Searching for the best location: Neighborhood effects and neighborhood choice*

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Abstract

Self-selection into residential locations hampers identification of neighborhood effects. It is also an opportunity because neighborhood choices reveal preferences for the behavior and characteristics of neighbors and neighborhoods. We explore these features by means of a model in which households search, subject to search frictions, for the best location in the presence of neighborhood effects in children's education and transmission of parents' cultural identity. The ensuing relation between mobility rates and contextual characteristics is tested using geocoded micro data from the PSID, merged with contextual information from the US Census. We find, consistently with neighborhood effects theories, that households with children, but not those without, tend to leave neighborhoods whose social attributes do not favor offspring's human capital and to move into neighborhoods which instead exhibit desirable such attributes. This human capital motive appears to dominate the cultural transmission one.

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1 Introduction

While theories describing that economic outcomes for individuals and groups are influenced by the social context continue to be appealing, the empirical identification of such social effects in non-experimental contexts is still challenging. Formal results establishing identification conditions do exist (Blume *et al.*, 2011, provide an overview), but identification faces unresolved obstacles in practice. One key hurdle is that forces underlying self-selection by individuals into groups may also affect their behavior. That is, sorting generates "correlated effects" (Manski, 1993) in observed individual behavior that are hard to distinguish from neighborhood effects, a particular form of selection bias.[1]

However, presence of sorting is also an opportunity, an important insight that we owe to Brock and Durlauf (2001). By choosing among alternative locations, individuals reveal their preferences for different neighborhood characteristics—as Thomas Schelling (1971) famously put it, "to choose a neighborhood is to choose neighbors". Thus, data on moves can be utilized to infer whether or not, and the extent to which, individuals value potential neighborhood effects. Based on this insight, we study a frictional model of households' location decisions in the presence of neighborhood effects and seek to infer preferences for social neighborhood characteristics directly from equilibrium outcomes. Despite being based on a relatively small sample and survey data, our approach has an advantage over the study of interventions that alter group memberships exogenously, such as Moving to Opportunity (Kling *et al.*, 2007; Chetty *et al.*, 2016). As Moffitt (2001) noted, such interventions may not reveal the presence of social effects, if an equilibrium is reached before the effects of social interactions have fully worked out.

To be clear, our approach cannot pin down neighborhood effects, but it can establish whether households' residential choices are consistent with the presence of social effects in the formation of human capital or cultural identity, an important class of neighborhood effects.[2]

[1]The relevance of this problem is well illustrated empirically by Oreopoulos (2003), who finds that neighborhood effects are irrelevant for households whose place of residence is exogenously assigned but appear to be relevant for households who endogenously chose where to live. A precursor of this result appears in the work of Evans, Oates and Schwab (1992).

[2]Durlauf (2004), and Bisin and Verdier (2011) offer valuable surveys.

As shown by Zanella (2007), these effects imply that individuals choose locations that offer desirable social interactions: when allowed to search for the best neighborhood, they search for the "best" neighbors—neighbors whose attributes and behavior they value most—and not only for better access to jobs, attractive dwellings and neighborhood ambience, or other amenities. Furthermore, at a locational (sorting) equilibrium rents and housing prices also reflect the valuation of the social context (i.e., of neighborhood effects), in addition to other neighborhood characteristics, in line with theories of hedonic prices. We test these implications by studying the impact of the social context on observed residential choices and prices. The idea that determinants of self-selection can be exploited to identify neighborhood effects was first suggested by Brock and Durlauf (2001). It has been employed by, among others, Ioannides and Zabel (2008) to help identify contextual effects separately from endogenous neighborhood interactions in housing markets.

We propose a general equilibrium model of neighborhood effects and neighborhood choice. The latter follows the optimal sequential search strategy characterized by Weitzman (1979), that is a search framework that allows for heterogeneity in the distributions of payoffs across alternatives, and also naturally fits the spatial dimension of residential decisions in a frictional housing market. Moreover, such framework suggests instruments for our empirical analysis of location choices. In the model, parents value the effects of social interactions, at the residential neighborhood level, on their children's acquisition of human capital and their enculturation within the parents' own culture.[3] This is the case if: (i) human capital depends on social contacts (e.g., providing role models and peer effects) and on local public schools; and (ii) culture is transmitted both directly within the family and indirectly through extra-familial social interactions. With such derived preferences over neighborhood characteristics and conditional on their current location, households search optimally over alternative locations within their opportunity set, subject to search frictions. Households "flow"through different neighborhoods over time according to transition probabilities that depend on the characteristics of other individuals across neighborhoods and that we derive as part of the model's equilibrium. The central testable implication is that there exist two

[3]Enculturation is "the process where the culture that is currently established teaches an individual the accepted norms and values of the culture or society in which the individual lives." (Kottak, 2004, p. 199).

regimes governing residential choices: one pertains to households with school-age children, for whom social interactions in human capital and enculturation matter for residential sorting; the other regime pertains to households without school-age children, for whom such interactions do not matter.

Our empirical analysis defines neighborhoods as census tracts and uses two consecutive waves of the Panel Study of Income Dynamics (PSID), which we have linked (thanks to access to confidential geocodes) with tract-level contextual information from the 2000 US Census. We test the aforementioned central implication in a "reduced-form" econometric setting that is disciplined by the theoretical model, relating the equilibrium probability of moving to contextual characteristics in the neighborhoods of origin and destination. To deal with the endogeneity of the latter, we leverage the model's implication that characteristics of broader areas "visited" by households are instruments for the characteristics of smaller neighborhoods that lie within them. Results indicate that households with or without children younger than 18 behave differently. The former are more likely to move out of neighborhoods with characteristics that are commonly considered as not favoring children's acquisition of human capital. They are more likely to move into neighborhoods whose characteristics are perceived as facilitating this process. Such human capital motive appears to dominate parents' desire to transmit their cultural trait via neighborhood effects. These two motives may pose a trade-off to disadvantaged minorities, and our estimates suggest that the trade-off is resolved in favor of the former. This observation implies, in turn, that parents not exposing their children to desirable cultural influences in the neighborhood may exert extra cultural socialization effort within the family, i.e., engage in "cultural substitution" (Bisin and Verdier, 2011). Overall, this evidence suggests that households' moves depend on preferences for social interactions in addition to strictly economic factors, which we regard as *prima facie* evidence in favor of theories of neighborhood effects as represented in our model.[4]

The rest of the paper is organized as follows. Section 2 relates our paper to the literature on residential mobility. A theoretical neighborhood search model is presented in Section 3. Section 4 contains the empirical analysis. Section 5 concludes.

[4]Calabrese *et al.* (2006) show that a locational equilibrium model with neighborhood effects measured by relative mean community income fits the data better than one without such effects.

2 Understanding residential mobility

By emphasizing what we think is an important motivation driving residential choices, this research aims at contributing to a deeper understanding of residential mobility. People move for a multitude of reasons: they may wish to locate more conveniently in relation to attractive job opportunities, to locations nearer family members and friends, or in order to adjust their housing consumption. Or they may be prompted to move for exogenous reasons, in which case they make optimal location decisions in the light of information at their disposal.

A well-established empirical literature has studied how the presence of persistent income differentials across regions may motivate moves. These studies of internal mobility consistently find that search of better economic prospects is an important factor underlying mobility. In a pioneering investigation that is based on a human capital investment approach with state-level data, Bowles (1970) found that the expected income increase from moving out of the US South in the late 1950s was a very good predictor of migration outflows from that region. Borjas, Bronars and Trejo (1992) emphasize returns to skills, rather than expected income, as a key force driving migration across US states. Kennan and Walker (2011) estimate a structural dynamic model of search among spatially dispersed wage offers that allows for multiple moves. Using panel data, these authors find that differences in expected income have a strong effect on interstate mobility of white male Americans. Jia *et al.* (2023) provide a recent comprehensive overview of this research area.

Research on household members' co-location decisions shows empirically that college-educated couples ("power couples") locate in larger cities mainly because such areas afford them opportunities to pursue dual careers (Costa and Kahn, 2000). Similar dual-career motives, as well as their reverse implications later in life, are also supported by findings reported in Chen and Rosenthal (2008). The latter study considers indices of quality-of-life and of quality-of-business locations, and matches them with information of migration flows by individual characteristics. While individuals in prime-age labor force groups, and power couples in particular, tend to move to high quality-of-business locations (seeking career jobs primarily), older individuals tend to move to high quality-of-life locations (seeking amenities primarily). Furthermore, a negative correlation between those two indices suggests that households may face trade-offs when choosing their residence, suggesting that mobility may be driven by more than the quest for improved economic prospects (as they are narrowly construed) and by subtle aspects of individual taste and characteristics. Such presumption is confirmed by the results of Ioannides and Zabel (2008), who find significant social interactions effects when they treat neighborhood choice and housing quantity as joint decisions. They find, in particular, that individuals choose to locate near others like themselves. These authors use micro data for individuals and their neighbors in small neighborhoods from the American Housing Survey, a data set for dwelling units and the characteristics of their occupants. They augment those data by means of confidential access to underlying US Census tract variables. However, their primary data, in effect a set of repeated cross sections, offer a limited number of individual covariates, relative to what we use in this paper. In particular, households are not observed in conjunction with residential moves.

Card, Mas, and Rothstein (2008), although not directly concerned with residential choices, provide strong evidence on the importance for white American families of a host of factors that have come to be known as Schelling-type motives. That is, such families tend to leave locations where the inflow of ethnic minority groups has brought neighborhood composition with respect to the share of minority residents above a critical point (Schelling, 1971). Such "neighborhood tipping" models aim at explaining circumstances under which neighborhoods may change fast. They are also supported by field (Wilson and Taub, 2006) and descriptive (Bruch and Mare, 2006) evidence at the Census tract level. Thus, the social context and the changes it may undergo are important determinants of residential mobility.

3 Theory

Consider a population of households, each composed of an adult and, possibly, a child. A household's location, or neighborhood, is indexed by g and is characterized by a set Y_g of variables that represent neighborhood attributes and prices. For example, indicators of housing and labor market conditions (including rents and wages), and neighborhood composition in terms of ethnic groups, and of education, income, and age of its residents, incidence of crime, and other quality of life attributes. For simplicity, we ignore natural amenities. Note that this vector Y_g includes variables that generate what Manski (1993) labeled "contextual effects". Individuals do not have direct preferences over intrinsic characteristics of neighborhoods as such, except for a location-specific random shock. This unobservable (to the econometrician) shock may reflect a new job offer in a particular city, breakup of an existing job or a family breakup, both of which may induce specific location demands.

3.1 Indirect preferences over locations

Let $\theta \in \Theta$ denote parents' cultural identity, which is summarized in terms of a cultural trait such as ethnicity, religion, etc. Such a trait parameterizes an adult's preferences, represented by utility function U^θ. A parent who lives in location g values own and her child's consumption, z and z', respectively, where a prime " $'$ " denotes a magnitude associated with the next generation, according to utility index:

$$U_g^\theta = u^\theta(z) + \rho u^\theta(z') + \epsilon_g, \tag{1}$$

where $\rho \in [0,1]$ is a parent's degree of altruism towards her child. By default, $\rho = 0$ if an individual has no children. On the other hand, we assume that a parent is always altruistic toward the child, to some degree, so in this model having children is indicated $\rho > 0$. Note that parents are altruistic in a paternalistic sense, i.e., they evaluate their children's welfare through their own preferences. The term ϵ_g denotes the location-specific random shock.

A parent cares about her child's human capital, h' (an economic motive), and her child's cultural trait θ' (a cultural motive).[5] A child's human capital is determined by a technology whose inputs include human capital of her parent, h, other household characteristics denoted by a k-dimensional vector X, average income of the community containing location g, m_g, and a child's own study effort, e:

[5] Parents' preferences over their children's human capital and over their cultural trait may clash. We will return on this point when interpreting our empirical results.

$$h' = h'(e, h, X, m_g). \tag{2}$$

This function is assumed to be increasing in all of its arguments (the signs of the elements of X having been chosen so to be consistent with this assumption). Dependence on h and X reflects interactions within the family, while dependence on m_g accounts for quality of schools and other local public goods. We assume that all cross partial derivatives involving e are nonzero, that is, a child's effort is complementary to all other inputs in the production of a child's human capital. We allow for peer effects in human capital acquisition via a cost function for study effort, $c(e; e_g)$, where e_g denotes mean effort of a child's peers in neighborhood g. We assume that this function is increasing convex with respect to own effort e, and that peer effects are beneficial, that is, the marginal cost of own effort decreases with mean effort in the reference group within neighborhood g, formally $c_{ee_g} < 0$. Such an assumption is consistent with empirical evidence on the interdependence of effort among peers in schools and expresses such advantageous effects as students' learning from one another, or being influenced by each other's working habits, which may also operate through standards of effort set by teachers, etc.[6]

A child's cultural trait is determined as illustrated in Bisin and Verdier (2011). A parent may influence the transmission of her own cultural trait, θ, by exerting direct socialization effort $d \in [0, 1]$ within the family ("vertical socialization") at cost $\widetilde{c}(d)$, a convex increasing cost function; or the child may be indirectly socialized with cultural trait θ via social interactions with individuals who carry that same trait in the neighborhood ("horizontal socialization"). The probability that a child meets an individual in neighborhood g who carries the same cultural trait is equal to the local share of that trait, and is denoted ϕ_g^θ. Therefore, a child whose parent has trait θ inherits that trait with probability $q^{\theta\theta} = d + (1-d)\phi_g^\theta$, and acquires some other trait τ with probability $q^{\theta\tau} = (1-d)\phi_g^\tau$, where $\sum_{\tau\neq\theta} \phi_g^\tau = 1 - \phi_g^\theta$.

The solution can be characterized, using backward induction, by first considering a child's choice of effort, then a parent's choice of consumption, socialization effort and location, conditional on the child's decision process. A child knows that her own human capital, and

[6]Sacerdote (2011) provides a comprehensive overview

so her own future income, is affected by her own effort via (2). She chooses effort by solving problem $\max_e : h'(e, h, X, m_g) - c(e; e_g)$. The optimal level of effort depends on household characteristics, h and X, average income in the community to which g belongs, m_g, as well as (via e_g) on the respective average characteristics of other households in the neighborhood, h_g and X_g. By substituting for optimal effort into (2), a child's optimal human capital depends on those same variables. Conditional on a child's optimal choice, a parent maximizes the expected value of (1) with respect to consumption, socialization effort, and location, subject to: a budget constraint,

$$z + r_g + \widetilde{c}(d) \leq hw_g, \tag{3}$$

where w_g and r_g are the wage and the housing rental rates, respectively, at location g; and also subject to the cultural transmission mechanism specified earlier. This part of the problem may be decomposed further into two stages. At a second stage, a parent chooses consumption and socialization effort, given location, while considering the trade-off between vertical and horizontal socialization and the budget constraint. At a first stage, a location is chosen in order to maximize the value of the process. The consideration of alternative courses of action determines location probabilities and so the probability of moving. That is, a parent forms a consumption and socialization plan, conditional on location g by solving:

$$\max_{z,d} : \ u^\theta(z) + \rho \sum_{\tau \in \Theta} q^{\theta\tau} u^\theta\left(z'\left(h'\left(h, X, h_g, X_g, m_g\right)\right); \theta' = \tau\right) + \epsilon_g, \tag{4}$$

subject to (3) and the cultural transmission mechanism. A parent's derived preferences over locations, as encapsulated in the optimal value of the above problem (which exists and is unique given our assumptions), involve a full set of contextual characteristics of each alternative location. Recall that we use vector Y_g to denote contextual characteristics in neighborhood g, including mean educational attainment, h_g, mean characteristics of neighboring families, X_g, mean income, m_g, the neighborhood's cultural composition $\left\{\phi_g^\tau\right\}$, $\tau \in \Theta$, as well as equilibrium wage and rental rates, w_g and r_g. Using i to index households, the value function for problem (4) may then be written concisely as:

$$\upsilon_{i,g} \equiv V(X_i, Y_g) + \epsilon_{i,g}, \tag{5}$$

where X_i denotes all observable characteristics of household i as of the time the decision process is observed, which act as taste shifters. This value represents household's preferences over neighborhoods. The model implies that if there are young children in household i, i.e., if $\rho > 0$, then, *ceteris paribus*, $V(X_i, Y_g)$ increases in h_g, X_g, m_g, and ϕ_g^θ (positive "contextual effects"),[7] while for any value of ρ, $V(X_i, Y_g)$ increases in w_g and decreases in r_g.

3.2 Choosing the best location subject to search frictions

Household i chooses a neighborhood in order to maximize value $v_{i,g}$, as defined by (5). Denote by o a household's *o*riginal location, and by by d its optimal choice of location, *d*estination. A household moves if and only if its destination differs from its origin, $d \neq o$. It does not move, if $d = o$. A move from o to d involves a mobility cost, $\mu_i(o, d) > 0$.

With only two generations in the model, the original location is given at the time the idiosyncratic shock is realized and destination is chosen, so the location problem consists of choosing a destination, subject to search frictions. Such frictions reflect that it takes time and effort to find out about alternative locations and their characteristics. We account for them by modelling choice of neighborhood as a sequential search problem. Since alternative locations are heterogeneous, we can think of their characteristics as draws from possibly different distributions and adopt Weitzman's (1979) general model of search.

This model allows for heterogeneity in the distributions of payoffs across alternatives. Denoting an *area* (a set of distinct but spatially adjacent neighborhoods) by a, the optimal search strategy in Weitzman (1979) is nested: a household orders areas, and then searches within areas. An area is described in terms of a cumulative distribution $F_a(Y)$ for vectors of characteristics. Crucially, areas are heterogeneous in the sense that $F_a(\cdot) \neq F_{a'}(\cdot)$ for $a' \neq a$. These distribution functions are known to households, but the characteristics of specific neighborhoods within each area, Y_g, are realized by searching. Given area a, the Y_g's are i.i.d. draws from F_a. A household "visits" the area and samples from $F_a(Y)$. Search within area a involves a search cost $s_{i,a}$, which is incurred once upon visiting the area.

[7] $V(X_i, Y_g)$ is, *ceteris paribus*, increasing in ϕ_g^θ because $u^\theta(z'(h'); \theta')$ is maximized when $\theta' = \theta$.

These assumptions capture the intuitive notion that when looking for a place to live, households have a rough idea of the characteristics of an area but need to expend resources in order to find out about a specific neighborhood therein.[8] If household i does not move, its payoff is $\upsilon_{i,o}$, while moving from o to d requires to pay the mobility cost and yields $\upsilon_{i,d}$. Thus, expected net utility associated with *optimally* searching in area a is given by:

$$\mathbb{E}\left\{\max_{g\in a}:\ \left[\upsilon_{i,g}-\mu\left(o,g\right)\right]\right\}-s_{i,a}, \tag{6}$$

where the expectation is taken with respect to the distribution of *maximum* utility attainable in area a by household i, net of mobility costs. Denoting the underlying random variable, i.e., the term within the curly brackets in (6), by $W_{i,a}$ and its distribution by $G_{i,a}$, expected maximum *net* utility from searching in area a when household i is located at origin o is given by:

$$\upsilon_{i,o}\int_{-\infty}^{\upsilon_{i,o}} dG_{i,a}\left(W\right)+\int_{\upsilon_{i,o}}^{+\infty} W dG_{i,a}\left(W\right)-s_{i,a}. \tag{7}$$

A household is indifferent between searching and not searching area a if this quantity is equal to utility at origin, $\upsilon_{i,o}$. Such indifference condition defines *reservation utility* associated with area a for household i, denoted by $\widetilde{\upsilon}_{i,a}$. If $\upsilon_{i,o}=\widetilde{\upsilon}_{i,a}$, then household i is indifferent between searching and not searching area a. Thus, by definition:

$$\widetilde{\upsilon}_{i,a}=\widetilde{\upsilon}_{i,a}\int_{-\infty}^{\widetilde{\upsilon}_{i,a}} dG_{i,a}\left(W\right)+\int_{\widetilde{\upsilon}_{i,a}}^{+\infty} W dG_{i,a}\left(W\right)-s_{i,a}, \tag{8}$$

which may be rewritten in the standard fashion for sequential search problems as:

$$\int_{\widetilde{\upsilon}_{i,a}}^{+\infty}\left[W-\widetilde{\upsilon}_{i,a}\right] dG_{i,a}\left(W\right)=s_{i,a}. \tag{9}$$

The LHS of equation (9) is a monotonically decreasing function of $\widetilde{\upsilon}_{i,a}$ and satisfies limit conditions at the boundaries of the support of maximum utility attainable by searching area a. Therefore, reservation utility $\widetilde{\upsilon}_{i,a}$ exists and is unique.

[8] We use the metaphor of "visiting" a neighborhood as a description of a more general process. For example, walking around a neighborhood or talking to acquaintances or real estate agents provide a lot of information about neighborhood characteristics.

Weitzman (1979) establishes that in this model the optimal search strategy is nested and is fully characterized by a *selection rule* and a *stopping rule*. The *selection rule* is: if an area a is to be searched by household i, it should be the one with the highest reservation utility among those not yet searched. Therefore, denoting by $\widetilde{\upsilon}_{i,n}$ the reservation utility of the n^{th} area in the optimal ranking, after $n-1$ steps the n^{th} area is searched if and only if:

$$\upsilon_{i,o} \leq \widetilde{\upsilon}_{i,n}. \tag{10}$$

If this condition is satisfied, the household searches within area n. At this second stage, the order in which locations are visited is irrelevant and the solution is fully characterized by a reservation utility strategy. Weitzman (1979) proves that the reservation utility for searching within an area is the same as the reservation utility of that area defined for searching among areas, i.e., is implicitly defined by equation (9).[9]

The *stopping rule* requires that household i stops when it finds a location for which realized utility exceeds the reservation utility of its best alternative as of that point. That is, at the n^{th} step, conditional on searching, the household moves to destination d if and only if

$$\upsilon_{i,d} \geq \widetilde{\upsilon}_{i,n}. \tag{12}$$

Taken together, rules (10) and (12), form what Weitzman (1979) labels *Pandora's Rule* for a nested search process.[10] It follows that, conditional on stopping the search process in area a, the probability that household i leaves its current location, o, and chooses a specific destination d, denoted $P_{i,o,d}$, is given by:

[9]The proof is straightforward. Suppose that, after $(n-1)$ steps, household i wants to visit locations within area n. That is, condition (10) is satisfied. The appropriate state variable is utility of origin. The value of searching within area n, given $\upsilon_{i,o}$, $\Psi(\upsilon_{i,o})$, satisfies the Bellman equation:

$$\Psi\left(\upsilon_{i,o}\right) = \max\left\{\upsilon_{i,o}, \mathbb{E}\left[\max_{g\in a}\left\{\upsilon_{i,g} - \mu\left(o,g\right)\right\}\right] - s_{i,a}\right\}\ , \tag{11}$$

which implies a reservation utility of exactly $\widetilde{\upsilon}_{i,a}$.

[10]If areas were composed of a single location, *Pandora's Stopping Rule*, would require that a household stop when it finds a location whose utility exceeds the reservation utility of all areas not yet visited, or when utility of its current location, i.e. origin, satisfies this same condition. It is easy to see that when areas are composed of multiple locations, which is the case in our model, then the rule reduces to (10) and (12) taken together. This follows immediately if one interprets a single location as a degenerate area, i.e. a singleton. See Weitzman (1979) for the proof of optimality of *Pandora's Rule*.

$$P_{i,o,d} = \Pr\left(\upsilon_{i,o} \leq \widetilde{\upsilon}_{i,a} \leq \upsilon_{i,d}\right). \tag{13}$$

This equation defines household i's transition probabilities, which determine equilibrium flows across neighborhoods in a given area. The model features three types of equilibrium variables: housing rents, r_g; wages, w_g; and contextual variables that are defined as the location-specific averages of individual characteristics, $\mathbb{E}[X_i|g]$ that are also included in Y_g. These variables are exogenous to the individuals but endogenous in the sense that they are determined at equilibrium based on individuals' decisions, as we illustrate next.

Rents are determined by the interplay of demand and supply of housing in each location, given the housing stock. Let $Y_{g\backslash y}$ denote the "reduced" contextual vector of location g obtained from Y_g after removing particular variable(s) $y \in Y_g$. For any neighborhood g in area a, the expected inflow of residents at a steady state, I_g, is given by:

$$I_g\left(r_g, \mathbf{r}_{-g}, \mathbf{Y}_{\backslash r}\right) = \sum_i \sum_\gamma P_{i,\gamma,g}, \tag{14}$$

where γ denotes an index of summation over all neighborhoods of origin, $\mathbf{r}_{-g}$ denotes the vector of prices for all locations other than g, and $\mathbf{Y}_{\backslash r}$ stacks the "reduced" vectors of contextual characteristics. Similarly, the expected outflow, O_g, is given by:

$$O_g\left(r_g, \mathbf{r}_{-g}, \mathbf{Y}_{\backslash r}\right) = \sum_i \sum_\gamma P_{i,g,\gamma}, \tag{15}$$

a quantity that increases with r_g. Denote with N_g the fixed number of housing units available at location g in the short run. Equilibrium requires zero excess housing demand, i.e.:

$$I_g\left(r_g, \mathbf{r}_{-g}, \mathbf{Y}_{/r}\right) - O_g\left(r_g, \mathbf{r}_{-g}, \mathbf{Y}_{/r}\right) - N_g = 0\ . \tag{16}$$

The LHS of (16) is monotonically decreasing in r_g. Therefore, by the intermediate value theorem, there exists a market-clearing rent level in every neighborhood, given rents at other locations. Because all locations are gross substitutes, a unique equilibrium vector of rents exists and is a function of characteristics in all neighborhoods. That is, rents are hedonic prices that also contain a "social premium" (Zanella, 2007).

As for wages, they are determined at the level of local labor markets, which are indexed by A and which consist of a collection of adjacent areas. Transition probabilities from equation (13) decrease with the wage rate at origin and increase with that at destination. Assuming competitive labor markets and denoting by ω_A the rental rate of mean human capital in labor market A (which includes neighborhood g), we can express the wage rate as:

$$w_g = w_A = N_A^{-1}\omega_A \sum_{a\in A}\sum_{g\in a}\sum_i \sum_\gamma (P_{i,\gamma,g} - P_{i,g,\gamma})h_i, \tag{17}$$

where N_A^{-1} is the expected number of households in area A. Both $P_{i,\gamma,g}$ and $P_{i,g,\gamma}$ on the RHS above contain w_g. Therefore, the equilibrium wages rate is a fixed point of (17).[11]

The remaining contextual variables in Y_g are determined by households' holding rational expectations over the future compositions of neighborhoods. This allows us to define the j^{th} contextual variable $y_g^j \in Y_g$ as the neighborhood average of the respective individual level variable $x_i^j \in X_i$, which is determined implicitly as a fixed point of:

$$y_g^j = N_g^{-1} \sum_i \sum_\gamma (P_{i,\gamma,g} - P_{i,g,\gamma})x_i^j. \tag{18}$$

An equilibrium is defined as the set of values of consumption, socialization effort, study effort, probability distributions governing transitions across neighborhoods, and a set of rents, wages, and other neighborhood characteristics such that: parents maximize utility given their budget constraints, children maximize their net human capital, and the housing and labor markets clear.

The empirical analysis that follows aims at testing theoretical predictions about the impact of neighborhood attributes on equilibrium transition probabilities, as defined by equation (13). It is a test of necessary conditions of neighborhood effects theories. We next present the data set, the econometric model, and the results.

[11]Since the RHS of equation (17) is increasing in w_g, we cannot rule out the possibility of multiple equilibria. This problem is beyond the scope of the paper, so we assume that the equilibrium is unique.

4 Empirics

4.1 Data

Our sample consists of 6,432 households from the Panel Study of Income Dynamics (PSID), which we follow for two successive waves, 2001 and 2003. We choose these waves because they can be naturally matched with the 2000 US Census, which provides proxies for the contextual variables that feature in our theoretical model. Thus, for each household in the sample, we have detailed information on individual and neighborhood characteristics in both periods, down to the Census tract level of disaggregation, thanks to access to confidential geocodes. Census tracts are defined by the US Bureau of the Census as relatively homogeneous units with respect to population characteristics, economic status, and living conditions. In our sample they average 5,200 inhabitants, with a standard deviation of 2,450. Therefore, they are a reasonable and indeed very popular choice as a concept of neighborhood.[12]

Individual-level data from the PSID are merged with the 2000 Census tract-level data, assuming that the population means estimated with the US Census in 2000 approximate well the respective ones for 2001 and 2003. We also use Census maps to associate each tract with area-level information. A tract's area is defined as the set of Census tracts surrounding it.[13] The resulting data set contains: (*i*) individual characteristics; (*ii*) contextual variables in the Census tract of origin (2001 wave); (*iii*) contextual variables in the Census tract of destination (2003 wave); (*iv*) contextual variables in the areas that contain origin and destination.

Table 1 reports sample statistics of household-level variables, for the full sample and by whether children younger than 18 were present in the household in 2001 or not. About 1/5 of households moved between January 1, 2002 and the interview date in 2003.[14] Movers were

[12]This is the reason why they have been used so in the past by other researchers, e.g., Kremer (1997) and Weinberg *et al.* (2004).

[13]We are deeply grateful to Dr. Yelena Ogneva-Himmelberger and the staff of the Tufts GIS Lab for their priceless help with this step.

[14]Two data issues arise when identifying movers. First, 260 households (4% of the sample) report in 2003 that they did not move in the above period, but live in a Census tract that is different from that of day of interview in 2001. We treat this as misreporting and classify these 260 households as movers. On the other hand, 621 households (9.7% of the sample) report in 2003 that they had moved but are found in the same location as in 2001. This is either misreporting or that households in question moved *within* Census tracts.

Table 1: Household-level sample statistics

	All households		With children		Without children	
	Mean	SD	Mean	SD	Mean	SD
Age	49.3	(16.3)	40.7	(9.2)	53.7	(17.4)
White	0.792	(0.406)	0.710	(0.454)	0.834	(0.372)
Black	0.124	(0.330)	0.153	(0.360)	0.109	(0.312)
Hispanic	0.057	(0.232)	0.112	(0.315)	0.029	(0.168)
Asian	0.021	(0.144)	0.031	(0.174)	0.016	(0.126)
Dropout	0.180	(0.384)	0.184	(0.388)	0.178	(0.383)
High School	0.321	(0.467)	0.323	(0.468)	0.321	(0.467)
Some college	0.173	(0.378)	0.181	(0.385)	0.168	(0.374)
College or more	0.326	(0.469)	0.312	(0.463)	0.333	(0.471)
Number of children	0.63	(1.05)	1.87	(0.96)	–	–
Total income	66.3	(86.4)	78.2	(99.0)	60.3	(78.6)
Homeowner	0.662	(0.473)	0.694	(0.461)	0.646	(0.478)
Mover	0.219	(0.414)	0.212	(0.409)	0.223	(0.416)
for work reasons	0.056	(0.230)	0.080	(0.271)	0.044	(0.206)
for housing reasons	0.319	(0.466)	0.345	(0.476)	0.306	(0.461)
for neighborhood reasons	0.073	(0.261)	0.067	(0.251)	0.076	(0.266)
for involuntary reasons	0.122	(0.328)	0.142	(0.349)	0.113	(0.317)
N	6,432		3,036		3,396	

Notes: The table reports means and standard deviations (SD) of household-level variable from the 2001 wave of the Panel Study of Income Dynamics (PSID). Sampling weights are applied. Ethnic group and education variables refer to household head or spouse; age refers to household head only. Total family income is expressed in thousands of dollars (2000 values).

asked the reasons why they moved. The table reports the incidence of different motives that were first mentioned, conditional on having moved. About one third of movers did so for housing reasons (expansion/contraction of housing: more/less space; more/less rent; better place), although about 7% of movers mention a neighborhood reason (better neighborhood; go to school; to be closer to friends and/or relatives) at the main driver. In practice, these motives are hard to disentangle as a move may eventually be prompted by their interaction.

As summarized in Table 2, the data provide proxies of the model's variables. Parents' and neighborhood human capital are proxied by, respectively, a dummy indicating if either parent has at least a high school degree and the corresponding Census tract share. Income is family income, while at the tract level we use median household income to neutralize outliers.

Since we are interested in moves across Census tracts, these households are reclassified as non-movers. With these adjustments, movers across Census tracts comprise 21.9% of the final sample, as reported in Table 1.

Table 2: Proxies of model variables

Model variable	Description	Individual	Neighborhood
h, h_g	human capital (HC)	high school or more	% high school or more
m_g	income	total family income	median income
θ, ϕ_g^θ	cultural trait	ethnic group dummies	% in own ethnic group
ω_A	return on HC	–	state fixed-effects
r_g	housing price	–	estimated median rent

Notes: The table summarizes our empirical proxies for variables that feature in the theoretical model.

Cultural traits are proxied by the main ethnic groups as defined by the US Census: White Non-Hispanic, Black Non-Hispanic, Hispanic, and Asian. Only a handful of observations do not belong to any of these groups. We classify a household as belonging to one of these groups if either the household head or spouse does. The neighborhood shares of such traits are measured by associating with each household in the sample the percentage of population in its tract belonging to the same ethnic group (or groups, in case of cross-group partners). Finally, the rate of return on human capital is proxied by state fixed effect, while the housing price is constructed by associating renters with the median rental price in a tract—which is readily available in the Census—and owners with the median value of a house converted into rental value in order to make renter- and owner-occupied housing units comparable.[15]

4.2 Econometric model

Note that by using definition (5) in equation (13), the latter can be written as

$$\begin{aligned} P_{i,o,d} &= \Pr(\widetilde{v}_{i,a} \geq V(X_i, Y_o) + \epsilon_{i,o} \ , \ \widetilde{v}_{i,a} \leq V(X_i, Y_d) + \epsilon_{i,d}) \\ &= \mathcal{F}(\widetilde{v}_{i,a} - V(X_i, Y_o) \ , \ V(X_i, Y_d) - \widetilde{v}_{i,a}). \end{aligned} \tag{19}$$

where $\mathcal{F}$ is the joint cumulative distribution of $\epsilon_{i,o}$ and $-\epsilon_{i,d}$. Structural estimation of these probabilities is not possible because nothing about the steps involved in search is observed, unlike problems treated in the recent econometrics of search literature (Seiler *et al.*, 2023).

[15]Conversion follows Bayer *et. al* (2007) closely. One can regress the log of price (pooling rents and values) on a dummy indicating whether the unit is owner-occupied and a number of variables controlling for the characteristics of the house and the neighborhood. The exponential of the coefficient on the onwer-occupied dummy is the conversion factor, i.e. an estimate of the ratio between values and rents.

However, we observe the last area that a household visited (this is the area where the chosen neighborhood, d, is located) and whether it moved or not (i.e., whether $d \neq o$ or not). Thus, conditional on this last area being visited (i.e., given $\widetilde{v}_{i,a}$), we can take a "reduced-form" route to testing the empirical relation between residential mobility and the contextual neighborhood characteristics at origin (Y_o) and destination (Y_d) that feature in equation (19). To this end, it is convenient to employ a linear probability model:

$$P_{i,o,d} = \alpha + \beta_{i,o} Y_o + \beta_{i,d} Y_d + \gamma_i X_i + \eta_{i,o,d}. \tag{20}$$

The signs of the coefficients of pairs of the same contextual variables associated with origin and with destination, respectively, in this equation have intuitively appealing interpretations. If coefficient $\beta^j_{i,o} \in \beta_{i,o}$ is negative (positive), the associated contextual variable, $y^j_o \in Y_o$, is an attractor (repeller) for household i: larger values decrease (increase) the probability that the household leaves a neighborhood. Similarly, if a coefficient in $\beta^j_{i,d} \in \beta_{i,d}$ is positive (negative), then $y^j_d \in Y_d$ is an attractor (repeller) for household i: larger values increase (decrease) the probability that the household chooses a given neighborhood.

In our theoretical model, the only structural difference between households that induces heterogeneity in these coefficients is whether or not there are young children in the household, in which case the value of the process, equation (5), should be directly affected by neighborhood attributes that are salient for the acquisition of human capital by children and in the transmission of own cultural traits to them. Therefore, households are classified into one of two distinct "regimes" according to whether there are young children living in the household (regime 0) or not (regime 1) at the interview date in 2003.[16] Since these two states are mutually exclusive, we can write equation (20) as:

$$\begin{aligned} P_{i,o,d} &= \mathbb{I}[\text{regime } 0]\,[\alpha_0 + \beta_{0,o} Y_o + \beta_{0,d} Y_d + \gamma_0 X_i] \\ &+ \mathbb{I}[\text{regime } 1]\,[\alpha_1 + \beta_{1,o} Y_o + \beta_{1,d} Y_d + \gamma_1 X_i] + \eta_{i,o,d}. \end{aligned} \tag{21}$$

Note that we do not model fertility choice, i.e., we assume that the two regimes are exogenous—

[16] In this way, we allow that young parents without children in 2001 may anticipate having children, and older parents who have children living with them in 2001, though not in 2003, to make residential choices in transition from one regime to the other.

even if Table 1 shows important differences in observables across them. Yet, even under this assumption, "reduced-form" identification requires instrumenting housing prices and neighborhood characteristics, both at origin and destination. It is the essence of our approach that socioeconomic characteristics of neighborhoods are the outcome of purposeful decision making by their residents, and so are correlated with unobserved components of preferences. An additional major source of endogeneity is simultaneity, since the object of estimation is actually the system of simultaneous equations derived from general equilibrium.

We construct instruments following our model's spatial structure, i.e., exploiting information on the characteristics of the set of neighborhoods surrounding any particular neighborhood. Specifically, we average the characteristics of such surrounding locations, including prices, and use them as instruments for the corresponding characteristics in the neighborhood of residence. It is intuitive that the characteristics of neighboring locations *within* a given area are correlated. On the other hand, as long as all relevant interactions take place within neighborhoods with no cross-neighborhood effects, the characteristics of surrounding locations are uncorrelated with the utility that a household derives from living in a given neighborhood. In this case, the other neighborhoods in the area are like "exogenous" objects, and the variation in their average characteristics across alternative locations can be used as a proxy for exogenous variations in neighborhood attributes. As reported earlier in this section, Census tracts are large enough to make the "no cross-neighborhood effects" assumption plausible. Note that, as far as prices are concerned, our instrumental variables strategy is equivalent to the one suggested by Berry, Levinsohn, and Pakes (1995). The characteristics of surrounding locations (i.e., substitute "products") are valid instruments for the rental price in a given neighborhood because prices will be lower in neighborhoods that face good substitutes in a given area.

4.3 Results

Table 3 reports the results from OLS and 2SLS estimation of equation (21). Considering 2SLS results, the percentage of individuals in the neighborhood with at least a high-school degree and median income are both significant attractors for households with young children, but have no effect on households without, in line with the theory. On the other hand, the percentage of individuals in the neighborhood who belong to one's own ethnic group appears to have no explanatory power: not only the coefficients are statistically insignificant, but the point estimates have the "wrong" sign. A possible interpretation of this null result in the light of the model is that the human capital motive dominates the cultural transmission motive. That is, parents' quest for desirable neighborhood effects in children's human capital formation dominates parents' desire to transmit their own cultural traits to children via exposure to these traits in the neighborhood. As noted in Section 3, parents' preferences over their children's human capital and cultural identity may clash. For example, these two motives may pose a trade-off to disadvantaged minorities who are characterized by below-average educational attainment in the population, forcing parents who value children's human capital to statistically discriminate against neighborhoods where their own cultural trait is prevailing. Our estimates suggest that, on average, this trade-off is resolved in favor of the human capital motive. This observation implies that parents not exposing their children to otherwise desirable cultural influences in the neighborhood may exert extra, within-family cultural socialization effort, i.e., enagage in *cultural substitution* (Bisin and Verdier, 2011). Indeed, we think that this result expresses an outcome of a genuine dilemma facing ethnic minority households anxious to equip their children with the potential for upward mobility.

As for housing prices, the 2SLS point estimates are too imprecise to allow for reliable conclusions. However, we note that the sign of point estimates across the two type of households is in line with our theory. A possible interpretation of these imprecise estimates is that rents are market prices but also hedonic prices that reflect other desirable neighborhood characteristics that we do not model explicitly. For example, we lack spatially detailed information about such important variables as crime and about local amenities that may attract different types of households. The inclusion of these hedonic prices in our regression may capture the effect of such unobservables on transition probabilities, on top of the impact of rents on households' budget constraints.

Table 3: Results of OLS and 2SLS estimation

	With children		Without children	
	OLS	2SLS	OLS	2SLS
% High school, origin (h_o)	−0.721	−0.538	0.116	0.066
	(0.154)	(0.240)	(0.145)	(0.220)
% High school, destination (h_d)	0.957	0.703	0.173	0.319
	(0.155)	(0.239)	(0.144)	(0.215)
Median income, origin (m_o)	0.003	−0.065	−0.026	−0.013
	(0.014)	(0.028)	(0.011)	(0.019)
Median income, destination (m_d)	−0.015	0.065	0.020	0.021
	(0.014)	(0.027)	(0.011)	(0.019)
% Own ethnic group, origin (ϕ_o^θ)	0.036	0.054	−0.116	−0.098
	(0.064)	(0.085)	(0.062)	(0.086)
% Own ethnic group, destination (ϕ_d^θ)	−0.108	−0.114	0.014	−0.034
	(0.064)	(0.084)	(0.061)	(0.085)
Housing price, origin (r_o)	−0.129	0.088	0.029	0.013
	(0.062)	(0.104)	(0.065)	(0.098)
Housing price, destination (r_d)	0.138	−0.129	−0.044	−0.094
	(0.059)	(0.101)	(0.065)	(0.098)
Household covariates	Yes	Yes	Yes	Yes
State-of-origin fixed effects	Yes	Yes	Yes	Yes
State-of-destination fixed effects	Yes	Yes	Yes	Yes
N	2,919	2,919	3,513	3,513

Notes: The table reports the regression coefficients in equation (21) estimated via OLS and 2SLS by splitting the sample. 2SLS uses area-level means of the corresponding tract-level variables as excluded instrumental variables. The dependent variable is whether a household moved between Jan 1, 2002, and interview date in 2003. Regimes are determined by whether there are children younger than 18 in the household at the interview date in 2003. Household-level covariates and state fixed effects at origin and destination are always included. Standard errors in parentheses. Sample 6,432 households matche across the 2001 and 2003 waves of the Panel Study of Income Dynamics (PSID).

5 Conclusions

This paper takes seriously the argument that self-selection into residential locations is an opportunity for inference about neighborhood effects, because residential choices reveal preferences for the behavior and characteristics of neighbors. Our behavioral model allows households to search, subject to search frictions, for the best location when they recognize that neighborhoods affect their children's education and facilitate transmission of their own cultural identity. We have tested the ensuing relationship between mobility rates and contextual neighborhood characteristics using geocoded micro data from the PSID, merged with contextual information from the US Census, defining neighborhoods as Census tracts in accordance with other researchers.

Our key finding is twofold: (i) households with children—but not those without—tend to leave neighborhoods whose social attributes do not favor offspring's human capital and to move into neighborhoods which instead exhibit desirable such attributes—which is consistent with neighborhood effects theories; (ii) this human capital motive dominates the cultural transmission one—which strikes at the heart of the dilemma that ethnic minority households that reside in heterogeneous societies may face.

Many ethnic minority households in the US (and elsewhere) find desirable to pass on to their offspring their own cultural and ethnic values, while recognizing that however personally important that might be, it might clash with a general understanding of forces that are commonly understood as facilitating integration into the majority culture. Social and economic mobility typically depends critically on the acquisition of human capital, a force that may be more important on balance than the benefits that ethnic identity confer. Our findings depend on instrumental-variable estimation techniques that are well motivated in the context of our model. If such instruments are valid, then we have *prima facie* evidence of neighborhood effects. If they are not, we believe that our conclusion, however weaker, is still important: the residential choices of US families with young children exhibit a correlation with neighborhood characteristics that is consistent with the belief that social interactions, as measured here, matter.

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