An Equilibrium Analysis of the Effects of Neighborhood-based Interventions on Children*

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October 1, 2021

Abstract

To study the effects of neighborhood and place-based interventions, this paper incorporates neighborhood effects into a general equilibrium (GE) heterogeneous-agent overlapping-generations model with endogenous location choice and child skill development. Importantly, housing costs as well as neighborhood effects are endogenously determined in equilibrium. Having calibrated the model using U.S. data, we use simulations to show that predictions from the model match reduced form evidence from experimental and quasi-experimental studies of housing mobility and urban development programs. After this validation exercise, we study the long-run and large-scale impacts of vouchers and place-based subsidies. Both policies result in welfare gains by reducing inequality and generating improvements in average skills and productivity, all of which offset higher levels of taxes and other GE effects. We find that a voucher program generates larger long-run welfare gains relative to place-based policies. Our analysis of transition dynamics, however, suggests there may be more political support for place-based policies.

Keywords: Neighborhood effects, housing vouchers, intergenerational mobility.

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1 Introduction

An emerging literature demonstrates that neighborhoods have important impacts on long-run outcomes of children. Recent analysis of the Moving to Opportunity (MTO) experiment finds substantial improvement in earnings and other outcomes for young children whose families moved to low-poverty neighborhoods using subsidized housing vouchers (Chetty et al., 2016). Similarly, Chyn (2018) finds notable long-run gains for children whose families were forced to relocate to less disadvantaged areas due to public housing demolitions.

In light of this evidence, a natural question is: How should policymakers design policies to improve neighborhood quality for children? The answer to this question depends on equilibrium responses that are not well-captured by highly credible but short-run and relatively small experimental studies. For example, the benefits of encouraging poor families with children to move to low-poverty areas may be diminished if the characteristics of more advantaged neighborhoods change in response over time.[1]

This paper provides a new assessment of the equilibrium effects of housing mobility programs and government policies that aim to revitalize disadvantaged neighborhoods. We study a spatial equilibrium model that features overlapping generations and incorporates endogenous childhood development. Our model extends on seminal work that theoretically studies inequality and neighborhoods (Benabou, 1996; Durlauf, 1996; Fernandez and Rogerson, 1996). Specifically, there are three main building blocks in our framework. The first is that parental choices are important for child outcomes. An individual's productivity depends on their skills. A key element in the model is that these skills are determined by parental choices made during childhood. Specifically, parents choose one of two neighborhoods and make time investments into their children. Neighborhood quality matters due to local externalities. The second building block is the GE life-cycle Aiyagari framework, with endogenous labor supply, in which these investments and inter-generational linkages are embedded. The wage shocks in this block of the model increase income inequality and help explain why parents may be unable to move to a more advantaged neighborhood. The GE forces also allow us to account for the policy effects on prices in the economy—i.e., housing costs, capital returns, and wages. Finally, the third building block is the government which funds policy interventions by levying income taxes. Taxes have distortionary effects due to the endogeneity of labor supply and human capital in our model. These building blocks are important

[1]Prior research has justified this concern by providing evidence that changes in neighborhood demographics may cause out-migration of incumbents and alter the distribution of public goods (Boustan, 2010; Derenoncourt, 2019).

for a comprehensive welfare evaluation of how investments that shape neighborhood quality affect children.

We estimate the model using simulated method of moments to match recent data on the geography of opportunity in the U.S. We map the neighborhoods in our model to Census tracts in U.S. For each commuting zone (CZ), we divide Census tracts into two groups according to income per capita, the bottom 10 and top 90 percent, and then average across CZs. In addition to matching standard moments (e.g., the average hours worked), we target those that are informative about income and parental investment by neighborhood as well as moments related to neighborhood externalities. For the latter, we rely on data on long-run outcomes and childhood neighborhoods from the Opportunity Atlas (Chetty et al., 2018). Our model requires us to specify explicitly how time and neighborhood characteristics aggregate to form "parental investments." We do this via a CES aggregator and estimate the parameters of this function by matching the income of children who grow in different neighborhoods, the average amount of quality time parents spend with their children, and the differences in time allocation between neighborhoods.

As validation exercises, we show that simulated predictions from the calibrated model match reduced form evidence from experimental and quasi-experimental studies. First, we demonstrate that the model is in line with experimental estimates of the impact of moving from Chetty et al. (2016). Chetty et al. studied disadvantaged families that received housing vouchers that could only be used in a low-poverty neighborhood through the MTO randomized control trial (RCT). We study an equivalent program within our model that mimics the features of the small-scale and short-run nature of the RCT.[2] We find that the model-generated impacts on the labor market outcomes of children treated by the intervention are similar to those from MTO. Second, we find that a simulated version of a place-based wage subsidy program generates impacts that match evidence from Busso et al. (2013). They use quasi-experimental methods to study the Empowerment Zone (EZ) program, a federal policy in the U.S. that provided incentives (e.g., tax credits for employing local workers) to encourage development of disadvantaged urban and rural communities. We simulate the EZ program as a place-based wage subsidy program and obtain predicted earnings gains for adults that match Busso et al. (2013). The results from these two exercises provide evidence that the model is in line with the most credible reduced-form evidence on the impacts of housing vouchers and place-based incentive programs.

After this validation exercise, we begin by studying the long-run effects of housing voucher

[2]That is, we simulate effects for a single generation while holding prices and neighborhood qualities fixed.

programs taking into account general equilibrium effects.[3] We explore versions of the policy which differ in terms of three characteristics: (1) the voucher subsidy rate; (2) an eligibility restriction in terms of the individuals hourly wage; and (3) an eligibility restriction based on the presence of children (which is based on age given an exogenous fertility assumption in the model). The highest steady-state welfare gains are achieved with a policy that has a full subsidy rate and targets households that have children and wages below the fourth quintile (i.e., the 80th percentile). This voucher program generates a 3.4 percent increase in consumption equivalent units, despite the fact that the average marginal tax rate must increase by 15.7 percent to fund the voucher program. As an additional 12.5 percent of children move to the better neighborhood, labor productivity increases by 1.1 percent. In addition, we find that the voucher program has consequences for inequality and upward mobility. Specifically, the program leads to a reduction in the variance of log-after-tax-lifetime-earnings of 6.3 percent along with an increase in upward mobility by 27.7 percent.[4,5]

We decompose these results—particularly the welfare gains of 3.4 percent—into four key equilibrium effects. The equilibrium effects of adjustments in rent and neighborhood quality (e.g., lower-income individuals tend to move to the advantaged neighborhood) have relatively muted impacts—jointly reducing the benefits by 1.4 percentage points. The other two equilibrium forces, taxation effects and long-run intergenerational dynamics, are much more quantitatively relevant. Taking into account the tax increase needed to finance the rental voucher program substantially reduces welfare gains in a large-scale intervention (by 10.2 percentage points). In contrast, long-run intergenerational dynamics are the key source of additional gains in equilibrium (increasing welfare by 11.5 percentage points). This occurs because investing in a child not only improves their skills but also creates better parents for the next generation. These four equilibrium effects almost perfectly compensate each other, making the long-run general-equilibrium welfare gains similar to those from a short-run partial-equilibrium version of the program (i.e., implemented on a small group for single generation).

Next, we examine long-run effects of place-based policies in general equilibrium. As in our validation exercise, we study a neighborhood-specific wage subsidy program and explore versions of the program that vary the level of the subsidy. The highest steady-state welfare

[3]Note that we assume that progressive labor taxes finance the voucher program in our analysis.

[4]Note that we measure upward mobility as the probability that a child reaches the top 20 percent of the income distribution given that had parents with income at the bottom 20 percent of the distribution.

[5]The inequality effect is as large as the difference in the variance of log-income between Sweden and the US. The effect on upward mobility is approximately equal to one-half of its standard deviation across US Census tracts.

gains are achieved with a 12 percent wage subsidy. This policy achieves a 0.7 percent increase in consumption equivalence terms, notably smaller benefits than what is possible with a voucher program.[6] As a result of the subsidy, there is substantial resorting to the disadvantaged neighborhood, and the share of children living in the advantaged area decreases by 6.7 percent. Income inequality decreases by 8.7 percent and upward mobility increases by 20.4 percent.

Our decomposition analysis for the wage subsidy program shows that all four of the equilibrium forces that we consider have relatively important roles in determining the 0.7 percent welfare gain. When the program is implemented in a short-run (so the subsidy is not provided to future children) partial equilibrium world, the impact on welfare (calculated only for children) is negative at 1.0 percent. This occurs because the wage subsidy induces parents to relocate to the disadvantaged neighborhood. When the equilibrium allows for adjustments neighborhood quality and rental price adjustments, welfare increases by 0.6 percentage points. Implementing the program for the long-run further increases welfare by 2.5 percentage points because neighborhood quality increases more in the long run, and children in this scenario take advantage of the wage subsidy when they reach adulthood. The tax increases needed to finance the wage subsidy do not fully crowd out the gains from the long-run program as welfare is only reduced by 1.4 percentage points.

Why do government policies that shape exposure to high-quality neighborhoods increase welfare? There are two main explanations within our model. First, neighborhood externalities create a role for place-based policies because the government accounts for the fact that individual work choices affect skills of children. Location-based wage subsidies are a means of increasing this positive externality. Second, the main channel for welfare improvement through housing vouchers lies in the government's capacity to make up for the absence of intergenerational borrowing—i.e., a parent's inability to borrow against their child's future income. For example, a poor parent who could invest in their child's development by moving would want to smooth consumption intergenerationally. The inability to make this type of transfer reduces the incentive to move. Housing vouchers can be thought of as using taxation to address this market failure. In sum, these two factors imply that the government can use housing and urban development policies to invest in children and tax them later once they become adults.

In terms of distributional impacts, a natural consideration is that the programs we con-

[6]Following Andrews et al. (2017), we conduct a sensitivity analysis to show that our welfare results for vouchers and place-based subsidies are robust to empirically-reasonable changes in the parameters used in our calibration. See Section 5.2.2.

sider may have heterogeneous effects on welfare for the adults alive at the introduction of the policy. For housing vouchers, we analyze transition dynamics and find that gains are concentrated among young cohorts. As a result, we find that only 33 percent of adults would rationally vote in favor of the voucher program. In contrast, the wage subsidy program generates relatively evenly distributed positive effects on welfare. We estimate that over 63 percent of adults would support the place-based policies. This pattern of results suggests that, despite the larger gains for future cohorts, there may be important political economy tradeoffs between "people-based" policies such as vouchers and place-based investment programs.[7]

Our analysis and findings contribute to a large and growing literature that studies neighborhoods and government policies to promote urban development. A number of recent studies have focused on providing credible reduced form evidence on the effects of moving using housing vouchers (Kling et al., 2007; Chetty et al., 2016; Chyn, 2018) and the neighborhood-level impacts of place-based policies such as Empowerment Zones (Busso et al., 2013).[8] Relatively few studies use equilibrium frameworks to study housing assistance policies. Diamond and McQuade (2019) and Davis et al. (2019) study the effects of government programs that construct low-income housing programs. Closer to the concerns of this paper, Davis et al. (2021) study rental vouchers and equilibrium sorting behavior. Our analysis complements these prior works by studying housing mobility and place-based policies in a single framework that accounts for labor supply responses and taxation—two features that we find are important for understanding large-scale equilibrium responses.

Finally, this paper is also closely related to an emerging literature in macroeconomics that quantitatively studies location choice, inequality, and children. Important work by Fogli and Guerrieri (2019), Zheng and Graham (2020) and Eckert and Kleineberg (2021) similarly use spatial equilibrium models to study child development but differ in at least two ways.[9] First, we focus on related but distinct questions on the effects of residential choice. While Fogli and Guerrieri (2019) study the contribution of segregation to increases in U.S. inequality since the 1980s, we use our calibrated model to study counterfactual welfare gains. While Zheng and Graham (2020) and Eckert and Kleineberg (2021) also consider welfare questions, our focus is

[7]As usual when the gains are concentrated among the future cohorts (e.g., Daruich, 2020), one may expect that introducing government borrowing to temporarily finance the rent vouchers and increased taxation in the future (to pay for the government debt) could make the policy accepted by a majority of individuals.

[8]For comprehensive reviews of the neighborhood effects literature, see Chyn and Katz (2021) and Durlauf (2004).

[9]Agostinelli et al. (2020) also use a model of child development, peer effects, and parenting behavior to study the equilibrium effects and relocation policies that affect neighborhood compositions. Their work differs from ours in that they focus on studying peer selection and short-run effects whereas we examine long-run dynamics, taxation, and housing equilibrium effects.

on different policies. Their analysis centers on the effects of equalizing school funding whereas we study the effects of housing vouchers and place-based incentive programs, two prominent types of government policies in countries around the world.[10] Second, Zheng and Graham (2020) and Eckert and Kleineberg (2021) use models that have more spatial heterogeneity and allow for greater location choice. The main benefit of their approach is that they can evaluate policy effects on more locations. In contrast, our model allows for a larger range of equilibrium effects—through changes in wages, capital returns, taxes, as well as housing costs and neighborhood qualities—in the long-run steady state and during the transition after policy adoption. A key advantage of this approach is that our analysis accounts for the costs of raising taxes to pay for policies of interest. In addition, by incorporating the analysis of transitional dynamics, we can assess issues of political economy. This feature of our analysis delivers one of our core findings in that the policy with the largest long-run welfare gains may not have the broadest political support.

2 Stylized Facts

To motivate our model and analysis, this section briefly highlights several stylized facts regarding the distribution of economic outcomes across neighborhoods. Our focus is on Chicago, the third largest city in the U.S., but the patterns we document in this section hold in cities across the U.S.[11] We focus on neighborhoods as defined by U.S. Census tracts. Tracts are small geographic units that have an average population of 4,250 persons.

The first pattern that we note is that economic outcomes are spatially segregated. Panel (a) of Figure 1 demonstrates this by reporting the distribution of tract level median household income using data from the 1990 U.S. Census. Dark red areas on the map indicate neighborhoods which had relatively low median household income (i.e., below $20,000). These tracts are predominantly in the western and southern parts of the city.[12] Dark blue areas are those with high median income (i.e., above $34,000), and these areas are located in the northern and northeastern parts of the city. Previous studies have documented spatial sorting on the

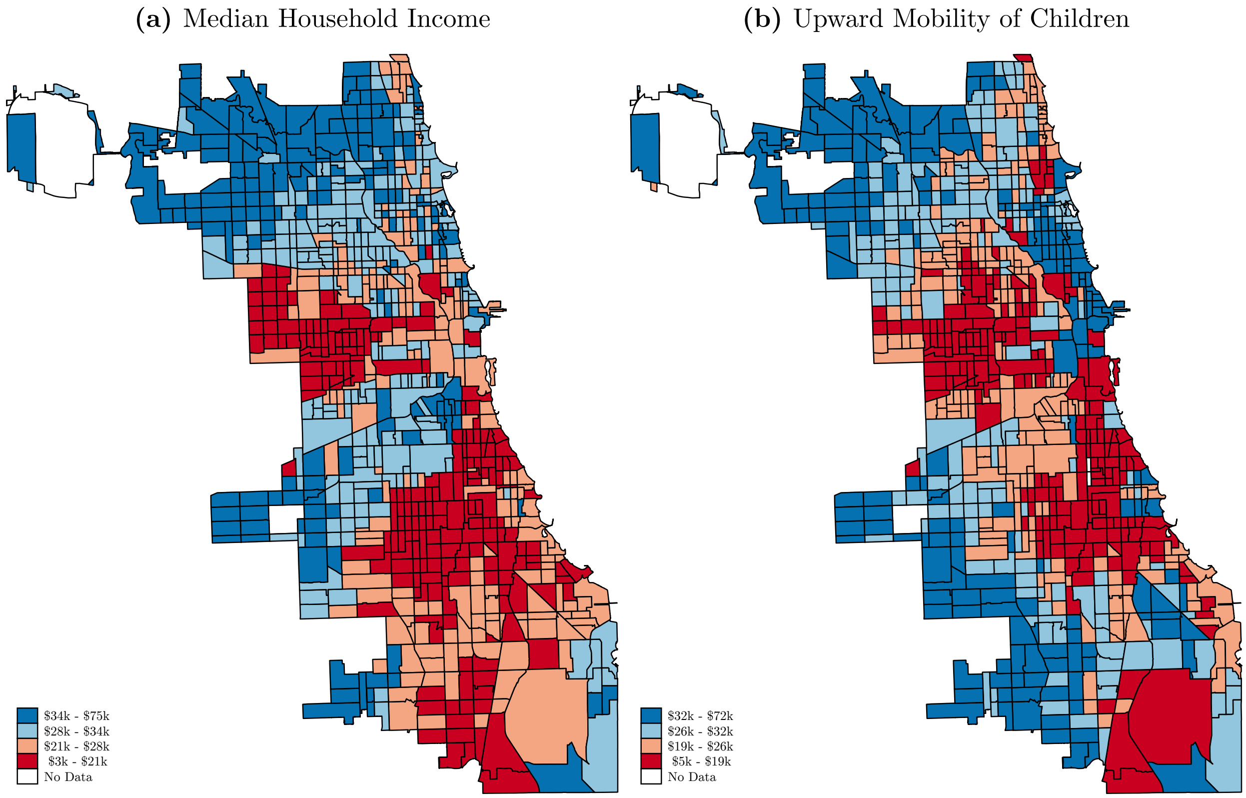
[10] In the U.S., approximately 2.3 million households receive assistance in the form of a Section 8 voucher each year (Collinson et al., 2015). Large-scale housing subsidies are also prevalent in European countries (Salvi et al., 2016). In terms of place-based policies, the U.S. currently spends nearly $60 billion annually on such programs (Bartik, 2020). As noted by Neumark and Simpson (2015), a number of European countries also use place-based policies to aid municipalities that have high rates of unemployment or poverty.

[11] Further statistics on the relationship between median household income and long-run outcomes of children are provided in Appendix Section B.

[12] Areas in Chicago are often grouped into nine districts or "sides." The areas with lower household income in the map include the South Side, Southwest Side, Far Southeast Side, and the West Side. The areas with higher household income in the map include the Central Side and North Side.

basis of income throughout U.S. cities (Jargowsky, 1996, 2013).

Figure 1: Economic Outcomes Across Neighborhoods in Chicago



Notes: Panel (a) plots median household income from the 1990 U.S. Decennial Census. Panel (b) plots estimates of mean household income ranks for children who grew up in the tract and had parents with household income at the 25th percentile of the national income distribution. This measure of "upward mobility" for children comes from the Opportunity Atlas (Chetty et al., 2018). The measure is specific to children who were born in the 1978-83 cohorts.

Panel (b) extends on these findings by showing that there is spatial clustering in the upward mobility of poor children. This data comes from the Opportunity Atlas (Chetty et al., 2018). Upward mobility is measured as the estimated mean household income for children whose parents were at the 25th percentile of the national income distribution. Incomes for children were measured as the mean earnings in 2014-2015 when a child was between ages 31-37. The map shows that many western and southern areas of the city have relatively low rates of mobility.

The similarity of the patterns in the maps from Figure 1 reflects a significant correlation between the outcomes of adults in a neighborhood and the long-run outcomes of children growing up in these areas. A simple regression using this data from Chicago suggests that a one standard deviation increase in the median household income of adults in an area would increase the expected household income of poor children by roughly \$4,500 ($p-$value< 0.01). Appendix B shows that this pattern holds more generally using data from all U.S. Census tracts.

Recent studies provide compelling evidence that the correlation between long-run economic outcomes of children is largely driven by causal effects. Chetty et al. (2016) and Chyn (2018) find that moving out of high-poverty neighborhoods has large positive benefits for children living in severely distressed public housing projects. Chetty and Hendren (2018*a*) use tax records for 7 million families that move across commuting zones (CZs) and find notable benefits from relocating to more advantaged areas. Their analysis suggests that a young child who moved at birth to a better area and stayed there for 15 years would pick up 60 percent of the difference in permanent resident outcomes between their origin and destinations.

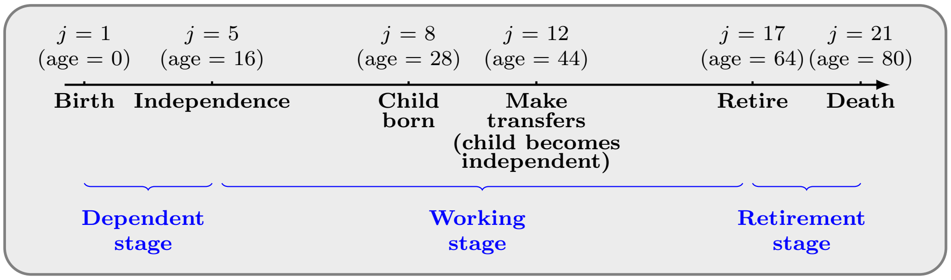
3 Model

The model has three main components. First, the long-run outcomes of children depend on parental choices. An individual's earnings depend on skills that are determined in childhood. Parents affect the skills of their children by choosing neighborhoods and making time investments. Neighborhoods matter for children due to endogenous local spillovers. Specifically, local spillovers occur because the skills of children increase when they grow up in an area with higher income per capita. Second, the economy is modeled using a GE life-cycle Aiyagari framework which features wage uncertainty and incomplete markets. The model features distortive taxation by allowing for endogenous labor supply. A representative firm combines capital and labor from workers who vary by skill to produce a final consumption good. Third, the government levies taxes on consumption, labor, and capital to finance lump-sum transfers and retirement benefits to individuals.

3.1 Individual Choices and Timing

The model assumes a dynastic framework with 20 age periods and three main stages: childhood, working adulthood, and retirement. Figure 2 shows the life cycle of an individual. Periods are four years long. Let j denote the age in each period (e.g., $j = 1$ refers to ages 0–3). From $j = 1$ to $j = 4$, a child lives with their parents in neighborhood n, and they do not make any choices. In our stylized model, the child reaches adulthood and achieves independence at the beginning of $j = 5$ (age 16). At independence, the individual's state

Figure 2: Model Timeline: A Dynastic Framework with Three Stages



Notes: This figure illustrates key events and the three main stages of life for an agent in the model.

variables include their neighborhood n, savings a (from parental transfers), skills θ, and an idiosyncratic moving cost κ.

Each period can be divided in two parts. In the first part, the agent chooses a neighborhood. Each neighborhood is associated with a rent τ_n (and, potentially, a moving cost). Having selected a neighborhood, the second part of the period takes place. When individuals are young, they are in the working stage of their lives so they choose their savings, consumption expenditures, and labor supply (where idiosyncratic, uninsurable risk makes labor income stochastic). Individuals can borrow up to a limit and save through a non-stage-contingent asset. At $j = 8$, the individual becomes a parent and new decisions must be made. For four periods (i.e., until their child is 16 years old), they must decide how much time to invest in child development. Time investments and neighborhood choice both determine the child's skills. Before the child becomes independent, the parent also makes a transfer to the child. Once the agent enters the period when $j = 17$, they enter the retirement stage. At this time, agents have two sources of income: savings and government provided retirement benefits.

3.1.1 Working Stage Decisions

During the working stage, individuals consume c, save a', and choose labor supply h in the second part of each period. These choices depend on the individual's level of assets a, level of skills θ, the current neighborhood location n (which is chosen previously during the first part of each period as detailed below), and a stochastic labor efficiency parameter η.

Formally, the value function during the working stage is given by:

$$V_j(a,\theta,n,\eta) = \max_{c,a',h}\left\{u(c,h,n) + \beta\mathbb{E}\left[\widehat{V}_{j+1}(a',\theta,n,\eta')\right]\right\}, \tag{1}$$

$$c(1+\tau_c) + \tau_n + a' - (y - T(y)) - \omega = \begin{cases} a(1+r(1-\tau_a)) & \text{if } a \geq 0 \\ a(1+r^-) & \text{if } a < 0 \end{cases}$$

$$y = w_n E_j(\theta,\eta)\,h, \quad a' \geq \underline{a_j}, \quad 0 \leq h \leq 1, \quad \eta' \sim \Gamma_j(\eta).$$

Individuals receive a flow utility (given by the function $u(c,h,n)$) which depends on consumption, labor supply, and the neighborhood where they live (e.g., its amenities). An individual can borrow up to an age-specific limit $\underline{a_j}$ by paying interest at rate r. Individuals can also save for a rate of return r. The return from working is the wage w_n. Wages are scaled by the function $E_j(\theta,\eta)$, which is an age-specific function of the individual's skills θ and the idiosyncratic labor efficiency η. Finally, individuals pay linear taxes on consumption (given by τ_c) and capital income (τ_a), pay a non-linear (which are progressive in the calibration described below) tax on labor income ($T(y)$), and receive lump-sum government transfer ω.

In the first part of each period, individuals choose where to live taking into their expected utility value (which depends on their current state variables and rent costs, as represented above), and moving costs. During the first period of independence ($j = 5$), we specify that the moving cost is heterogeneous—this assumption will help us capture the fact that younger individuals are more likely to live in lower-income neighborhoods. Given the neighborhood location n in the period when $j = 4$ (chosen by one's parents), the value function determining agent's first location choice at independence (i.e., age-period $j = 5$) is given by:

$$\widehat{V}_{j=5}(a,\theta,n,\eta,\kappa) = \max_{n'\in\{1,2\}} V_{j=5}(a,\theta,n',\eta) - \kappa 1(n' \neq n),$$

where κ is the stochastic utility cost of moving. As specified in equation 3, we assume that κ is normally distributed with mean $\bar{\kappa}$ and standard deviation σ_κ. Of course, this cost is only incurred when an individual chooses a new neighborhood (i.e., $n' \neq n$).

From $j = 6$ until retirement (which starts at $j = 17$), the individual's optimization problem in the first part of each period (except for parenthood as described below) is similar to Equation 1. The main difference from the first period of independence is that the location choice involves a fixed moving cost $\bar{\kappa}$. Hence, the value function is given by:

$$\widehat{V}_j(a,\theta,n,\eta) = \max_{n'\in\{1,2\}} V_j(a,\theta,n',\eta) - \bar{\kappa}\,1(n' \neq n).$$

Note that, while there are no moving cost shocks, wage shocks η can induce workers to move between periods.

3.1.2 Parental Investment and Child Development

The individual's problem changes when a child is born at the exogenously given fertility age-period $j = 8$ (representing age 28). We assume that each individual has one child. Parents are altruistic as in Barro and Becker (1989), so they care about the utility of the child with the weight $\tilde{\beta}$. Parents invest in children's skills while they are young ($j = 8 - 11$) and give them an asset transfer once they are about to become independent ($j = 12$).

Children are born with skills θ_k that are potentially correlated with parent's skills. To be in line with the estimates from Cunha (2013), we assume that skills are a vector that includes cognitive $\theta_{c,k}$ and non-cognitive $\theta_{nc,k}$ components. During each period of parenthood ($j = 8-11$), the individual chooses the number of hours τ to invest in the child's development of skills.

In addition to time investment, the skill development of children also depends on neighborhood quality. We summarize neighborhood quality as a single index measure s_n. We assume that this spillover effect is determined by per capita total income (the sum of capital and labor) for those living in neighborhood n. Note that we include all residents—those working and not working—in this calculation. Intuitively, this allows our measure to capture the idea that the fraction of children in a neighborhood matters. In addition to ideas related to economic resources per child, previous work in sociology highlights that adults within a neighborhood play a key role in promoting community social organization by supervising children and limiting deviant behavior (Sampson and Groves, 1989; Sampson et al., 2002). In this way, neighborhoods where adults are a larger fraction of the population may be particularly beneficial to children.

Our focus on income captures a number of standard theoretical mechanisms thought to drive neighborhood effects. Areas with richer parents typically have higher quality schools due to the local financing of public schools (Howell and Miller, 1997; Hoxby, 2001; Biasi, 2019).[13] In addition, children may benefit from growing up with highly productive adults due to role model effects (Wilson, 1987). More generally, our choice of representing effects in terms of earnings broadly follows prior studies that proxy for neighborhood quality using

[13]Prior evidence suggests that schools are not the only mechanism that can generate neighborhood effects. As noted in Chetty et al. (2018), there is substantial variance in child outcomes across Census tracts within the same school attendance zone, and schools account for less than half of the observed variance across tracts within a county.

measures of local area income or poverty rates (Kling et al., 2007; Chetty and Hendren, 2018*b*).

We model skill development θ_k using two nested constant elasticity of substitution (CES) functions that determine the influence of parent time and neighborhood spillovers. The outer CES is based on Cunha et al. (2010) and allows a child's skills in the next period θ_k' to depend on current skills, parental skills θ, parental investments I, and an idiosyncratic shock v. The inner CES function determines I and explicitly incorporates τ and s_n.

Formally, we assume that the problem of parents in age-periods $j = 8 - 11$ is:

$$V_j(a, \theta, n, \eta, \theta_k) = \max_{c,a',h,\tau} u(c, h, n) - v(\tau) + \beta\mathbb{E}\left(\widehat{V}_{j+1}(a', \theta, n, \eta', \theta_k')\right), \tag{2}$$

$$c(1 + \tau_c) + 2\tau_n + a' - (y - T(y)) - \omega = \begin{cases} a(1 + r(1 - \tau_a)) & \text{if } a \geq 0 \\ a(1 + r^-) & \text{if } a < 0 \end{cases}$$

$$y = w_n E_j(\theta, \eta)\, h, \quad a' \geq \underline{a_j}, \quad 0 \leq h + \tau \leq 1, \quad \eta' \sim \Gamma_j(\eta)$$

$$\theta_{q,k}' = \left[\alpha_{1,q,j}\theta_{c,k}^{\rho_{q,j}} + \alpha_{2,q,j}\theta_{nc,k}^{\rho_{q,j}} + \alpha_{3,q,j}\theta_c^{\rho_{q,j}} + \alpha_{4,q,j}\theta_{nc}^{\rho_{q,j}} + \alpha_{5,q,j}I^{\rho_{q,j}}\right]^{1/\rho_{q,j}} e^{\nu_q}$$

$$\nu_q \sim N(0, \sigma_{q,j,\nu}), \quad q \in \{c, nc\}$$

$$I = \bar{A}_j\left[\alpha_{I,j} f(s_n)^\gamma + (1 - \alpha_{I,j})\tau^\gamma\right]^{1/\gamma}$$

Given that we estimate rent costs in a per-person basis in Section 4, we assume that rent doubles when a child is present. Regarding the skill development function, the parameter $\rho_{q,j}$ determines the substitutability of ability inputs in the outer CES function for $q \in \{c, nc\}$. The substitutability of parental time investments and neighborhood quality is determined by the parameter γ in the inner CES function.

As in other periods, the individual can move at the beginning of each period. Differently from previous periods, however, the value function for that choice incorporates the children's skills θ_k:

$$\widehat{V}_j(a, \theta, n, \eta, \theta_k) = \max_{n' \in \{1,2\}} \{\mathbb{E}(V_j(a, \theta, n', \eta, \theta_k) - \bar{\kappa}\, 1(n' \neq n)\}.$$

3.1.3 Child Independence

Before the parent reaches age-period $j = 12$ (i.e., when they are 44 years old and the child is 16 years old), they need to decide the size of a monetary transfer $\hat{a}$ given to the child. We model this as a sub-period that takes place just before the child becomes independent, with a value for the agent defined by V_{Transfer}:

$$V_{\text{Transfer}}\left(a,\theta,n,\eta,\theta_k\right)=\max_{\hat{a}}\widehat{V}_{j=12}\left(a-\hat{a},\theta,n,\eta\right)+\tilde{\beta}\mathbb{E}_{\eta_k,\kappa}\left(\widehat{V}_{j'=5}\left(\hat{a},\theta_k,n,\eta_k,\kappa\right)\right), \tag{3}$$
$$\hat{a}\geq 0,\quad \kappa\sim N(\bar{\kappa},\sigma_\kappa),\quad \eta_k\sim\Gamma_{j'=5}.$$

Importantly, the transfer $\hat{a}$ should be non-negative. This ensures that the parent cannot leave debt to their children nor borrow against their future income. When making this choice, the parent knows the realization of their own income shock η, but is not aware of the child's income shock η_k or stochastic moving cost draw κ. Note that, unlike Equation (2), the value function at this stage includes the continuation value of the child $\widehat{V}_{j'=5}$ where j' stands for the age-period of the child. As the problem is written recursively, this implies that at every period in which parent choices affect their children's outcomes (i.e., all previous periods), the utility of their children (and future descendants) is taken into account. This formulation embeds the parental altruism motive. After the child's independence, the parent's individual problem reverts to Equation (1).

3.1.4 Retirement

At $j=17$ (i.e., age 64), the individual retires from work (i.e., $h=0$) and has two sources of income: savings a and publicly financed retirement benefits π. For simplicity, retirement benefits are assumed to depend on the agent's skill level. Note that we assume that individuals pay taxes on retirement benefits according to the same labor tax function $T(.)$. Formally, the problem at the age of retirement is:

$$V_j\left(a,\theta,n\right)=\max_{c,a'}u\left(c,0,n\right)+\beta\widehat{V}_{j+1}\left(a',\theta,n\right), \tag{4}$$
$$c\left(1+\tau_c\right)+\tau_n+a'-\omega-\left(\pi(\theta)-T\left(\pi(\theta)\right)\right)=\begin{cases}a\left(1+r\left(1-\tau_a\right)\right) & \text{if } a\geq 0\\ a\left(1+r^-\right) & \text{if } a<0\end{cases}$$
$$a'\geq \underline{a_j}.$$

As in other periods, the individual can move at the beginning of each period:

$$\widehat{V}_j\left(a,\theta,n\right)=\max_{n'}\left\{V_j\left(a,\theta,n'\right)-\bar{\kappa}\,1(n'\neq n)\right\}.$$

3.2 Aggregate Production

We assume that there is a representative firm in each neighborhood n with the production technology $Y_n = AK_n^{\alpha}H_n^{1-\alpha}$, where A is the total factor productivity, K_n is aggregate physical capital in neighborhood n, and H_n is the sum of efficiency units in neighborhood n. As standard, capital is assumed to be perfectly mobile across regions and depreciates at a fixed rate of δ per period. We assume that firms are perfectly competitive (i.e., making zero profits) and pay unit wages equal to the marginal product of labor. Formally, the equilibrium wage and return on capital are given as:

$$w_n = (1-\alpha)A\left(\frac{K_n}{H_n}\right)^{\alpha}$$
$$r + \delta = \alpha A\left(\frac{H_n}{K_n}\right)^{1-\alpha}.$$

People are assumed to work in the same neighborhood n. Since capital is freely mobile, wages are equal across neighborhoods in an equilibrium with no government intervention so our no-commuting assumption has no impact. In Section 5.2, neighborhood wages w_n will differ when we introduce the place-based wage subsidy $\tilde{w}_s$,

$$w_1 = (1-\alpha)A\left(\frac{K_1}{H_1}\right)^{\alpha}(1+\tilde{w}_s).$$

This type of wage subsidy programs (e.g., Opportunity Zones) tend to target those living and working in a particular area, which is in line with our assumption of people working where they live.

3.3 Housing Markets

Rental prices are determined in equilibrium given the supply functions: $S_n = \bar{S}_n\tau_n^{\Delta}$, where τ_n is the rent price in neighborhood n and Δ is the price elasticity of housing supply. For simplicity, we assume there are two neighborhoods denoted $n = 1$ and $n = 2$.[14] Without any loss of generality, we assume that neighborhood $n = 1$ is the disadvantaged neighborhood (i.e., we assume it has a lower amenity value).

[14]Our approach is similar to prior studies. For example, Fogli and Guerrieri (2019) also construct a spatial equilibrium model that features two neighborhoods.

3.4 Definition of Stationary Equilibrium

The model includes J_d overlapping generations and is solved numerically to characterize the stationary equilibrium allocation. Stationarity implies that we study an equilibrium in which the cross-sectional distribution for any given cohort of age j is invariant over time periods. Particularly important is that the distribution of initial states is determined by the choices of the older generations. The equilibrium allocation requires that households choose location, consumption, labor supply, parental time investments, and parental transfers such that they maximize their expected utility; firms maximize profits; prices (wages, rents, and the interest rate) clear markets; and neighborhood quality s_n is equal to the total income per capita in each neighborhood.

Note that we do not require that the government budget is balanced. The government may have other non-modeled expenses G. Hence, G will be defined in the initial steady state as a residual. However, to evaluate policies (e.g., housing subsidy vouchers), we do assume that any net additional expenses must be offset by additional revenue.

3.5 Role for Government Interventions

Why might government interventions increase welfare in our model? There are two key channels. First, a key friction in our model stems from the fact that parents cannot borrow against their child's future income. This reduces the incentive for parental investments (i.e., from paying the higher rent associated with $n = 2$). To illustrate this, consider a parent who is poor but pays the higher rent associated with $n = 2$ to raise a high-skilled, high-income child. This parent would want to smooth consumption intergenerationally. The fact that this rent must come at the cost of her own lifetime consumption limits their investment. If the child could promise to compensate their parent in the future (and parents were able to borrow against that future compensation), the parent would not need to reduce their consumption. Government action can make up for a parent's inability to borrow against their child's future income. Specifically, rent subsidies targeted to those with children can be thought of as (imperfectly) replacing the missing compensation mechanism via the power of taxation.[15] Rather than children compensating parents for their investments, the government

[15]Note that there are additional sources of inefficiency in the environment that motivate a government role aside from limitations on intergenerational borrowing. For example, an agent's inability to borrow fully against their own future income or to insure against future outcomes leads to imperfectly smooth consumption and worse neighborhood choices than if people were able to fully borrow. This consequence of capital market imperfections is well-understood, and a targeted rent subsidy can facilitate self-insurance and provide a lower variance of consumption. Additionally, given that investing in children is risky (since there are skills and wage shocks), parents are likely to underinvest since they cannot insure against such risk. The government,

invests directly in children and taxes them once they are adults.

Second, another key friction stems from the externalities in our model. There is inefficiency because individuals do not internalize their impact on neighborhood quality. Similar to the solution for other externality problems, the government in our context can account for the fact that individual location and work choices affect the next generation. For example, place-based wage subsidies can provide additional incentives to work in a particular neighborhood, thereby helping internalize the effect of a person's income on their neighbors.[16]

Of course, any positive effects must be weighed against the cost of increased distortionary taxation. A higher labor income tax will, ceteris paribus, reduce the incentives to invest in human capital and work. Whether the gains outweigh the losses is, therefore, a quantitative question that can be addressed by studying a calibrated model.

4 Estimation

In this section, we describe how we parameterize and estimate the model. The model is estimated using simulated method of moments to match standard moments as well as more novel ones (e.g., moments informative about parental investments and the neighborhood income gap) for the U.S. in the 2000s. Some of the parameters can be estimated "externally," while others must be estimated "internally" from the simulation of the model. For these, we numerically solve the steady state of this economy, obtain the ergodic distribution of the economy, and calculate the moments of interest. After estimating the model, we validate the model using reduced-form estimates from previous experimental and quasi-experimental research. The subsections below provides further details on the data and parameter estimates that we use for our calibrated model.

4.1 Preliminaries

Overview of Data and Samples: Parameters of the model are estimated to match two types of data. First, we construct individual level statistics from the following sources: the Panel Study of Income Dynamics (PSID); the National Longitudinal Survey of Youth (NLSY); and the American Time Use Survey (ATUS). Second, we use various Census data products, the ATUS, and the Opportunity Atlas from Chetty et al. (2018) to construct neighborhood level moments on income, housing costs, time with children, and long-run

instead, can pool that risk when providing rent subsidies to many families with children.

[16]Given that low-income families tend to live in $n = 1$, a place-based wage subsidy can also help reduce inequality (an additional outcome that a social planner may seek to change) and provide insurance against negative shocks.

outcomes of children. The remainder of this section provides details on all data sources and the key measures we use.

Wages and the Return to Skill: The wage process and return to skills are important elements for the model since they determine the career profile. We focus on a wage process that allows for differences across ages and skill levels. We propose that the wage process of a household at age j is given by the product of the wage w and efficiency units $E_j(\theta, \eta)$.[17] These are defined as $E_j = \iota_j \psi_j(\theta, \eta)$ where ι_j is the age profile and $\psi_j(\theta, \eta)$ is the idiosyncratic component of labor productivity:

$$\begin{aligned} log(\psi_j) &= \Upsilon log(\theta_c) + \eta_j \\ \eta_j &= \rho\eta_{j-1} + \xi_j \quad \xi_j \sim N(0, \sigma_{\xi,j}), \end{aligned} \tag{5}$$

where θ_c is the cognitive skill level and η_j is the idiosyncratic shock. As shown above, the latter is modelled as an AR(1) process. An agent's initial productivity shock η_0 is drawn from a normal distribution with mean zero and variance σ_{η_0}.

We estimate this wage process in two steps. First, we use data from the PSID to estimate the age profile ι_j as a second order polynomial. Since the model has four year periods, we estimate this income process by grouping observations over four years. We include year fixed effects (defined as the initial year of the four year period) to control for possible changes in average wages over time and control for selection into work. We use the PSID instead of the NLSY because it includes a representative cross-section every year, so it avoids having the average age of the sample change directly with the calendar year. Specifically, we estimate the following model:

$$w_t = \beta_0 + \beta_1 Age_t + \beta_2 Age_t^2 + \beta_3 X_t + \Pi_t + \psi_t,$$

where X_t is the control for selection into work based on a Heckman-selection estimator.[18] Appendix Table A1 reports the results from this estimation.

Second, we use the NLSY to identify the effect of skills on wages. We rely on the NLSY because it includes measures of skills while the PSID does not. We begin by using the age profile estimates from the PSID data to recover ψ_t as a residual in the NLSY data. Next, an

[17] Note that due the free mobility of capital, wages are equal in the two neighborhoods so $w_1 = w_2 = w$.

[18] To control for selection, we construct Inverse Mills ratios by estimating the participating equation using number of children as well as year-region fixed effects.

estimate of Υ is obtained by regressing our estimate of ψ_t on the log of cognitive skills as measured by the AFQT score (i.e., we estimate equation 5). Lastly, the AR(1) process for the residual η is estimated using the standard Minimum Distance Estimator developed by Rothenberg (1971). Appendix Table A1 shows the estimates obtained from our approach. These estimates are broadly in line with those obtained in previous studies that estimate similar parameters (e.g., Abbott et al., 2019; Daruich and Fernández, 2020).

Parental Time Investment: The ATUS contains detailed measures of how survey respondents use their time. The ATUS sample is based on the group of households in the outgoing rotation of the Current Population Survey (CPS). For each household, one adult is randomly selected to complete the survey. The respondent is asked to recount the activities of the previous day. For each activity, the respondent reports the starting and ending time, their location, and the members of their household who were present during the activity. Because the ATUS respondents also participated in the CPS, we have detailed information on household characteristics.

Using the ATUS, we create a sample of parents and estimate the amount of "quality time" spent with each child in the household. The sample of parents includes all ATUS respondents surveyed during the period 2003-2019 and who were ages 18-65 and had at least one child in the household.[19,20] We follow Price (2008) and define quality time to include all activities in which either the child was the primary focus of the activity or in which there would be a reasonable amount of interaction (e.g., eating together). We compute the total time that a parent spends with their children and construct a per capita (child) measure by dividing by the number of children in the household. We scale this measure by two when the respondent has a partner in the household to obtain a measure of the average amount of parental time that a child receives.[21]

Neighborhoods: As noted above, there are two neighborhoods in the model. To match this with the data, we divide U.S. Census tracts into two groups that correspond to neighborhoods

[19]As discussed further below, our analysis is based on measuring time based on residential location. Due to this, the ATUS sample that we construct only contains respondents who had non-missing geographic information. County-level residential information is suppressed when a respondent resided in an area where the population was less than 100,000.

[20]Descriptive statistics on the underlying ATUS sample are as follows. The average age of an ATUS respondent in our sample was 39 years old, and the average number of children is 1.91.

[21]Note that the ATUS sample includes married and non-married individuals. The marriage rate was 79 percent.

$n = 1$ and $n = 2$.[22] We do this in three steps. First, we use tract-level data and calculate the population-weighted percentiles of median household income within each commuting zone (CZ).[23] In each CZ in the U.S., we assign all tracts that have median household income below the 10th percentile to neighborhood $n = 1$ (i.e., the disadvantaged neighborhood with low amenity value). The remaining tracts are assigned to $n = 2$. Second, we compute averages of tract-level characteristics (detailed below) for the tracts assigned to $n = 1$ and $n = 2$ within each CZ. Finally, we average the statistics across CZs weighting by population.

Our approach allows us to aggregate several local area characteristics measured at the Census tract level to the two fictitious neighborhoods in our model. Table 1 reports summary statistics for the neighborhood characteristics that are the focus of our analysis. Columns 1 and 2 report summary statistics for neighborhoods $n = 1$ and $n = 2$, respectively. The percent difference between each statistic is reported in Column 3.

The following tract-level characteristics are key to our model: per capita income, home value, property taxes, time spent with children, and expected child outcomes. The income and housing-related measures come from the reported from the 2012-2016 American Community Survey (ACS). Note that we estimate yearly housing costs by converting home values to annual rental rates and summing this to the property tax.[24,25] We divide this number by the average number of people in a household to obtain a per individual estimate. The time-use measures are based on the ATUS sample described above.[26] The measures of expected child outcomes come from Chetty et al. (2018). Specifically, we rely on tract-level statistics on the expected income for children who have parents at the 25th, 50th, and 75th percentile of the income distribution.

Table 1 shows that there are substantial differences between the less and more advan-

[22]Recall that tracts defined by the Census are small geographic units that have an average population of 4,250 persons.

[23]Commuting zones are aggregations of counties analogous to metropolitan statistical areas. Unlike metropolitan statistical areas, commuting zones have complete coverage of the entire United States.

[24]The conversion is obtained by multiplying home values by 0.05, as is standard in the literature (e.g., Fogli and Guerrieri, 2019).

[25]Housing value and property tax statistics are available at the tract and CZ-level, respectively. We impute tract-level property taxes in two steps. First, we use CZ-level data and regress property taxes on median household income. Second, we return to tract-level data and use the CZ-level regression estimates to predict property taxes based on the median household income in a given tract. This approach parallels how we impute time-use statistics to the tract level.

[26]Note that the ATUS does not include Census-tract information for respondents. We construct tract-level measures of parental time spent with children using a two-step approach. First, we aggregate ATUS respondent time-use to the CZ-level and regress measures of average quality time spent with children on median household income. Second, we return to tract-level data and use the CZ-level regression estimates to predict quality time spent with children based on the median household income in a given tract.

Table 1: Neighborhood Summary Statistics

	(1) **Bottom**	(2) **Top**	(3) **Pct. Diff.**	(4) **Area**
Income				
Mean Individual Income	\$14,673	\$30,444	107.5%	Tract
Mean Household Income	\$39,348	\$81,314	106.7%	Tract
Poverty Share	28%	10%	-63.8%	Tract
Child's Mean Income at Age 26 by Parental Income				
25th Percentile	\$17,916	\$23,347	30.3%	Tract
50th Percentile	\$24,021	\$28,795	19.9%	Tract
75th Percentile	\$27,413	\$32,354	18.0%	Tract
Housing				
Median Home Value	\$150,166	\$250,378	66.7%	Tract
Property Tax	\$1,568	\$3,677	134.6%	CZ
Avg. HH Size	2.78	2.74	-1.7%	Tract
Yearly Housing Cost (Est.)	\$3,259	\$5,915	81.5%	Tract/CZ
Time (Hours per Week) With Children				
All Ages	14.6	19.3	32.5%	CZ
Age 0–3	17.6	26.1	48.6%	CZ
Age 4–7	14.4	17.4	20.4%	CZ
Age 8–11	11.9	14.2	19.9%	CZ
Age 12–15	12.7	14.4	13.2%	CZ

Notes: This table reports neighborhood summary statistics for two types of neighborhoods. Columns 1 and 2 report statistics for areas that are "disadvantaged" and "advantaged", respectively. The threshold for a disadvantaged neighborhood is based on whether median household income in the area is in the bottom 10 percent. When possible, we report summary statistics based on tract-level data. Due to data limitations, we also rely on summary statistics based on commuting zone (CZ) level data. Commuting zones are geographical aggregations of counties that are similar to a metro area but cover the entire United States (including rural areas). We convert the CZ-level statistics to tract-leave measures to match the two neighborhoods in our model. Yearly housing costs are estimated combining tract-level home values and CZ-level statistics on property taxes, as explained in the main text. Housing, demographic, and income statistics are from the 2012-2016 ACS. Child outcome statistics are from the Opportunity Atlas Chetty et al. (2018). Time-use statistics are from ATUS surveys from 2003-2016.

taged neighborhoods that we study. For example, the average individual income and median home values are 108 and 67 percent higher in the more advantaged neighborhood. Most importantly, the summary statistics are consistent with a model that features sorting and causal neighborhood effects: children who grow up in the more advantaged neighborhood have higher later-life incomes. This is particularly true for children from low-income households (i.e., whose parents are at the 25th percentile of the national income distribution) whose incomes are 30 percent higher. Finally, parent time investment is about 32 percent higher in the more advantaged location. It is important for the model to match this moment, otherwise there is a risk of misattributing the impact of parent time investments as neighborhood effects.

Child Skill Development: We estimate children's future skills as being dependent on current skills, parental skills, and an index of investments. Investments are a function of neighborhood income and parental time inputs. As explained in Section 3, we assume that the child development function has a nested CES form.

For the outer CES, we use estimates of the parameters from Cunha et al. (2010), which were estimated using a representative sample. These estimates are specific to each age-period j (i.e., the parameters vary with the age of the child). A key finding from their work is that the estimates indicate skills are more malleable when children are young (i.e., the elasticity of substitution determined by $\rho_{q,j}$ is larger for younger children).[27] We also follow Cunha et al. (2010) in assuming that skills are a vector of both cognitive and non-cognitive skills. In their work, Cunha et al. highlight that failure to allow for these two types of skills leads to estimates that suggest investments for low-skill children are much less productive. Thus, θ and θ_k are vectors with an entry for each skill type.

The initial draw of skills is assumed to depend on parent skill as an AR(1) process that is independent for cognitive and non-cognitive skills:

$$log(\theta_{k,q}) = \hat{\rho}_q log(\theta_q) + \epsilon_{\theta_{k,q}}, \quad q \in \{c, nc\},$$

where $\epsilon_{\theta_{k,q}}$ is a shock, independent across skill types. We define the persistence component $\hat{\rho}_q$ to be equal to $\rho_k \times \left[\frac{Var(log(\theta_{k,q})}{Var(log(\theta_q))}\right]^{0.5}$, where ρ_k is the correlation between $log(\theta_{k,q})$ and $log(\theta_q)$. We obtain estimates of the variance terms directly from Cunha et al. (2010) to calculate $\hat{\rho}_q$. Note that the variance of the skill shock is given by: $\epsilon_{\theta_{k,q}} = Var\left(log(\theta_{k,q})\right) - \hat{\rho}_q^2 Var\left(log(\theta_q)\right)$.

We assume the following functional form for neighborhood spillovers. As mentioned above, we assume that the neighborhood quality effect on children is summarized by the sum of capital and labor income per capita: $s_n = \overline{y}_n + (r + \delta)\overline{a}_n$, where the terms $\overline{y}_n$ and $\overline{a}_n$ are the labor income and asset holdings per capita in neighborhood n. For the functional form of neighborhood effects, we assume that $f(s_n) = As_n^{\zeta}$. Intuitively, a larger value for the

[27]The estimates are reported in Appendix C1.

parameter ζ allows neighborhoods to have a larger impact on child development.

In this framework, there are three sets of parameters governing investments. We internally estimate the parameters $\alpha_{I,j}$ and ζ to match two key moments for the average difference in child outcomes between advantaged and disadvantaged neighborhoods: the difference in average incomes for low-income children (i.e., have parents at the 25th percentile of the income distribution) and the differences in average incomes for high-income children (i.e., have parents at the 75th percentile of the income distribution). We estimate the neighborhood substitutability parameter γ to match the average difference in parental quality time across neighborhoods.[28] Note that we allow for $\alpha_{I,j}$ to take a different value when children are the youngest ($j = 8$) than in other age-periods ($j = 9 - 11$), to capture that parental time investments are decreasing with the age of the children.[29]

Taxes, Lump-sum Transfers, and Pension Benefits: Our model features several margins of taxation. For the labor income tax function, we assume that $T(y) = y - \lambda y^{1-\tau_y}$. The parameter τ_y helps determine the progressivity of the marginal tax rate. We use the preferred estimation of $\tau_y = 0.18$ from Heathcote et al. (2017). We estimate λ to match the average marginal income tax rate of 35.1 percent.[30] In addition to taxes on work, the government also taxes consumption and capital income. Based on McDaniel (2007), we set $\tau_a = 0.266$ and $\tau_c = 0.079$.

The model also features a lump-sum transfer ω that we estimate to match a measure of income redistribution—the ratio of the variance of pre-tax total (i.e., labor plus savings) income to after-tax total income—to capture the disposable income available at the bottom of the income distribution. We find that ω=\$2,425 on an annual basis. Note that lump-sum transfers are a standard feature in equilibrium models such as ours. The justification for this stems from the observation that low-income tend to have higher after-tax income than what would be predicted based on a tax function without a lump-sum component.[31]

Finally, our model features pension benefits, where we based the replacement rate on the Old Age, Survivors, and Disability Insurance federal program. We use skill levels in the model to estimate the average lifetime income on which the replacement benefit is based.[32]

[28] Note that, without loss of generality, we set the scaling parameter A such that the quality of neighborhood $n = 2$ is normalized to one (i.e., $f(s_2) = 1$) in the baseline steady state.

[29] Since we allow $\alpha_{I,j}$ to take two values, we also allow the investments scaling parameter $\bar{A}_j$ to take a different value when children are the youngest ($j = 8$) than in other periods ($j = 9 - 11$).

[30] As estimated by the Urban-Brookings Tax Policy Center. See https://www.taxpolicycenter.org/model-estimates/baseline-effective-marginal-tax-rates-july-2016/t16-0114-effective-marginal-tax.

[31] For example, see Figure 1 from Heathcote et al. (2017).

[32] See Appendix C2 for details.

Preferences: We specify that the period utility function for consumption and labor as:

$$u(c, h, n) = \frac{c^{1-\sigma_c}}{1-\sigma_c} - \mu \left(\frac{h^{1+\theta_h}}{1+\theta_h} \right) - \bar{v}_n,$$

where $\bar{v}_n$ is the fixed (exogenous) amenity value of living in neighborhood n (we make the normalization $\bar{v}_2 = 0$). We follow the literature and specify $\sigma = 2$ and $\theta_h = 3$ (implying the Frisch elasticity is one-third). We estimate the scaling parameter μ to match the average number of working hours observed in the PSID data. When parents choose their time to spend with children, we assume the disutility is assumed to be linear: $v(\tau) = \xi\tau$. The parameter ξ is estimated to match the average time spent with children. Finally, the altruism factor $\tilde{\beta}$ in Equation (3) is estimated to match the average monetary transfer from parents to children based on the PSID.[33]

Prices: Wages are normalized such that the average annual income at age 48 is equal to 1 in the model. In the PSID data, this income is equal to \$36,575.

Aggregate Production Function: As noted above, we assume there are there is representative firm in neighborhood n with the production technology $Y_n = AK_n^{\alpha} H_n^{(1-\alpha)}$. We set $\alpha = 1/3$. Capital depreciates at rate $\delta = 0.065$.

Housing Markets: Rental prices are determined in equilibrium given the supply functions: $S_n = \bar{S}_n \tau_n^{\Delta}$, where τ_n is the rent price in neighborhood n and Δ is the price elasticity of housing supply. Saiz (2010) estimates the population-weighted average price elasticity in the US to be 1.75, so we set $\Delta = 1.75$. Based on that elasticity and our neighborhoods definition such that 10 percent of people live in $n = 1$, we can back out $\bar{S}_1$ and $\bar{S}_2$ using the housing costs reported in Table 1. This leads to $\bar{S}_1 = 11.9$ and $\bar{S}_2 = 37.6$.

4.2 Simulated Method of Moments: Results

As previewed above, there are 15 parameters of the model that we estimate. We use simulated method of moments to estimate the following parameters: μ, $\tilde{\beta}$, $\bar{v}_1$, $\bar{\kappa}$, σ_κ, ξ, γ, $\bar{A}_{j=1}$, $\bar{A}_{j\neq1}$, $\alpha_{I,j=1}$, $\alpha_{I,j\neq1}$, ρ, $\hat{A}$, λ, and ω. Specifically, we use a Sobol sequence in order to

[33] We follow the steps in Daruich (2020) in our sample. We estimate the average total transfers received by children when they are between the ages of 17 and 26 and obtain an estimate of total parental transfers per child of \$40,837, equivalent to 125 percent of average annual individual income. The transfer data include small and large (e.g., to buy houses or cars) transfers, in-kind transfers (i.e., college tuition), and estimates for housing costs if the child lives with the parents. See cited paper for details.

solve and simulate the model in a fifteen-dimensional hypercube in which parameters are distributed uniformly and over a "large" support. This provides a global method to find combinations of parameters.

Table 2: Estimation Parameters and Moments

Parameter	Value	Description	Moment	Data	Model
Preferences					
μ	226.8	Mean labor disutility	Avg. hours worked	32.9	32.6
$\tilde{\beta}$	0.36	Altruism	Parent-to-child transfer as share of income	125.4%	127.6%
Neighborhood Value and Moving Costs					
$\bar{v}_1$	0.29	Exogenous disutility of $n = 1$	Income neighborhood ratio	107.5%	109.4%
$\bar{\kappa}$	3.47	Moving cost	Share in $n = 2$	90.0%	88.9%
σ_κ	1.34	Moving cost shock	Share of young ($j = 5 - 7$) in $n = 2$	85.6%	83.5%
Skill Formation: $I = \bar{A}\left[\alpha_{I,j} f\left(\bar{y}_n\right)^\gamma + (1-\alpha_{I,j})t^\gamma\right]^{1/\gamma}$					
ξ	0.15	Parent disutility of time with children	Avg. weekly hours with child (age 0-3)	25.6	24.0
γ	-1.43	Neighborhood-time substitutability	Time difference by neighborhood (age 0–3)	48.3%	51.7%
$\bar{A}_{j=1}$	4.33	Returns to investments ($j = 1$)	Average log-skills (age 4)	0.00	0.00
$\bar{A}_{j\neq 1}$	2.90	Returns to investments ($j = 2 - 4$)	Average log-skills (age 16)	0.00	0.00
$\alpha_{I,j=1}$	0.09	Neighborhood share (j=1)	Child inc. diff.: 25th pct. parents	30.3%	29.0%
ρ	3.41	Neighborhood curvature	Child inc. diff.: 75th pct. parents	18.0%	19.3%
$\alpha_{I,j\neq 1}$	0.97	Neighborhood share ($j = 2 - 4$)	Avg. weekly hours with children (age 4-15)	15.2	15.8
$\hat{A}$	1.23	Neighborhood scaling	Neighborhood $n = 2$ normalization	1.00	1.00
Government					
λ	0.22	Tax function scalar	Avg. marginal income tax rate	0.35	0.34
ω	0.07	Lump-sum transfer	Income variance ratio: Disposable to pre-gov	0.61	0.61

Notes: This table reports estimates of the model parameters as well as the observed and simulated moments associated with each parameter estimate. See text for definitions and data sources.

Table 2 reports estimated parameters as well as the corresponding moments in data (column 5) and the simulated economy (column 6). Overall, the model provides a good fit of the data. Given our purposes, we highlight that the simulated moments related to the skill formation parameters are close to their empirical counterparts. Moreover, the simulated moments that are informative for the neighborhood value parameter and costs are also close to the ones observed in the data.

4.3 Validation Exercises

4.3.1 Comparing Simulations with Experimental Estimates of Housing Voucher Effects

We begin our validation exercises by using credible estimates from the literature to test the most important and novel feature of our model: the influence of neighborhoods on child development. Chetty et al. (2016) studied the Moving to Opportunity (MTO) experiment which provided housing vouchers to low-income families living in deeply impoverished neighborhoods in Baltimore, Boston, Chicago, Los Angeles and New York. Families were randomized into one of three groups: an "experimental" group, a Section 8 comparison group, and a control group. Those in the experimental group received housing vouchers that could only be used to subsidize rent for private market housing units located in Census tracts with poverty rates below 10 percent. Families in the Section 8 Comparison group received vouchers that could be used without any neighborhood restrictions. Members of the control group received no vouchers through this experiment.

Prior studies of MTO have found that the program had reduced the likelihood of living in a high-poverty neighborhood and had beneficial impacts on long-run outcomes of children. Chetty et al. (2016) find that moving through MTO increased earnings of children who moved by $3,500. The pattern in the MTO results is consistent with a model of childhood exposure effects in which exposure to "better" environments leads to improved long-run outcomes.

We simulate a policy similar to the MTO voucher program in our model. From the steady state, we evaluate a scenario in which the government provides low-income families that have children and live in the disadvantaged neighborhood with a voucher that subsidizes rent for housing in the more advantaged area. In our simulation, we limit eligibility to individuals whose income falls below the tenth percentile of income.[34] The subsidy in our simulation covers 100 percent of rent and must be redeemed in the advantaged neighborhood. Note that this validation exercise also assumes that rental prices and other equilibrium quantities (such as neighborhood quality) do not change. These assumptions are in line with idea that relatively few families move in a small-scale RCT such as MTO, implying that neighborhood characteristics are not affected.

Voucher-eligible families make two key choices in our model. First, they must decide whether to take-up the voucher and relocate to the more advantaged neighborhood. We find that 25 percent of households opt for the voucher in our simulation. Second, parents adjust the amount of time that they spend with their children. Given that time and neighborhood

[34] Results from our validation exercise are similar when we use alternative low-income definitions.

quality are complements in our estimation, parents with young children ($j = 8$) spend on average 7.8 (30.9 percent) more weekly hours with their children after taking-up a housing voucher.

Our main finding is that the voucher-subsidy program in this simulation exercise generates similar positive impacts on long-run outcomes of children. We calculate that children in our simulation have 23 percent higher income when children are in their late 20s. This effect can be compared to the MTO results in two ways.

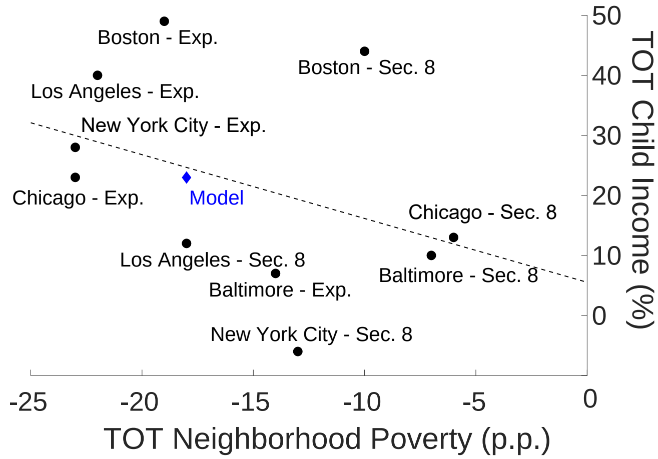
First, we can compare this impact to the average 31 percent increase in earnings experienced by children whose household moving using an MTO experimental voucher. While the simulation effect is about three-fourths of this impact, it is worth noting that there are some important differences between the types of moves observed in the MTO experiment and those captured by our simulation. Specifically, the experimental MTO voucher reduced neighborhood poverty rates by 22 percentage points. In our simulation, the contrast in neighborhood quality is less stark, and the resulting decrease in the poverty rate from voucher take-up is 18 percentage points.[35] Hence, the simulation and MTO results are roughly similar given the impacts on average neighborhood quality.

Second, we can compare the impact on earnings in the simulation to the range of effects the site-specific treatment effects observed in the MTO demonstration.[36] The Figure 3 plots dots (in black) for the treatment effects for the unrestricted (i.e., standard Section 8) and experimental voucher groups in each of the five MTO cities. The results show that reductions in neighborhood poverty were larger for treated households in the experimental group. In line with this, the treatment effects on the earnings of children generally increase with the larger improvements in neighborhood quality (i.e., reductions in neighborhood poverty rates). The dashed line plots the predictions from a linear regression through the site-specific estimates. The diamond (blue) point on the figure represents the results from our simulation. Reassuringly, we see that the simulation generates results that are very close to the simple linear prediction based on the pattern of site-specific MTO results.

[35] Neighborhood poverty is a characteristic that we measure for the two fictional neighborhoods using averages of the tract-level Census data (as described in Section 4.1). We do not directly measure poverty status for individuals in the simulation.

[36] Site-specific treatment effects on long-run earnings of children and household poverty rates are from Chetty et al. (2016) and Ludwig et al. (2013).

Figure 3: Validation Exercise: Comparing MTO Site-Specific Effects to Model Simulation



Notes: This figure compares results from the Moving to Opportunity (MTO) housing voucher experiment and simulation results based on our calibrated model. The MTO experiment took place in five cities: Baltimore, Boston, Chicago, Los Angeles and New York. Families were randomized into one of three groups: an experimental group, a Section 8 comparison group, and a control group. The solid (black) dots plot the treatment effects on long-run earnings of children (y-axis) and the change in neighborhood poverty for each site and voucher group (x-axis). Since there were five sites and two vouchers arms (Section 8 and Experimental, respectively), there are 10 solid dots. The solid (blue) diamond plots the simulated effect on long-run earnings of children and associated change in poverty rates from moving to the more advantaged neighborhood ($n = 2$). The dashed line shows predictions from a linear regression of the treatment effects on long-run child income (as a percent effect relative to the control group mean) on the reductions in poverty rates.

4.3.2 Comparing Simulations with Quasi-experimental Estimates of Place-Based Policy Effects

As a supplemental validation exercise, we also test whether simulations from our calibrated model can match credible reduced form evidence on the effects of place-based policies on labor markets. Busso et al. (2013) studied the impact of the EZ program, one of the largest federal policies in the U.S. that provided incentives to encourage development of distressed and economically underperforming areas. A key feature of the policy was a wage subsidy in the form of an employment tax credit. Specifically, firms operating in a designated EZ became eligible for a credit of up to 20 percent of the first $15,000 in annual wages earned by an employee who lived and worked in the area.

Busso et al. (2013) found that the EZ program had large positive impacts on labor market activity. To estimate effects, they used a difference-in-differences approach that compared Census tracts selected for the EZ program to a comparison group of tracts that had applied but been rejected for EZ designation. Their results indicate that the program increased annual wage income in 2000—approximately five years after the program began—by 17 to 24 percent for local residents who worked in the designated area.[37]

We simulate a policy experiment to mirror the EZ program using our calibrated model. Relative to the steady state with no intervention, we study a scenario in which the government provides a wage subsidy of 20 percent to all workers who live (and by assumption work) in the disadvantaged neighborhood $n = 1$ for a specified duration.[38] In this simulation, we allow rental prices and other equilibrium quantities (such as neighborhood quality) to change. These assumptions are in line with the idea that the EZ designation in Busso et al. (2013) was sufficiently large to have equilibrium impacts.

Table 3: Validation Exercise: Simulated Impacts of a 20-percent Wage Subsidy on Income

	(1)	(2)	(3)	(4)
	Δ Log-income			
Period of Evaluation				
First	0.21	0.19	0.17	0.17
Second	-0.01	0.26	0.24	0.24
# of Subsidy Periods	1	2	3	4

Notes: This table presents results from simulations of a 20-percent wage subsidy provided to residents of the disadvantaged neighborhood $n = 1$ using our calibrated model. Each column reports simulated effects (relative to a steady state with no government intervention) on the income of $n = 1$ residents when the wage subsidy program lasts for one, two, three, or four periods. The rows report results on income evaluated in the first or second periods.

Our main finding is that the simulated impacts of a 20 percent subsidy on income that are similar to the positive impacts found in Busso et al. (2013). Table 3 shows a range of simulated impacts where each column varies the duration of the 20 percent wage subsidy from 1 to 4 periods, and the rows report impacts on income in different periods. For example, we find that adults in $n = 1$ have 21 percent higher earnings when the program is only run for one-period (corresponding to four years). Although the effects vary slightly with the intervention duration and time of evaluation, the range of estimates is broadly similar to Busso et al. (2013).

[37]See Panel C of Table 6 from Busso et al. (2013).

[38]Note that the EZ program did not provide permanent employment tax credits. Tax credits were available to a business for as long as ten years.

5 Policy Analysis

This section quantitatively evaluates the general equilibrium effects of government interventions that change neighborhood quality for children. As in most OLG models with intergenerational human capital investments, the main rationale for government involvement, as detailed in Section 3.5, stems from the fact that children do not control the inputs into their development or compensate their parents for doing so. This can lead to reduced levels of childhood investment relative to an economy where it is possible for parents and children to sign contracts to facilitate intergenerational transfers.[39] In addition, the presence of externalities in our environment provides another motivation for intervention since government policies can help internalize the effect of a person's income on other individuals.

As previewed above, our analysis focuses on two types of interventions: housing rental vouchers and place-based wage subsidies. For each program, we begin our analysis by evaluating the large-scale and long-run effects of several alternative versions of the program that vary programmatic features such as the subsidy rates. We start by identifying the version of each program that has the highest steady-state welfare gains. Note that welfare is defined by consumption equivalence under the veil of ignorance.[40] We compare the highest steady-state welfare policy to several alternatives in order to understand the quantitative importance of each feature of the voucher or wage-subsidy programs. Focusing on the welfare-maximizing policy, we provide a decomposition analysis to study the role of the different equilibrium forces (e.g., long-run intergenerational dynamics, limited housing supply, endogenous neighborhood quality, and taxation) and study transition dynamics.[41] We conclude this section with a discussion of the distribution of each program's impact on welfare and how this may have political economy implications.

5.1 Evaluating Alternative Housing Voucher Programs

The goal of this section is to study the consequences of a housing voucher program after accounting for the general equilibrium forces that are difficult to evaluate using existing empirical evidence based on RCTs and small-scale natural experiments. The policy is such

[39]Previous theoretically focused research on parent investment highlights that childhood development policies (e.g., Loury, 1981; Baland and Robinson, 2000) and investments in neighborhood or schooling programs (e.g., Benabou, 1996; Durlauf, 1996; Fernandez and Rogerson, 1996) can be welfare enhancing (using the standard consumption equivalence measure).

[40]See Appendix D for details on the definition of our welfare measure.

[41]In our transition analysis, we study the impacts on welfare for adults alive at the time of a policy's introduction. Here, we evaluate the welfare gain of each adult and report either the average or a moment of distribution (e.g., the share with gains).

that individuals in the program would pay $\tau_2 \times (1-s)$ if living in $n=2$, where s is the rent subsidy rate. The government finances these programs by adjusting the labor tax parameter λ (which is typically thought of as governing the average labor tax rate) such that its budget is unchanged from the initial steady state.

In order to simplify the analysis, we focus on the program that generates the highest steady state welfare (under the veil of ignorance). To determine this, we simulate versions of our model which differ in terms of three characteristics: (1) the voucher subsidy rate s; (2) an eligibility restriction in terms of the individuals hourly wage $wE_j(\theta, \eta)$; and (3) an eligibility restriction based on the presence of children (which is based on age j given the exogenous fertility assumption in our model). We search over 50 variations of voucher programs defined by these characteristics.[42] After determining the policy with characteristics that leads to the largest steady-state welfare gains (relative to the baseline scenario where there is no voucher program), we similarly report results for several alternatives policies to better understand which policy features drive the gains.

The highest steady-state welfare gains are achieved with a policy that has a full subsidy rate and targets households that have children and wages below the fourth quintile (i.e., the 80th percentile). In this scenario, the share of children living in the more advantaged neighborhood increases by 12.5 percent. As lower-income parents and more children move to $n=2$, average income per capita is reduced in this location, leading to a reduction in its neighborhood quality of 4.7 percent. Despite this, the average neighborhood quality to which children are exposed to increases by 1.2 percent. This leads to a 1.1 percent increase in labor productivity (calculated by $\psi = e^{\Upsilon \log(\theta_c)}$ as detailed in equation (5)). As more people are willing to move to $n=2$, the rent τ_2 increases by 3.4 percent. Even though rent increases and funding the policy requires a large increase in taxes, with the marginal tax rate increasing by 15.7 percent, the positive effects of the policy dominate and welfare increases by 3.4 percent.

Table 4 reports results that permit a comparison of the policy that achieves the highest steady-state welfare gains to alternatives. Columns 2 and 3 show that voucher programs which reduce the subsidy rate to 20 and 80 percent decrease take-up of the voucher program, and the share of children in $n=2$ increases by only 1.9 and 10.7 percent, respectively. These increases are smaller than the 12.5 percent increase observed in the highest welfare policy. In line with this, the welfare gains are relatively smaller at 0.5 and 2.9 percent in

[42] We allow for five different subsidy rates (i.e., 20, 40, 60, 80, and 100 percent). We target the levels of wage targeting by quintiles of the cross-section distribution (e.g., below the 1st quintile or below the 3rd quintile). Finally, targeting by the presence of children means that only those age $j = 8 - 11$ can obtain the subsidy.

these scenarios. Columns 4 and 5 show that restricting eligibility based on parent earnings has limited impacts on take-up and corresponding small differences in welfare gains. For example, targeting the program to only those with wages in the bottom quintile still leads to welfare gains of 2.6 percent. Notably, it is cheaper to finance this policy so taxes only need to increase by one-fifth as much (i.e., 2.9 versus 15.7 percent). This may matter for the political economy of a voucher program, a point we return to when we discuss transition dynamics. Finally, the last column reports steady-state outcomes in a scenario which mirrors the policy that delivers the highest welfare but eliminates the requirement that individuals have children. In this scenario almost everyone lives in $n = 2$ (12 percent more people than in the initial steady state), increasing rent prices by 5.3 percent. Thus, large increases in the average marginal tax rate (44 percent) are necessary to fund this less-targeted program, leading to sizable reductions in labor supply, thereby lowering income and notably decreasing neighborhood quality in $n = 2$. These negative effects sum up to large welfare losses of 5.0 percent, suggesting that targeting families with children is crucial for the rent-voucher program to have positive effects.

To summarize, the comparison across columns of Table 4 suggest there are two crucial components of the rent voucher program. The program should feature a high subsidy rate such that the take-up is high and restrict eligibility only to the families with children to avoid the large increases in taxes that have large negative effects on income and neighborhood quality. While wage targeting does have an effect on welfare, its importance appears to be much smaller than the other two program parameters.[43]

5.1.1 Voucher Decomposition

The results so far demonstrate that a large-scale targeted housing voucher program can notably increase long-run welfare. In this section, we provide an analysis that traces out the mechanisms that drive these gains. Specifically, we define the highest welfare achieving policy introduced in the previous section as our benchmark and compare this to several simulations that shut down several equilibrium channels in our model.

Table 5 presents decomposition results for our main economic outcomes. The bottom row in bold reports statistics for the benchmark, including all equilibrium effects. The first row reports simulation results when the voucher program defined in our benchmark simulation is introduced for one generation (starting from the initial steady state without a rent-voucher

[43]Less wage-targeting leads to higher take up, increasing gains, but also leads to higher tax increases, reducing the gains. These two opposing effects make the welfare effects of rent voucher programs relatively constant across different levels of wage targeting.

Table 4: Long-Run Effects of Alternatives Housing Voucher Programs

	(1)	(2)	(3)	(4)	(5)	(6)
	Long-Run Optimal	**Alt. Subsidy Rates**		**Alt. Wage Targets**		**Alt. Demo.**
Rent Subsidy						
Subsidy Rate	100%	20%	80%	100%	100%	100%
Wage Below Quintile	4	4	4	1	5	4
Target Children	✓	✓	✓	✓	✓	✗
Welfare	3.4%	0.5%	2.9%	2.6%	3.3%	-5.0%
Policy						
ΔTax Rate	15.7%	3.1%	12.4%	2.9%	18.1%	44.0%
Share with subsidy	21.8%	21.9%	21.8%	4.9%	25.0%	82.6%
Subsidy take-up	99.2%	88.5%	97.3%	93.4%	99.4%	100.0%
ΔShare of children in n=2	12.5%	1.9%	10.7%	4.7%	12.7%	13.3%
Aggregates						
ΔGDP	-0.3%	-0.2%	-0.3%	0.2%	-0.1%	-6.0%
ΔCapital	-0.5%	-0.5%	-0.8%	-0.6%	0.9%	-13.1%
ΔLabor Productivity	1.1%	0.1%	1.0%	0.8%	1.2%	-0.7%
ΔInterest Rate	-0.3%	0.1%	-0.1%	0.9%	-1.3%	7.4%
Neighborhoods						
ΔQuality n=1	12.8%	-1.8%	4.7%	16.3%	13.4%	49.1%
ΔQuality n=2	-4.7%	-1.2%	-4.0%	-2.5%	-4.6%	-11.6%
ΔQuality for avg. child	1.2%	-0.3%	1.1%	0.5%	1.4%	-5.8%
ΔWage n=1	0.2%	-0.1%	0.0%	-0.4%	0.6%	-3.5%
ΔWage n=2	0.2%	-0.1%	0.0%	-0.4%	0.6%	-3.5%
ΔRent n=2	3.4%	0.4%	2.8%	1.2%	3.4%	5.3%

Notes: This table presents results from an analysis of the effects of various housing voucher programs on equilibrium outcomes. All effects are calculated by comparing the difference in outcomes between a simulation for a given voucher and the baseline scenario where there is no government housing intervention. Column 1 reports differences when comparing the policy that generates the highest welfare gain relative to the baseline scenario. Columns 2-3 presents results for scenarios where the voucher subsidy covers 20 and 80 percent of rent, respectively. Columns 4 and 5 presents results for scenarios where the voucher eligibility targets those whose hourly wages, $wE_j(\theta, \eta)$, are below the first and fifth quintiles, respectively. Column 6 presents results for the scenario where the voucher eligibility does not depend on whether the household has children. The asterisks highlight that short-run effects are evaluated for children of the cohort that received the policy intervention.

program), there are no general equilibrium effects (i.e., rents, neighborhood quality, wages, and interest rates do not change), and the economy has no requirement to balance the government's budget. Effects are evaluated for the children of the single generation that is offered the voucher. This initial simulation is intended to be representative of what we would expect from an RCT, which is typically implemented on a small scale (i.e., taxes, prices and neighborhood qualities do not change) and applied to only to members of one generation.[44]

Table 5: Rent Subsidy: Decomposition of Equilibrium Forces for Main Economic Outcomes

Equilibrium Forces				**Change from Initial Steady State (%)**						
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Long Run	**Real Estate Mkt.**	**Neigh. Qual.**	**Prices & Taxes**	**Share in** $n = 2$	**Neigh. Qual,** $n = 1$	**Neigh. Qual,** $n = 2$	**Capital**	**Labor Prod.**	**GDP**	**Cons. Equiv.**
✗	✗	✗	✗	1.1	0.0	0.0	–	0.9*	1.7*	3.5*
✓	✗	✗	✗	11.9	0.0	0.0	7.1	2.1	1.3	15.0
✓	✓	✗	✗	9.5	0.0	0.0	7.3	2.1	1.4	14.4
✓	✓	✓	✗	9.2	12.7	-4.0	6.7	1.2	0.7	13.6
✓	✓	✓	✓	**8.4**	**12.9**	**-4.9**	**-0.5**	**1.1**	**-0.3**	**3.4**

Notes: This table presents results that decompose how various equilibrium forces affect economic outcomes under the housing voucher program that generates the highest steady-state welfare gains. Each row provides results from a separate simulation of the model. Columns 1-4 describe which equilibrium force is shut down in each simulation. Columns 5-11 report changes (in percent) in outcomes calculated by comparing each simulation to the initial steady state (where there is no housing voucher program). The asterisks highlight that short-run effects are evaluated for children of the cohort that received the policy intervention.

The main finding apparent in this section is that the welfare gains predicted based on an RCT evaluation of the benchmark program are similar to those obtained in the long-run steady state. Column 11 shows that welfare increases 3.5 percent under a small-scale voucher program in the short-run. This is only slightly larger than the 3.4 percent increase that is produced in the long-run benchmark introduced in the previous section. In other words, the welfare improvements predicted from a small-scale voucher program are not offset by the equilibrium effects captured in our model.

The following rows provide results that help unpack the role of the equilibrium forces. The second row allows for long-run effects: the benchmark voucher program is implemented

[44]Note that the initial simulation in the top row of Table 5 differs from the validation simulation in two main ways. First, the simulation for the validation exercise only targets those with wages below the tenth percentile. In contrast, the simulation in this section sets voucher eligibility to those with wages below the fourth quintile. Second, the validation simulation only considers providing vouchers to individuals who live in the disadvantaged neighborhood initially. In this section, the simulation in the top row provides vouchers to anyone living in the good neighborhood who meets the eligibility conditions.

permanently and effects are evaluated in the new steady state. Note that we hold constant several other endogenous variables such as housing market prices, neighborhood quality, labor market conditions, and other equilibrium objects (e.g., taxes and interest rates). Our goal is to simulate a scenario that solely accounts for the fact that improving one generation's level of skills has intergenerational dynamic effects that accumulate over time. In our model, improving one generation's skills creates higher-skilled and higher-income parents (which may invest more in their children and makes these investments more productive) and higher-income neighbors (increasing neighborhood qualities). In line with this, the effect on labor productivity doubles (from 0.9 to 2.1 percent, as shown in Column 9) and welfare gains increase by 11.5 percentage points (from 3.5 percent to 15 percent).

Next, the third and fourth rows show that there are relatively muted impacts of two equilibrium forces that are expected to reduce the benefits impacts of voucher programs. The simulation in the third row allows for housing price adjustments. Rent in $n = 2$, τ_2, increases by 3.9 percent, slightly reducing movements to the advantaged neighborhood relative to the scenario in which rents do not adjust (a 9.5 percent increase rather than 11.9 percent). Taking into account housing prices reduces the welfare gains from voucher programs by just 0.6 percentage points. Similarly, the fourth row shows that there is only a small decrease in welfare benefits when the simulation allows neighborhood quality to adjust in response to resorting. As more low-income parents and children relocate to $n = 2$, income per capita in the advantaged neighborhood is reduced and neighborhood quality declines by 4 percent. As a direct result of this resorting, neighborhood quality in $n = 1$ increases as some higher-income people without children move from the $n = 2$ location due to the high rents and children move to the more advantaged area.[45] Taking into account these resorting effects reduces the average child's neighborhood quality, thereby cutting the labor productivity gains by half (from 2.1 to 1.2 percent, as shown in Column 9). Nevertheless, these two rows of results suggest that subsequent household resorting may have a relatively little impact on the potential of voucher programs to generate welfare gains.

The key decomposition finding apparent from the fifth row is that government financing and production input prices (i.e., wages and interest rate) adjustments are important. Relative to the long-run simulation that allows housing markets and quality to adjust, the welfare gains decline from 13.6 to 3.4 percent. Column 1 in Table 4 shows that this policy is associated with only minor changes in wages and the interest rate (of 0.2 and -0.3 percent,

[45]Recall that neighborhood quality is measured as the total labor and capital income in an area divided by the total population across all ages. This implies that the arrival of children reduces quality in the model, possibly capturing the idea of over-crowding.

respectively). Thus, most of the negative effects captured in the fifth row of Table 5 stems from the large increase in taxes necessary to finance the voucher program. Even though productivity increases, the average marginal tax rate must increase by 15.7 percent. As taxes increase, individual's income is reduced leading to lower consumption and further decreases in neighborhood quality (from -4.0 to -4.9 percent in $n = 2$, as shown in Column 7).

Finally, we conclude our decomposition analysis by also studying impacts on income inequality and upward mobility. We measure income inequality using the variance of log-lifetime-after-tax-earnings. Upward mobility is defined as the probability that a child born to parents in the bottom quintile of the income distribution is in the top income quintile during the working stage of their life. Comparing the first and fifth rows of Table 6, the main finding is that the effects on these outcomes are substantial and similar between the short-run small-scale version and the large-scale long-run version. Inequality is reduced by 6.3 percent, which is about as large as the percent difference in after-tax inequality between Sweden and the US (Krueger et al., 2010).[46] Upward mobility increases by 27.7 percent, which is approximately half of the standard deviation in upward mobility across US Census tracts (Chetty et al., 2018).

Table 6: Rent Subsidy: Decomposition of Equilibrium Forces for Inequality and Mobility

Equilibrium Forces				**Change from Initial Steady State (%)**				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Long Run	**Real Estate Mkt.**	**Neigh. Qual.**	**Prices & Taxes**	**Share in** $n = 2$	**Neigh. Qual,** $n = 1$	**Neigh. Qual,** $n = 2$	**Income Inequality**	**Upward Mobility**
✗	✗	✗	✗	1.1	0.0	0.0	-6.0*	25.9*
✓	✗	✗	✗	11.9	0.0	0.0	-7.4	25.9
✓	✓	✗	✗	9.5	0.0	0.0	-5.4	25.7
✓	✓	✓	✗	9.2	12.7	-4.0	-5.5	27.4
✓	✓	✓	✓	**8.4**	**12.8**	**-4.7**	**-6.3**	**27.7**

Notes: This table presents that decompose how various equilibrium forces affect economic outcomes under the housing voucher program that generates the highest steady-state welfare gains. Each row provides results from a separate simulation of the model. Columns 1-4 describe which equilibrium force is shut down in each simulation. Columns 5-9 report changes (in percent) in outcomes calculated by comparing each simulation to the initial steady state (where there is no housing voucher program). The asterisks highlight that short-run effects are evaluated for children of the cohort that received the policy intervention.

To summarize, a government housing program can lead to large welfare gains in the

[46] See Table 3 of Krueger et al. (2010).

long-run steady equilibrium. This occurs because relocating to a better neighborhood using housing vouchers enhances child development and creates better parents and neighbors for future generations. This long-run intergenerational dynamic effect is sufficiently large to offset several countervailing equilibrium forces. Rent increases and neighborhood quality decreases in equilibrium, but tax increases are the largest source that dampens the welfare gains associated with voucher programs.

5.1.2 Voucher Transition Dynamics

In this section, we evaluate the transition dynamics associated with implementing the benchmark housing voucher program described above. A logical concern is that the welfare benefits achieved in the long-run steady state may take too long to accrue. This matters for understanding the political economy issues at play with the housing voucher program that we consider.

To study dynamics, we simulate the model where the government unexpectedly introduces the benchmark housing voucher program with associated (i.e., the one associated with the largest long-run welfare gains). Note that the steady-state change in labor income tax may not be enough to balance the government's budget initially because the pool of skills in the economy takes time to increase. Due to this, the government is assumed to adjust taxes (by adjusting tax parameter λ) every period in order to achieve a balance budget in each period in the transition.

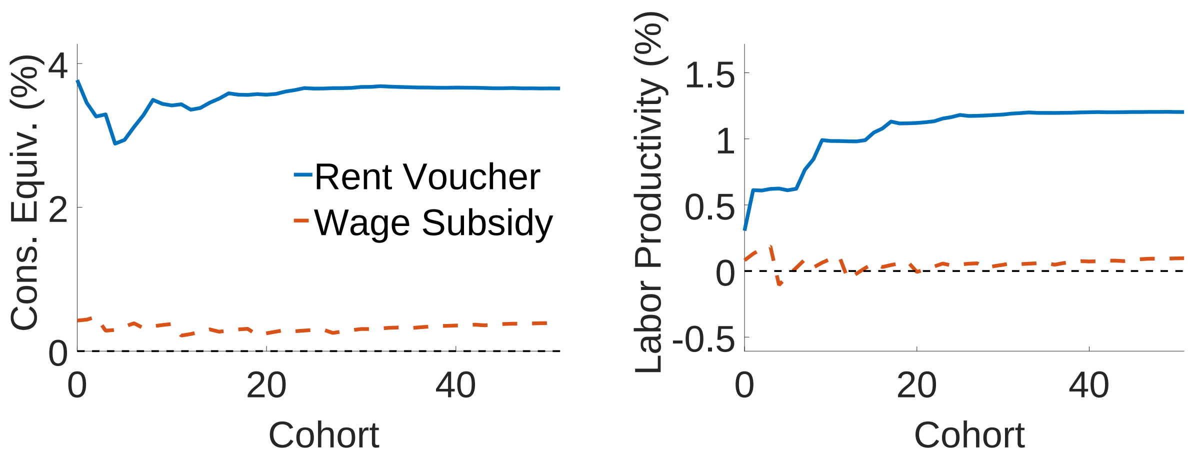
Figure 4 plots the impacts of the voucher program for newborns and future cohorts as a solid (blue) line.[47] Here, cohort "0" is the first cohort born at the time the policy is introduced, and cohort x (for all $x > 0$) refers to the cohort born x periods after the policy is introduced. Panel (a) shows that welfare increases by about 4 percent for cohort 0. These gains initially decline for subsequent cohorts to around 3 percent before rebounding. The impact on welfare stabilizes to the steady state increase of 3.4 percent for the twentieth cohort that is born after the introduction of the housing voucher program. Panel (b) shows that productivity increases cohort-by-cohort until the steady-state level is achieved. The first cohort's productivity increases by about 0.5 percent. Productivity is then almost unchanged until a jump (to about 1 percent) is observed for the first cohort born to the parents who received the intervention (i.e., those born 28 years after the policy is introduced). A second jump (to almost 1.2 percent) takes place afterwards for the first cohort born that had grandparents who received the voucher subsidy. These jumps in the productivity demon-

[47] Note that the figure also reports effects for an alternative policy, a place-based wage-subsidy, which will be discussed in Section 5.2.

strate the mechanism driving long-run intergenerational gains: exposing a child to a better neighborhood today creates a better parent for the next generation.

Figure 4: Transition Analysis Comparison: Effects of the Benchmark Policies by Cohort

(a) Welfare **(b)** Labor Productivity



Notes: This figure presents an analysis of the transition dynamics associated with the two government interventions. Results for the rent voucher program that generates the highest steady-stead equilibrium welfare gains (detailed in Section 5.1) are reported in solid (blue). Results for the place-based wage subsidy program that generates the highest steady-stead equilibrium welfare gains (detailed in Section 5.2) are reported in dashed (red). All effects of the programs are at the cohort level starting with the first cohort born at the introduction of the policy (i.e., cohort 0) up to the fiftieth cohort born afterward. The x-axis on the figure indicates the relevant cohort. These effects represented by the y-axis are calculated as the difference in a given outcome compared to the steady-state where no housing voucher program existed. Note that welfare is measured as consumption equivalence (see Section D for further details).

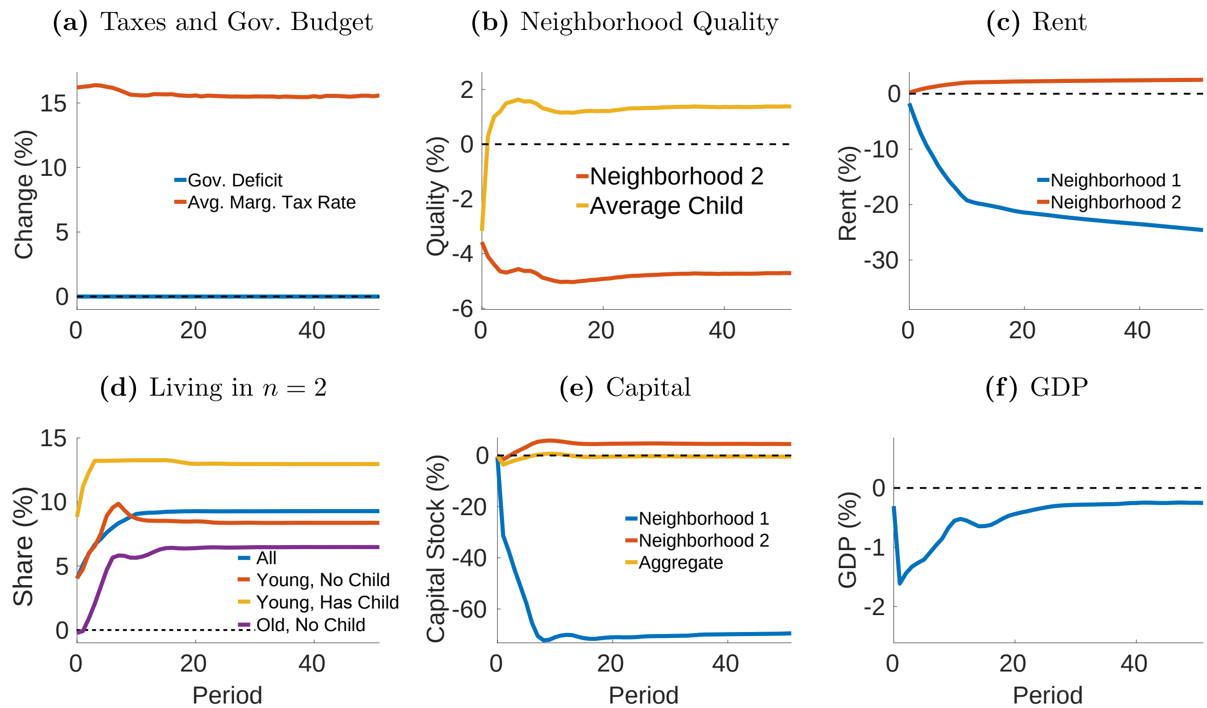
Why do welfare gains initially decline before rebounding? Figure 5 provides an explanation by showing the dynamics of several key economic outcomes by time period. Here, period "0" is the time when the rent voucher policy is introduced. There are two key points from this analysis. First, Panels (a) and (b) show that neighborhood quality decreases and rent increase shortly after the policy is introduced which lowers welfare gains.[48] Why do rent and quality change gradually? Theoretically, these effects on neighborhood conditions and rent stem from moving costs that slow resorting. This prediction is confirmed in Panel (d) which shows gradual change in population shares in $n = 2$.[49] The second key finding

[48]In contrast, Panel (c) shows that equilibrium taxes increase immediately and do no change substantively over time (i.e., they are relatively constant at a 15.7 percent increase). This rules out that taxes play a role in explaining the initial decrease in welfare gains observed in Figure 4.

[49]Panel (d) also shows population shares by type of household. Families with children (particularly children who are young) are the first to move. Population shares for older individuals increase much more slowly.

can be observed from the transition dynamics for the capital stock and GDP illustrated in Panels (e) and (f), respectively. Capital in the advantaged neighborhood increases over time which drives a recovery in GDP. Yet, these changes lag the resorting that drives changes in rents and quality. To summarize, the initial decline in welfare gains is due to decreases in neighborhood quality and increases in rent that are offset in the long-run when capital stock growth and GDP recovery are fully in place.

Figure 5: Transition Analysis: Effects of the Benchmark Voucher Program by Period



Notes: This figure presents an analysis of the transition dynamics associated with the housing voucher program that generates the highest steady-state equilibrium welfare gains. We report effects of the voucher program at the period level starting with the first period when the policy is in effect (i.e., period 0) up to the fiftieth period afterward. The x-axis on the figure indicates the period of interest. The effects represented by the y-axis are calculated as the difference in a given outcome compared to the initial steady state (where no housing voucher program existed). Note that the results in Panel (d) show population shares in the advantaged neighborhood ($n = 2$) for the following groups: all individuals, young individuals with no children (i.e., $j = 5{-}7$), young individuals with children ($j = 8{-}11$), and old working-age individuals without children ($j = 12 - 16$).

5.2 Evaluating Place-Based Policies

The goal of this section is to study the effects of place-based policies in general equilibrium. The policy that we study is a wage subsidy, $\tilde{w}_s$, for individuals who live (and work) in the disadvantaged area. Specifically, the policy is such that in equilibrium workers in $n = 1$ earn $w_1 = (1 + \tilde{w}_s)w_2$. As in our analysis of housing vouchers, the government finances this program by adjusting labor taxes (λ) to ensure the budget remains at its initial steady state level.

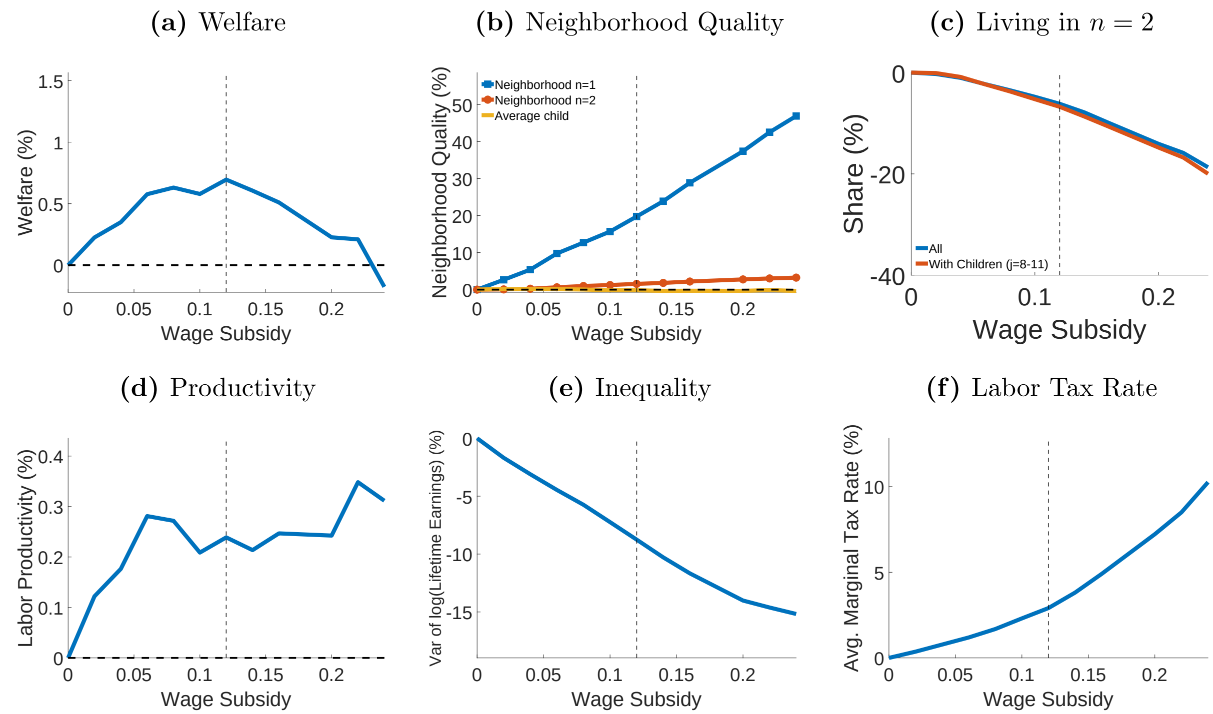
In line with our prior analysis, we aim to identify the wage subsidy program that generates the highest steady state welfare (under the veil of ignorance). We determine this by varying the subsidy rate from 2 to 24 percent (in intervals of 2 percent) and simulating the equilibrium in each case. For each simulation, we calculate percent changes for various equilibrium outcomes relative to the baseline scenario in which there is no wage subsidy program.

Figure 6 reports results from the various wage subsidies that we consider. The vertical dashed (black) line in Panel (a) shows that the highest steady state welfare gain is 0.7 percent when the wage subsidy is set to 12 percent. The remaining panels on the top row show there are important impacts on residential sorting. At this welfare maximizing subsidy rate, Panel (b) shows that neighborhood quality increases in the disadvantage area by 19.7 percent. As shown in Panel (c), this is driven by relocation of relatively higher-skilled workers who are induced to move from the advantaged area. Note that Panel (c) also shows that the share of children in the advantaged also decreases as their parents are drawn by the higher wages, lower rents and the newly realized increases in neighborhood quality.

The results in Figure 6 also show how welfare and other equilibrium outcomes change as a function of the subsidy rate. Panel (a) shows that the steady state welfare gains increase at a relatively constant rate before decreasing when the subsidy exceeds 12 percent. The results in the bottom row of panels illustrate some of the forces that drive this pattern. The initial welfare gains are driven by effects of the wage subsidy on labor productivity. Panel (d) shows that labor productivity increases steadily until leveling off at a constant gain equal to approximately 0.2 percent. Another source of welfare gains is likely due to reduced inequality.[50] Panel (e) shows that the variance of log-lifetime-earnings is reduced by approximately 9 percent when the wage subsidy is set to 12 percent. Finally, note that the decline in welfare at relatively high wage subsidy rates is due to taxes. As expected, Panel (f) shows that the average marginal labor tax rate increases steadily in order to raise revenue for the wage subsidy program. The negative effect of increased tax distortions seems to dominate the gains from productivity and inequality at this relatively higher level of taxes.

[50]Given that low-income individuals tend to live in $n = 1$, this effect may also be interpreted as insurance against negative shocks that can reduce income.

Figure 6: Long-Run Effects of Alternatives Wage Subsidy Policies



Notes: This figure presents results from an analysis of the effects of various wage subsidy policies on equilibrium outcomes. All effects are calculated by comparing the difference in outcomes between a simulation for a given wage subsidy level and the baseline scenario where there is no government intervention. The x-axis in each panel shows the level of the wage subsidy for each simulation. We vary the subsidy rate from 2 to 24 percent (in intervals of 2 percent). The vertical dashed (black) line in each panel indicates the subsidy rate (12 percent) that achieves the highest steady state welfare gain.

5.2.1 Wage Subsidy Decomposition

Next, we turn to analyzing the equilibrium forces that drive the highest steady state welfare gains achieved with a wage subsidy policy. Our analysis again mirrors the approach we use to study housing vouchers. The 12 percent wage subsidy that generates the highest steady state welfare of 0.7 percent is defined as the benchmark and we compare this to several simulations that shut down other channels in the model.

Table 7 presents the wage subsidy policy decomposition results. The first row reports a simulation where the 12 percent wage subsidy is introduced for one generation (starting from the initial steady-state without a wage subsidy program), there are no general equilibrium effects (e.g., neighborhood quality and prices do not change), and the government does not need to balance its budget. Effects are evaluated for the children of the single generation that is affected by the wage subsidy. In this scenario, children are affected by the wage subsidy due to changes in their parents behavior such as new patterns of investment or neighborhood relocation. As in our previous analysis, the next rows report economic outcomes allowing for additional equilibrium channels, with the final bold row providing results with all general equilibrium effects.

Table 7: Wage Subsidy: Decomposition of Equilibrium Forces for Main Economic Outcomes

Equilibrium Forces				**Change from Initial Steady State (%)**						
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Long Run	**Real Estate Mkt.**	**Neigh. Qual.**	**Prices & Taxes**	**Share in** $n = 2$	**Neigh. Qual,** $n = 1$	**Neigh. Qual,** $n = 2$	**Capital**	**Labor Prod.**	**GDP**	**Cons. Equiv.**
✗	✗	✗	✗	-3.1	0.0	0.0	–	-1.3*	-1.0*	-1.0*
✗	✗	✓	✗	-4.5	3.4	1.5	–	-1.1*	0.0*	-0.8*
✗	✓	✓	✗	-2.8	4.7	0.6	–	-0.7*	0.0*	-0.4*
✓	✓	✓	✗	-6.0	19.5	1.7	1.9	0.2	0.3	2.1
✓	✓	✓	✓	**-6.2**	**19.7**	**1.5**	**0.4**	**0.2**	**0.0**	**0.7**

Notes: This table presents results that decompose how various equilibrium forces affect economic outcomes under the wage subsidy program that generates the highest steady-state welfare gains. Each row provides results from a separate simulation of the model. Columns 1-4 describe which equilibrium force is shut down in each simulation. Columns 5-11 report changes (in percent) in outcomes calculated by comparing each simulation to the initial steady state (where there is no housing voucher program). When calculating short-run effects, GDP is calculated as lifetime earnings for the children of the single generation that is affected by the policy. In such cases, we do not report effects on the capital stock as these depend on selecting a specific time period for measurement. The asterisks highlight that short-run effects are evaluated for children of the cohort that received the policy intervention.

The main finding from our decomposition is that all four of the equilibrium forces that we study have a role in determining the 0.7 percent highest steady state welfare gain. In the top row, Column 11 shows that the impact on welfare stands at -1.0 percent when the program is implement for a single generation without equilibrium effects. Intuitively, this occurs because the share of children living in the more advantaged neighborhood $n = 2$ decreases which reduces the later-life labor productivity of this single generation whose parents are eligible for the wage subsidy. The next row shows that this impact is reduced to -0.8 percent when the simulation allows for neighborhood quality to adjust. In this scenario, Columns 6 and 7 show that neighborhood quality in both neighborhoods increases (by 3.4 and 1.5 percent in $n = 1$ and $n = 2$, respectively). Similarly, the third row shows that allowing for changes in rental prices in the housing market further reduces the negative impacts because fewer children move away from the advantaged neighborhood (due to the price increases in $n = 1$

in this scenario). The fourth row shows that implementing the program for the long-run shifts the welfare gains from negative to positive (from -0.4 to 2.1 percent, as shown in Column 11). Two factors drive this increase in welfare in this scenario. One is that children are able to benefit from the subsidy directly (rather than solely due to changes in parental behavior) when they reach adulthood. Another is that there are productivity gains due to large increases in neighborhood quality in the disadvantage area driven by an increase in relocation. Finally, the last row shows that accounting for taxation changes is important as the welfare gains are reduced by 1.4 percentage points (from 2.1 to 0.7 percent, as shown in Column 11).

Finally, Table 8 decomposes the effects of the wage subsidy policy on inequality and upward mobility. Recall that the first three rows report effects only for the children of the single generation that receives the wage subsidy. In these cases, we find that a short-run program has little impact on inequality and mobility even when we allow for equilibrium effects on neighborhood quality or housing markets. In contrast, the main finding apparent in the fourth row is that instituting the wage policy in the long-run—when children themselves can receive the subsidy when they grow—is what drives impacts on these outcomes. When housing markets and neighborhood quality adjust, the long-run version of the program reduces inequality by 8.5 percent and increases upward mobility by 20.3 percent. As demonstrated in the last row, the accounting for taxation does relatively little to these effects.

5.2.2 Wage Subsidy Transition Dynamics

In the next component of our analysis, we study the transition dynamics associated with implementing the 12 percent benchmark wage subsidy policy in general equilibrium. To begin this discussion, we return to Figure 4 which also plots the impact of the wage subsidy for newborns and future cohorts as a dashed (red) line. Panel (a) shows that welfare gains are relatively constant at around 0.7 percent for all cohorts born with the policy in place for the rest of their lives. In line with this, Panel (b) shows that all cohorts experience the same average productivity increase.

The relatively constant gains in welfare and productivity by cohort are in line with immediate and relatively rapid adjustments in key economic outcomes by period reported in Figure 7. Panel (a) shows that taxes jump when the policy is put in place and stay relatively constant at 2.8 percent. The effects on neighborhood quality in Panel (b) occur slightly more gradually. After 10 periods, the impact on neighborhood quality is 18 percent and stays relatively constant thereafter. Panel (d) demonstrates that resorting drives this

Table 8: Wage Subsidy: Decomposition of Equilibrium Forces for for Inequality and Mobility

Equilibrium Forces				Change from Initial Steady State (%)				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Long Run	**Real Estate Mkt.**	**Neigh. Qual.**	**Prices & Taxes**	**Share in** $n = 2$	**Neigh. Qual,** $n = 1$	**Neigh. Qual,** $n = 2$	**Income Inequality**	**Upward Mobility**
✗	✗	✗	✗	-3.1	0.0	0.0	1.3*	-4.2*
✗	✗	✓	✗	-4.5	3.4	1.5	0.2*	0.1*
✗	✓	✓	✗	-2.8	4.7	0.6	-0.3*	0.0*
✓	✓	✓	✗	-6.0	19.5	1.7	-8.5	20.3
✓	✓	✓	✓	**-6.2**	**19.7**	**1.5**	**-8.9**	**20.4**

Notes: This table presents results that decompose how various equilibrium forces affect economic outcomes under the wage subsidy program that generates the highest steady-state welfare gains. Each row provides results from a separate simulation of the model. Columns 1-4 describe which equilibrium force is shut down in each simulation. Columns 5-9 report changes (in percent) in outcomes calculated by comparing each simulation to the initial steady state (where there is no housing voucher program). The asterisks highlight that short-run effects are evaluated for children of the cohort that received the policy intervention.

impact on neighborhood quality. The share of young workers (without children) declines almost immediately in the advantaged $n = 2$ neighborhood as these workers seek to fully exploit the benefits of the wage subsidy. Relocation takes slightly longer (about 10 periods) for most of the remaining age groups.

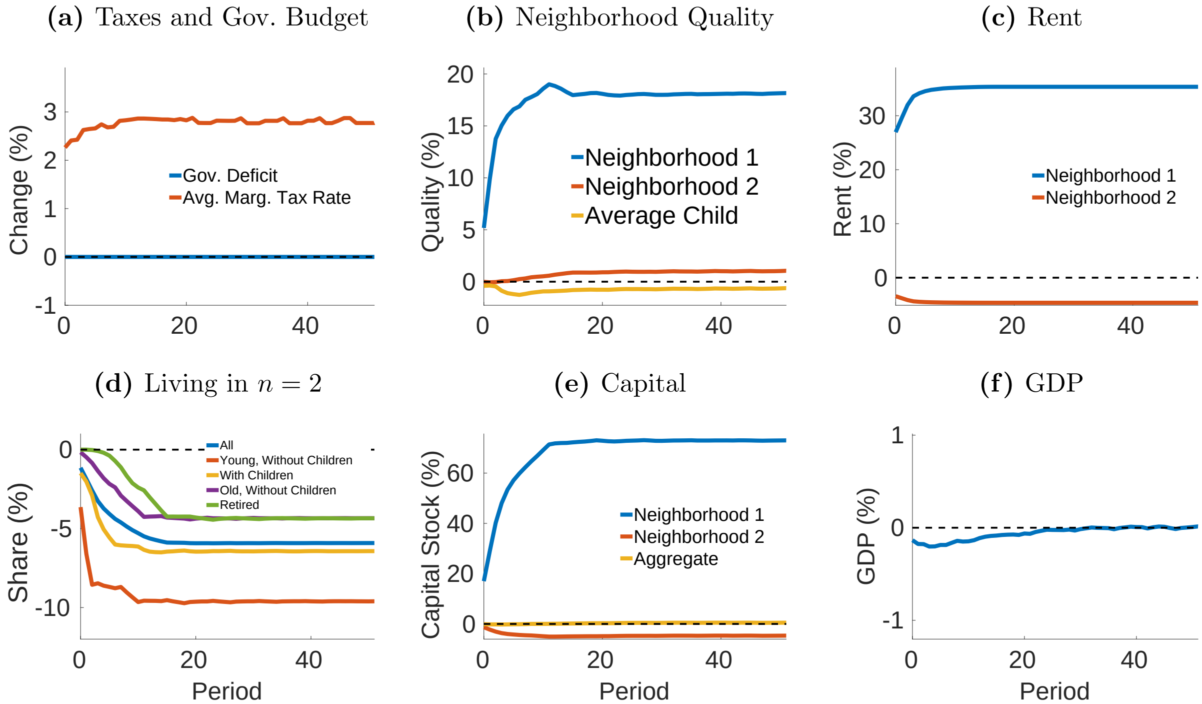
5.3 Robustness Exercises: Welfare Analysis and Parameter Sensitivity

The results so far show that rent vouchers and wage subsidies can lead to welfare gains in the long run, and the gains from rent vouchers are almost five times as large as those from wage subsidies. How sensitive are these quantitative results to alternative parameter values? We follow the approach from Andrews et al. (2017), as implemented by Elenev et al. (2020), and evaluate the change in welfare gains (or any other simulated moment) when we increase each parameter i in the vector of model parameters Θ by one percent:

$$\Delta \text{Welfare Gain}_i = \frac{\text{Welfare Gain}\left(\Theta_i^+\right) - \text{Welfare Gain}\left(\Theta_i^-\right)}{2}, \tag{6}$$

where we increase (Θ_i^+) and decrease (Θ_i^-) each parameter by one percent. Table 9 reports our estimates of welfare changes for the benchmark rent voucher and wage subsidy programs in separate rows.

Figure 7: Transition Analysis: Effects of the Benchmark Wage Subsidy Policy by Period



Notes: This figure presents an analysis of the transition dynamics associated with the place-based wage subsidy program that generates the highest steady-state equilibrium welfare gains. We report effects of the wage subsidy program at the period level starting with the first period when the policy is in effect (i.e., period 0) up to the fiftieth period afterward. The x-axis on the figure indicates the period of interest. The effects represented by the y-axis are calculated as the difference in a given outcome compared to the initial steady state (where no housing voucher program existed). Note that the results in Panel (d) show population shares in the advantaged neighborhood ($n = 2$) for the following groups: all individuals, young individuals with no children (i.e., $j = 5 - 7$), young individuals with children ($j = 8 - 11$), and old working-age individuals without children ($j = 12 - 16$).

There are three main takeaways from our sensitivity analysis. First, some parameters seem relatively more important. The parameters for the labor disutility, μ, and altruism, $\tilde{\beta}$, have comparatively larger influence among the parameters that are internally estimated. For example, a one percent increase in altruism is estimated to reduce the welfare gains from the rent-voucher and wage-subsidy programs by 0.15 percent (out of 3.37 percent) and -0.03 percent (out of 0.7 percent), respectively. This is likely driven by the fact that higher altruism reduces the tradeoff between own (parent) consumption and investment in child development, thereby reducing the role for government intervention. In terms of externally estimated parameters, we focus on the labor supply parameter θ_h and the housing supply elasticity δ. These are critical parameters as they influence the distortionary impact of employment taxes and the amount of dislocation that occurs in reaction to interventions that shape housing markets, respectively. For these two parameters, we find that changes in the labor supply parameter θ_h matter more than changes in the housing supply elasticity Δ in the case of the rent voucher program. Here, increases in θ_h reduce the Frisch elasticity. Intuitively, this is important for the rent voucher program, which is comparatively expensive.[51]

Second, there are only a few parameters for which changes have opposite signed effects on welfare for the two policies. This suggests that most changes for individual parameter values will not cause us to reach different conclusion on whether a rental subsidy policy generates higher steady-state welfare.[52] Among the parameters considered in Table 9, some with opposing effects on welfare have natural interpretations. For example, a 1 percent increase in the housing supply elasticity Δ has positive effects on welfare associated with rental vouchers and negative impacts for the wage subsidy welfare. Intuitively, this occurs under the rent subsidy program because increases in this elasticity make it easier to accommodate growth in the more advantaged neighborhood and avoid the displacement effects that reduce welfare. In contrast, a larger elasticity appears to worsen welfare associated with a wage subsidy presumably because the easier availability of housing increases sorting to the disadvantaged area where child development is hindered.

Finally, the third main takeaway is that any single parameter would need to change substantially to affect the welfare gains achieved under either policy. For example, the altruism factor $\tilde{\beta}$ would need to increase by 22 percent to eliminate the long-run welfare gains of the rent-voucher program. Is such an increase reasonable? While a formal analysis would require knowing the standard deviation of the parameters of interest, we can evaluate how such an increase would affect non-welfare moments and compare the resulting (changed) moments to empirical benchmarks. For example, increasing $\tilde{\beta}$ by one percent would increase the parental-transfer estimation moment (i.e., the average parental transfer as a share of average income) by 3.2 percent (from 127.6 percent in our benchmark voucher program). Thus, the 22 percent increase in $\tilde{\beta}$ would require increasing this parent-transfer moment to approximately 198 percent—relatively far from the empirical benchmark of 125.4 percent. We similarly see that only substantively large changes (that are inconsistent with prior studies) in the housing supply elasticity would affect our results. Specifically, consider how our results would change

[51]Note that the average marginal employment tax rate under the benchmark housing voucher program is 15.7 percent (Table 4, Column 1), substantively larger than the 2.9 percent rate under the wage subsidy program (Figure 6, Panel (f)).

[52]Of course, if a change in an individual parameter has a relatively larger impact on welfare for one of the policies, it is possible for our welfare to change even if the sign of the impact is the same for both. One interesting case for this is the labor supply parameter θ_h discussed above.

Table 9: Parameter Sensitivity

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		Change in Welfare Given 1 Pct. Increase in Parameter							
		Panel A. Parameters:							
	Baseline Welfare Gain	μ	$\tilde{\beta}$	$\bar{v}_1$	$\bar{\kappa}$	σ_κ	ξ	γ	$\bar{A}_{j=1}$
Rent Voucher	3.37	0.08	-0.15	-0.09	-0.02	0.02	0.01	-0.00	-0.00
Wage Subsidy	0.70	0.05	-0.03	0.04	-0.02	-0.00	-0.00	0.01	-0.00
		Panel B. Parameters:							
	Baseline Welfare Gain	$\bar{A}_{j\neq1}$	$\alpha_{I,j=1}$	ρ	$\alpha_{I,j\neq1}$	λ	ω	Δ	θ_h
Rent Voucher	3.37	0.04	0.00	-0.03	-0.07	-0.10	-0.07	0.01	0.09
Wage Subsidy	0.70	0.01	-0.00	-0.01	0.08	-0.01	-0.02	-0.01	0.01

Notes: This table provides an analysis of the sensitivity of welfare gains to changes in the parameter values used in our calibrated model. Columns 1-8 report results from increasing a given parameter (e.g., the altruism parameter $\tilde{\beta}$) by one percent. We examine sensitivity to changes in 16 different parameters spread across two panels of the table. Rows indicate whether the results are specific to either the wage-subsidy programs studied in Sections 5.1 and 5.2. For comparison, the left of the table reports the baseline welfare gains of 3.37 and 0.70 for the rent voucher and wage subsidy programs, respectively. See text for further details on all calculations.

if we used a more conservative housing supply elasticity from Baum-Snow and Han (2021). They estimate an elasticity at the tract level that ranges from 0.3 to 0.4—notably smaller than the city-level estimate of 1.75 that our baseline estimate uses from Saiz (2010) (which is the standard in the literature). Although the more conservative housing elasticity is 80 percent smaller than what is specified in our baseline, the results in Table 9 suggest that this would reduce the welfare gains from vouchers to 2.57 percent ($3.37 - 80 \times 0.01$).[53] In sum, we interpret our sensitivity analysis as suggesting that the welfare gains not significantly altered by empirically-reasonable changes in most of our model parameters.

[53]This same analysis suggests that reducing the housing supply elasticity by 80 percent would increase the welfare gains from the wage subsidy program to 1.5 percent, most likely because of the additional gains from reducing rent in $n = 2$.

5.4 Discussion: Comparing Voucher and Wage Subsidy Policies

Why is it possible to achieve higher welfare gains with a voucher program relative to a place-based wage subsidy? The analysis so far shows that highest steady state welfare for a housing voucher program is 3.4 percent larger relative to our baseline scenario where the government does not intervene in the housing market. In contrast, we find that the highest steady state improvement with a wage subsidy policy is 0.7 percent.

The main explanation is that the highest steady-state-welfare voucher program has larger impacts on labor productivity. Specifically, the voucher program can generate a 1.1 percentage point increase in productivity (Table 5, Column 9), whereas the wage subsidy only increase productivity by 0.2 percentage points (Table 7, Column 9). This difference in labor productivity is due to differences in each program's impact on neighborhood conditions (which thereby affects child development). Equilibrium neighborhood quality for the average child increases by 1.2 percent for the voucher program but it decreases by 0.2 percent for the wage subsidy program.

Notably, the results do not indicate that the relatively larger welfare gains from the voucher program are due to the programs impact on inequality. The benchmark voucher program generates reduces income inequality by 6.3 percent (Table 6, Column 8). In contrast, the wage subsidy has a larger magnitude impact, decreasing inequality by 8.8 percent (Table 8, Column 8).

Given the welfare gains associated with both programs, a final exercise that we undertake sheds further light on the political economy associated with these policies. A natural concern is that the policies may have heterogeneous effects on welfare for adults alive at the introduction of the policy (hereafter "incumbent adults"). Heterogeneity in the gains from either program implies that policymakers may face tradeoffs when considering whether to implement voucher or place-based wage subsidies in a democratic system.

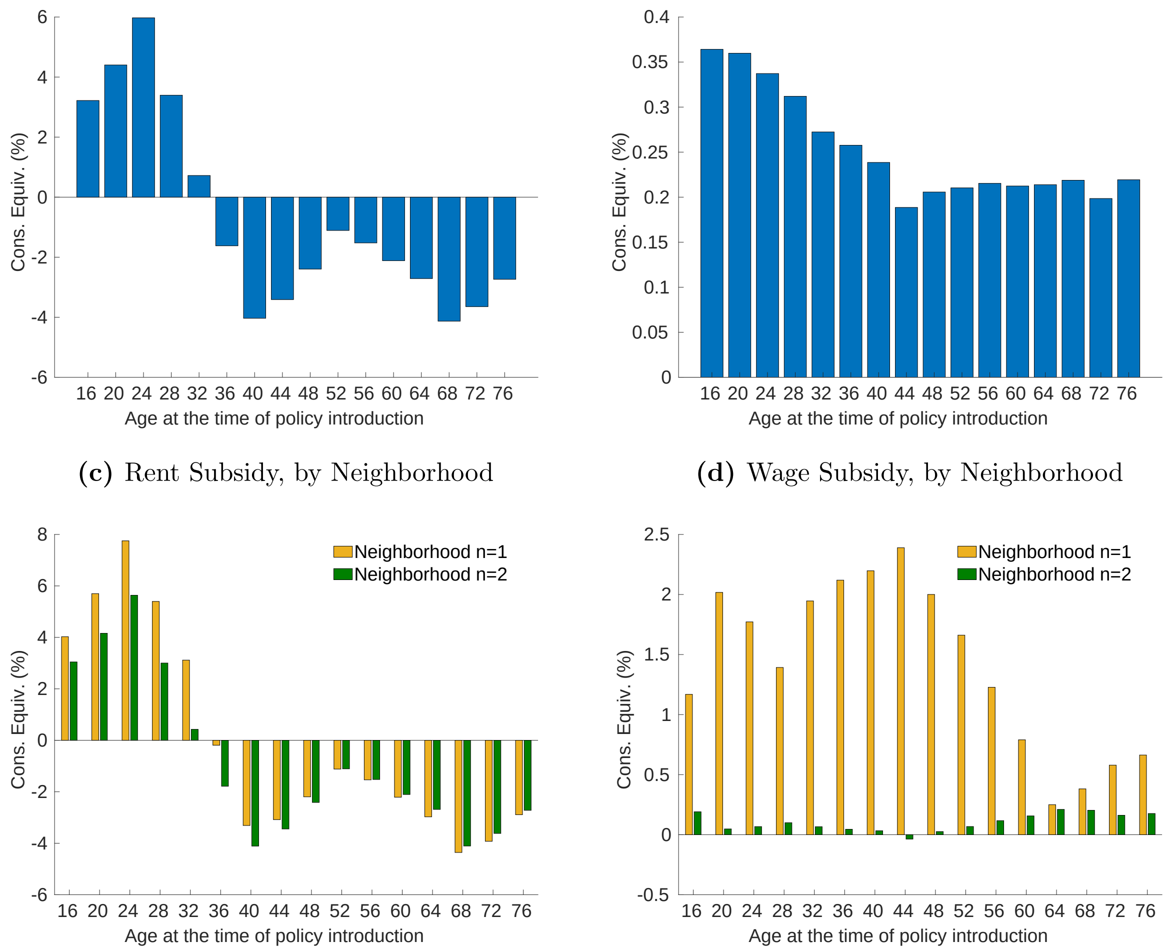
Figure 8 reports welfare gains from voucher and place-based subsidies for incumbent adults. The results in the top row highlight important heterogeneity in the effects of both programs. For vouchers, the results in Panel (a) show that welfare gains are concentrated among the individuals who will soon have children (i.e., those ages 16–27) and those who already have children (i.e., those ages 28–43). Older individuals, instead, tend to lose from the new housing voucher policy.[54] Panel (b) shows that the the wage subsidy has a notably

[54] Note that this result is *not* driven by failing to allow the parental value function to account for changes to child utility after they have leave the households. To avoid this typical issue when calculating welfare gains in OLG models over the transition, we extend the parents value function to include its effect on their children (and future descendants) when calculating welfare gains for incumbent adults whose children have

Figure 8: The Welfare Effects of Rent and Wage Subsidy Policies on Incumbent Cohorts

(a) Rent Subsidy **(b)** Wage Subsidy

(c) Rent Subsidy, by Neighborhood **(d)** Wage Subsidy, by Neighborhood



Notes: This figure presents an analysis of welfare gains for adults alive at the time the highest-welfare voucher program is introduced (i.e., incumbent adults). Panels (a) and (b) plot the effects by age and by age and neighborhood of residence, respectively. In both panels, the x-axis indicates the age of an adult at the policy's introduction.

different pattern of impacts. Notably, the average benefit for each cohort alive at the policy's introduction is always positive (although the gains are larger for younger cohorts).

The second row expands on these results by showing welfare impacts by age *and* the initial location where individuals reside. The results in Panel (c) show that, within the population of younger individuals, it is those originally living in the disadvantaged neighborhood ($n = 1$) who have larger welfare benefits from the voucher program. The results in Panel (d) show the

already become independent (i.e., $j >= 12$).

disadvantaged residents again are the largest beneficiaries of the place-based wage subsidy program. Yet, it is worth noting that distribution of gains are tilted more in favor of the disadvantaged residents in this case.

What do we conclude from this analysis of incumbent adults? The benchmark voucher program leads to larger welfare gains relative to a place-based wage subsidy, but there is heterogeneity that has political economy considerations. The fact that gains are concentrated for the young implies limited democratic support for the policy that we consider. If individuals calculate welfare gains as in our model, our analysis implies that only 33 percent of incumbent adults would vote to create the housing voucher program that generates a 3.4 percent welfare gain in the long run. In contrast, we estimate that over 63 percent of adults would support the wage-subsidy policy in the disadvantaged neighborhood. Given these results, the voucher program may only be acceptable to a majority of individuals in a setting where the government is able to borrow to initially finance a voucher program and increase taxation in the future—as found for early childhood education programs in Daruich (2020).

6 Conclusion

This paper provides a new quantitative assessment of the impact of policies that aim to shape neighborhood quality for children. Building on prior theoretical research that studies inequality and neighborhoods (Benabou, 1996; Durlauf, 1996; Fernandez and Rogerson, 1996), our analysis focuses on a spatial equilibrium model that features overlapping generations and incorporates endogenous childhood development. We calibrate the model using U.S. data and use simulations to study the long-run and large-scale impacts housing vouchers and location-specific wage subsidies, two types of government policies common around the world. The programs that we study represent distinct antipoverty strategies: a people-based approach that provides assistance directly to low-income families and a place-based approach that targets government resources at a local area.

Our core finding is that government housing voucher and place-based wage subsidies can increase welfare in the long-run despite several countervailing equilibrium forces such as taxation. These welfare gains occurs because both programs increase the average neighborhood quality for children, thereby creating better parents and neighbors for future generations. We find that housing vouchers can generate larger gains in welfare relative to what is feasible with a wage-subsidy approach.

Although we find that housing vouchers represent a more promising long-run approach to increasing welfare, our analysis of transition dynamics suggests there may be more political support for place-based policies. For adults alive at the introduction of a voucher program, young cohorts achieve welfare gains while older cohorts are worse off. In contrast, a place-based wage subsidy delivers increases average welfare for all cohorts alive when the policy is introduced. This pattern of results suggests that policymakers face important tradeoffs when choosing between people- or place-based government interventions.

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Table A1: Estimates of Wage Parameters

	(1)	(2)	(3)
Age	0.0356***		
	(0.003)		
Age^2	-0.000***		
	(0.000)		
Inv. Mills Ratio	-1.611***		
	(0.039)		
Υ		0.999***	
		(0.021)	
ρ			0.959***
			(0.000)
σ_z			0.037***
			(0.000)
σ_{η_0}			0.042***
			(0.000)
R^2	0.116	0.146	–
# of households	3,052	2,509	2,509
Observations (N)	21,204	19,603	19,603

Notes: This table reports estimates of the parameters of the wage process in our model. Column 1 reports results for the age profile parameters. This is obtained using a sample constructed from the PSID (1968–2016) and regressing wages on age, age-squared, and controls for selection into work based on the Inverse Mills Ratio obtained from a Heckman-selection correction approach. The selection estimator is based on estimating an employment participation equation using the number of children and year-region fixed effects. Column 2 reports estimates of the return to skills. This is obtained using a sample from the NLSY and regressing of the idiosyncratic component of labor productivity ψ_j (measured as a residual based on the age profile estimates from Column 1) on the log of cognitive skills as measured by the AFQT score. Column 3 reports estimates of the parameters that govern the AR(1) process that we assume determines the shock η_j which is the idiosyncratic component of labor productivity. These estimates are obtained from the Minimum Distance Estimator developed by Rothenberg (1971). Standard errors are reported in parentheses. Statistical significance is denoted by: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

B Additional Statistics on Household Income and Upward Mobility

This section provides further descriptive analysis of the spatial distribution of economic outcomes. As noted in Section 2, there is a positive relationship between median adult household income and upward mobility of children in Chicago. Panel (a) of Figure B1 is a binned scatterplot of this relationship for Census tracts in Chicago. The solid red line on the figure illustrates the fit of a linear regression fit to the tract-level data ($N = 805$). The point estimate for the slope is equal to 0.43 (Std. Error = 0.02), indicating that every \$1,000 increase in median household income increases expected later-life earnings of children \$430. Panel (b) of Figure B1 shows that a similar relationship holds using national level data for U.S. Census tracts. Again, we fit a linear regression to the tract-level data ($N = 71,920$). The point estimate is slightly smaller at 0.31 (Std. Error = 0.01).

Figure B1: Correlations Between Median Household Income and Upward Mobility of Children

(a) Chicago

(b) National Data

Notes: Panel (a) is a binned scatterplot of median household income from the 1990 U.S. Decennial Census (x-axis) and estimates of mean household income ranks for children who grew up in the tract and had parents with household income at the 25th percentile of the national income distribution (y-axis). This measure of "upward mobility" for children comes from the Opportunity Atlas (Chetty et al., 2018). The measure is specific to children who were born in the 1978-83 cohorts. We use the national income distribution statistics to convert income ranks into 2015 U.S. dollars.

C Estimation Details

C1 Child Skill Production Function

We rely on estimates from Cunha et al. (2010) for the calibrated model. Specifically, they estimate the following multistage production function for children's cognitive (c) and non-cognitive skills (nc):

$$\theta'_{q,k} = \left[\alpha_{1,q,j}\theta_{c,k}^{\rho_{q,j}} + \alpha_{2,q,j}\theta_{nc,k}^{\rho_{q,j}} + \alpha_{3,q,j}\theta_{c}^{\rho_{q,j}} + \alpha_{4,q,j}\theta_{nc}^{\rho_{q,j}} + \alpha_{5,q,j}I^{\rho_{q,j}}\right]^{1/\rho_{q,j}} e^{\nu_q}, \qquad \nu_q \sim N(0, \sigma_{q,j,\nu})$$

for $q \in \{c, nc\}$. Using a nonlinear factor model with endogenous inputs, their main estimates, which are based on two-year periods, are reported in Table C1 below. We interpret their first stage estimates as referring to the period in which the child is born in our model when the parent's age-period is $j = 8$ and the child's age-period is $j' = 1$, (i.e., 0–3 years old). The second stage is assumed to refer to the last period of skill development when the parent's age-period is $j = 11$ and the child's age-period is $j' = 4$ (i.e., 12–15 years old). We use linear interpolation to obtain the estimates for $j = 9$ and $j = 10$.

Table C1: Child Skill Production Function Estimates from Cunha et al. (2010)

	Cognitive Skills		**Non-Cognitive Skills**	
	1st Stage	**2nd Stage**	**1st Stage**	**2nd Stage**
	($j = 8$)	($j = 11$)	($j = 8$)	($j = 11$)
Current Cognitive Skills ($\hat{\alpha}_{1,q,j}$)	0.479	0.831	0.000	0.000
	(0.026)	(0.011)	(0.026)	(0.010)
Current Non-Cognitive Skills ($\hat{\alpha}_{2,q,j}$)	0.070	0.001	0.585	0.816
	(0.024)	(0.005)	(0.032)	(0.013)
Parent's Cognitive Skills ($\hat{\alpha}_{3,q,j}$)	0.031	0.073	0.017	0.000
	(0.013)	(0.008)	(0.013)	(0.008)
Parent's Non-Cognitive Skills ($\hat{\alpha}_{4,q,j}$)	0.258	0.051	0.333	0.133
	(0.029)	(0.014)	(0.034)	(0.017)
Investments ($\hat{\alpha}_{5,q,j}$)	0.161	0.044	0.065	0.051
	(0.015)	(0.006)	(0.021)	(0.006)
Complementarity parameter ($\hat{\rho}_{q,j}$)	0.313	-1.243	-0.610	-0.551
	(0.134)	(0.125)	(0.215)	(0.169)
Variance of Shocks ($\hat{\sigma}_{q,j,\nu}$)	0.176	0.087	0.222	0.101
	(0.007)	(0.003)	(0.013)	(0.004)

Notes: Standard errors in parentheses. The first stage refers to the period in which the child is born when the parent's age-period is $j = 8$ and the child's age-period is $j' = 1$ (i.e., 0–3 years old). The second stage refers to the period after the child is born when the parent's age-period is $j = 11$ and the child's age-period is $j' = 4$ (i.e., 12–15 years old).

To go from two-year periods to four-year periods (as in our model), we follow the steps in

Daruich (2020). Using $\hat{\alpha}$ to notate the estimates in Cunha et al. (2010) and α for the values in our model, the two main steps/assumptions for the transformation are: (i) we iterate in the production function under the assumption that the shock ν only takes place in the last iteration, i.e., replace $\theta_{q,k}$ by $\left[\alpha_{1,q,j}\theta_{c,k}^{\rho_{q,j}} + \alpha_{2,q,j}\theta_{nc,k}^{\rho_{q,j}} + \alpha_{3,q,j}\theta_{c}^{\rho_{q,j}} + \alpha_{4,q,j}\theta_{nc}^{\rho_{q,j}} + \alpha_{5,q,j}I^{\rho_{q,j}}\right]^{1/\rho_{q,j}}$;[55] and (ii) we assume that the cross-effect of skills (i.e., of cognitive on non-cognitive and of non-cognitive on cognitive) is only updated every two periods.[56] Under these assumptions, the persistence parameter needs to be squared (i.e., $\alpha_{1,c,j} = \hat{\alpha}_{1,c,j}^2$ and $\alpha_{2,nc,j} = \hat{\alpha}_{2,nc,j}^2$), while other parameters inside the CES function need to be multiplied by 1 plus the persistence parameter (e.g., $\alpha_{2,c,j} = (1 + \hat{\alpha}_{1,c,j})\,\hat{\alpha}_{2,c,j}$).

C2 Replacement benefits: US Social Security System

The pension replacement rate is obtained from the Old Age Insurance of the US Social Security System. We use the skill level to estimate a proxy for average lifetime income, on which the replacement benefit is based. Average income at age j is estimated as $\widehat{y}_j(\theta_c) = wE_j(\theta_c, \overline{\eta}) \times \overline{h}$ where $\overline{\eta}$ is the average shock (i.e., zero) and $\bar{h}$ are the average hours worked (in the economy). Averaging over j allows average lifetime income $\widehat{y}(\theta_c)$ to be calculated and used in (C1) to obtain the replacement benefits.

The pension formula is given by

$$\pi(\theta_c) = \begin{cases} 0.9\widehat{y}(\theta_c) & \text{if } \widehat{y}(\theta_c, e) \leq 0.3\bar{y} \\ 0.9(0.3\bar{y}) + 0.32(\widehat{y}(\theta_c) - 0.3\bar{y}) & \text{if } 0.3\bar{y} \leq \widehat{y}(\theta_c) \leq 2\bar{y} \\ 0.9(0.3\bar{y}) + 0.32(2 - 0.3)\bar{y} + 0.15(\widehat{y}(\theta_c) - 2\bar{y}) & \text{if } 2\bar{y} \leq \widehat{y}(\theta_c) \leq 4.1\bar{y} \\ 0.9(0.3\bar{y}) + 0.32(2 - 0.3)\bar{y} + 0.15(4.1 - 2)\bar{y} & \text{if } 4.1\bar{y} \leq \widehat{y}(\theta_c) \end{cases} \tag{C1}$$

where $\bar{y}$ is approximately \$288,000 (\$72,000 annually).

[55] We assume that the variance of the shock in the 4-year model is twice the one in the 2-year model (i.e., $\sigma q, j, \nu^2 = \hat{\sigma} q, j, \nu^2$).

[56] Removing this assumption does not change results significantly since the weights corresponding to these elements are very small or even zero in the estimation (in Table C1, see row 2 under columns 1 and 2, as well as row 1 under columns 3 and 4), but it eliminates the CES functional form if $\rho_{c,j} \neq \rho_{nc,j}$.

D Welfare Measure

Our analysis centers on evaluating aggregate welfare under scenarios that feature different policies. Welfare is defined by the consumption equivalence under the veil of ignorance in the baseline economy relative to the economy with the policy in place. Formally, let $P \in \{0, 1, 2, ...\}$ denote the set of policies, with $P = 0$ being the initial economy (with no voucher or wage-subsidy program) in steady state. We refer to the consumption equivalence as the percentage change in consumption Δ in the initial economy that makes individuals indifferent between being born in the initial economy ($P = 0$) and the one in which the policy $P \neq 0$ is in place. Denote $V^P_{j=5}(a, \theta, n, \epsilon, \Delta)$ be the welfare of agents with initial state of the economy if their consumption (and that of their descendants) were multiplied by $(1 + \Delta)$:

$$\widetilde{V}^P_{j=5}(a, \theta, n, \epsilon, \Delta) = \mathbb{E}^P \sum_{j=5}^{j=J_d} \beta^{j-5} u(c^P_j(1 + \Delta), h^P_j, n_j) + \beta^{12-5} \delta \widetilde{V}^P_{j'=5}(\widehat{a}, \theta_k, n_{j=11}, \epsilon', \Delta),$$

where for the sake of clarity the expression above suppresses the utility terms for moving costs and disutility of time with children. Note that the policy functions are assumed to be unchanged when Δ is introduced. For example, consumption c^P_j is consumption chosen by individuals in economy P (in age j) and is not affected by Δ. For any measure Δ, the average welfare is:

$$\overline{V}^P = \int_{a,\theta,n,\epsilon} \widetilde{V}^P(a, \theta, n, \epsilon, \Delta) \mu_p(a, \theta, n, \epsilon),$$

where μ_P is the distribution of initial states $\{a, \theta, n, \epsilon\}$ in the economy P. We define Δ^P as the consumption equivalence that makes individuals indifferent between being born in the baseline economy or one in which policy P is in place:

$$\overline{V}^0(\Delta^P) = \overline{V}^P(0).$$

By definition, the welfare gains come from two sources. First, there are changes in the expected discount utilities at each state $\widetilde{V}^P_{j=5}(a, \theta, \epsilon, n, \Delta)$. Second, there are also shifts in the probabilities of each state $\mu_p(a, \theta, n, \epsilon)$.