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Can Housing Mobility Programs Make a Long-Term Impact on the Lives of Poor Families and the Health of Middle-Class Communities: A Policy Simulation

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Can Housing Mobility Programs Make a Large Difference in the Number of Poor Families and/or the Health of Middle-Class Communities: A Policy Simulation

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Abstract

Housing mobility programs enable families living in high-poverty neighborhoods to relocate to lower-poverty neighborhoods using tenant-based subsidies. Recent research indicates that these programs improve participant outcomes on a number of economic and social outcomes. Can such programs be run at a scale sufficient to help a large proportion of eligible families? Would doing so change the character of lower-poverty neighborhoods or have other macro demographic or economic effects? This paper applies policy simulation to a stylized representation of a housing mobility program to give a sense of scale and proportion for what a "full scale" mobility program might entail.

Results indicate that our system model reaches steady-state fairly quickly, that rates of concentrated poverty decrease more quickly than those for system-wide poverty, consistent with the notion of a housing mobility program as primarily a tool for poverty deconcentration. Destination communities absorb a substantial number of mobility in-movers without suffering substantial adverse demographic impacts, indicating that the "carrying capacity" of these communities may sufficient to support large-scale mobility initiatives. Middle-class flight per mobility family is moderately high and almost independent of housing mobility program intensity; selected sprawl-related social costs are relatively small. Sensitivity analyses show that the model behaves in predictable ways in response to changes to structural parameters. A "worst-case" scenario of parameter values still generates modest poverty reductions with moderate levels of poverty in destination communities but very high rates of middle-class "flight".

Keywords:

Policy simulation, housing mobility, policy modeling, poverty reduction

Introduction

Policy and Modeling Motivation

Access to housing that is affordable to low- and moderate-income families, of adequate quality, and in neighborhoods providing access to economic and social opportunity is a fundamental value in American housing policy (Millennial Housing Commission 2002). There are two broad strategies for improving housing options for poor families: (1) improving the housing stock in neighborhoods where those families now live and (2) enabling those families to relocate to neighborhoods with better-quality housing. For many years US housing policy focused on the first, but over the last two decades there has been greater interest in the second, particularly for people now living in areas of concentrated urban poverty.

However, housing policy for the poor is not limited to improving housing quality—it also addresses the need for families to live in neighborhoods that provide improved access to other amenities associated with beneficial family outcomes: educational opportunities, social and economic diversity, access to employment, and many others. One way to do this is via housing mobility programs, which subsidize moves from areas of concentrated poverty into other neighborhoods within the same metropolitan area. One argument for so-called “mobility” strategies rests on the belief that neighborhoods – specifically one’s neighbors – affect welfare and social mobility. The theory posits that disadvantaged families living in neighborhoods comprised almost entirely of other disadvantaged people fare less well than those same families would if they were surrounded by middle class neighbors. This could be true for a variety of reasons, ranging from direct assistance to social network or role model effects.

Housing mobility programs are in principle quite flexible. Destination neighborhoods could be working class, middle class, or even affluent. They could be within city limits or in the suburbs. The main restriction is that less than some specified maximum proportion of the residents in the destination neighborhood are disadvantaged so that the program succeeds in its basic objective of dispersing disadvantaged families out of pockets of concentrated poverty. Not all non-poor areas are viable destinations, however. Some are unavailable because they are physically distant, lack appropriate housing stock, or marshal effective political resistance to block placement of mobility families.

While the Housing Choice Voucher Program was not designed as a housing mobility program, its emphasis on individual choice of housing across entire regions has made it a crucial tool for housing mobility. Indeed, Section 8 subsidies (the predecessor to HCVP) were essential in enabling participants in the Gautreaux Assisted Housing Program residing in or on the waiting list for public housing in the city of Chicago to relocate to racially-integrated city and suburban neighborhoods. Section 8 played a similarly central role in the Moving to Opportunity for Fair Housing Demonstration Program (MTO).

Briggs (2005), citing promising evaluation results of housing mobility programs, advocates significant expansion of well-designed, metropolitan-wide housing mobility programs. Could housing mobility programs generate positive net social benefits if they were made available to large numbers of families? One challenge in answering this question is the difference in scale between HCVP and mobility programs: HCVP served about 1.46 million families in 1997 (Olsen 2003) while over 22 years the Gautreaux Program enabled only about 7,100 families to relocate using Section 8 vouchers out of perhaps 35,000 eligible applicants (DeLuca and Rosenbaum 2003). MTO was even smaller, helping about 1,600 families to relocate out of 4,600 families who have participated in the program (Orr, *et al*. 2003). Potential nonlinear effects in housing mobility program outcomes, both positive (upward social mobility) or negative (middle-class "flight" from neighborhoods serving as destinations for mobility program participants) makes simple extrapolation from these small studies impossible.

Traditional empirical methods are not helpful for evaluating outcomes of a mobility program operated "at scale" for the simple reason that – unless one thinks of HCVP as a mobility program –there have never been any truly large scale implementations of mobility programs. This does not preclude all analysis, however. In this paper, we apply some simple methods from systems analysis to provide a framework for thinking through matters of scale. These models are "what if" tools that provide order-of-magnitude estimates for social outcomes associated with stylized housing mobility programs operated in generic metropolitan areas at different intensities. Our goal is not to determine whether large-scale mobility programs would be good policy (Goetz (2006) identifies a number of practical obstacles to large-scale mobility initiatives) or even to predict what would happen if they were pursued. Rather, it is simply to give a sense of scale and proportion for social outcomes of large-scale housing mobility programs.

Policy and Literature Review

This paper uses results from descriptive and prescriptive research addressing movements of households over space and class, which are briefly reviewed here. The Housing Choice Voucher program (HCVP, formerly the Section 8 program) allows low-income families to find rental housing that met certain minimum quality and contract rent requirements. Newman and Schnare (1997) have shown that families using Section 8 tenant-based subsidies live in lower-poverty neighborhoods than families in public housing, and that neighborhoods in which Section 8 units are sited have lower poverty rates on average than those containing public housing, or those containing rental units of any kind. However, HCVP is not a housing mobility program: it was not designed to encourage, or provide resources to enable families from high-poverty neighborhoods to relocate to specific types of destination communities.

The first *housing mobility* initiative in the U.S. is generally considered to be the Gautreaux Assisted Housing Program. Between 1976 and 1998, the Gautreaux Program enabled black families in or on the waiting list for public housing in the city of Chicago to relocate to neighborhoods in the city of Chicago or its suburbs whose populations were not more than 30 percent black. Numerous evaluations have demonstrated high levels of satisfaction with destination communities, high levels of persistence in integrated neighborhoods, and improved levels of educational attainment and labor market participation, especially for those participants who moved to suburban neighborhoods (Rosenbaum 1995, Rubinowitz and Rosenbaum 2000, DeLuca and Rosenbaum 2003).

The highest-profile housing mobility initiative since the Gautreaux Program has been the Moving to Opportunity for Fair Housing (MTO) national demonstration, started in 1994 by the U.S. Department of Housing and Urban Development. MTO intended for participants to relocate to low-poverty neighborhoods rather than those defined exclusively by race, and used an explicitly experimental design. MTO has been well-studied[1], and there are many findings of note.

[1] Goering et al. (1999) performed an initial evaluation focusing on administrative details and locational outcomes. Goering and Feins (2003) and Johnson, Ladd and Ludwig (2002) address family and neighborhood impacts after the

First, experimental-group participants, required to move to low-poverty neighborhoods, and Section 8 participants, allowed to use housing vouchers without locational constraints, relocated to neighborhoods that were significantly lower-poverty than those in the control group (though more so, by design, for experimental-group participants). Destination neighborhoods for non-control group members tended to be predominately minority, though not at the levels of control group neighborhoods. Second, MTO participants, whose motivations to relocate were driven primarily by fears of criminal victimization, felt their destination neighborhoods to be safer and friendlier, and their new housing to be of higher quality, than was the case before moving. Third, measures of changes in life outcomes have been mixed. Generally, many beneficial impacts measured in the initial set of studies, including improved measures of mental health, reduced levels of welfare receipt, improved educational outcomes, reduced levels of violent criminal offending and reduced levels of punitive or restrictive parenting, were moderated or not statistically significant at the mid-term evaluation.

Household mobility addresses the process by which families decide to move and, given a decision to move, the choice of destination neighborhood or region. Theories of family migration have evolved from simple applications of the gravity model to more behaviorally-oriented approaches in which the mobility decision is a function of factors associated with the areas of origin and destination, intervening obstacles and personal factors (Cadwallader 1992). Mover-stayer-type models postulate a threshold level of stress before a family considers moving and then, given a decision to move, a cost-benefit calculation is made in which families rank potential destination regions (Speare, Goldstein and Frey 1975). Descriptive research in migration has focused on path analysis to distinguish between direct effects, indirect effects, associated causes, and common causes (Cadwallader 1992).

Housing mobility planning models link descriptive research in housing mobility and household mobility to practice. To identify long-term outcomes associated housing mobility programs, Caulkins *et al*. (2005*a*, *b*) use stylized representations of populations and regions in the context of dynamic optimization models.

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first few years of placements. Popkin, Harris and Cunningham (2001) and Orr, *et al*. (2003) evaluate impacts after five years of placements using qualitative and quantitative methods, respectively.

These models generate trajectories over time and populations of groups affected by housing mobility initiatives, and identify conditions under which systems can become stable or remain unstable. In the medium term, planning models with greater spatial specificity and programmatic detail can enable affordable housing providers to generate alternative distributions of housing units, or of families who might rent housing using vouchers (see e.g. Johnson 2003, 2006a,b). Housing mobility planning decision support systems (DSS) such as (Johnson 2001b) enable planners to visualize alternative housing policies in order to identify most-preferred strategies. In the short term, housing mobility counseling DSS (Johnson 2005) may enable program participants to identify and rank relocation alternatives consistent with their values and resources.

Paper Structure

The format of the paper is as follows. We first describe a conventional "static" analysis of a housing mobility program. Next, we develop the policy simulation model, including states, state equations and parameter values. We then solve the underlying dynamic model and present steady-state results (as if the housing mobility program has run indefinitely at specific intensity levels). We then present transient results (showing the system's evolution to steady state) and perform sensitivity analysis. Next, we discuss modeling and policy implications. Finally, we conclude and identify issues for further research.

Static Policy Analysis

The model we develop in this paper is applied to a hypothetical metropolitan area that is representative of metropolitan areas nationwide. 2000 Census data suggest that about 3.1% of Americans in metropolitan areas (about 7.04 million persons) live in concentrated poverty (Jargowsky 2003). As noted in the previous section, mobility programs operate on such a small scale that they now include a negligible proportion of the overall US population.

To answer questions concerning housing mobility programs we differentiate between four populations whose levels we denote by capital letters as follows.

P = poor people living in areas of concentrated urban poverty,

M = mobility program participants,

N = people living in potential destination (“near”) neighborhoods who are not program participants, and

F = people living in neighborhoods that are not available to (“far” from) program participants.

Note that physical distance between persons in the different groups represents part but not all of the distinction between the two groups. Later in this paper we discuss the implications of such a simple model of neighborhoods and opportunities.

What are the demographic characteristics of the *P* group? While minority populations are likely to be disproportionately represented, as was the case for previous housing mobility programs, whites may be represented more broadly than conventional wisdom might indicate. For example, using Census 2000 data, Jargowsky (2003) shows that about 39% of all residents of concentrated poverty neighborhoods are African-American, 29% are Hispanic, 24% are white and 8% are Asian or another racial/ethnic classification.

The division of the remaining 97% of the U.S. population in metropolitan areas between areas that are or are not available for placing mobility program families is more subjective. The near/far split reflects not only physical geography but also housing stock constraints and policymaker beliefs about the proportion of non-concentrated urban poverty areas that would be inhospitable to a large-scale mobility program. The interim MTO evaluation notes that while more than half of the low-poverty tracts into which participants relocated with vouchers were outside the central cities of the five study regions (Orr, *et al*. 2003, p. 32), census tracts that served as initial destinations had high concentrations of minority populations (p. 37)—fractions similar to, and sometimes greater, than those of the central city overall and much higher than the metropolitan area average. Also, among families who leased up, almost 70 percent of the children attended schools in the same district as the one they attended at baseline, i.e. city school districts (p. 113). Thus, "near" neighborhoods can be treated as non-poor central-city neighborhoods, plus non-poor suburban neighborhoods similar demographically to central cities generally.

According to the March 1999 and 2000 Current Population Surveys (U.S. Bureau of the Census 2005), about 34% of non-poor Americans in metropolitan areas live in central cities. Rounding up to include near suburban neighborhoods, we assume that 40%*97% = 39% of the U.S. metropolitan-area population lives in neighborhoods that are plausible destinations for mobility program participants, while the remaining 58% are in areas that are "far", socially and/or geographically.

Negative reactions by residents of neighborhoods serving as destinations for mobility program participants are a potential concern[2]. Negative reactions to visible and large-scale mobility programs can take many forms: lobbying political leaders, public demonstrations, or relocation to more-distant or more homogeneous communities. In this paper we focus on the last.

Quantifying the magnitude of such middle-class "flight" is challenging. Smith and Crowder (1997) find little conclusive evidence supporting the white-flight hypothesis from central cities to suburban areas. Freeman and Rohe (2000) also find little support for white "flight" from communities in which significant levels of investment in assisted housing occurred. However, Betts and Fairlie (2003) show that one native-born person moves out of a school district for every four immigrants entering. Also, Gould Ellen (2000, p. 124 - 125) presents evidence that white residents of communities into which blacks move react more to changes in the level of minority population (a possibility that Smith and Crowder acknowledge) then to absolute levels of minority population. Moreover, Gould Ellen concludes that white residents appear to react similarly to a growing and affluent black population as to a growing and poor black population, and that these reactions are relatively insensitive to the income level of white residents (p.

[2] The Gautreaux Program was originally intended to include a significant project-based housing component in majority-white neighborhoods. However, due to excessive costs and local opposition, relatively little such housing was built, most of it in majority-Hispanic communities (Rubinowitz and Rosenbaum 2000). The Sanders Consent Decree, a remedy to historical discrimination in the siting of subsidized housing in Allegheny County, PA, had as one component the location of a few hundred units of project-based housing in a large number of suburban communities. This task encountered substantial popular opposition, and ran over budget and behind schedule (Martin and Johnson 1999).

124). We believe that the evidence is weakly supportive of a "flight" reaction to housing mobility programs, especially those that might annually serve client populations at a much higher rate than the MTO or Gautreaux programs.

Assume, then, that β families in N neighborhoods "flee" to F neighborhoods for every program family placed. Then a naïve analysis might imagine that the consequence of moving a proportion f of families living in concentrated urban poverty to N neighborhoods is that the new population distribution would be as follows, where the 0 subscript denotes an initial population size:

$$P = (1 - f)\, P_0 \tag{1}$$

$$M = f\, P_0 \tag{2}$$

$$N = N_0 - \beta f\, P_0 \tag{3}$$

$$F = F_0 + \beta f\, P_0 \tag{4}$$

The proportion of mobility program people living in N-type neighborhoods would be

$$f\, P_0 \,/\, (f\, P_0 + N_0 - \beta f\, P_0). \tag{5}$$

Using the initial population distribution above (P_0 = 3%, N_0 = 39% and F_0 = 58%) and assuming based on Betts and Fairlie that β = 25%, this proportion would be $0.03\, f / (0.39 + 0.023\, f)$. But this implies that all concentrated urban poverty could be eliminated (all residents of P-type neighborhoods relocate as part of a housing mobility program) while only 7.3% of all families in N-type neighborhoods would be mobility program participants. This result is overly optimistic because we have not considered feedback effects, i.e. poor families who enjoy upward social mobility in the absence of a housing mobility program, mobility program participants who return to their neighborhoods of origin, and natural household mobility between residents of N- and F-type neighborhoods. We turn next to development of a dynamic model that incorporates those feedback effects.

Dynamic Policy Analysis

Stocks and Flows Model Structure

One useful method for capturing the dynamic effects omitted by the back of the envelope calculations is sometimes called “stocks and flows” modeling. These models keep track of the number of people or families in various conditions or “states”. Those are the stocks. They also track rates at which people or families flow or “transition” from one state to another.

Normally in systems analysis one is careful to view all stocks as functions of time. For instance, $M(t)$ would denote the number of mobility program participants at time t. However, it can be shown that the systems dynamics are very simple: there is a unique stable steady state to which all trajectories converge. Therefore, we focus on those long-run equilibrium levels.

The equilibrium number of people in each of the four states, P, M, N, and F will depend on how aggressively mobility programs are implemented. That intensity is a policy choice, or “control variable”, so we define

> u = proportion of people currently living in state P who participate in a mobility program each year.

For example, if $u = 0.10$, then every year one in ten people living in areas of concentrated urban poverty would relocate to N-type neighborhoods. One might at first think that with $u = 0.10$, concentrated poverty would be eradicated in ten years in the sense that the population in state P would be reduced to zero. That is not true for two reasons. First, reducing a stock by 10% each year for ten years doesn’t eliminate the stock because the second 10% reduction applies to a smaller base, the 90% who remain after the first year. So ten 10% reductions would leave the stock at $(1 – 10\%)^{\wedge 10}$ = 34.9% of its original level.

More fundamentally, though, there are other “flows” happening at the same time. Some people will move out of areas of concentrated poverty on their own, without participating in a mobility program. Conversely, there is downward social mobility with some people moving from middle-class neighborhoods into areas of concentrated poverty. There is also constant movement from neighborhood to neighborhood outside areas of concentrated poverty which in our model creates flows from state *N* to state *F* and back. In addition, we want to allow for the possibility of "middle class flight" in the sense that for every family mobility programs place in destination neighborhoods, β families flee from *N* to the "far" neighborhoods, *F*.

We might represent these flows by the arrows in the diagram labeled Figure 1.

[Figure 1: "Stocks and Flows" Diagram of Housing Mobility Program Effects]

All but one of the flows in Figure 1 are per capita rates, as is the control variable *u*. For example, r_{PN} represents the annual per capita rate at which people living in pockets of concentrated poverty move up or out into *N*-type neighborhoods. So the total number flowing along that path per year would be $r_{PN} * P$, not just r_{PN}. The exception is the βu flow from state *N* to state *F*. It is a reaction to the mobility program flow out of state *P*, so its total magnitude is $\beta u P$, not $\beta u N$.

Throughout we will assume that $r_{NP} = r_{FP}$ as that considerably simplifies the analysis. That is, downward social mobility into areas of concentrated urban poverty is similar from *N* as from *F* neighborhoods.

Dynamic Model in the Absence of a Mobility Program

To illustrate how the system of equations underpinning Figure 1 can be analyzed, consider first the simpler subset of Figure 1 that pertains when there is no mobility program. In that case, assuming there are not any families in the mobility program (state *M*) at the outset, there never will be any, and the system reduces to that depicted in Figure 2.

[Figure 2: State Transition Diagram When There Is No Mobility Program]

When a stocks and flows system is in steady state, the number of families flowing into a state must be exactly equal to the number flowing out, otherwise the population in that state would be changing and the system would not be in steady state. In Figure 2, the number of families flowing into state *F* is $r_{NF}\, N$ and the number flowing out is $(r_{\mathrm{FN}} + r_{\mathrm{FP}})\ F$. Equating those two flows, $r_{\mathrm{NF}}\ N = (r_{\mathrm{FN}} + r_{\mathrm{FP}})F$, implies that in steady state

$$F = N\ r_{NF} \,/\, (r_{FN} + r_{FP}). \tag{6}$$

Likewise the flows in and out of state P are $r_{\mathrm{NP}}\ (N + F)$ and $r_{\mathrm{PN}}\ P$, respectively, so in steady state

$$P = (N + F)\ r_{\mathrm{NP}} \,/\, r_{\mathrm{PN}}. \tag{7}$$

Finally, if there are no mobility programs then every family belongs to one of these three states, so

$$P + N + F = \text{total number of families.} \tag{8}$$

Equations (6) – (8) are three equations in the three unknowns P, N, and F, so they can be solved algebraically. It is convenient to "normalize" all quantities by expressing them as percentages of the total number of families, so the right-hand side of Equation becomes 100% or, equivalently, 1. Solving Equation (7) for $(N + F)$ in terms of P and substituting into Equation (8) we find

$$P + N + F = (1 + r_{\mathrm{PN}} \,/\, r_{\mathrm{NP}})\ P = ((r_{\mathrm{NP}} + r_{\mathrm{PN}}) \,/\, r_{\mathrm{NP}})\ P = 1, \tag{9}$$

so

$$P = r_{\mathrm{NP}} \,/\, (r_{\mathrm{NP}} + r_{\mathrm{PN}}). \tag{10}$$

Hence, since $P + N + F = 1$,

$$N{+}F = r_{\mathrm{PN}} \,/\, (r_{\mathrm{NP}} + r_{\mathrm{PN}}). \tag{11}$$

Dividing that quantity $N{+}F$ between N and F individually as per Equation (6) yields

$$F = (r_{\mathrm{NF}} \,/\, (r_{\mathrm{FP}} + r_{\mathrm{FN}} + r_{\mathrm{NF}}))\ r_{\mathrm{PN}} \,/\, (r_{\mathrm{PN}} + r_{\mathrm{NP}}) \tag{12}$$

and

$$N = (r_{\mathrm{FP}} + r_{\mathrm{FN}}) \,/\, (r_{\mathrm{FP}} + r_{\mathrm{FN}} + r_{\mathrm{NF}}))\ r_{\mathrm{PN}} \,/\, (r_{\mathrm{PN}} + r_{\mathrm{NP}}). \tag{13}$$

Equations (11) – (13) "solve" the steady state of the system in the sense that if one knew the flow rates (r_{PN}, r_{NP}= r_{FP}, r_{NF}, and r_{FN}) one could compute what proportions of families would be living in each of the three states. In practice, measuring flow rates is hard, but counting the number of families in each state is not. Therefore, we use Equations (11) – (13) in reverse by assuming that the current population distribution is in a no-program steady state. With that assumption we can use the observed proportions of families living in states *P*, *N*, and *F* (from the previous section) to draw some inferences about the flow rates.

Three equations are insufficient to determine four unknown flow rates, so more information is needed. Since the over-riding goal of housing mobility programs is to increase the rate of upward social mobility out of concentrated poverty, it makes sense to specify *a priori* that flow rate (r_{PN}). In this paper, "upward social mobility" is interpreted as an individual's transition from long and continuous periods in poverty to long and continuous periods out of poverty.

If upward social mobility out of regions of concentrated poverty were high, there would be little need for or interest in government intervention. For example, if children born into concentrated poverty had a good chance of escaping it, many taxpayers might be forgiven for wanting to let the market resolve the problem of concentrated poverty. So presumably $r_{\mathrm{PN}} < 4\%$, implying that the average time to upward social mobility is more than 25 years or one generation. Defining a particular value for r_{PN} is difficult, because the length of time children spend in poverty is influenced by race, ethnicity, family income, family composition and other factors. Moreover, children may exit and enter poverty multiple times during their childhood and early adulthood, and long-term poverty is not synonymous with residence in concentrated-poverty neighborhoods (Corcoran and Choudhry 1997).

Given the stylized nature of this modeling exercise, and the fact that typical participants in the housing mobility program we model are minority families living in concentrated poverty neighborhoods, we take as our base case value that r_{PN} is half as large, or $r_{PN} = 2\%$, implying that in the absence of government intervention it would take families an average of two generations to escape concentrated poverty. We will later explore the implications of assuming other values through sensitivity analysis. Then from Equation (7), $r_{\mathrm{NP}} = r_{\mathrm{FP}} = r_{\mathrm{PN}} * P / (N+F) = 2\% * 3\% / 97\% = 0.062\%$.

Likewise, we can use data concerning the frequency of moves and/or tenure plus the sizes of the *F* and *N* population to sort out r_{FN} and r_{NF}. As the focus of this paper is on a stylized representative U.S. metropolitan area, our concern is with households that move within metropolitan areas as opposed to households that move between metropolitan areas. Unfortunately, recent Census data on mobility and migration focuses on moves within counties and between counties and states (U.S. Bureau of the Census 2004). Annually about 14.2% of Americans move, but not all of those moves are to a different type of state in terms of this model. This makes estimates of movement rates within and between states *N* and *F* for a typical metropolitan area difficult.

An alternative measure of geographic mobility can be derived from the results of South and Crowder (1997), who use the Panel Study of Income Dynamics between 1979 and 1985 to compute the probability that white households move from the suburbs to the central city over the study period as 0.023. This corresponds to a yearly rate of 0.39%[3]. Assuming that states *N* and *F* are populated by white families, and that state *F* represents suburbs while *N* represents the central city, we set r_{FN} = 0.39%. From equation (6), we compute r_{NF} = 0.67%.

Dynamic Model with Mobility Programs

Analysis of the full model in Figure 1 proceeds in a similar fashion, although the algebra becomes tedious and so is omitted[4]. Formally, the stocks and flows diagram in Figure 1 corresponds to a system of linear differential equations. For each state *S*, the rate of change in the level of that state, $\frac{dS}{dt}$, denoted $\dot{S}$, equals the sum of rates of flow into *S*, minus the sum of rates of flow out of *S*:

$$\dot{P} \;=\; r_{MP}\, M + r_{NP}\, N + r_{FP}\, F - \left(r_{PN} + u\right)P \tag{14}$$

[3] Let $\hat{r}$ denote the probability, or rate, of a given movement over *n* years, and let *r* denote the yearly equivalent probability or rate. *r* can be computed from $e^{-r*n} = 1 - \hat{r}$.

[4] For simplicity, we have omitted from the full model the consideration of mobility participant families who choose not to remain in their new housing and return to their original neighborhoods. Equations (18) – (21) can be modified in a straightforward way to include this “bounce” rate; however, there are few data available to estimate this parameter.

$$\dot{M} \quad = \quad u\,P - \left(r_{MP} + r_{MN}\right)M \tag{15}$$

$$\dot{N} \quad = \quad r_{PN}\,P + r_{MN}\,M + r_{FN}\,F - \left(r_{NP} + r_{NF}\right)N - \beta u\,P \tag{16}$$

$$\dot{F} \quad = \quad r_{NF}\,N + \beta\,u\,P - \left(r_{FN} + r_{FP}\right)F \tag{17}$$

This system (14) – (17) can be written more compactly in matrix notation as

$$\dot{X} \quad = \quad A \cdot X \tag{18}$$

where $X^{\mathrm{T}} = [P,\ M,\ N,\ F]$ and

$$A \quad = \quad \begin{bmatrix} -\left(r_{PN} + u\right) & r_{MP} & r_{NP} & r_{FP} \\ u & -\left(r_{MP} + r_{MN}\right) & 0 & 0 \\ r_{PN} - \beta u & r_{MN} & -\left(r_{NP} + r_{NF}\right) & r_{FN} \\ \beta u & 0 & r_{NF} & -\left(r_{FN} + r_{FP}\right) \end{bmatrix}. \tag{19}$$

Since matrix A is negative definite, the solution to the system (Tu 1992) is

$$X(t) \quad = \quad \hat{X} + \left(X_0 - \hat{X}\right)e^{At}, \tag{20}$$

where $X_0^{\mathrm{T}} = [P_0, M_0,\ N_0,\ F_0]$. The vector of (unique, stable) steady state values $\hat{X}$ can be shown to be:

$$\hat{P} \quad = \quad \frac{r_{NP}\left(r_{MP} + r_{MN}\right)}{\left(r_{NP} + r_{PN}\right)\left(r_{MP} + r_{MN}\right) + \left(r_{NP} + r_{MN}\right)u} \tag{21}$$

$$\hat{M} \quad = \quad \frac{r_{NP}\,u}{\left(r_{NP} + r_{PN}\right)\left(r_{MP} + r_{MN}\right) + \left(r_{NP} + r_{MN}\right)} \tag{22}$$

$$\hat{N} + \hat{F} \quad = \quad \frac{r_{PN}\left(r_{MP} + r_{MN}\right) + r_{MN}\,u}{\left(r_{NP} + r_{PN}\right)\left(r_{MP} + r_{MN}\right) + \left(r_{NP} + r_{MN}\right)u} \tag{23}$$

$$\hat{F} \quad = \quad \left(\frac{1}{r_{NF} + r_{FN} + r_{FP}}\right)\left(\frac{r_{NF}}{r_{NP}}\left(r_{PN} + \frac{r_{MN}\,u}{\left(r_{MP} + r_{MN}\right)}\right) + \beta\,u\right)\hat{P}\,. \tag{24}$$

$\hat{N}$ is derived via $\hat{N} = \left(\hat{N} + \hat{F}\right) - \hat{F}$.

The only additional parameters to specify are the two flow rates out of state M: r_{MP} and r_{MN}. The premise of mobility programs is that program participants will have improved social outcomes and upward social mobility, so presumably $r_{MN} > r_{PN}$. The ratio of the two might be construed as one key measure of mobility programs' effectiveness. For example, if physically moving out of concentrated urban poverty doubled the rate at which transplanted families assimilated into the middle-class, then $r_{MN} = 2\ r_{PN}$. We will refer to this ratio as the program's "social mobility multiplier effect" and denote it by m.

A second program success indicator is the proportion of mobility program families who will assimilate into the middle class before or instead of moving back into areas of concentrated urban poverty. That proportion, which we call a program "success rate" and denote by s, equals r_{MN} / ($r_{MN} + r_{MP}$).

Choosing an assumed social mobility multiplier effect and success rate specifies the final two model parameters:

$$r_{MN} = r_{PN}\ m \tag{25}$$

$$r_{MP} = r_{MN}\ (1 - s) / s = r_{PN}\ m\ (1 - s) / s. \tag{26}$$

and, hence, all of the long-run macro-effects of pursuing mobility programs with a particular intensity u. That the results of interest can be calculated so easily is useful because there is considerable uncertainty surrounding several of the parameter values, and the simplicity of the calculations allows us to explore how the results depend not only on program intensity (u) but also on the values of those uncertain parameters.

The literature on housing mobility programs offers only limited guidance on specific values for the program success rate s. According to the 2003 MTO interim evaluation, while perceptions of quality of life and quality of housing have significantly improved for experimental group members as compared to control group members, there are fewer strong improvements in life outcomes, i.e. educational achievement, labor market participation, receipt of family assistance, and risky behaviors (among boys), than one might have expected given early MTO results. So if we were to define an assimilation indicator based on recorded life outcomes for MTO experimental group members, such rates would be only modestly improved over baseline rates.

An alternative approach is to infer program success rates from locational outcomes deemed desirable. The MTO interim evaluation indicates that four to seven years after baseline, 38.4% of experimental-group members who did not move again (35% of all experimental-group members who leased-up) remained in neighborhoods with poverty rates of 10% or less. Also, 18.2% of the 65% of experimental-group members who moved at least once after the initial relocation remained in low-poverty neighborhoods (p. 34). The fraction of all experimental group members who leased up who remained in low-poverty neighborhoods at the interim evaluation point is 0.252. Thus, we conservatively set s = 20%, assuming that some mobility program participants in our framework would be living in *N*-type neighborhoods while not having yet assimilated (i.e. still in state *M*).

There is little guidance as to preferred values for the social multiplier parameter m. We assume that m = 1.3, which seems conservative given the general tenor of the outcome studies. These values of s and m imply values of r_{MN} and r_{MP} of 2.60% and 10.40%, respectively. That is, moving out of concentrated poverty enhances the rate of upward social mobility from 2% per year to 2.6% per year, but the rate of downward movement back into concentrated poverty remains higher (10.40%), so only s = 20% of program participants eventually “assimilate” into their middle-class surroundings.

The implied value of r_{MP} seems roughly right given the following observations. Ideally we would estimate r_{MP} using data on mobility participant movements back to origin neighborhoods, or neighborhoods like them, one or more years after relocation. However, trends such as HOPE VI redevelopments and reductions in concentrated poverty meant that some neighborhoods that were high-poverty at the start of the MTO evaluation were no longer so over time. Therefore, we use MTO evaluation measures for movements by experimental-group members to neighborhoods with poverty rates of 30% or more. 32.3% of experimental-group members who moved at least once after the initial move relocated to neighborhoods in excess of 30% poverty (14.6% to neighborhoods in excess of 40% poverty). Also, 1.2% of experimental-group members who did not move again initially relocated to neighborhoods in excess of 30% poverty (Orr *et al*. 2003, p. 34). Thus, the fraction of all experimental group members who leased up who ended up in high-poverty neighborhoods at the interim evaluation point is 0.214. The equivalent annual return rate, r_{MP}, would then equal 6.95%.

Table 1 contains values, definitions and sources for all structural parameters used in the policy simulation model.

[Table 1: Base-Case Values for Policy Model Structural Parameters]

Model Results

Base-Case Results

Steady-state values for states and various outcome measures using values in Table 1 applied to equations (21) – (24) are contained in Table 2:

[Table 2: Base-Case Policy Simulation Outcomes]

Column (1) represents the program intensity, i.e. the percentage of households in concentrated poverty neighborhoods who enroll in the housing mobility program per year. Columns (2) – (5) contain steady state values of the proportion of people in the metropolitan area who are in states *P*, *M*, *N* and *F*. Column (6) represents the percentage decrease in families living in concentrated urban poverty neighborhoods, $1-\frac{\hat{P}}{P_0}$. Column (7) represents the percentage decrease in the total fraction of the study area population that is poor, $1-\frac{\left(\hat{P}+\hat{M}\right)}{P_0}$. Columns (8) and (9) are cost-effectiveness ratios, with cost in the numerator so lower values are better. In particular, Column (8) represents the increase in families in "far" neighborhoods divided by the decrease in families in concentrated poverty neighborhoods, $\frac{\left(\hat{F}-F_0\right)}{\left(P_0-\hat{P}\right)}$.

Column (9) represents the increase in families in "far" neighborhoods divided by the decrease in the total population that is poor, $\frac{\left(\hat{F}-F_0\right)}{\left(P_0-\hat{P}-\hat{M}\right)}$. Column (10) represents the increase in the poverty rate in "near" middle-class neighborhoods that are destinations for mobility programs, $\frac{\hat{M}}{\left(\hat{M}+\hat{N}\right)}$.

At baseline (u = 0), 3.0 percent of all families are in state P and the remainder are split between "near" and "far" neighborhoods in a 39%/58% ratio. As u increases, the number of mobility families increases, the number of "near" middle-class families decreases, the number of "far" middle-class families increases and the poverty rate of "near" middle-class neighborhoods increases. This is reasonable since we have allowed the possibility of flight, and class mobility from "far" neighborhoods does not exceed that of "near" neighborhoods.

Specifically, given a flight coefficient β = 0.25, and other parameters as described above, placing 10% of poor families annually into middle-class neighborhoods via stylized MTO-like programs would reduce concentrated poverty by 49.8%, total poverty by about 11.2%, and increase the poverty rate in middle-class neighborhoods by 3.5%. A mobility program intensity of u = 20%—20 percent of all poor families would relocate under a mobility program each year—would reduce the fraction of the population in concentrated urban poverty by about 66.5%, decrease the fraction of the total population that is poor by about 15% and increase the poverty rate in middle-class neighborhoods by 4.3%. For all levels of program intensity, the increase in "sprawl" is substantial. For every family that mobility programs lift out of poverty, there would be 10.6 more families living in "far" rather than "near" neighborhoods.

Figure 3 contains a graphical representation of changes in model outcome measures in columns (6), (7) and (10).

[Figure 3: Base-Case Policy Simulation Outcomes]

Key results in Table 2 and Figure 3 associated with a housing mobility program at progressively increasing rates of intensity are: (1) a decrease in the percentage of population in concentrated urban poverty that is much larger than the decrease in the percentage of the total population that is poor, (2) relatively small increase in the poverty rate in *N*-type neighborhoods and (3) the constancy of the two "sprawl" ratios. Particularly encouraging are the relatively small increases in poverty in communities that would be destinations for housing mobility participants—at all intensity levels, much less than a 10 percent threshold percent that might serve as a "red flag" for mobility program opponents and/or trigger accelerated, nonlinear flight dynamics.

Note that the three performance measures of interest are monotonically increasing at decreasing rates. This indicates an absence of threshold effects or "tipping points" that might imply potential administrative or political challenges for a hypothetical mobility program run at high levels, but also the presence of scale effects that emphasize the benefits to policy analysis of using dynamic rather than static models.

Transient Analysis

Figure 3 shows how the system (1) – (4) evolves over time with a mobility program intensity of 10% when starting from initial conditions representing steady state with $u = 0$.

[Figure 4: Transient Results for Simulated Housing Mobility Program, One-Year Time-Step]

For base-case model parameters, flight has only a modest effect on levels of different states. In addition, the system approaches steady state (yearly percentage changes in all state variables of less than 0.5%) in less than 20 years, an indication that the steady-state results are of policy significance not only in the long run, but perhaps in a timespan typical of strategic policy planning. For this model, system dynamics are straightforward, and the sensitivity analysis can focus on the steady state results.

Sensitivity Analysis

We now examine changes in values of the parameters for model (21) – (24). Suppose that the reaction of middle-class families to housing mobility program in-movers is more highly negative than originally assumed, i.e. that β is 0.5 rather than 0.25. The primary effects of this change are small changes in the fraction of the total population in "near" and "far" communities and large changes in the sprawl impact of poverty reduction. For u = 10%, steady state values for "near" and "far" states N and F are (32.41%, 64.93%) as compared to (35.77% and 61.57%) for the base case, and an increase in the population in the F state per unit increase in total poor population of 20.6 persons, as compared with 10.6 for the base case. Steady-state values for P and M are unchanged from the base case, as expected, and the increase in poverty rate in "near" communities is 3.45% as compared to 3.14% in the base case.

If housing mobility programs are less effective in inducing changes in participant life outcomes, then mobility programs should appear less promising as a large-scale strategy than is true in the base case. This turns out to be the case: if the social multiplier effect, m, is reduced from 1.3 to 1.1, there is essentially no change in the reduction in the rate of concentrated urban poverty (49.93% versus 49.83% in the base case), but a substantial reduction in the rate of decrease in total poverty, i.e. (4.42% versus 11.23%). In addition, the unit increase in sprawl measure increases to 26.0 from 10.6 in the base case, and the poverty rate in "near" communities increases from 3.14% to 3.68%[5].

If the success rate, s, decreases from 20% to 10%, the negative impacts are even stronger: at u = 10%, the percent decrease in concentrated urban poverty and total poverty is 33.18% and 7.48%, substantial decreases in effectiveness over the base case. The unit increase in sprawl indicator increases to 20.57, more than double the base-case value. However, poverty rate in "near" communities actually decreases from 3.14% to 2.18%. This is a result of the increased rate at which mobility program participants drop out of the program and return to concentrated poverty neighborhoods, 23.40% as compared to 10.40% in the base case.

A housing mobility program need not be targeted exclusively at residents of concentrated poverty neighborhoods. If we increase P_0 from 3% to 6%, roughly the fraction of metropolitan area populations

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[5] If m is reduced to 1.0, i.e. there is no social multiplier effect associated with the housing mobility program, then $\hat{P} + \hat{M} = P$ for all values of the program intensity u, and key outcome measures either go to 0 (rate of decrease in total poverty) or infinity (increase in sprawl per family removed from poverty). We ignore such asymptotic outcomes.

that are urban poor (U.S. Bureau of the Census 2005), and reduce the values of N_0 and F_0 according to their 39%/58% proportion in the base case, new values for N_0 and F_0 are 37.79% and 56.21%, respectively. The indicators for percent changes in concentrated urban poverty and in total poverty, as well as the sprawl indicators (49.65%, 10.92%, 2.11, 9.59) are little changed from the base case, but the poverty rate in "near" neighborhoods more than doubles, to 6.74% from 3.14%. This result arises from the larger pool of program participants in P, and the smaller destination neighborhoods N for which a given level of in-movers will result in a higher poverty rate. This may indicate the greatest barrier to widespread use of housing mobility programs: many potential participants may be low-income yet living in disadvantaged, but not high-poverty neighborhoods.

We conclude by presenting a "worst-case" scenario for our housing mobility program: a metropolitan area characterized by low-income families more widely distributed, and a smaller set of destination neighborhoods than in the base case: (P_0, N_0, F_0) = (6%, 37.79%, 56.21%); less favorable mobility program outcome measures: (m, s) = (1.1, 10%) and greater middle-class "flight" propensity: $\beta = 0.5$. These values imply large changes in structural parameters from base-case levels; for example, the rate at which mobility program participants "assimilate" decreases from 2.60 to 2.2, and the rate at which mobility program participants return to their home neighborhoods increases from 10.40 to 19.80. The results are shown in Figure 5:

[Figure 5: "Worst-Case" Mobility Program Outcomes]

As expected, mobility program outcomes are significantly less favorable than the base case: at program intensity u = 10%, the decrease in concentrated poverty is 33.21% (base case = 49.83%); the decrease in total poverty is 2.85% (base case = 11.23%), and the poverty rate in "near" neighborhoods increases by 7.57% (base case = 3.14%). In addition, about 91.9 middle-class families move from "near" to "far" neighborhoods in response to each mobility program in-mover (base case = 10.6). This enormous increase in the sprawl outcome measure results from smaller decreases in total poverty $\left(P_0 - \hat{P} - \hat{M}\right)$ as well as significant increases in "far" populations $\left(\hat{F} - F_0\right)$ due to increased middle-class flight. It is likely that the political and social impacts of such increases in flight in reaction to a housing mobility program would have much more negative impacts on the viability of the program than reduced effectiveness measures.

Discussion

Comparisons Between Alternative Modeling Strategies

Earlier we presented simple, "back-of-the-envelope" calculations of housing mobility program outcomes, with no consideration of system dynamics. We estimated that mobility programs operated at an intensity of about 7% would redistribute all of the 3% of the population living in concentrated urban poverty among the 39% of the population living in mobility-accessible neighborhoods while inducing only a small percentage of the population already living in those neighborhoods to relocate to more-distant communities. This unrealistic estimate motivated development of a full policy simulation model, incorporating system dynamics.

This new model did not result in dramatically more pessimistic outcomes, but the results were still quite promising. The model using base-case parameter values suggests that at a program intensity of u = 10%, mobility programs could achieve a 50% reduction in concentrated urban poverty and an 11% reduction in total poverty with modest total impact on sprawl to distant neighborhoods. Even with "worst-case" parameter values, mobility programs could still make a sizable dent in the population living in concentrated urban poverty (~33% reduction) if program intensity were increased to20%.

Social Implications of Model Results

Base-case dynamic model results indicate that a program intensity of 10% results in a net increase of 3.57% of the population living in "far" neighborhoods. What might be the implications of this population shift for urban sprawl? Given a 1999 U.S. metropolitan area population of 221.3 million persons (U.S. Bureau of the Census 2005), an additional 7.9 million persons, or approximately 3.2 million families would relocate. This increase in suburban populations would likely result a number of social costs associated with: increased infrastructure development; increased automobile usage, increased use of agricultural lands and open spaces, increased concentration of poverty and socio-economic decline, and increase pollution (10,000 Friends of Pennsylvania 2000). For example, in Pennsylvania, an estimated one to six acres of agricultural land are lost for each new household (10,000 Friends of Pennsylvania 2000, p. 8); at the national level, perhaps 3*3.2 million = 9.6 million acres of crop land would be lost. This represents about 38% of the 25 million acres of farmland estimated to have been lost between 1982 and 1997 due to development of various kinds (NumbersUSA 2006), but only 1% of the 938.3 million acres of farmland in the U.S. (U.S. Department of Agriculture 2006).

As another example, in Pennsylvania, daily vehicle miles traveled (VMT) per capita is about 50% higher in the suburbs than in central cities, resulting in about $1,500 more per year in automobile costs per suburban household as compared with households in the urban center (10,000 Friends of Pennsylvania 2000, p. 7). Current national surveys estimate that “urban” (central city plus suburban) households incur about 21,600 VMT per year as compared with 28,700 VMT per year for rural households, or equivalently, about 1,054 gallons of gas per year per urban household, compared to 1,469 gallons of gas per year per rural household (U.S. Department of Energy 2006). If we assume that suburban households consume 20% more gas than the metropolitan (central city plus suburban) average, then the increase in sprawl associated with base-case model results might result in 0.2*1,054*3.2 million = 674,560,000 extra gallons per year consumed. This amounts to about 0.6% of current annual U.S. household-based gasoline consumption of about 113 trillion gallons (U.S. Department of Energy 2006).

Model Limitations

This paper develops a stylized model to project impacts of a policy on different groups defined by socio-economic characteristics and geographic location. There are benefits of this modeling approach, notably the clarity with which the effects of a mobility program can be defined in terms of transitions between states.

However, there is significant uncertainty in the values of some parameters, and tension between defining parameters in terms of the system of equations versus those derived from more traditional studies. We have illustrated the first problem through efforts to estimate rates of household mobility between “near” and “far” neighborhoods. Data on migration from the U.S. Census Bureau are too aggregate to use in our model, but studies such as Smith and Crowder (1997) that examine actual intrametropolitan mobility patterns by race require overly restrictive assumptions on the demographic characteristics of “near” and “far” neighborhoods. We have illustrated the second problem by noting differences in values for flow rates out of state *M* imputed using performance measures we have defined—the social mobility multiplier effect and the program success rate—as compared to flow rates derived using MTO evaluation data on residential stability, itself an imperfect proxy for upward social mobility presumed to be one outcome associated with housing mobility programs.

Another limitation, implied by the first, is that certain system transitions do not fully account for demographic realities. For example, we have ignored birth rates and immigration as additional cause for state transitions from *N* to *P* and *F* to *P*. Finally, our model addresses only one kind of housing-based social policy: family mobility using tenant-based subsidies. Policy analysts may wish to evaluate system outcomes associated with place-based as well as person-based policies operating at different intensity levels.

These limitations would imply a need for dynamic models with a greater number of states than the four used in this study. However, such models are more difficult solve analytically and require many more parameters.

Conclusions

In this paper we have used a policy simulation model to estimate the potential impacts of housing mobility programs were they operated at a scale likely to significantly reduce the spatial concentration of urban poverty, This “stocks and flows” model is defined for a stylized housing mobility program operating in a hypothetical metropolitan area reflecting average characteristics of the U.S. as a whole. We find that for “base case” parameter values, our hypothetical housing mobility program has significant beneficial impacts on numbers living in concentrated urban poverty and modest beneficial effects the number living in poverty overall, while generating only modest increases in poverty rates in destination communities and moderate effects on middle-class “flight” from destination communities. In particular, with those parameters, placing 10% of poor families annually into middle-class neighborhoods via MTO-like programs would reduce concentrated poverty by 50%, total poverty by about 113%, and increase the poverty rate in middle-class neighborhoods by 3.1%. For all levels of program intensity, there would be 10 more families living in “far” rather than “near” neighborhoods for every family that mobility programs lift out of poverty,.

These impacts are moderated significantly when accounting for increased rates of middle-class “flight”, lower success rates (represented by the ratio of middle-class “assimilation” with the program to upward class mobility in the absence of the program, and the ratio of the assimilation rate to the total rate of movement out of destination communities), and a more ambitious policy goal of serving all urban poor, not just those living in areas of concentrated urban poverty. A “worst-case” scenario combining all of these changes to base-case assumptions generates negative outcomes that might call into question the political, if not social viability of a large-scale housing mobility program.

These results yield a number of interesting policy insights. First, a scaled-up mobility program similar to the one we have modeled would have do significantly more to disperse families living in concentrated urban poverty neighborhoods into middle-class neighborhoods than to enable these families to enter the middle class. Thus, there is likely to be a need for a “continuum of care” of human services for mobility program participants post-move, to ensure beneficial long-term family outcomes. These costs are beyond the scope of our model. Second, the impacts on destination communities of such a housing mobility program are likely to be modest, as measured by increase in population and in poverty rate. This is an indication that the “carrying capacity” of such neighborhoods appears to be adequate to support large-scale poverty deconcentration initiatives. Finally, benefits to mobility program participants must be balanced against increased costs associated with middle-class “flight” and resulting urban sprawl. Small increases in total annual farmland and gasoline consumption consumption resulting from a scaled-up housing mobility program must be compared to the social benefits of a large reduction in concentrated urban poverty.

As with any modeling exercise, there are model limitations that restrict our ability to predict real-world consequences of policy choices based on our analysis. Hence, we view this model as a tool for clarifying understanding about and communication concerning issues of scale that would be raised by ramping up mobility programs’ scope, not as a tool for making specific quantitative predictions. Salient among these limitations are uncertainties in the values of important structural parameters and the homogeneity assumption implicit in modeling populations as stocks. In addition, the lack of data to support a social cost-benefit analysis restricts the range of outcome measures to be generated from our model. Finally, we have developed a simulation model, not an optimization model, so a hypothetical housing mobility program managed according to an optimal policy might generate more desirable social outcomes than those we have represented with steady-state values for our state variables.

Various extensions of this model could be of interest for further research. Given the fiscal restrictions faced by U.S. public housing authorities, perhaps it might be reasonable to define program intensity in terms of a specific number of families that corresponds to current budgets, rather than a fraction of all poor families. We could extend the model to address multiple assisted housing initiatives, for example the conventional Housing Choice Voucher Program and the HOPE VI project-based housing redevelopment program. Choosing structural parameters to model HCVP would be particularly attractive since it would allow us to validate many of our modeling assumptions using extensive administrative data. Finally, this work provides a basis for evaluation of other housing initiatives, such as housing strategies for persons displaced by last year’s Hurricane Katrina.

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Tables and Figures:

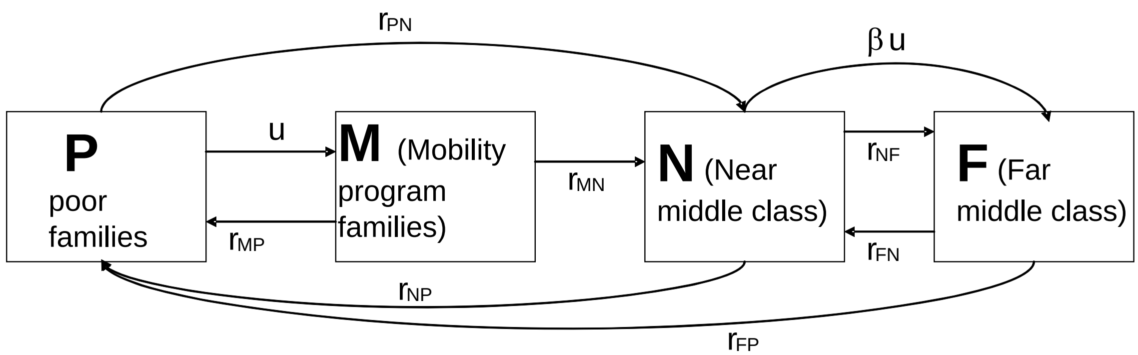

Figure 1: "Stocks and Flows" Diagram of Housing Mobility Program Effects

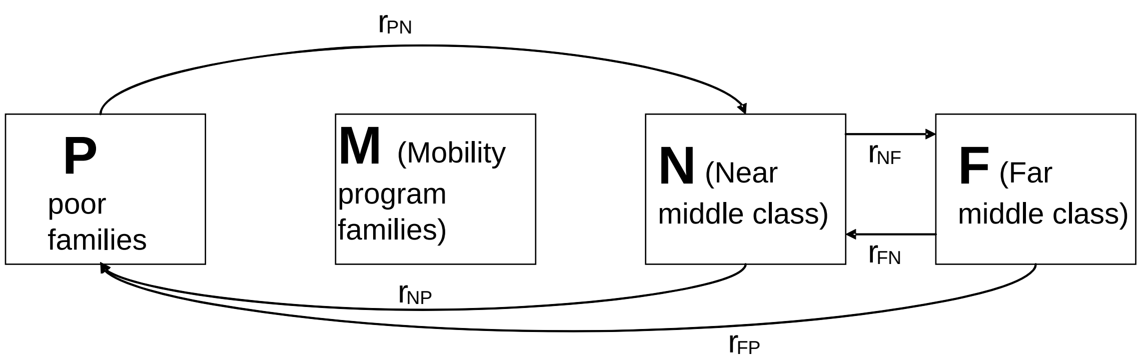

Figure 2: State Transition Diagram When There Is No Mobility Program

Parameter	Definition	Value	Source
β	Rate of middle-class "flight" from state *N* per mobility participant in-mover from *P*	0.25	Betts and Fairlie (2003), cited in Caulkins *et al*. (2005a,b)
P_0	Baseline fraction of metropolitan-area population living in concentrated-poverty neighborhoods	3%	Jargowsky (2003)
N_0	Baseline fraction of metropolitan-area population living in neighborhoods that are potential destinations for mobility program participants	39%	U.S. Bureau of the Census (2005) and authors' computations
F_0	Baseline fraction of metropolitan-area population living in neighborhoods that are not available to mobility program participants	58%	U.S. Bureau of the Census (2005) and authors' computations
$r_{NP} = r_{FP}$	Natural downward social mobility from "near" destination communities *N* and "far" communities *F*	0.062%	Authors' computations [Equation 7]
r_{PN}	Rate of upward social mobility out of concentrated poverty due to mobility program	2%	Authors' assumptions
r_{FN}	Natural household mobility rate from "far" to "near" neighborhoods	0.39%	Authors' computations [Equation 17]
r_{NF}	Natural household mobility rate from "near" to "far" neighborhoods	0.67%	Authors' computations [Equation 16]
m	Social mobility multiplier	1.3	Authors' assumptions
s	Mobility program success rate	20%	Authors' assumptions
r_{MN}	Rate of "assimilation" of mobility program participants into middle class	2.60%	Authors' computations, using proposed values for *m* and *s*
r_{MP}	Rate at which mobility program participants move back to concentrated urban poverty neighborhoods	10.40%	Authors' computations, using proposed values for *m* and *s*

Table 1: Base-Case Values for Policy Model Structural Parameters

	States				**% Reduction in…**		**Sprawl per Unit Decrease in…**		**"Near" Poverty Rate**
Program Intensity (u)	**Concentrated Urban Poverty (P)**	**Mobility Participants (M)**	**Total "Near" Population (N)**	**"Far" Population (F)**	**Concentrated Urban Poverty (P)**	**Total Poverty (P+M)**	**Concentrated Urban Poverty (P)**	**Total Poverty (P + M)**	**M/(M+N)**
0.0%	3.00%	0.00%	39.00%	58.00%	0.00%	0.00%	2.39	10.58	0.00%
1.0%	2.73%	0.21%	38.41%	58.65%	9.03%	2.04%	2.39	10.58	0.54%
2.0%	2.50%	0.39%	37.93%	59.19%	16.57%	3.74%	2.39	10.58	1.01%
3.0%	2.31%	0.53%	37.51%	59.64%	22.95%	5.17%	2.39	10.58	1.40%
4.0%	2.15%	0.66%	37.16%	60.03%	28.43%	6.41%	2.39	10.58	1.75%
5.0%	2.00%	0.77%	36.85%	60.37%	33.18%	7.48%	2.39	10.58	2.05%
6.0%	1.88%	0.87%	36.58%	60.67%	37.34%	8.42%	2.39	10.58	2.32%
7.0%	1.77%	0.95%	36.34%	60.94%	41.01%	9.24%	2.39	10.58	2.56%
8.0%	1.67%	1.03%	36.13%	61.17%	44.27%	9.98%	2.39	10.58	2.77%
9.0%	1.58%	1.10%	35.94%	61.38%	47.20%	10.64%	2.39	10.58	2.96%
10.0%	*1.51%*	*1.16%*	*35.77%*	*61.57%*	*49.83%*	*11.23%*	*2.39*	*10.58*	*3.14%*
11.0%	1.43%	1.21%	35.62%	61.74%	52.21%	11.77%	2.39	10.58	3.29%
12.0%	1.37%	1.26%	35.48%	61.89%	54.37%	12.26%	2.39	10.58	3.44%
13.0%	1.31%	1.31%	35.35%	62.03%	56.35%	12.70%	2.39	10.58	3.57%
14.0%	1.26%	1.35%	35.23%	62.16%	58.16%	13.11%	2.39	10.58	3.69%
15.0%	1.21%	1.39%	35.12%	62.28%	59.83%	13.49%	2.39	10.58	3.81%
16.0%	1.16%	1.43%	35.02%	62.39%	61.37%	13.83%	2.39	10.58	3.91%
17.0%	1.12%	1.46%	34.93%	62.49%	62.80%	14.16%	2.39	10.58	4.01%
18.0%	1.08%	1.49%	34.84%	62.59%	64.13%	14.45%	2.39	10.58	4.10%
19.0%	1.04%	1.52%	34.76%	62.68%	65.36%	14.73%	2.39	10.58	4.19%
20.0%	*1.00%*	*1.55%*	*34.69%*	*62.76%*	*66.51%*	*14.99%*	*2.39*	*10.58*	*4.27%*

Table 2: Base-Case Policy Simulation Outcomes

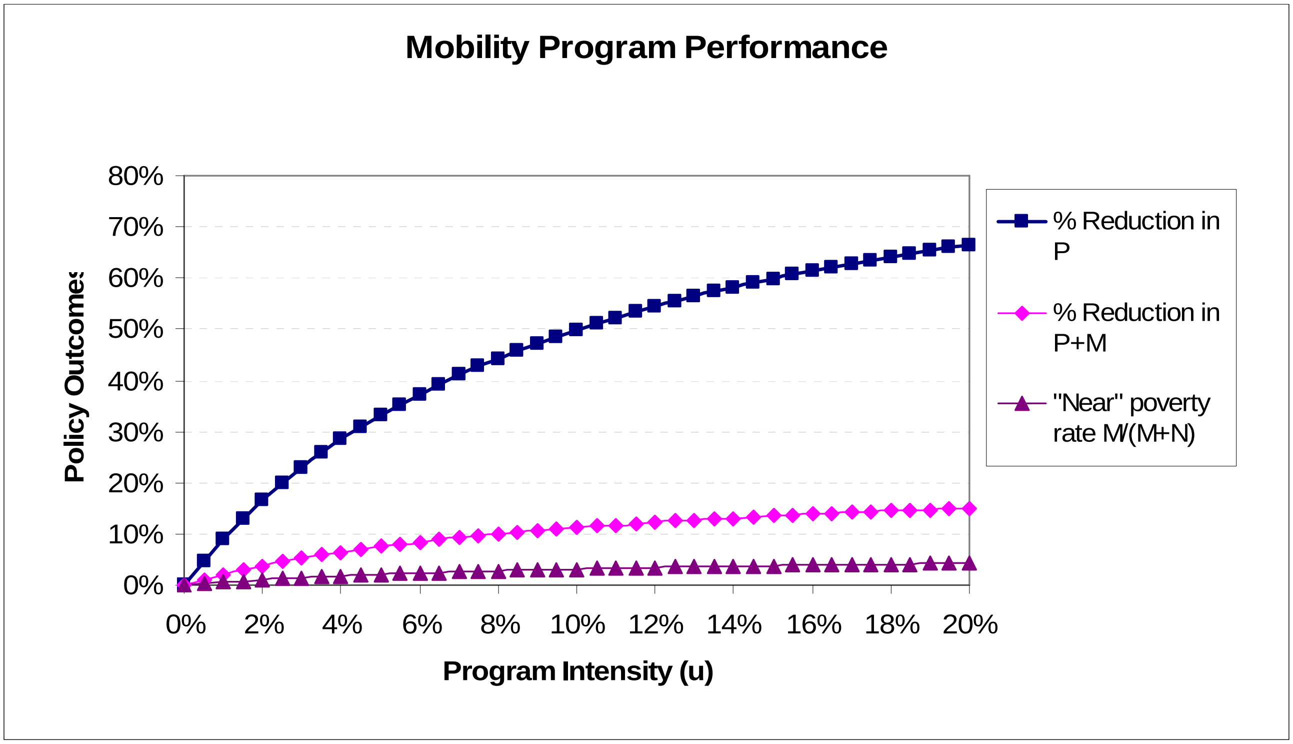

Figure 3: Base-Case Policy Simulation Outcomes

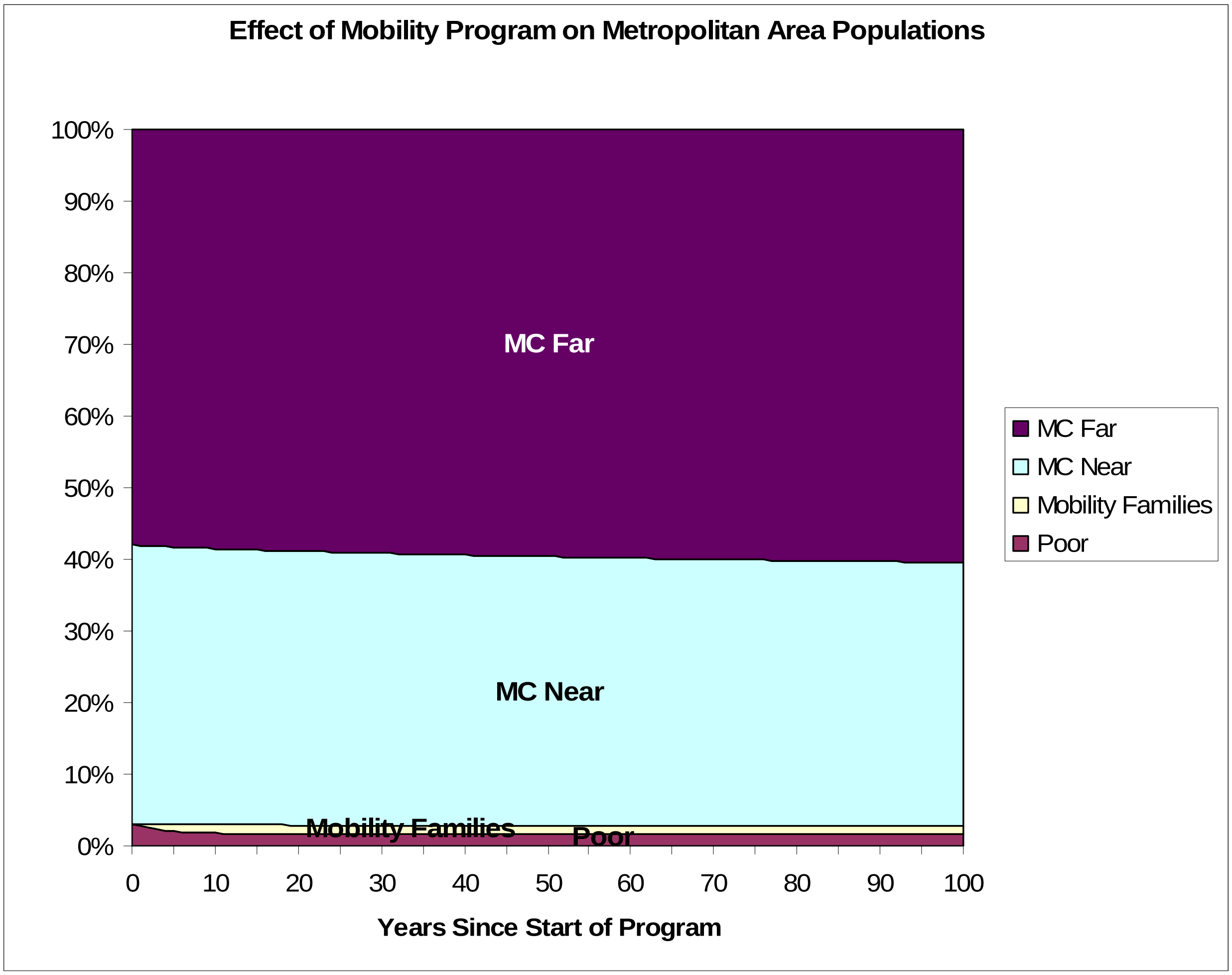

Figure 4: Transient Results for Simulated Housing Mobility Program, One-Year Time-Step

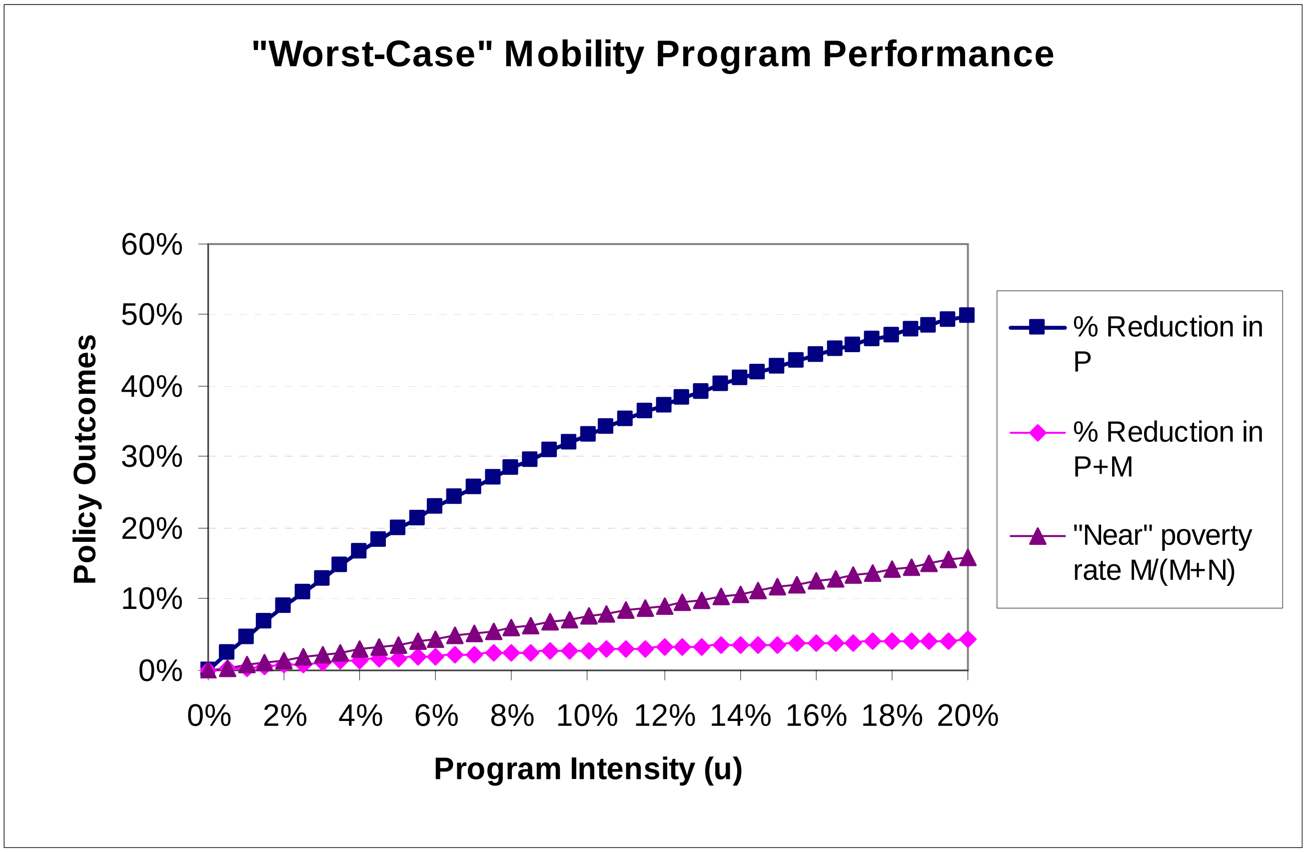

Figure 5: “Worst-Case Mobility Program Outcomes