}\right)\middle|F_t\right)= \\
&\pi_1 \log\left((1-\tau)Y_{it}\right)+\pi_2 \log\left(\tau\phi\xi_{it}\frac{\theta\left(\bar{Y}_{nt}\right)\bar{Y}_{nt}}{\lambda_1+\lambda_2 p(n,t)}\right)
\end{aligned} \tag{11}$$

Taxes are budget shares for families. The first proposition is immediate from the Cobb-Douglas formulation.

Proposition 1. Equilibrium tax rates

Equilibrium tax rates are unanimously preferred and constant in all neighborhoods at all times $\forall n,t \quad \tau_{nt} = \frac{\pi_1}{\pi_1 + \pi_2}$.

While constant tax rates are empirically unappealing, they simplify the model in useful ways. In particular, Proposition 1 immediately implies a monotonicity property that links the utility of a parent to the income distribution in a neighborhood.

Proposition 2. Effects of Higher Income Neighbors

Conditional on a given neighborhood population size $p(n,t)$, the expected utility of parent it is increasing in monotonic rightward shifts of the empirical income distribution over other families in his neighborhood

Why does the Cobb-Douglas preference assumption matter for what would seem to be an intuitively obvious result? If tax rates are fixed, then it is immediate that expected utility increases in monotonic rightward shifts of a neighborhood's income distribution because of the effects on the tax base and the positive social interaction effects of higher income neighborhoods. The only reason why more affluent neighbors could be undesirable is because they affect the equilibrium tax rate in the neighborhood. But Cobb-Douglas ensures unanimity on the preferred tax rate, which eliminates this possibility.

Proposition 2, in turn, allows for a simple construction of equilibrium neighborhoods as well as a characterization of their structure. To see this, consider highest income adult at time t. This adult will have most preferred neighborhood composition. By Proposition 2, the neighborhood will consist of all families with incomes above some threshold, since higher income neighbors are always preferred to lower income neighbors. All neighbors in that neighborhood will agree on the income threshold since the educational quality of the neighborhood is constant across families[12]. Repeat this procedure until all families are allocated to neighborhoods. This will be a stable configuration of neighborhoods.

Proposition 3. **Equilibrium neighborhood structure**

i. At each t for every cross-section income distribution, there at least one equilibrium configuration of families across neighborhoods.

ii. For any equilibrium,neighborhoods are segregated..

Proposition 3 does not establish that income segregation will occur. Clearly it is possible that all families are members of a common neighborhood. If all families have the same income, complete integration into a single neighborhood will occur because of the nonconvexity in the education investment process. Income inequality is needed for segregation. Proposition 4 follows from the form of the education production function nonconvexity we have assumed.

Proposition 4. Segregation and Inequality

There exist income levels $\bar{Y}^{high}$ and $\bar{Y}^{low}$ such that families with $Y_{it} > \bar{Y}^{high}$ will not form neighborhoods with families with incomes $\bar{Y}^{low} > Y_{it}$

Intuitively, if family incomes are sufficiently different incomes, then more affluent families do not want neighbors whose tax base effects and social interactions effects are

---

[12]Another way to understand the result is to consider the variable $\frac{\left(\lambda_1 + \lambda_2 p(n,t)\right)\Theta\left(\bar{Y}_{nt}\right)}{\bar{Y}_{nt}}$ which is the implicit price, in consumption terms, of an additional unit of offspring human capital in a neighborhood. The most affluent family seeks to minimize this price, given the fixed budget share that is implicitly paid for human capital out of income. The maximization for one family applies to all.

substantially lower than their own. Benefits to agglomeration for the affluent can be reversed when families are sufficiently poorer.

5. Inequality and Mobility Dynamics

Along an equilibrium path for neighborhoods, dynasty income dynamics follow the transition process

$$\Pr\left(Y_{it+1} \middle| F_t\right) = \Pr\left(Y_{it+1} \middle| \bar{Y}_{n_t}, p(n,t)\right) \tag{12}$$

This equation illustrates the primary difficulty in analyzing income dynamics in this framework: one has to forecast the neighborhood compositions. This leads us to focus on the behavior of families in the tails of the income distribution, in particular the highest and lowest income families at a given point in time.

We first observe that there is a deep relationship between the equilibrium neighborhood configurations in the model and persistent income inequality.

Proposition 5. Equilibrium Income Segregation and its Effect on the Highest and Lowest Income Families

i. Conditional on the income distribution at t, the expected offspring income for the highest family in the population is maximized relative to any other configuration of families across neighborhoods.

ii. Conditional on the income distribution at t, the expected offspring income of the lowest income family in the population is minimized relative to any other configuration of families across neighborhoods that does not reduce the size of that family's neighborhood.

The maximization of inequality along an equilibrium path of matches occurs in other contexts. For example, Becker's (1973) marriage model, in which complementarities between partners will induce assortative matching of types which maximizes differences in the output of marriages. Unlike the Becker case, our equilibria are not necessarily efficient, i.e. they do not necessarily lie on the Pareto frontier, because borrowing is ruled out.

The maximization of offspring differences by equilibrium neighborhood configurations interacts with the technology structure (10). Higher income neighborhoods can produce higher expected average growth in offspring income than poorer ones. Formally,

Proposition 6. Expected Average Growth Rate for Children in Higher Income Neighborhoods for Children in Lower Income Neighborhoods

> Let g_{nt+1} denote the average expected income growth between parents and offspring in neighborhood n,t . For any two neighborhoods n and n' if $\bar{Y}_{nt} < \bar{Y}_{n't}$ $p(n,t) \geq p(n',t)$, then $g_{nt+1} - g_{n't+1} > 0$.

Intuitively, neighbors have three distinct effects on a family. The more neighbors present in a community, (high income or not), the greater the set of taxpayers to defray fixed costs to educational investment. The higher the incomes of a set of neighbors, the greater the tax base and the more favorable social interaction effects. The Proposition, by ordering neighborhood sizes, formalizes these factors.

Proposition 6 does not speak to the sign of g_{nt}. Under the linear assumptions of this model, there will exist formulations of $\Theta(\cdot)$ and $\xi(\cdot,\cdot,\cdot)$ such that neighborhoods exhibit positive expected growth in all time periods, i.e. $\forall nt \;\; g_{nt} > g_{\min} > 0$. In essence, this will hold when educational investment is sufficiently productive relative to the preference-determined equilibrium tax rates so that investment levels grow (this is the AK growth model requirement as modified by the presence of social interactions.) Growth in turn leads to the potential for permanent dynastic inequality.

Proposition 7. Possibility of Permanent Income Inequality

If $\forall nt \;\; g_{nt} > 0$, then there exists a set of time t income distributions such that the ratio of the income of the highest family income to the lowest family income never decreases for the descendants of that pair of adults,

$$\Pr\left(\frac{Y_{it+v}^{High}}{Y_{it+v}^{Low}} \geq \frac{Y_{it+v}^{High}}{Y_{it+v}^{Low}} \forall v > 0 \middle| F_{Y_t} \right) > 0; \tag{13}$$

In words, the income ratio difference between the highest and lowest income families at time t represents a floor on the income ratios of their descendants. By implication, the rank order of the families in the overall income distribution is never reversed.

The mathematical intuition for this proposition is the following. Log income differences behave in fashion similar to random walk with drift. A reduction in the initial income ratio of descendants of the highest and lowest income families is analogous to the initial income different not representing a lower bound on the process. The probability that a random walk with positive drift and an initial positive value will ever decline relative to the initial value is less than one because of the trend in the process. In our model, growing disparities between the neighborhoods experienced by the descendants of the highest and lowest income families induce disparities in growth rates across generations, hence local public finance and social interactions can combine to produce permanent differences between dynasties.

Note that this proposition does not imply that dynastic income differences can ever become fixed, i.e. that contemporary inequality becomes irreversible. There is no literal poverty or affluence trap, in which a dynasty is permanently consigned to absolute or relative income levels. Permanent differences occur with probabilities bounded between 0 and 1. How can this occur? The key to our results is that the economy is growing, and so is nonstationary. Specifically, the range of incomes over which incomes take a probability $1-\varepsilon$ value changes, for any $\varepsilon > 0$ [13]. A growing economy admits forms of intergenerational persistence that are ruled out in stationary environments. The possible (nonzero probability) patterns for dynastic income differences are qualitatively different. Growth in fact facilitates the emergence of permanent inequality.[14][15]

Proposition 8 involves the magnitude of income gaps between the very richest and poorest. A related issue concerns the relationship between tails of the income distribution and the rest of the population. Our model admits the possibility that the upper and lower tails can decouple from the rest of the population. This possibility is formalized in Proposition 9.

Proposition 9. Decoupling of Upper and Lower Tails from Rest of Population of Family Dynasties

i. If $\forall nt \;\; g_{nt} > 0$, then there exists a set of time t income distributions at the top α % of families in the distribution ever experience a reduction in the ratios their income to any dynasty outside this group

ii. If $\forall nt \;\; g_{nt} > 0$, then there exists a set of time t income distributions at the bottom β % of families in the distribution ever experience an increase in the ratios their income to any dynasty outside this group

[13]This is technical detail that accounts for the fact that the densities for shocks are not required to have bounded supports.

[14]The distinctions between the types of persistent inequality found in stationary versus growing environments suggests limitations of conventional forms of inequality measurement such has the intergenerational correlation of income or the Markov transition matrix for relative rankings. Durlauf (2011) discusses some metrics for mobility for environments with growth.

[15]If there is a minimum average income requirement for expected growth of income of offspring in a neighborhood to be positive, it is possible, then it is possible for the model to exhibit a conventional poverty trap in the sense that some family dynasties follow a stationary income process, i.e. one without growth.

This proposition

Our final proposition formalizes an exact sense in which the Gatsby Curve can be produced by the model.

Proposition 10. Intergenerational Great Gatsby Curve

> There exists a set of time t income distributions such that the intergenerational elasticity of parent/offspring income will be increased by a mean preserving increase in the variance of initial income.

This is trivially proved by example. Starting with an initial income distribution in which all families are members of a common neighborhood, an increase income dispersion which generates multiple neighborhoods will necessarily raise the parent/child income correlation.

Together, Propositions 7-9 provide a set of perspectives which captures the inequality/segregation/mobility nexus that we believe is useful in understanding the Great Gatsby curve. We note that, in their current formulations, Propositions 7-9 are weak since they do not characterize the sets of initial income distributions for which the results hold; this is part of future work.

6. Conclusions

This paper has provided a model with behavior similar to that associated with the Great Gatsby curve. The cross-section distribution of family incomes determines the degree of income segregation across residential neighborhoods. Disparities in income distribution across neighborhoods produce disparities in human capital formation which create parent child income covariation. Unlike family based models, this correlation is socially determined. The nature of the parent/child covariation is sensitive to the whether the environment admits growth. A novel form of a poverty trap emerges, one that is never deterministic in the sense that the probability that one family dynasty is permanently consigned to a fraction of the income of more affluent dynasty is always bounded between 0 and 1.

We emphasize that this approach is hardly the only theoretical structure which can produce a Gatsby curve. One can do so in a family income model in which offspring income is a nonlinear function of parental income and a shock. We believe our approach is appealing because the implicit nonlinearities in our model are natural due to the interplay of social interactions and the associated political economy[16]. Social interactions models are naturally nonlinear, when complementarities are present.

In the next version of this paper, there are three important modifications needed. First, the neighborhood formation rule needs to be enriched to either account explicitly for zoning or prices. Second, preferences over racial composition need to be added. It is well understood, from Massey and Denton (1993) to Sharkey (2013), that race places a distinct role in neighborhood effects, regardless of recent declines in racial segregation per se. Third, heterogeneity in parental preferences is needed, in order to account for overlaps in neighborhood income distributions. Calabrese, Epple, Romer, and Sieg (2006) and Epple, Peress, and Sieg (2008) describe strategies to do this. Once these extensions are made, the model should be amenable to calibration.

[16]Our model mimics much of the linearity of the Becker Tomes (1973) formulation.

Proofs of Propositions

forthcoming

.

Figure 1. The Great Gatsby Curve

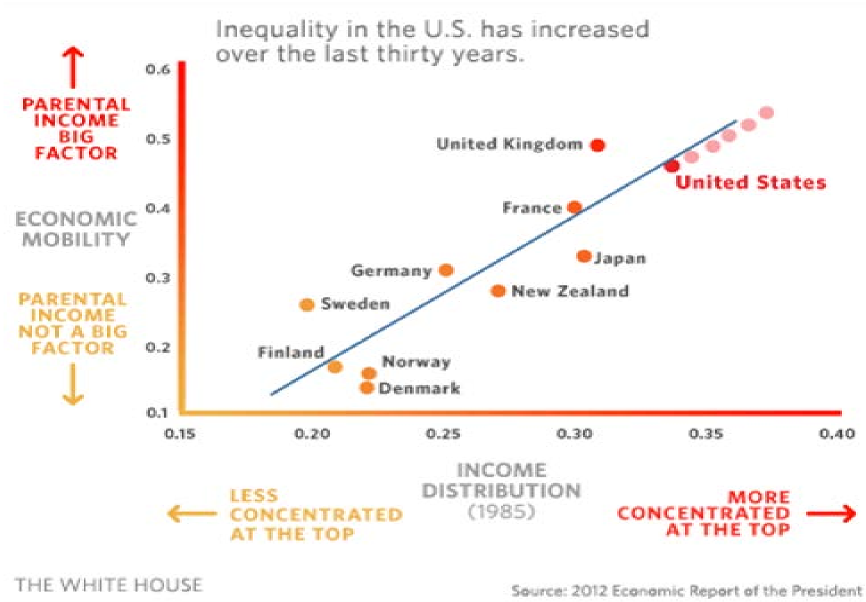


Figure 2a. Rising Intergenerational Elasticities

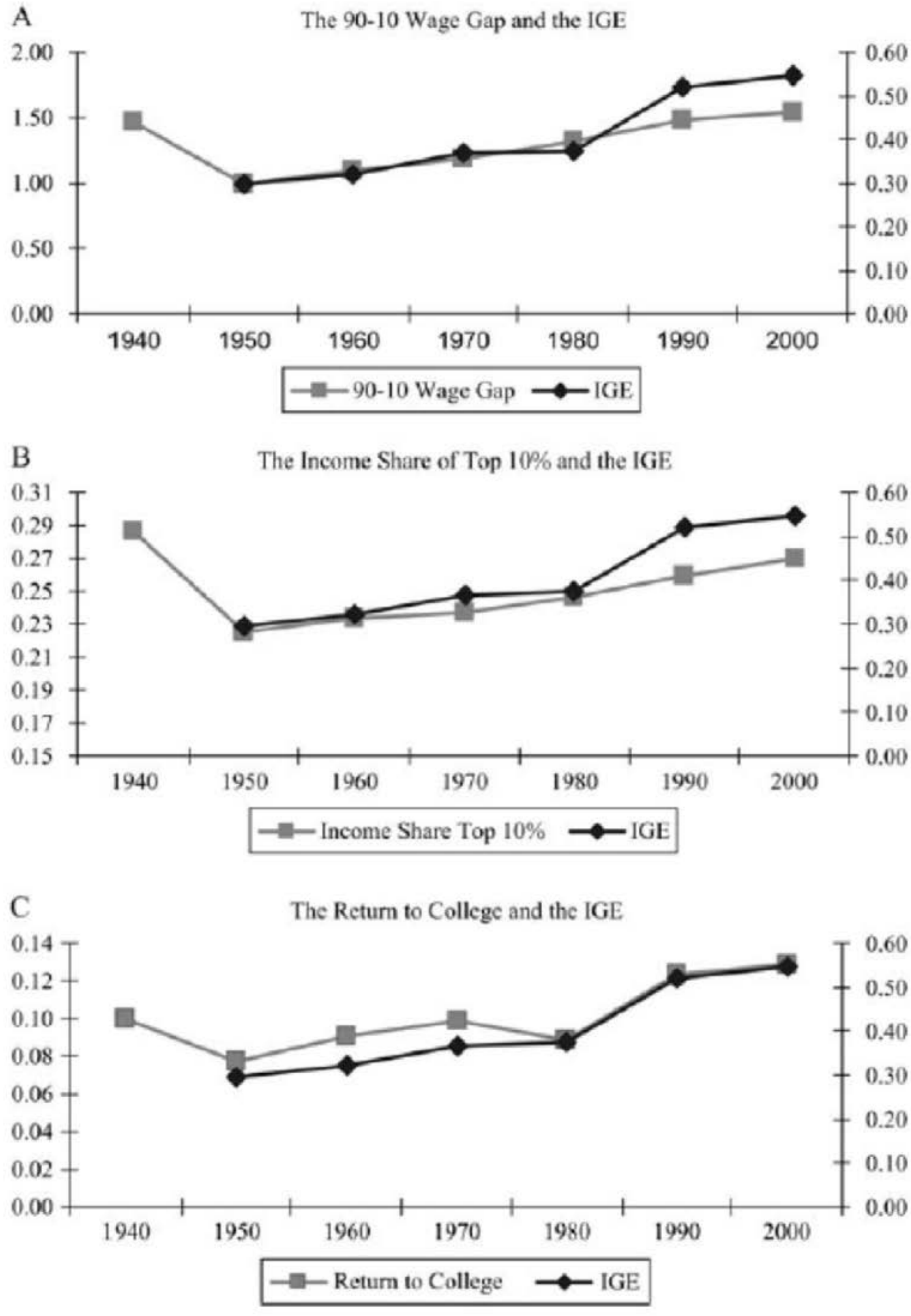
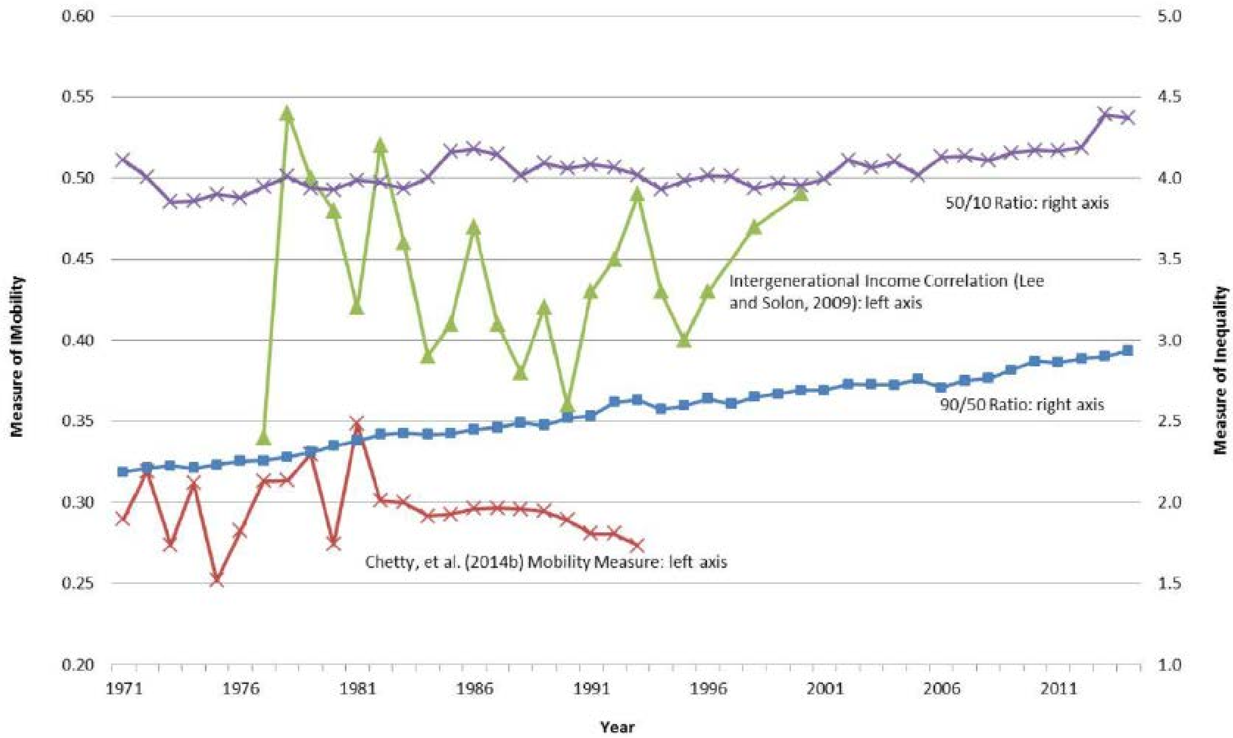


Figure 4
Comparison of Trends in Inequality and the IGE

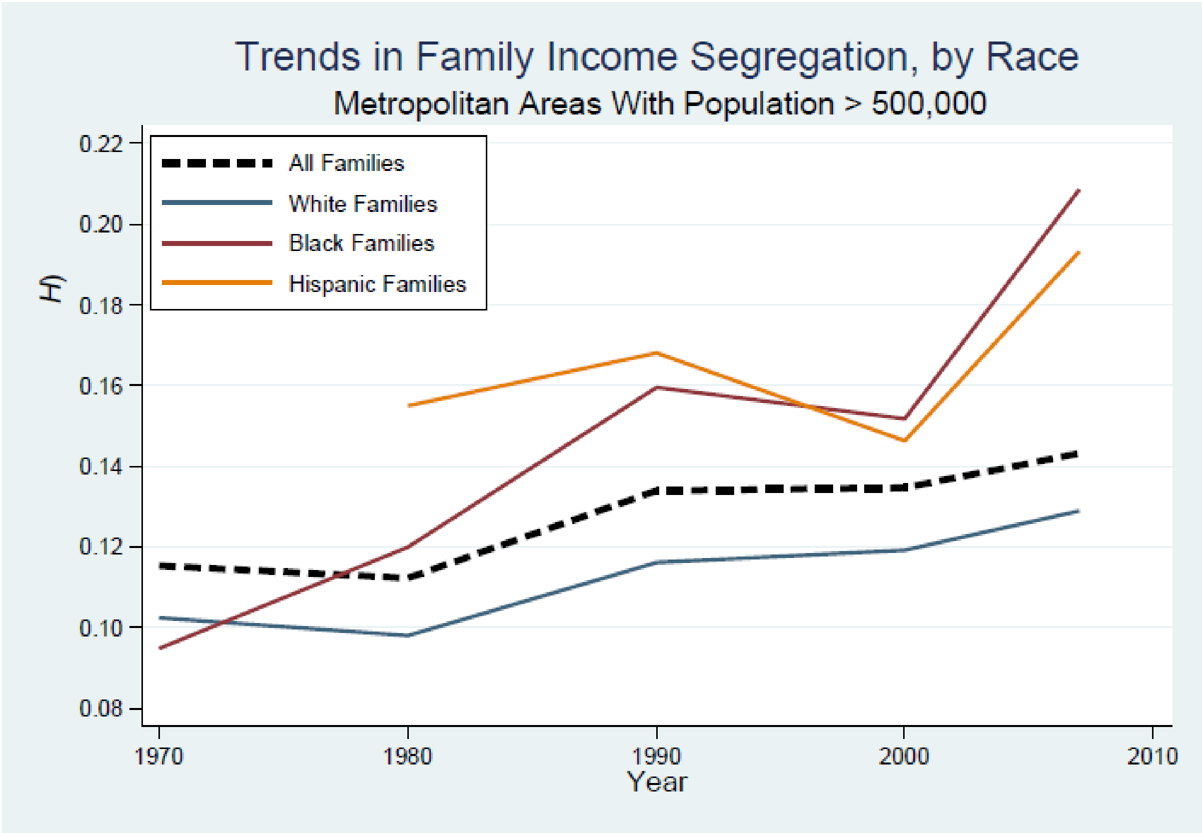
Source: Aaronson and Mazumder (2008)

Figure 2b. Inequality and Mobility over Time (US)



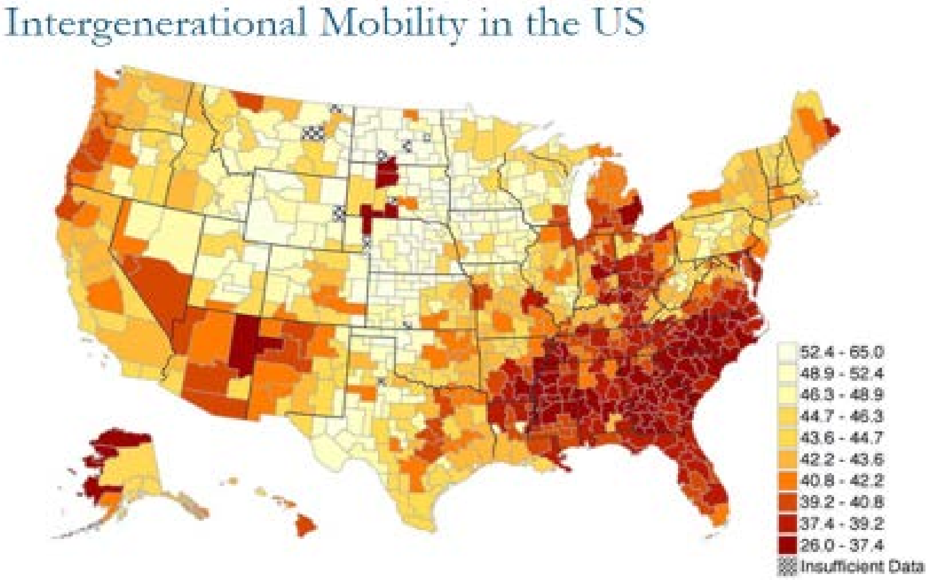
Source: Kearney and Levine (2015). Notes: The x-axis reflects the year in which income is measured for the 90/50 and 50/10 ratios For the mobility measure in Chetty et al. (2014b), year reflects birth cohort. For the mobility measure in Lee and Solon (2009), year reflects the year in which the son's income was recorded.

Figure 2c. Trends in Family Income Segregation, by Race



Source: Authors' tabulations of data from U.S. Census (1970-2000) and American Community Survey (2005-2009). Averages include all metropolitan areas with at least 500,000 residents in 2007 and at least 10,000 families of a given race in each year 1970-2007 (or each year 1980-2007 for Hispanics). This includes 117 metropolitan areas for the trends in total and white income segregation, 65 metropolitan areas for the trends in income segregation among black families, and 37 metropolitan areas for the trends in income segregation among Hispanic families. Note: the averages presented here are unweighted. The trends are very similar if metropolitan areas are weighted by the population of the group of interest.

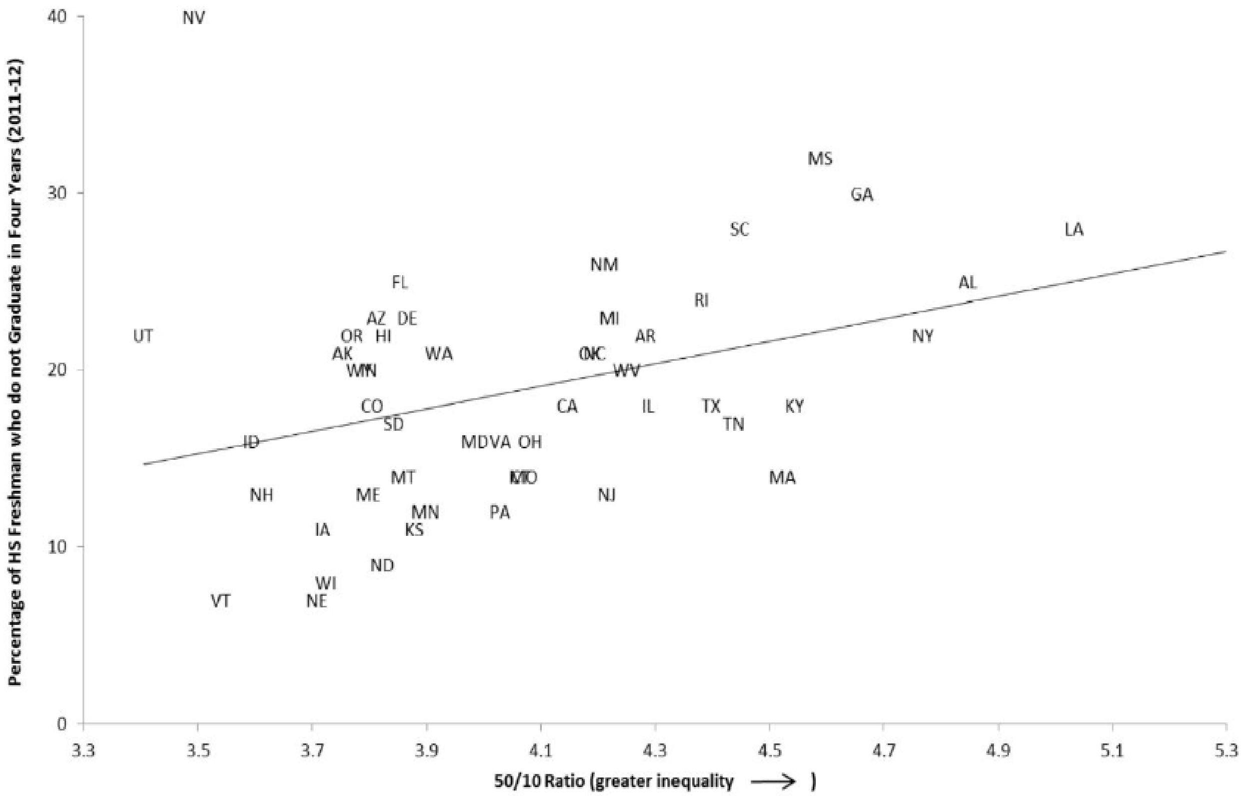
Figure 3. Spatial Variation in Intergenerational Mobility



Notes: This map shows the average percentile rank of children who grow up in below-median income families across areas of the US (absolute upward mobility). Lighter colors represent areas where children from low-income families are more likely to move up in the income distribution.

Source: Chetty et al. (2014)

Figure 4. Relationship between Inequality and the Rate of High School Non-Compeltion



Source: Kearney and Levine (2015). Notes: The graduation data is from Stetser and Stillwell (2014). The 50/10 ratios are calculated by the authors. The District of Columbia is omitted from this figure because it is an extreme outlier on the X axis (50/10 ratio = 5.66).

Figure 5 Spatial Distribution of Poverty Rates

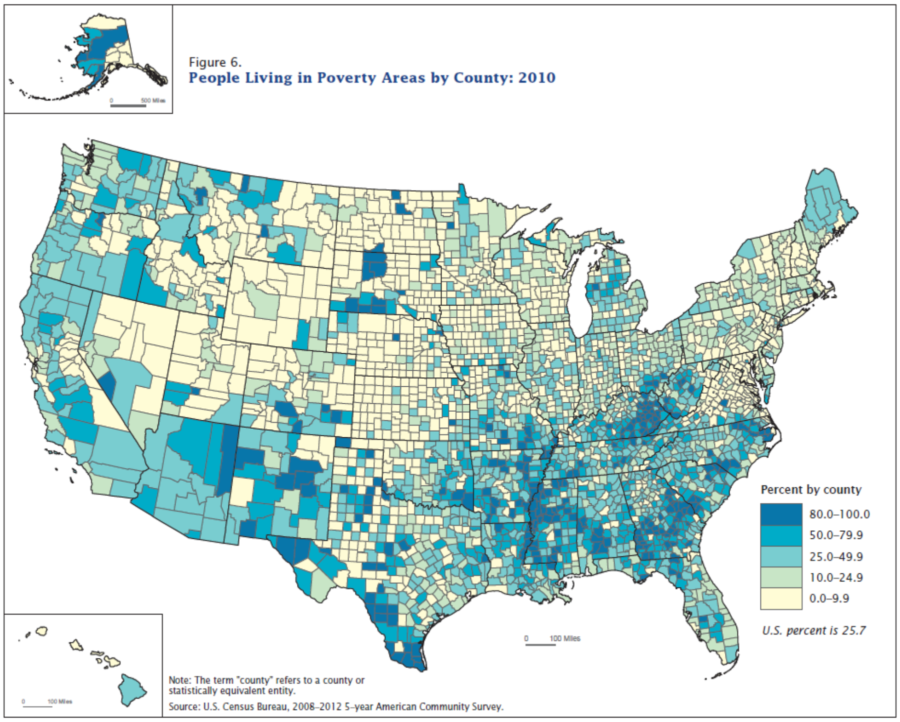
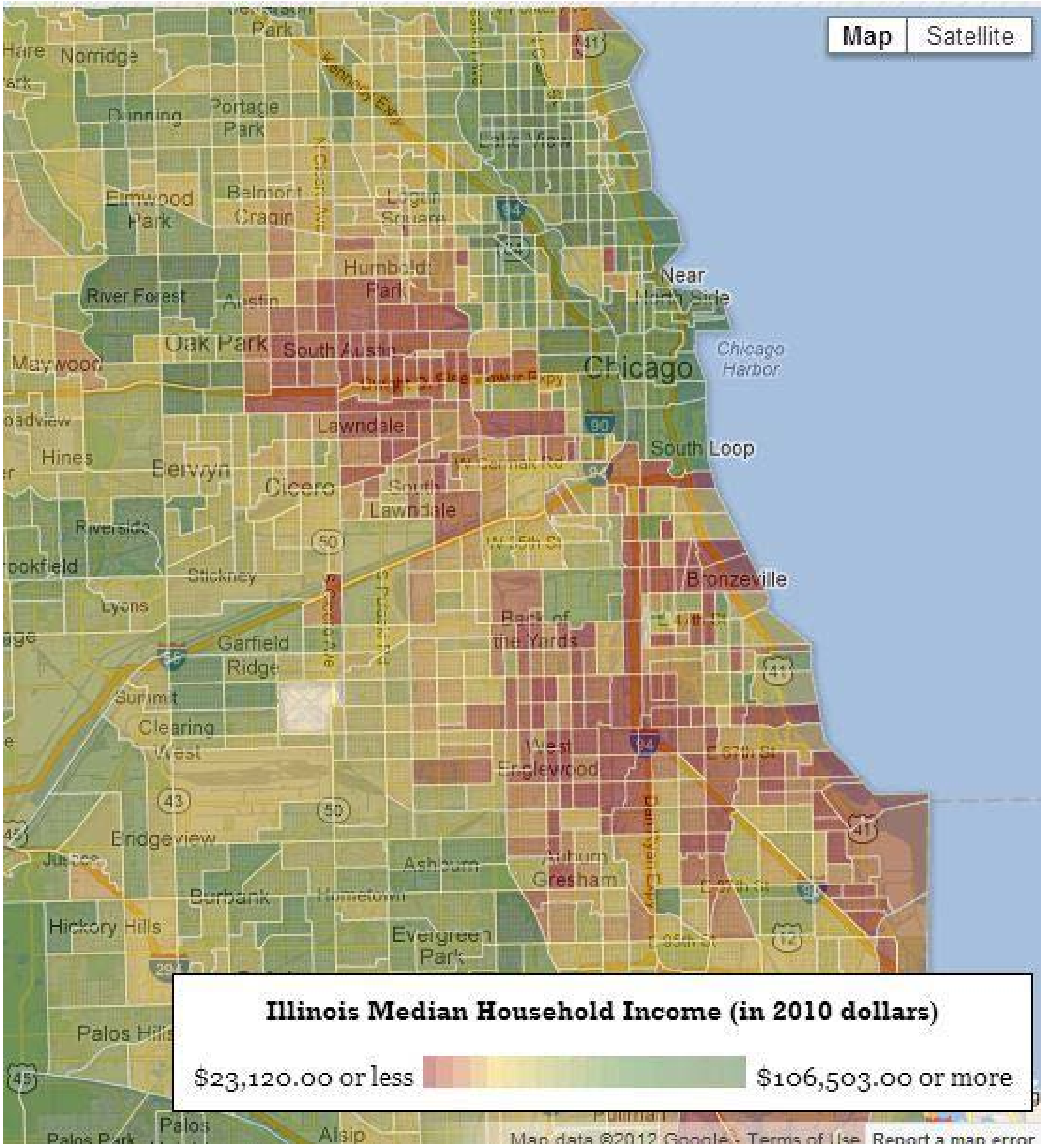


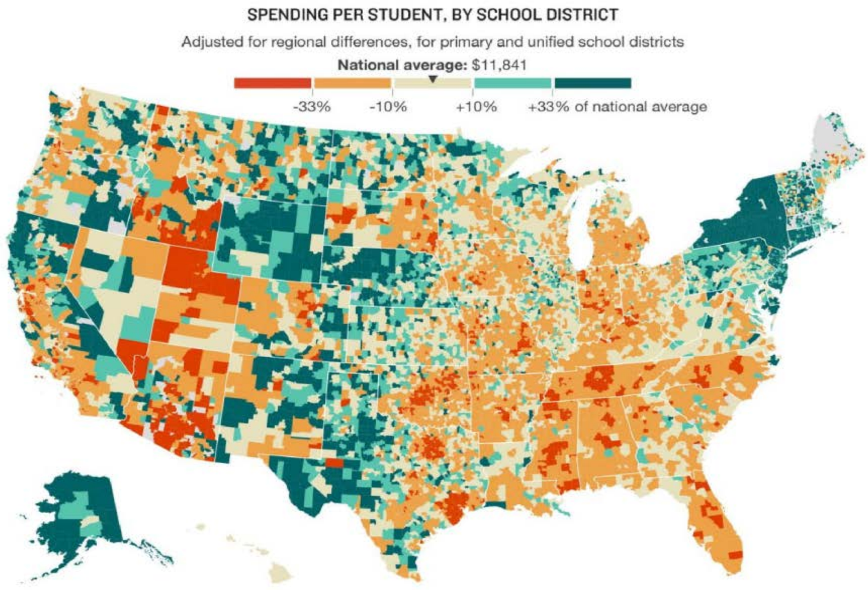
Figure 6. Income Segregation in Chicago



Source: RichBlocksPoorBlocks

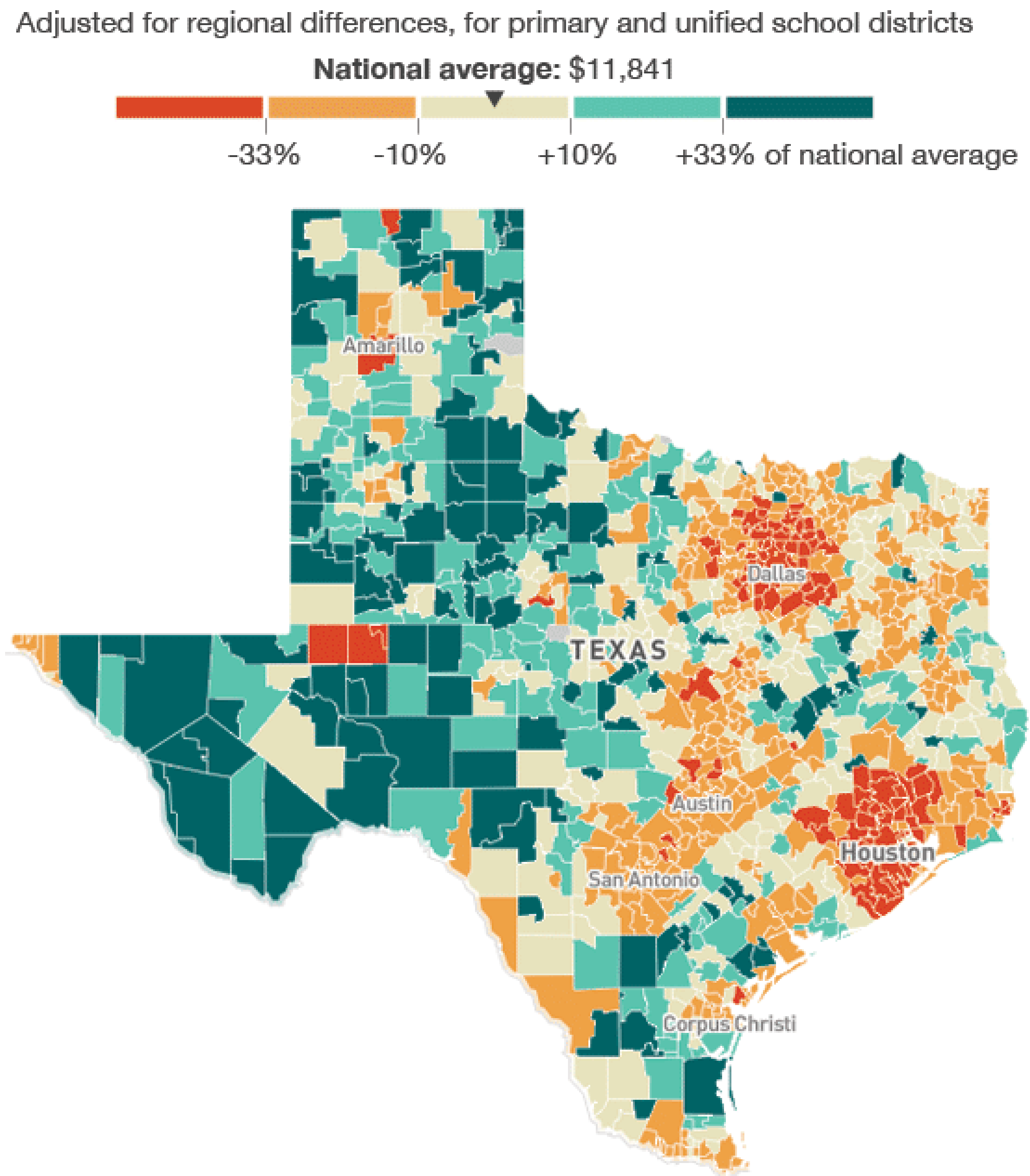
Figure 7: Reardon

Figure 8. Spatial Variation in Per Capita Public School Expenditure



Source: NPR, Education Week, U.S. Census Bureau.

Figure 9. Spending Per Student, By School District, Texas



Source: Education Week, U.S. Census Bureau, Mapbox, OpenStreetMap

Credit: Katie Park and Alyson Hurt/NPR

Figure 10. Exposure to Violent Crime

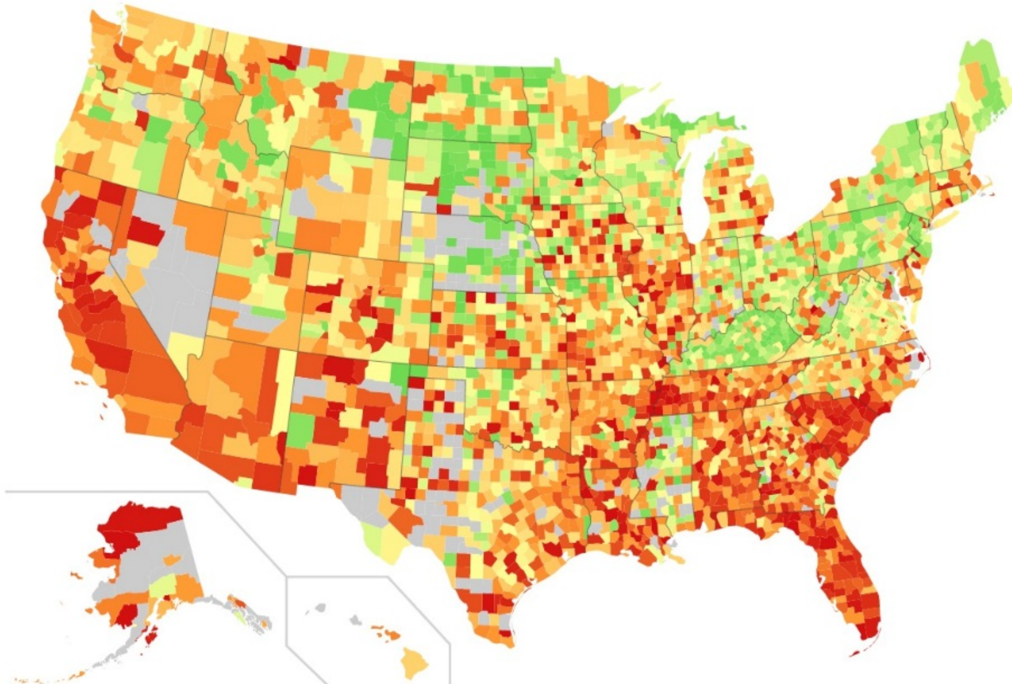
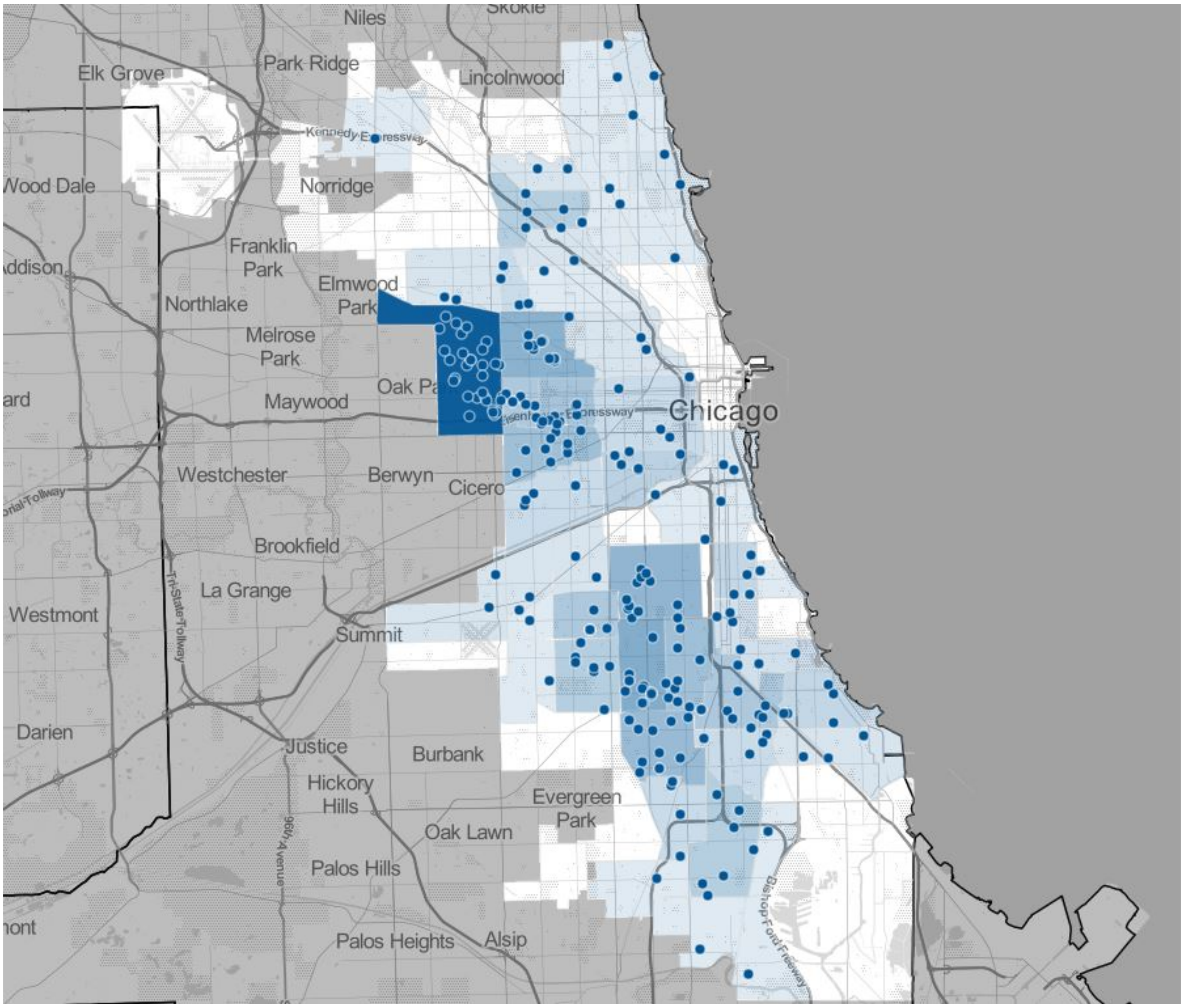


Figure 11 Distribution of Homicides in Chicago



Source: Chicago Tribune. Accessed May 21, 2016.

Bibliography

Aaronson, D. and B. Mazumder. 2008. “Intergenerational Economic Mobility in the United States, 1940-2000.” *Journal of Human Resources* 43: 139-172.

Becker, G. 1973. “A Theory of Marriage, Part I.” *Journal of Political Economy* 81: 813-846.

Becker, G. 1974. “A Theory of Social Interactions.” *Journal of Political Economy* 82: 1063-1093.

Becker, G. and K. Murphy. 2000. *Social Economics*. Cambridge: Harvard University Press.

Becker, G. and N. Tomes. 1979. “An Equilibrium Theory of the Distribution of Income and Intergenerational Mobility.” *Journal of Political Economy* 87: 1153-1189.

Bloome, D. 2015. “Income Inequality and Intergenerational Income Mobility in the United States.” *Social Forces* 93: 1047-1080.

Bénabou, R. 1996a. “Equity and Efficiency in Human Capital Investment: The Local Connection.” *Review of Economic Studies* 63: 237-264.

Bénabou, R. 1996b. “Heterogeneity, Stratification and Growth: Macroeconomic Implications of Community Structure and School Finance.” *American Economic Review* 86: 584-609.

Benhabib, J., A. Bisin, and M. Jackson (eds.). 2011. *Handbook of Social Economics, vols.* 1 and 2. Amsterdam: Elsevier.

Bloome, D. 2015. “Income Inequality and Intergenerational Income Mobility in the United States.” *Social Forces* 93: 1047-1080.

Blume, L., W. Brock, S. Durlauf, and R. Jayaraman, 2015. “Linear Social Interactions Models.” *Journal of Political Economy* 123: 444-496.

Burdick-Will, J. 2013. “School Violent Crime and Academic Achievement in Chicago.” *Sociology of Education* 86: 343-361.

Calabrese, S., D. Epple, T. Romer, and H. Sieg. 2006. “Local Public Good Provision: Voting, Peer Effects, and Mobility.” Journal of Public Economics 90: 959–981.

Chetty, R., Friedman, J. N., Hilger, N., Saez, E., Schanzenbach, D. W., & Yagan, D. (2011). “How Does Your Kindergarten Classroom Affect Your Earnings? Evidence from Project Star.” *Quarterly Journal of Economics*, 126(4).

Chetty, R., Hendren, N., Kline, P. and Saez, E. 2014. “Where is the Land of Opportunity? The Geography of Intergenerational Mobility in the United States.” *Quarterly Journal of Economics* 129: 1553-1623.

Corak, M. 2013. “Income Inequality, Equality of Opportunity, and Intergenerational Mobility.” *Journal of Economic* Perspectives 27: 79-102.

Durlauf, S. 1996a. “A Theory of Persistent Income Inequality.” *Journal of Economic Growth*, 1: 75-93.

Durlauf, S. 1996b. “Neighborhood Feedbacks, Endogenous Stratification, and Income Inequality,” *Dynamic Disequilibrium Modelling*. W. Barnett, G. Gandolfo, and C. Hillinger, eds. New York: Cambridge University Press.

Durlauf, S. 1996c. “Associational Redistribution: A Defense,” *Politics and Society* 24: 391-410.

Durlauf, S. 2006. “Groups, Social Influences, and Inequality: A Memberships Theory Perspective on Poverty Traps.” *Poverty Traps*. S. Bowles, S. Durlauf, and K. Hoff, eds. Princeton: Princeton University Press.

Durlauf, S. 2012. “Poverty Traps and Appalachia,” *Appalachian Legacy: Economic Opportunity After the War on Poverty*. J. Ziliak, ed. Washington, DC: Brookings Institution Press.

Durlauf, S., P. Johnson, and J. Temple. 2009. “The Econometrics of Convergence,” with P. Johnson and J. Temple. *Handbook of Econometrics*. T. Mills and K. Patterson eds., London: Macmillan.

Dustmann, C., N. Rajah, and A. Soest. 2003.. “Class Size, Education, and Wages.” *Economic Journal* 113: F99-F120.

Epple, D., M. Peress, and H. Sieg. 2008. “Household Sorting and Neighborhood Formation,” Working Paper, Carnegie Mellon Unviersity.

Epple, D. and R. Romano. 2011. “Peer Effects in Education: Theory and Evidence” *Handbook of Social Economics*. J. Benhabib, A. Bisin, and M. Jackson, eds. Amsterdam: Elsevier.

Fernandez, R. and R. Rogerson. 1996. “Income Distribution, Communities, and the Quality of Public Education.” *Quarterly Journal of Economics* 111: 135-164.

Fernandez, R. and R. Rogerson. 1997. “Keeping People Out: Income Distribution, Zoning, and the Quality of Public Education.” *International Economic Review* 38: 23-42.

Gennetian, L. et al. 2012. "The Long-Term Effects of Moving to Opportunity on Youth Outcomes." *Cityscape* 14: 137-167.

Hanushek, E. 2006. "School Resources." *Handbook of the Economics of Education, vol.* 2. E. Hanushek and F. Welch, eds. Amsterdram: Elsevier.

Heckman, J. and S. Mosso. 2014. "The Economics of Human Development and Social Mobility." *Annual Review of Economics* 6: 689-733.

Katz, L., J. Kling, and J. Liebman. 2007. "Experimental Analysis of Neighborhood Effects." *Econometrica* 75: 83-119.

Kearney, M. and P. Levine, 2015. "Income Inequality, Social Mobility, and the Decision to Drop Out of High School." *Brookings Papers and Economic Activity.*

Krueger, A. 2003. "Economic Considerations and Class Size." *Economic Journal*, 113: F34-F63.

Krueger, A. 2012. "The Rise and Consequences of Inequality in the United States." Unpublished Speech.

Krueger, A. and D. Whitmore. 2001. "The Effect of Attending a Small class in the Early Grades on College-Test Taking and Middle School Test Results: Evidence from Project STAR." *Economic Journal* 111: 1-28.

Jones, L. and R. Manuelli. 1990. "A Convex Model of Equilibrium Growth: Theory and Policy Implications." *Journal of Political Economy* 98: 1008-1038

Jones, L, and R. Manuelli. 1992. "Finite Lifetimes and Growth." *Journal of Economic Theory* 58: 171-197

Lee, S.-Y. and A. Seshadri. 2015. "On the Intergenerational Transmission of Economic Status." Working Paper, University of Wisconsin.

Loury, G. 1977. "A Dynamic Theory of Racial Income Differences," in *Women, Minorities, and Employment Discrimination*, P. Wallace and A. Lamond, eds., Lexington, Massachusetts: Lexington Books.

Loury, G. 1981. "Intergenerational Transfers and the Distribution of Earnings." *Econometrica* 49: 843-867.

Massey, D. and N. Denton. 1993. *American Apartheid: Segregation and the Making of the Underclass.* Harvard: Harvard University Press.

Massey, D. and M. Fischer. 2003. "The Geography of Inequality in the United States, 1950-2000 (with commentary)." *Brookings-Wharton Papers on Urban Affairs*, 1-40.

Reardon, S. and K. Bischoff. 2011. "Income Inequality and Income Segregation," *American Journal of Sociology* 116: 1092-1153.

Reardon, S., J. Townsend, and L. Fox. 2015. "Characteristics of the Joint Distribution of Race and Income Among Neighborhoods," Working Paper, Stanford University.

Roemer, J. 1998. *Equality of Opportunity*. Cambridge: Harvard University Press.

Sharkey, P. 2013. *Stuck in Place: Urban Neighborhoods and the End of Progress toward Racial Inequality*. Chicago: University of Chicago Press.

Topa, G. and Y. Zenou. 2015. "Neighborhood and Network Effects." Handbook of Regional and Urban Economics, Vol. 5A. G. Duranton, V. Henderson and W. Strange eds. Amsterdam: Elsevier.

Wilson, W. J. 1987. *The Truly Disadvantaged*. Chicago: University of Chicago Press.

Wodtke, G., F. Elwert, and D. Harding. 2016. "Neighborhood Effect Heterogeneity by Family Income and Developmental Period." *American Journal of Sociology* 121:1168-222.