Place-Based Redistribution*

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Abstract

Place-based redistribution is ubiquitous but has traditionally enjoyed little support among economists. We develop a class of spatial equilibrium models characterizing the equity-efficiency tradeoff that arises when taxes and transfers are indexed to location. Transfers from one region to another are found to be welfare improving under empirically plausible assumptions on preference heterogeneity, even in an environment with optimal place-blind income taxes. A calibration shows that optimal place-based redistribution may be large.

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1 Introduction

Place-based policies tie economic benefits to geographic locations and are prevalent throughout the world (Bartik, 1991; Glaeser and Gottlieb, 2008; Kline and Moretti, 2014b; Duranton and Venables, 2018). For example, U.S. Opportunity Zones provide preferential capital gains tax treatment to the poorest 10% of U.S. local areas, while the European Union spends roughly thirty percent of its budget on Structural Funds targeted to poor regions. The espoused rationale for such programs is typically redistributive. Because poor people are concentrated in certain places – Appalachia, for example – targeting these places helps disadvantaged households. However, governments already redistribute to poor places through the national income tax as well as person-based transfer systems, such as disability insurance and social security. Should Appalachians receive an extra transfer, based on the fact that they live in Appalachia?

Glaeser (2008) succinctly articulates the traditional answer of economists that have studied these programs:

> "Help poor people, not poor places"...is something of a mantra for many urban and regional economists... [place-based] aid is inefficient because it increases economic activity in less productive places and decreases economic activity in more productive places.

In line with this view, academic research on place-based policies has focused almost exclusively on their efficiency costs; with a few studies also considering the potential efficiency benefits these programs might generate, such as the potential to correct market failures by internalizing productivity spillovers (Kline and Moretti, 2014a; Fajgelbaum and Gaubert, 2018). To date, however, little effort has been devoted to weighing the *equity gains* that such policies deliver against their net efficiency costs.

In this paper, we rigorously evaluate conditions under which place-based redistribution (henceforth, PBR) schemes are able to achieve equity goals that place-blind transfers cannot. We begin our analysis with three stylized facts. First, highly-skilled individuals (as measured by test scores in the National Longitudinal Survey of Youth 1979) tend to be born in, and therefore have family ties to, high-income states such as New York. Second, elite colleges are concentrated in high-income areas like New York City, suggesting that the highly-skilled tend to build tastes for the local cultures of high-income places even if they were not born there. Third, the highly-skilled tend to live in places like New York City even after adjusting for income. Together, these facts suggest that the highly-skilled have relatively strong tastes for living in high-income

areas such as New York City rather than low-income areas such as Appalachia.

To link these facts to policy we develop a simplified spatial equilibrium model with two locations: Appalachia and Elsewhere. Households decide where to live and how much to work. These decisions are driven by each household's skill level and their tastes for the Appalachian region, which may differ by skill group. Households inelastically demand shelter and the rental rate of housing is assumed lower in Appalachia than Elsewhere. There is a place-blind income tax through which a planner may achieve equity goals at the cost of distorting labor supply decisions. The planner may also use PBR, i.e.institute a place-based transfer to Appalachians, financed by a small lump-sum tax on others. Following Saez (2002), we assume that the planner's value of distributing an extra dollar to each household is monotone decreasing in that household's earnings.

Our first result is that, in this setup, skill-taste correlation implies PBR is always desirable even under the optimal income tax. The logic of this result is simple: a small PBR induces some households to move to Appalachia, but these moves do not change income tax revenue and induce only a second-order rise in transfers. Hence, PBR is desirable if the first-order effect of moving a dollar from the average Elsewhere resident to the average Appalachian improves social welfare. This condition is always satisfied when the low-skilled sort into Appalachia, so long as the optimal income tax fails to equalize earnings across space. Hence, there is no equity-efficiency tradeoff to a small PBR in this baseline setup: PBR leads to a first-order equity gain with no first-order efficiency loss.

Next we show that the same result regarding the desirability of PBR holds even without skill-taste correlation, when income effects drive location choice. The logic of this result is equally straightforward: poor households cannot afford the high rent in Elsewhere even if they have a high taste for Elsewhere. Hence, income effects generate the necessary skill-based sorting, and a small PBR is always desirable even under the optimal income tax.

A simple extension of our baseline model generates a more realistic equity-efficiency tradeoff. Building on the Glaeser (2008) quotation above, we suppose next that Appalachia is less productive than Elsewhere. Assuming wages directly reflect productivity, a small PBR will now generate a first-order efficiency loss: movers to Appalachia earn less and pay lower income taxes. PBR desirability now hinges on whether a small PBR reduces tax revenue by more or less than a small, distributionally equivalent perturbation to the optimal income tax. We characterize this equity-efficiency tradeoff: can PBR deliver the same equity benefit

as the income tax at lower efficiency cost?

Our analysis suggests that PBR is likely to be desirable under four intuitive conditions. First, PBR has small efficiency costs when there are few people who are indifferent between Appalachia and Elsewhere, in which case PBR induces a small mobility response. Second, PBR has small efficiency costs when productivity differs little between Appalachia and Elsewhere. Third, the income tax has large efficiency costs when labor supply is especially elastic. Fourth, PBR is likely to be desirable when high-earners sort disproportionately into Elsewhere and low-earners into Appalachia because under these conditions PBR is especially well targeted: it redistributes from rich to poor without the income tax's efficiency costs among non-movers.

In our general model, PBR is neither always desirable nor always undesirable. Its desirability is a quantitative question. We therefore conclude with a quantitative calibration. Specifically, we analyze a model with Stone-Geary preferences over consumption and leisure and additive heterogeneity in preferences for the chosen location. The tax system is approximated as a flat tax with a lump-sum transfer (i.e., a "universal basic income").

Without PBR, the optimal income tax is found to be an \$8,175 transfer funded by a 32% flat tax – a schedule remarkably similar to the actual U.S. tax code (Piketty et al., 2017). We find that PBR is desirable: social welfare rises when giving all Appalachians a \$1 transfer, funded by the perturbation to the income tax that maximizes social welfare. Quantitatively, the optimal PBR is positive and large. The key driver of the large optimal PBR is exceptional targeting. The lowest-skilled households have the highest marginal utility of consumption and sort into Appalachia. The optimal PBR scheme allows the planner to target transfers to this population with a much lower flat tax.

The primary message of our paper is that place-based policies can deliver unique equity benefits – not just Pigouvian efficiency benefits. Formally, this conclusion relies on extending workhorse models in urban economics (e.g., Rosen, 1979; Roback, 1982) to combine three key elements: household heterogeneity (which is necessary to motivate equity concerns), idiosyncratic preferences (which generate imperfect sorting), and labor supply decisions (which generate efficiency costs of income taxation). While the first two features are now commonplace, the last is not, which makes it difficult to formally compare place-based policies to income tax reforms.

Our analysis has parallels to classic problems in the field of public economics when residential location is viewed as a "commodity." A long line of work has identifed conditions under which a differentiated

commodity subsidy, such as a subsidy for food, is valuable (Atkinson and Stiglitz 1976, Mirrlees 1976, Christiansen 1984, Kaplow 2006, Allcott et al. 2019). The key result is that, under an optimal income tax, a commodity subsidy is superfluous if low earners disproportionately consume the good simply because they have low earnings (Saez, 2002).[1] A technical contribution of our analysis is to derive expressions for subsidy desirability when the commodity is binary (residential choice) rather than continous, and when commodity choice impacts household productivity, making labor and consumption choice inherently non-separable. Qualitatively, we provide suggestive evidence that low earners disproportionately reside in places like Appalachia because of factors other than income itself. Quantitatively, we find that the optimal PBR scheme could entail relatively large transfers.

This paper is organized as follows. Section 2 presents stylized facts. Section 3 details our baseline model. Section 4 generalizes our analysis. Section 5 calibrates optimal PBR. Section 6 concludes.

2 Stylized Facts

In the world, people have heterogeneous skill levels and heterogeneous geographic tastes. These are the two sources of heterogeneity in the models we evaluate in this paper. Our results will hinge in part on whether skill levels are correlated with geographic tastes. We therefore begin with stylized facts that may be suggestive of a correlation.

First, Figure 1a investigates whether skill level is correlated with birth state and therefore likely with geographic tastes, as people typical have a taste for living near family. We use the National Longitudinal Survey of Youth 1979 to plot mean scores of the Air Force Qualifying Test (AFQT) by birth state. The AFQT is an aptitude test that was administered to each NLSY79 respondent, regardless of whether she or he joined the military. AFQT scores are in percentile units. The figure shows that mean test scores vary substantially by birth state. Those born in West Virginia and other southern states have AFQT scores that are on average ten or more percentage points lower than those of people born in New York, Massachusetts, and other high-income states.[2] This pattern suggests that the low-skilled tend to have family ties to states like West Virginia while the high-skilled tend to have family ties to states like New York.

Second, Figure 1b investigates whether the high-skilled – regardless of where they are born – may build

[1] Earlier results calling for differentiated commodity taxes and subsidies did not allow for an optimal income tax (Ramsey 1927, Diamond 1975).

[2] One may be surprised that those born in northern plains states like Iowa tend to have high AFQT scores. However, Iowa has the highest high school graduation rate in the nation.

ties to states like New York during formative college years. The figure plots the number of elite colleges by commuting zone. Elite colleges are defined as the 173 colleges in the top two tiers of the 2009 Barron's 2009 selectivity ranking. Commuting zones are 741 collections of counties that share strong commuting ties. West Virginia has no elite colleges. New York has twenty. Massachusetts has twenty. Hence, high-skilled people may develop ties to high-income areas during college.

Third, Figure 1c investigates whether residential sorting on skill level is explained by income or whether there is a residual component that could be explained by correlated geographic tastes. Among 35-to-45-year-olds in the 2012-2016 American Community Survey, we regress an indicator of bachelors degree attainment on the individual's gross income percentile (defined nationwide) and commuting zone indicators. The figure plots the commuting zone indicators, with a constant added so that the mean bachelors degree attainment level is preserved. The figure shows that, even conditional on gross income, Appalachian residents tend to have low educational attainment, relative to higher income places like New York and Massachusetts. Not shown, a similar analysis of NLSY79 with state-level indicators yields a similar result. Thus there remains scope for skill-taste correlation to explain residential sorting patterns, even conditional on income.

These three stylized facts suggest that the low-skilled have relatively strong tastes for living in places like Appalachia. We incorporate this correlation into our model analyses below. This correlation will drive our main result.

We show below that a different mechanism – high-income places complementing leisure – can also drive our main result. Figure 1d investigates this mechanism. Among adults age 25-54 in the American Time Use Survey 2013-2017, we regress daily hours spent watching television on state indicators and a quartic in hours spent working in paid employment. The figure plots the state indicators, with a constant added so that the mean level of hours spent watching TV is preserved. The figure shows that, conditional on hours worked and thus available time to watch TV, residents of states like West Virginia watch approximately 20% more hours of TV than residents of states like New York or Massachusetts. This pattern is consistent with there being fewer leisure options in West Virginia than in high-income places, suggesting that high-income places complement leisure.

3 A simple model

We begin by examining a simplified model of location choice and labor supply. The model resembles standard formulations in the urban economics literature but incorporates elastic labor supply as in the public finance literature, in order to capture the traditional equity-efficiency trade-off faced when designing taxation. This analysis highlights the key forces that drive the desirability of place-based redistribution. We show in the next section that results and intuitions derived from this simple model carry through to more general setups.

3.1 Model Setup

We consider two locations, indexed by $j \in \{0, 1\}$. There is a continuum of households of measure 1, indexed by $h \in [0, 1]$. Households are heterogeneous in their skill level θ^h as well as in their valuations $\left\{a_j^h\right\}_j$ over the amenities of each community. Each household makes a discrete choice of the location (j) where they live and work and of labor supply (ℓ). Household h's preferences are given by:

$$U^h(c, \ell, j) = g\left(c - e\left(\ell\right)\right) + a_j^h, \tag{1}$$

where $g\left(.\right)$ is an increasing and concave function, and $e\left(\ell\right)$ is an increasing and convex function that captures the disutility of working. In particular, when $g(.)$ is linear, this formulation nests the case oflinear utility:

$$U^h(c, \ell, j) = c - e\left(\ell\right) + a_j^h. \tag{2}$$

A household h who supplies labor ℓ in community j earns pre-tax income $z = \ell\, w_j^h$, where the wage $w_j^h = w\left(\theta^h, \Theta_j\right)$ is an increasing function of household skill θ^h and of city productivity Θ_j.

Each household inelastically demands a unit of housing. The rental cost of housing in location j is denoted p_j, and we assume that $p_1 < p_0$. To fix ideas, we refer to location 1 as Appalachia and location 0 as Elsewhere. Although the price of housing is taken as exogenous in this partial equilibrium analysis, the higher cost of living in community 0 should be understood as reflecting a more desirable location, for which demand has pushed up housing prices relative to the other community. When locating in community j, a household faces the budget constraint:

$$c + p_j = z - T\left(z\right) - t + j\Delta, \tag{3}$$

where z denotes the household's pre-tax labor earnings. The function $T\left(.\right)$ denotes a "place-blind" income

tax schedule: it depends only on income, in a manner that is unrestricted a priori. We also allow for *place-based* transfers. Anticipating the results below on the direction of redistribution, we analyze the question of whether or not to subsidize the low cost-of-living community 1. For simplicity, we focus on a lump-sum place-based redistribution scheme (t, Δ). Without loss of generality, we consider budget-neutral schemes. Denoting with S the share of households residing in community 1, place-based transfers obey $t = S\Delta$. The tax t is a lump sum tax on the residents of community 0, while the residents of community 1 receive a lump sum subsidy of $\Delta - t$. Hence, Δ gives the *tax advantage* of residence in community 1. Of central concern to us will be whether the place-blind tax schedule obviates the need for place-based transfers.

Note that the indirect utility of a household h residing in location j is:

$$v_j^h = g\left(E_j^h - p_j\right) + a_j^h,$$

where

$$E_j^h \equiv z_j^h - T\left(z_j^h\right) - S\Delta + j\Delta - e\left(\frac{z_j^h}{w_j^h}\right)$$

is shorthand notation for income net of taxes and disutility of labor. The quantity z_j^h denotes the optimal earning choice of household h, conditional on living in j. That is,

$$z_j^h \equiv \arg\max_z \left\{ z - T\left(z\right) - S\Delta + j\Delta - p_j - e\left(\frac{z_j^h}{w_j^h}\right) \right\}. \tag{4}$$

Finally, household h's residential choice is denoted

$$\begin{aligned} j^h &\equiv 1\left\{v_1^h > v_0^h\right\} \\ &= 1\left\{\xi^h < g\left(E_1^h - p_1\right) - g\left(E_0^h - p_0\right)\right\}, \end{aligned} \tag{5}$$

where $\xi^h \equiv a_0^h - a_1^h$ gives household h's relative preference for the amenities of community 0. The indirect utility of household h at its optimal location can therefore be written:

$$v^h \equiv v_{j^h}^h = j^h v_1^h + \left(1 - j^h\right) v_0^h.$$

Likewise, we can write:

$$E^h \equiv E_{j^h}^h = j^h E_1^h + \left(1 - j^h\right) E_0^h.$$

3.2 Planning problem

A planner values allocations according to the social welfare function:

$$SWF \equiv \mathbb{E}\left[\omega^h G\left(v^h\right)\right], \tag{6}$$

subject tothe constraint of maintaining an exogeneous revenue requirement R:

$$\mathbb{E}\left[T(z^h)\right] = R. \tag{7}$$

In the social welfare function, ω^h is a Pareto weight, $G(.)$ is a concave function capturing the planner's preferences for redistribution, and the expectation operator is defined over household primitives. Specfically, for any function $x^h = x\left(\theta^h, a_0^h, a_1^h\right)$, we define:

$$\mathbb{E}\left[x^h\right] \equiv \int_0^1 x^h dh = \iiint x\left(\theta, a_0, a_1\right) dF\left(\theta, a_0, a_1\right),$$

where $F(.,.,.)$ denotes the joint CDF of houseolds primitives and is assumed to be continuously differentiable.

To gauge the desirability of a place-based redistribution scheme (hereunder, "PBR"), we evaluate the effect on social welfare of implementing a small PBR $\Delta > 0$, starting from an equilibrium with no PBR where $\Delta = 0$. Generically, the impact of this tax reform on social welfare can be decomposed as follows:

$$\frac{dSWF}{d\Delta} = \frac{dM}{d\Delta} + \frac{dB}{d\Delta} + \frac{dU}{d\Delta},$$

where $\frac{dM}{d\Delta}$ is the mechanical effect of the reform on government revenue, before behavioral changes (i.e. before changes in labor supply and/or community choice in response to the tax reform); $\frac{dB}{d\Delta}$ is the effect of these behavioral adjustment, in response to the tax change, on government revenues; and $\frac{dU}{d\Delta}$ is the dollar-denominated effect of the reform on on aggregate welfare. We first examine whether place-based redistribution is desirable in isolation, that is, whether: $\frac{dSWF}{d\Delta} > 0$. We then ask a more stringent question: is place-based redistribution desirable, even if the planner can also make use of income-based redistribution? To answer this question, we devise an income tax reform that mimics the place-based redistribution reform in terms of $\frac{dM}{d\Delta} + \frac{dU}{d\Delta}$, and compare the corresponding efficiency costs $\frac{dB}{d\Delta}$ between the two alternatives. If the efficiency cost of the place-based reform is lower, place-based redistribution is desirable, even in the presence ofoptimal income taxes, as it can achieve equity goals at a lower efficiency cost.

3.3 Desirability of PBR under no spatial productivity differences

We first focus on the case where there are no spatial differences in productivity between the two cities, that is: $\Theta_0 = \Theta_1$. Cities differ only in their amenities and in their cost of living. In this case, a household's wage is only a function of its skill and not its location. We normalize wage and skill to be identical, i.e. $w^h = \theta^h$. Hence, a given household will choose the same level of earnings in both cities (equation (4)). Therefore, in this case, we get that $z_0^h = z_1^h = z^h$ and $E_0^h = E_1^h = E^h$.

3.3.1 Place-based redistribution is welfare improving

We now establish that the assumptions made thus far unambiguously imply $\frac{dSWF}{d\Delta}\big|_{\Delta=0} > 0$. To establish this result, we evaluate the terms $\frac{dM}{d\Delta}$, $\frac{dB}{d\Delta}$ and $\frac{dM}{d\Delta}$ in turn.

Note first that, by construction, $\frac{dM}{d\Delta} = 0$ because we are considering an ex-ante budget neutral PBR, . To compute the behavioral response of households, we evaluate whether their earnings (hence tax payments) change in response to the implementation of the PBR. Households that do not move in response to the PBR do not adjust their labor supply. This result followsbecause the tax reform is lump-sum conditional on location, and the utility function (1) exhibits no income effect on labor supply. Moreover, households who do move in response to the PBR do not adjust their earnings eitherbecause $z_0^h = z_1^h = z^h$ from the optimal earnings choice in equation (4). Note that these movers also do not lead to losses in tax revenues in PBR, because we start the analysis at an equilibrium without place-based transfer, where $\Delta = 0$. We conclude from this discussion that the PBR leads to no first order loss in revenues for the government, even after accounting for behavioral responses: $\frac{dB}{d\Delta}\big|_{\Delta=0} = 0$.

Finally, to compute the effect of PBR on the aggregate welfare of households, let:

$$\lambda^h \equiv \frac{\omega^h G'\left(v^h\right) g'\left(E^h\right)}{\phi}$$

denote the social marginal welfare weight assigned to household h by the planner at the equilibrium we are considering, where ϕ is the lagrange multiplier on the budget constraint of the government in (7). The weight λ^h gives the planner's valuation of giving an additional dollar to household h. The first order effect of the transfer on welfare (expressed in terms of the value of public funds) is:

$$\frac{dU}{d\Delta} = \mathbb{E}\left[\lambda^h \frac{dE^h}{d\Delta}\right]. \tag{8}$$

Following Saez (2002) and Allcott et al. (2019), we assume the planner aims to redistribute across, but not within, income levels. We formalize this requirement with the following maintained assumption:

Assumption 1. $\lambda^h = \lambda\left(z^h\right)$ *where* $\lambda(.) : \mathbb{R}_{\geq 0} \to \mathbb{R}_{\geq 0}$ *is a monotone decreasing function*

Assumption 1 can be thought of as a horizontal equity constraint: the planner treats households with the same pre-tax earnings equally. Relaxing this constraint would generate a number of well-known dilemnas that arise in the face of preference heterogeneity, such as whether to reallocate from households with a taste for cheap goods to those with a taste for expensive goods (see Kaplow (2008) for discussion). The assumption that $\lambda(.)$ is decreasing with income captures the vertical equity motive that leads the planner to redistribute from higher earning to lower earning households. This motive is conspicuously absent from standard urban economics models but forms the basis of standard models of optimal income taxation (Mirlees, XX). As we shall see, the equity motive can also provide an important justification for indirect taxation on the basis of locational residence.

Putting together the elements above and noting that $\mathbb{E}\left[\lambda^h \frac{dE^h}{d\Delta}\right] = S(1-S)\left(\bar{\lambda}_1 - \bar{\lambda}_0\right)$, we find that the first order welfare effect of introducing the place- based redistribution Δ is:

$$\left.\frac{dSWF}{d\Delta}\right|_{\Delta=0} = S(1-S)\left(\bar{\lambda}_1 - \bar{\lambda}_0\right) \tag{9}$$

This result leads to the following Proposition:

Proposition 1. *Putting in place a place-based redistribution scheme from community 0 to community 1 is desirable if and only if the average social marginal welfare weight of residents is higher in community 1 than in community 0.*

This result is reminiscent of classic results obtained when studying the economics of "tagging" (Akerlof, 1978). Using immutable traits as a tag for redistribution is desirable when these traits are correlated with skill. In our setup, in contrast, the relevant tag – location of residence – is endogenous. Importantly though, given that behavioral responses to indexing taxation on location do not lead to revenue losses for the government, similar outcomes obtain compared to the well-known case of an immutable tag.

Given Assumption 1, Proposition 1 establishes that in this simple model, a small transfer from a high income to a low income location is always desirable. In parsing this result, it is worth considering how places come to be high or low income. There are two reasons why higher incomes can be overrepresented in

community 0, which are seen from computing the propensity of a household to choose community 1 or 0. The location choice equation (5), applied to the baseline equilbrium considered here with no spatial productivity difference and $\Delta = 0$, simplifies to:

$$j^h = 1\left\{\xi^h < g\left(E^h - p_1\right) - g\left(E^h - p_0\right)\right\}, \tag{10}$$

where $E^h = z^h - T\left(z^h\right) - e\left(\frac{z^h}{w^h}\right)$ is simply an increasing function of household skill $\theta^h \left(= w^h.\right)$It is straightforward to see that the propensity to choose $j^h = 0$ increases with the valuation of community 0 amenities (relative to community 1 amenities), as captured by ξ^h in equation (10). It also decreases with the consumption disutility generated by living in the higher cost-of-living city 0, compared to living community 1. This is captured by the right-hand side term $g\left(E^h - p_1\right) - g\left(E^h - p_0\right)$, which is decreasing with skill w^h by concavity of $g(.)$.

Therefore, a first reason for higher incomes to be over-represented in city 0 is that preferences for city 0 can be correlated with skill ($corr(\xi^h, w^h) > 0$). This correlation, by itself, generates sorting of higher incomes into community 0. A second reason comes from income effect in location choice, driven by the concavity of preferences $g(.)$ in the utility function (1). The higher cost of living in community 0 compared to community 1 generates a smaller disutility for higher incomes than for lower incomes. Therefore, even if different skills have the same preferences for community 0 vs community 1, households with higher skills, hence higher income, are more willing to pay the higher cost of living in community 0 and are overrepresented in community 0, making community 0 a higher income location.

Taking stock, when households with different incomes sort differentially across locations – either through income effect on location choice, and/or through locational preferences correlated with skill – then a transfer from high income to low income places fosters equity goals without reducing tax revenue. That is, equity goals are enhanced without a corresponding efficiency cost.

3.3.2 Place-based redistribution complements income-based redistribution

Proposition 1 establishes that, in our setup, place-based redistribution to lower income areas improves welfare. We now ask a more stringent question: is place-based redistribution desirable, even if the planner can also make use of income-based redistribution? To answer this question, we now establish that even in the presence of an optimally chosen place-blind income tax schedule $T^*(.)$, we still get that $\bar{\lambda}_1 - \bar{\lambda}_0 > 0$.

Therefore, there exists an infinitesimal place-based transfer that has a first order positive effect on welfare; whereas, by definition, there does not exist an infinitesimal income tax reform that has such an effect. In that sense, place-based redistribution complements, and improves upon, income-based redistribution.

To answer this question, we consider an equilibrium where the planner has implemented the optimal income tax $T^*(.)$. Infinitesimal income tax reforms have zero first order effect on welfare, by optimality of $T^*(.)$. We consider a perturbed tax schedule

$$\tilde{T}(z,q) = T^*(z) + q\mathring{T}(z), \tag{11}$$

with $q \ll 1$, and devise $\mathring{T}(z)$ to mimic the place-based redistribution reform. The PBR imposes a net tax $\Delta\left(S - j^h\right)$ on household h, so on average over individuals of income z, it imposes a net tax equal to $\Delta(S - \rho(z))$, where:

$$\rho(z) \equiv \Pr\left(j^h = 1 | z^h = z\right)$$

gives the probability a household resides in community 1 given it earns z. We therefore consider the following tax schedule:

$$\mathring{T}(z) = S - \rho(z), \tag{12}$$

and compute $\frac{dM}{dq}$, $\frac{dB}{dq}$ and $\frac{dU}{dq}$ for a tax reform in the direction $\mathring{T}(z)$. Note first that this tax reform is ex-ante budget neutral: by iterated expectations, $\mathbb{E}\left[\mathring{T}\left(z^h\right)\right] = 0$, so that $\frac{dM}{dq} = 0$. Second, we make use of Bayes' rule and Assumption 1 to establish that:

$$\frac{dU}{dq} = \mathbb{E}\left[\lambda\left(z^h\right)\mathring{T}\left(z^h\right)\right] = S(1-S)\left(\bar{\lambda}_1 - \bar{\lambda}_0\right).$$

Comparing this result to (9), we see that the place-blind perturbation yields the same equity effects as the place-based scheme it replicates. However, the place-blind perturbation has a negative first-order effect on the government's budget constraint, as earnings respond to the income tax reform. Specifically,

$$\frac{dB}{dq} = -\mathbb{E}\left[\frac{\partial z^h}{\partial(1-\tau)}\rho'\left(z^h\right)\frac{T'\left(z^h\right)}{1+T''\left(z^h\right)}\right].$$

The price effect is negative, $\frac{\partial z^h}{\partial(1-\tau)} < 0$, while marginal tax rates are positive. A sufficient condition for $\frac{dB}{dq}$ to be strictly negative is that $p'\left(z^h\right) > 0$, which is ensured if, for instance, ξ^h and w^h are positively correlated.

By optimality of $T^*(z)$, we know that $\frac{dM}{dq} + \frac{dB}{dq} + \frac{dU}{dq} = 0$. Therefore, $\frac{dM}{dq} + \frac{dU}{dq} = -\frac{dB}{dq} > 0$. Since $\frac{dSWF}{d\Delta} = \frac{dM}{d\Delta} + \frac{dU}{d\Delta} = \frac{dM}{dq} + \frac{dU}{dq} > 0$, we have established that the PBR improves welfare even in the presence of an optimal income tax.

We conclude that in our setup, place-based taxation is desirable over and above income taxation. This finding is at odds with the classic Atkinson and Stiglitz (1976) result that indirect taxation is superfluous when income taxation is available to the planner. The reasons for the failure of the Atkinson-Stiglitz result in our context are similar to those highlighted in Saez (2002) and Christiansen (1984). First, the Atkinson-Stiglitz result hold if prereferences are common to all households. Here, preferences for location are heterogeneous. If preferences for a certain community are correlated with skill, then it is efficient for the planner to leverage the information contained in location choice to devise a tax system that distorts labor choices less. Second, the Atkinson-Stiglitz result holds when consumption and leisure are weakly separable. The preferences in (1) imply, in contrast, that leisure is complement with living the high price-high amenity community 0: if more leisure is given to households without loss of income, they will choose more often to live in community 0 by equation (10). Hence, by the logic of Christiansen (1984), taxing high amenity / high cost of living areas lowers the tax distortions of work incentives.

3.3.3 Sufficient condition for PBR desirability

We conclude this section by discussing a sufficient condition for PBR to be desirable in this context, which is easily verifiable in the data. Whenever the distribution of pre-tax income in community 1 is stochastically dominated by the corresponding distribution in community 0, Assumption 1 implies that $\bar{\lambda}_1 > \bar{\lambda}_0$. Hence, we have easily verifiable conditions under which our place-based tax scheme will generate a strictly positive welfare effect.

Proposition 2. *Suppose Assumption 1 holds. If the distribution of earnings z^h among residents of community 0 first order stochastically dominates that of the residents of community 1, then:*

$$\left.\frac{dSWF}{d\Delta}\right|_{\Delta=0} > 0.$$

3.4 Desirability of PBR with spatial productivity differences

The previous discussion suggests that place-based redistribution can be a useful complement to place-blind redistribution based on income. In the absence of productivity differences between cities, place-based re-

distribution leads to equity gains at no efficiency cost. However, one of the main findings of the urban economics literature is that productivity varies considerably across space (see e.g. Moretti (2011) for a review). Glaeser (2008) notes that such productivity differences present a special challenge to place based redistribution schemes:

> [Place-based] aid is inefficient because it increases economic activity in less productive places and decreases economic activity in more productive places.

We now consider the case where productivity differs between the two communities, and reconsider the conditions under which place-based aid is likely to be welfare improving. By doing so, we formalize the equity-efficiency tradeoff of taxation in the context of place-based redistribution. Productivity differences between cities lead to an efficiency cost of PBR, but, as above, sorting of household based on income across locations leads to equity gains of PBR. All the derivations are given in the Appendix.

3.4.1 Solving the model

We focus on the case where there are spatial differences in productivity, and specifically on the empirically relevant case where high wage cities are also higher cost of living cities, i.e. $\Theta_0 > \Theta_1$. The household's wage is now a function of both household skill and the community they choose: $w_j^h = w\left(\theta^h, \Theta_j\right)$, so that $w_0^h > w_1^h$. Therefore, a given household will choose different levels of earnings when locating in each of the two cities (equation (4)), namely:

$$z_0^h > z_1^h.$$

Conditional on city choice, these levels of earnings only depend on household skill θ^h and city j, but not on other household characteristics. It will be useful to make these dependencies explicit by using the following notation in what follows $z_j^h = z_j(\theta^h)$, where $z_j(.)$ is some city-specific increasing function of skill θ.

3.4.2 Desirability of PBR in isolation

We now evaluate the effect of implementing an infinitesimal PBR, starting from a baseline equilibrium where only income-based redistribution is in place. It is easy to see that the introduction of productivity differences between cities does not change the computation of $\frac{dU}{d\Delta}$ and $\frac{dM}{d\Delta}$ described above. However, there is now a negative $\frac{dB}{d\Delta}$ term, driven by households that move from community 0 to community 1 in response to the PBR. These moves entails a loss in productivity hence in earnings and government revenue from the income

tax.

Define the share of households with skill θ who live in community 1 when PBR is Δ as:

$$\pi_\theta(\Delta) \equiv \mathbb{E}\left[j^h(\Delta)|\theta^h = \theta\right],$$

where location choice j^h is as in Equation 5 and we have made explicit that this choice depends on the size of the PBR Δ. Then, we find that the efficiency cost of PBR is:

$$\frac{dB}{d\Delta} = \mathbb{E}_\theta\left[\pi'_\theta(0)\left(T\left(z_1(\theta)\right) - T\left(z_0(\theta)\right)\right)\right] < 0 \tag{13}$$

where the expectation $\mathbb{E}_\theta$ is taken over the unconditional distribution of skills θ. The efficiency cost of PBR depends, first, on the density of movers in response to the PBR at each skill level, measured by $\pi'_\theta(0)$. Second, it depends on productivity differences between cities that entail lower earnings in city 1 conditional on skill ($z_1(\theta) < z_0(\theta)$), hence lower tax revenues for the government in city 1 conditional on skill ($T\left(z_1(\theta)\right) < T\left(z_0(\theta)\right)$).

Overall, the first order effect of a place-based transfer on the planner's constrained objective is:

$$\frac{dSWF}{d\Delta} = \underbrace{S\left(1-S\right)\left(\bar{\lambda}_1 - \bar{\lambda}_0\right)}_{\text{Equity Gain}} + \underbrace{\mathbb{E}_\theta\left[\pi'_\theta(0)\left[T\left(z_1(\theta)\right) - T\left(z_0(\theta)\right)\right]\right]}_{\text{Efficiency Cost}}. \tag{14}$$

It is an empirical question which of the two effects in (14) dominate. Quite intuitively, the higher the mobility response to the policy and the higher the earnings response to mobility, the less desirable is PBR.

3.4.3 Desirability of PBR with optimal place-blind tax

We now evaluate whether PBR can be desirable, over and above the use of income tax for redistribution. Consider again the place-blind tax reform (19) that replicates the equity effects of our place-based scheme. Productivity differences complicate the revenue effects of a place-blind tax reform as households may move, and therefore see a discrete jump in their earnings, in response to a change in income taxes. The efficiency

cost of the income tax perturbation (11) is now:

$$\begin{aligned}\frac{dB}{dq} &= \mathbb{E}_\theta \left\{ \underbrace{\pi'_\theta(0)\left(\rho\left(z_1(\theta)\right)-\rho\left(z_0\left(\theta\right)\right)\right)}_{\text{density of movers}} \times \underbrace{\left[T\left(z_1(\theta)\right)-T\left(z_0(\theta)\right)\right]}_{\text{earnings response of movers}} \right\} \\ &- \underbrace{\mathbb{E}\left\{ \frac{\partial z^h}{\partial\left(1-\tau\right)} \rho'\left(z^h\right) \frac{T'\left(z^h\right)}{1+T''\left(z^h\right)} \right\}}_{\text{earnings response of stayers}}\end{aligned} \tag{15}$$

The efficiency cost triggered by movers is smaller in the case of the income tax reform than in the case of the PBR, since $-1 < \rho\left(z_1(\theta)\right) - \rho\left(z_0\left(\theta\right)\right) < 1$. This is intuitive: the place-based redisitribution creates a direct incentive to move, while the income tax reform only has an indirect impact on location choice, through its impact on relative net earnings in the two cities. On the other hand, the income tax reform has an additional efficiency cost compared to the PBR. This cost comes from the earnings response of stayers, who adjust their labor supply in response to the income tax change -- just as in the case with no productivity differences. Comparing (15) to (13), we see that the place-based scheme will have a lower efficiency cost than its replicating income tax perturbation whenever: (i) substitution effects are large, so the labor supply response $\left|\frac{\partial z^h}{\partial(1-\tau)}\right|$ to the income tax reform is large; (ii) sorting is strong ($\rho'\left(z^h\right) \ll 0$); (iii) mobility responses are limited; and (iv) productivity differences between cities are limited. We conclude that income-based and place-based redistribution both entail equity gains and efficiency losses. Because their efficiency losses are of different nature, place-based redistribution schemes can be desirable over and above income-tax redistribution, depending on the model primitives. This conclusion results,in particular, when productivity differences between cities are minimal or mobility is very low.

4 Generalization

We consider here a more general specifications for the utility function, and show that our main results generalize.

4.1 Model Setup

Households derive utility from consumption c and leisure ℓ. They also derive utility from access to amenities of community j, made of two components. A common component a_j summarizes the quality of amenities of community j over which all household agree, and an idiosyncratic component ε_j^h captures the household-specific valuation of amenities of community j. We consider general preferences over c, ℓ and a_j. Namely,

the utility of household h is:

$$U^h(c, \ell, j) = u(c, \ell, a_j) + \varepsilon_j^h.$$

Compared to the cases explored above, this formulation allows in particular for income effects in labor choice. The rest of the setup is unchanged. Households consume one unit of housing. Beyond differing in their level of amenities, cities differ in productivity and in housing cost. A worker's wage in a given city depend positively on their own skill θ^has well as on city productivity Θ_j through:

$$w_j^h = w\left(\theta^h, \Theta_j\right).$$

Income is taxed through a place-blind income tax $T(z)$. Workers choose their earnings, conditional on their city choice, to solve:

$$z_j^h \equiv \arg\max_z \left\{ u\left(z - T(z) - p_j, \frac{z}{w_j^h}, a_j\right)\right\}.$$

Their earning choice can therefore differ in the two communities for three reasons: first, because their hourly wage differs, as different cities make workers more or less productive; second, because their leisure choice is potentially shaped by the amenities of the city where they live (a_j) and the amenities differ across cities; third, because of income effects on labor choice: the housing price differential in the two cities act as a wealth effect, which triggers a different labor/leisure choice in the two cities. To fix ideas, we frame the discussion below focusing on the case that seems to be the most empirically relevant, where $z_1^h < z_0^h$ for all households. We note though that the formulas we derive apply to all cases.

4.2 Desirability of PBR in isolation

Consider again the introduction of a small budget neutral place-based redistribution scheme. Residents of community 0 face a lump-sum tax of ΔS, while residents of community 1 receive a lump-sum subsidy of $\Delta(1-S)$, where S is the share of households in community 1, and Δ indexes the size of the policy.

As before, this tax reform is ex-ante budget neutral so that $\frac{dM}{d\Delta} = 0$. Furthermore, the effect of this reform on welfare is again proportional to the difference in average social weights in the two communities:

$$\frac{dU}{d\Delta} = S(1-S)\left(\bar{\lambda}_1 - \bar{\lambda}_0\right)$$

The behavioral responses to the small PBR are twofold: first, some households change their location,

hence their earnings. Second, households who do not move adjust their labor earnings in response to the tax reform. We define the share of skill-θ households who live in community 1 under PBR Δ as:

$$\pi_\theta(\Delta) = \mathbb{E}\left[j^h(\Delta)|\theta\right],$$

Then the movers term, computed in the Appendix, is simply:

$$\mathbb{E}_\theta\left\{\pi'_\theta(0)\left[T\left(z_1^\theta\right) - T\left(z_0^\theta\right)\right]\right\}.$$

It depends on the density of movers in response to the tax change ($\pi'_\theta(0)$), which is possibly different at different skill levels, and on the revenue losses of the government for each mover ($T\left(z_1^\theta\right) - T\left(z_0^\theta\right)$), which are driven by the productivity gap between the two cities.

Second, the stayers term measures the change in tax revenue from households who do not move but adjust their labor eanings in response to the PBR. We denote by $z_R^h = \frac{\partial z^h}{\partial R}$ the income effect, and by $z_c^h = \frac{\partial z^h}{\partial 1-\tau} - z^h\frac{\partial z^h}{\partial R}$ the substitution effect. The expressions below are computed at $\Delta = 0$, though to keep notation light, we do not make this explicit. The income effect response is:

$$\mathbb{E}\left[T'(z^h)\frac{z_R^h}{1 + z_c^h T''\left(z_j^h\right)}\left(j^h - S\right)\right].$$

For stayers in community 0, the behavioral response is positive: the PBR tax makes them work more. However, the PBR has the opposite effect for stayers in community 1, so the sign of this net income effect is ambiguous.

Overall, the total effect of a PBR tax reform due to behavioral changes is:

$$\frac{dSWF}{d\Delta} = S(1-S)\left(\bar{\lambda}_1 - \bar{\lambda}_0\right) + \mathbb{E}_\theta\left\{\pi'_\theta(0)\left[T\left(z_1^\theta\right) - T\left(z_0^\theta\right)\right]\right\} + \mathbb{E}\left[T'(z^h)\frac{z_R^h}{1 + z_c^h T''\left(z_j^h\right)}\left(j^h - S\right)\right].$$

This expression mirrors our result in (14) with the addition of a revenue response among stayers, the sign of which is not obvious a priori. The benefits of PBR are still driven by sorting, through which PRB generates equity gain. The efficiency costs are driven by movers - and perhaps, depending on its sign, on the change in earnings due to the income effect. Depending on its sign, this net incomeeffect could also actually dampen the efficiency cost of the PBR.

4.3 Desirability of PBR with optimal place-blind tax

Now consider the income tax reform that mimics the place-based reform, as summarized by equations 11 and 19 and indexed by q. The desirability of PBR over and above a place-blind tax schedule hinges on the difference in their behavioral responses:

$$\frac{dSWF}{d\Delta} - \frac{dSWF}{dq} = \frac{dB}{d\Delta} - \frac{dB}{dq}.$$

The income tax reform triggers a movers response, as well as an earnings adjustment for stayers, which is driven both by income effects and substitution effects because their marginal tax rate is affected by the income tax reform. We compute these earnings adjustment to the income tax reform as in Saez (2002). They are equal to:

$$\frac{dB_{stayers}}{dq} = -\mathbb{E}\left[T'\left(z^h\right)\frac{z_c^h}{1+z_c^h T''\left(z_j^h\right)}\rho'\left(z^h\right)\right] - \mathbb{E}\left[T'(z^h)\frac{z_R^h}{1+z_c^h T''\left(z_j^h\right)}\left(\rho\left(z^h\right)-S\right)\right]$$

Following Saez (2002), we make the following high-level assumption:

Assumption 2. *Conditional on earnings, the income effect z_R^h is independent of city choice j^h.*

Under this assumption, the income effect term is identical for the place-based reform and the corresponding income tax reform. The movers term is computed in the appendix and can be written as:

$$\frac{dB_{movers}}{dq} = \mathbb{E}_\theta\left\{\pi'_\theta(0)\left[T\left(z_1^\theta\right) - T\left(z_0^\theta\right)\right]\left(1-\phi^\theta\right)\right\},$$

where

$$\phi^\theta = \frac{\rho\left(z_0^\theta\right)u_{C,0}^\theta + \left(1-\rho\left(z_1^\theta\right)\right)u_{C,1}^\theta}{Su_{C,0}^\theta + (1-S)u_{C,1}^\theta},$$

are weights such that $\mathbb{E}_\theta\left[\phi^\theta\right] = 1$. Therefore, the movers term is strictly smaller in magnitude (less negative) for the income tax reform than for the PBR.

Taking stock, and maintaining Assumption 2, we conclude that the difference in welfare impact of the PBR and an income tax reform is:

$$\begin{aligned}\frac{dSWF}{d\Delta} - \frac{dSWF}{dq} = {} & \mathbb{E}_\theta\left\{\pi'_\theta(0)\left[T\left(z_1^\theta\right) - T\left(z_0^\theta\right)\right]\phi^\theta\right\} \\ & - \mathbb{E}\left[T'\left(z^h\right)\frac{z_c^h}{1+z_c^h T''\left(z_j^h\right)}\rho'\left(z^h\right)\right].\end{aligned}$$

In this more general setup, we see that the results obtained in the simplified model are confirmed.

5 Quantification

We have shown that, in a more general setup, PBR is neither always desirable nor always undesirable. Its desirability is a quantitative question. We therefore conclude with a quantitative calibration that considers PBR to the poorest 10% of local areas (similar to U.S. Opportunity Zones). Is PBR desirable? If so, how large is the optimal PBR even under the optimal income tax?

We analyze Stone-Geary preferences over consumption and leisure with additive tastes for the chosen location. Specifically, we consider household preferences of the form:

$$U^h(c,l,j) = \alpha \ln(c - \underline{c}) + (1-\alpha)\ln(l - \underline{l}) - j\mu + (1-j)\varrho w^h + \frac{1}{\kappa}\xi_j^h$$

where α governs the marginal propensity to earn, $\underline{c}$ and $\underline{l}$ denote minimal subsistence levels ofconsumption and leisure, μ denotes the average disamenity for Appalachia, ϱ governs the degree to which the high-skilled have a higher taste for Elsewhere relative to Appalachia, and ξ_j^h is an Extreme Value Type I distributed taste shock with scale parameter κ. Households maximize utility subject to the budget constraint:

$$c + p_j = (8760 - l)\theta_j w^h - T\left((8760 - l)\theta_j w^h\right) - t + j\Delta$$

where 8760 is the total number of hours in a year and θ_j denotes productivity.

We use the wage distribution from Mankiw et al. (2009), which is a lognormal fit to the 2007 wage distribution in the Current Population Survey, with a Pareto tail with Pareto parameter 2 as in Saez (2001) appended above the 95th percentile. We choose $\alpha = 0.1$; $\underline{c} = 4380$, which corresponds to a minimal consumption level of \$12 per day; and $\underline{l} = 2555$, which corresponds to a minimal leisure level of 7 hours per day. We also choose $\mu = 1.1$, $\varrho = 0.002$, $\kappa = 2.2$, Elsewhere productivity $\theta_0 = 1$, and Appalachia productivity $\theta_0 = 0.8$ (i.e., Appalachia is 20% less productive). These choices yield 10% of the population in Appalachia under no PBR (and the optimal place-blind income tax) and reasonable sorting patterns by earnings.

Social preferences are modified utilitarian:

$$SWF = \mathbb{E}\left[\ln(c' - \underline{c}) - j\mu + (1-j)\varrho w^h + \frac{1}{\kappa}\xi_j^h\right]$$

where:

$$c' = \begin{cases} c & j = 1 \\ c + p_0 - p_1 & j = 0 \end{cases}$$

That is, the social welfare function is the sum of household utilities except that it omits leisure utility and considers consumption utility as if the household lived in Appalachia, holding its actual after-tax-and-transfer income fixed. These social preferences satisfy Assumption 1: the planner is indifferent between distributing a dollar to an Appalachia resident and to an Elsewhere resident with the same earnings. Finally, the planner maximizes social welfare using a tax system that is a flat tax with a lump-sum transfer (i.e., a "universal basic income") and, when specified, PBR. Computationally, we use grid search to find the optimal policy, as described in the Appendix.

When the planner is restricted from using PBR, we find that the optimal income tax is an \$8,175 lump-sum transfer funded by a 32% flat tax. This tax system is remarkably similar to the actual U.S. tax-and-transfer system, which is approximately a \$10,000 transfer (which includes both cash assistance and non-cash assistance like food stamps and Medicaid) funded by a 28% flat tax (Piketty et al., 2017).

When the planner is allowed to use PBR and optimally adjusts the place-blind lump-sum transfer and flat tax, we find that optimal PBR is positive and large, despite the efficiency costs entailed when a household moves to Appalachia. Specifically, Figure 2 shows that we find that the optimal PBR is \$7,300. PBR induces only 2.6% of Elsewhere residents to move to Appalachia.

The key driver of the large optimal PBR is exceptional targeting. The lowest-skilled households have the highest marginal utility of consumption and sort into Appalachia, even without PBR. Optimal policy requires large transfers to the lowest skilled. Since only 10% of the population lives in Appalachia, PBR is very well targeted relative to the place-blind lump-sum transfer which is available to everyone. Hence, PBR allows the planner to deliver comparable resources to the lowest skilled while reducing flat tax rates alongside a reduced lump-sum transfer, thereby raising social welfare.

6 Conclusion

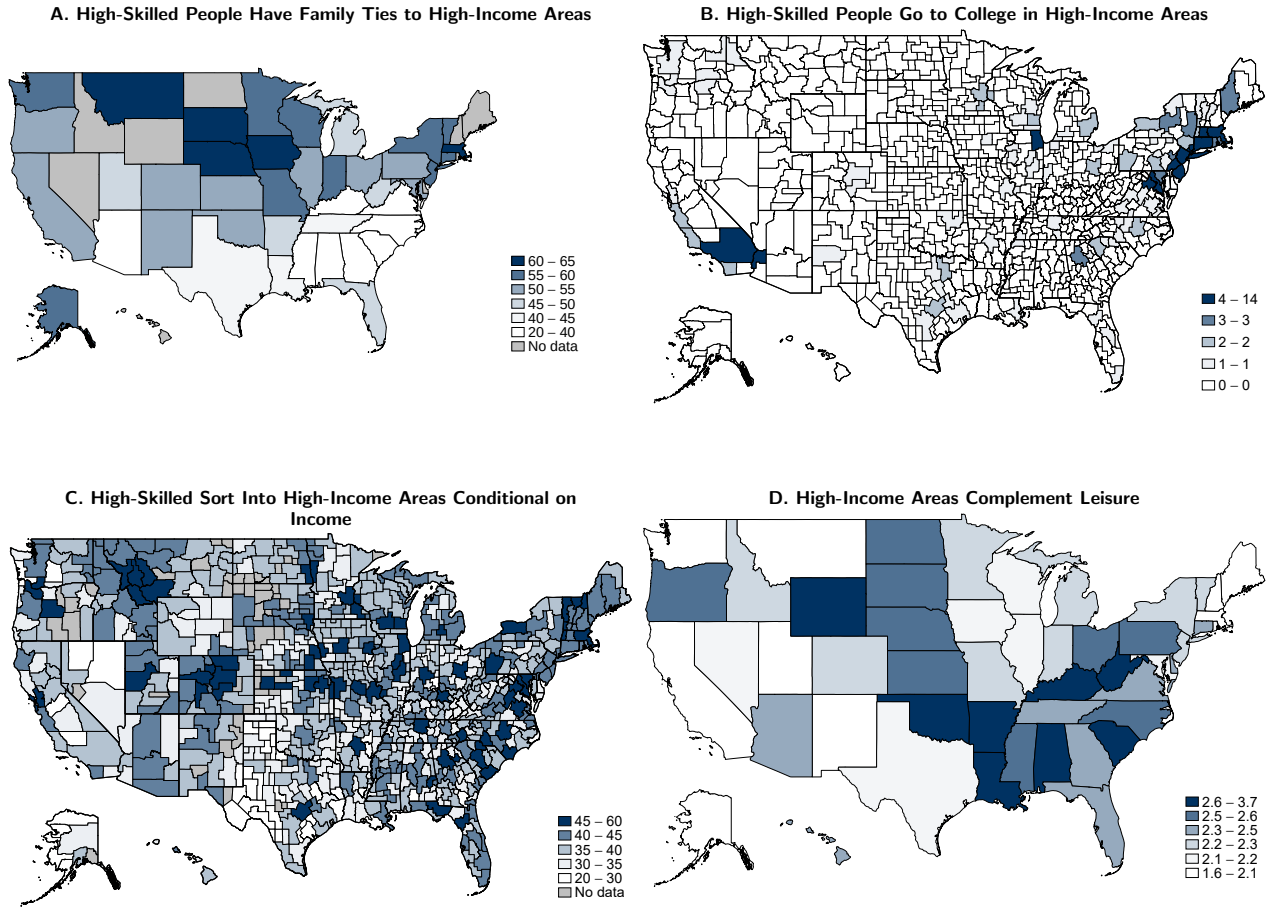
We have studied the equity rationale for place-based policies. We found that place-based redistribution is always desirable in standard urban and trade economics models, as long as low earners tend to have a relative taste for the subsidized area. In more general models, PBR may be desirable – depending on whether it can perform redistribution with smaller efficiency costs than the optimal place-blind income tax. PBR will

tend to be desirable when PBR induces few moves, when productivies are similar across place, when labor supply is especially elastic, and when there is strong sorting across place based on earnings. A quantitative calibration reveals that optimal PBR for the poorest 10% of U.S. regions may be large.

Readers may wonder whether transfers should be conditioned on much more than residential location. For example, height also correlates with earnings, so analogous models suggest that height should be taxed (Mankiw and Weinzierl 2010). We study place because, unlike height and almost all other potential "tags" (Akerlof 1978), governments around the world actually conditional transfers on place.

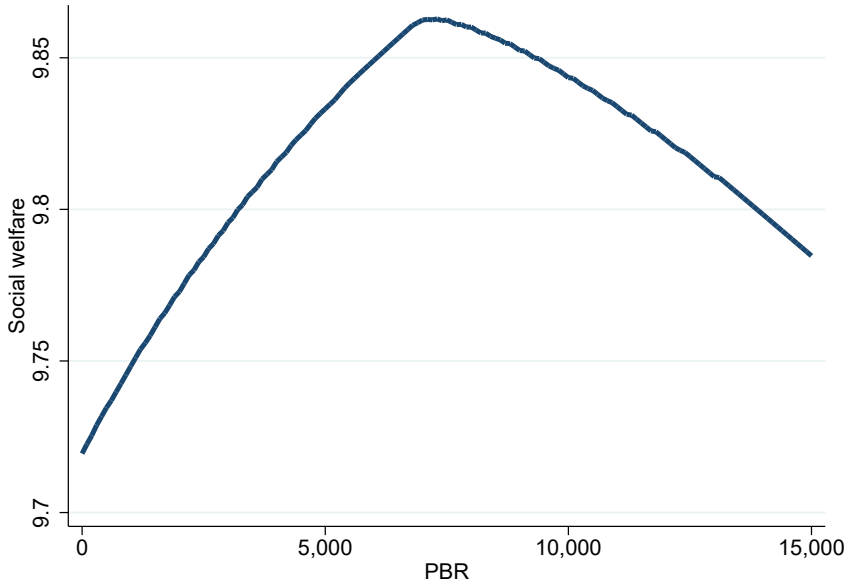
Future work can develop our results in at least three ways. First, our quantitative calibration will soon allow for a non-linear income tax rather than simply a linear tax. Second, natural experiment evidence could be provided to test for skill-taste correlation. Third, new natural experiment evidence could improve our calibration of optimal PBR magnitude.

FIGURE 1: Stylized Facts



Notes: Panel A uses the National Longitudinal Survey of Youth 1979 to plot mean scores of the Air Force Qualifying Test (AFQT) by birth state. The AFQT is an aptitude test that was administered to each NLSY79 respondent, regardless of whether she or he joined the military. AFQT scores are in percentile units. Panel B plots the number of elite colleges by commuting zone. Elite colleges are defined as the 173 colleges in the top two tiers of the 2009 Barron's 2009 selectivity ranking. Commuting zones are 741 collections of counties that share strong commuting ties. Among 35-to-45-year-olds in the 2012-2016 American Community Survey, panel C regresses an indicator of bachelors degree attainment on the individual's gross income percentile (defined nationwide) and commuting zone indicators. The figure plots the commuting zone indicators, with a constant added so that the mean bachelors degree attainment level is preserved. Among adults age 25-54 in the American Time Use Survey 2013-2017, Panel D regresses daily hours spent watching television on state indicators and a quartic in hours spent working in paid employment. The figure plots the state indicators, with a constant added so that the mean level of hours spent watching TV is preserved.

FIGURE 2: Optimal Place-Based Redistribution



Notes: This figure plots social welfare as a function of place-based redistribution in our quantitative calibration. The social welfare level shown at each level of PBR is the social weflare obtained when the planner optimally adjusts the place-blind income tax. See Section 5 for details.

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A Theory Appendix

A.1 Desirability of PBR under no productivity differences

A.1.1 Place-based redistribution is welfare improving

Computing $\frac{dU}{d\Delta}$ Starting at $\Delta = 0$, the total welfare effect expressed in terms of the value of public funds is:

$$\begin{aligned}\frac{dU}{d\Delta} = &\frac{1}{\phi}\int_{stayers} \omega^h G'\left(v^h\right)\left(\frac{\partial v^h}{\partial \Delta} + \frac{\partial v^h}{\partial z}\frac{\partial z^h}{\partial \Delta}\right) dh \\ &+ \frac{1}{\phi}\int_{movers} \omega^h G'\left(v^h\right)\left(v_1^h - v_0^h\right) dh,\end{aligned}$$

where ϕ is the lagrange multiplier on the government budget constraint. We then have an envelope result. The last term is 0 since movers are initially indifferent between the two communities, so that for them: $v_1^h - v_0^h = 0$. Furthermore, for each stayer, $\frac{\partial v^h}{\partial z} = 0$ as income is chosen optimally. Therefore:

$$\frac{dU}{d\Delta} = \frac{1}{\phi}\int \omega^h G'\left(v^h\right) g'\left(z_j^h - T\left(z_j^h\right) - p_j - e\left(\frac{z_j^h}{w_j^h}\right)\right)\left(j^h - S\right) dh$$

We define:

$$\lambda^h \equiv \frac{\omega^h G'\left(v^h\right) g'\left(z_j^h - T\left(z_j^h\right) - p_j - e\left(\frac{z_j^h}{w_j^h}\right)\right)}{\phi}$$

the social marginal welfare weight assigned to household h by the planner at the equilibrium we are considering. It measures the dollar value (in terms of public funds) of increasing consumption of household h by \$1.

This leads to:

$$\begin{aligned}\frac{dU}{d\Delta} &= \int \lambda^h\left(j^h - S\right) dh \\ &= \int_{j^h=1} \lambda^h\left(1 - S\right) dh - S\int_{j^h=0} \lambda^h dh \\ &= \left(1 - S\right) S\left(\bar{\lambda}_1 - \bar{\lambda}_0\right)\end{aligned}$$

Where we have used the following notation:

$$\begin{aligned}\bar{\lambda}_j &\equiv \mathbb{E}\left[\lambda | j^h = j\right] \\ &= \frac{\int_{j^h=j} \lambda^h dh}{\int_{j^h=j} dh}\end{aligned}$$

Which leads to:

$$\bar{\lambda}_0 = \frac{\int_{j^h=0} \lambda^h dh}{1-S}$$
$$\bar{\lambda}_1 = \frac{\int_{j^h=1} \lambda^h dh}{S}$$

Correlation of income and city choice Household h's residential choice in the baseline equilbrium without PBR can be written:

$$\begin{aligned} j^h &\equiv 1\left\{v_1^h > v_0^h\right\} \\ &= 1\left\{\xi^h < g\left(E^h - p_1\right) - g\left(E^h - p_0\right)\right\}, \end{aligned} \tag{16}$$

where $E^h = z^h - T\left(z^h\right) - e\left(\frac{z^h}{w^h}\right) = E\left(w^h\right)$ and $\xi^h = a_0^h - a_1^h$ gives household h's relative preference for the amenities of community 0. Given the household optimization problem (4), E^h and z^h are both increasing functions of household skill w^h, so that there is a one-to-one mapping from z to E, denoted $E(z)$. The share of households with income z choosing to locate in community 1 is:

$$\pi_z \equiv \mathbb{P}\left[\xi^h < g\left(E\left(z\right) - p_1\right) - g\left(E\left(z\right) - p_0\right) | z^h = z\right]. \tag{17}$$

Consider first the case where all households have the same distribution of preferences of communities irrespective of their skill, i.e. ξ^h is independent of w^h, hence of z^h. Then, given (17), π_z is decreasing in z: households with higher earnings are more likely to locate in the expensive city 0. This result comes from the concavity of preferences $g(.)$. This concavity implies that the higher cost of living in city 0 is less hurtful for higher incomes, who are therefore more willing to pay the higher cost of living in the desirable community 0.

Second, preferences for community 0 can be correlated with skill, reinforcing this sorting. If $corr(\xi^h, w^h) > 0$, then $corr(\xi^h, z^h) > 0$ which pushes the propensity π_z to live in community 1 to decrease even more with income z.

A.1.2 Place-based redistribution complements income-based redistribution

Consider then the perturbed tax schedule $\tilde{T}(z,q) = T(z) + q\mathring{T}(z)$ where $\mathring{T}(.)$ gives the perturbation direction. An optimal tax schedule is one for which $\frac{d\mathcal{L}}{dq} = 0$ for any direction $\mathring{T}(.)$. By the envelope theorem, this first

order condition is satisfied when:

$$\mathbb{E}\left[\lambda\left(z^h\right)\mathring{T}\left(z^h\right)\right] = \phi\mathbb{E}\left[\mathring{T}\left(z^h\right) + T'\left(z^h\right)\frac{dz^h}{dq}\right], \tag{18}$$

where the $T'\left(z^h\right)\frac{dz^h}{dq}$ term captures the revenue impact of any behavioral responses to the perturbation.

Consider a tax deviation $\mathring{T}(.)$ that replicates the income effects of our place based redistribution scheme:

$$\mathring{T}(z) = (1 - p(z))S - p(z)(1 - S) = S - p(z). \tag{19}$$

where $p(z) \equiv \Pr\left(j^h = 1 | z^h = z\right)$ gives the probability a household resids in community 1 given it earns z. Note that, by iterated expectations, $\mathbb{E}\left[\mathring{T}\left(z^h\right)\right] = 0$.

An application of Bayes' rule yields:

$$\mathbb{E}\left[\lambda\left(z^h\right)\mathring{T}\left(z^h\right)\right] = -S(1 - S)\left(\bar{\lambda}_1 - \bar{\lambda}_0\right).$$

Comparing this result to (9), we see that the place blind perturbation yields the same equity effects as the place based scheme it replicates.

However, the place-blind perturbation has non-negligible effects on the government's budget constraint. Because earnings exhibit no income effects we can write:

$$\begin{aligned}
\frac{dz^h}{dq} &= \frac{\partial z^h}{\partial(1-\tau)}\frac{d(1-\tau)}{dq} \\
&= \frac{\partial z^h}{\partial(1-\tau)}\left[-\mathring{T}'\left(z^h\right) + T''\left(z^h\right)\frac{dz^h}{dq}\right] \\
&= -\frac{\partial z^h}{\partial(1-\tau)}p'\left(z^h\right)/\left[1 + T''\left(z^h\right)\right]
\end{aligned}$$

where $\tau = T'\left(z^h\right)$ gives the marginal tax rate. To sign, note that z^h is chosen optimally by households. It obeys the first order condition:

$$1 - T'\left(z^h\right) = \frac{\partial}{\partial z}e\left(\frac{z^h}{w^h}\right), \tag{20}$$

From (20), $\frac{\partial z^h}{\partial(1-\tau)} = \left[\frac{\partial^2}{\partial z \partial w}e\left(\frac{z^h}{w^h}\right)\right]^{-1} < 0$. Assume further that ξ^h and w^h are positively correlated so that $p'\left(z^h\right) < 0$.

Plugging these results into (18) we have

$$S\left(1-S\right)\left(\bar{\lambda}_1-\bar{\lambda}_0\right)=\phi\mathbb{E}\left[\frac{\partial z^h}{\partial\left(1-\tau\right)}p'\left(z^h\right)\frac{T'\left(z^h\right)}{1+T''\left(z^h\right)}\right]>0$$

Hence, an optimal place-blind tax system will not eliminate income-based sorting. Consequently, Proposition 1 implies place based redistribution improves upon the optimal income tax. The intuition for this improvement is straightforward: a place blind tax enhances equity with no efficiency cost, while a place-blind perturbation that replicates the equity benefits incurs an additional social cost by distorting earnings from their optimal level.

A.2 Desirability of PBR with productivity differences

B Generalization

B.1 Desirability of PBR in isolation

Computing $\frac{dB}{d\Delta}$ The behavioral responses to the small PBR are twofold: first, some households change their location, hence their earnings. Second, households who do not move adjust their labor earnings in response to the tax reform. We derive these two terms in turn, starting with the movers term.

In the presence of a PBR Δ, the indirect utility of households in a given location is:

$$v_j^h\left(\Delta\right)=u\left(z_j^h-T\left(z_j^h\right)-\left(S-j\right)\Delta-p_j,\frac{z_j^h}{w_j^h},a_j\right)+\varepsilon_j^h.$$

Note that, in city j, the term $u\left(z_j^h-T\left(z_j^h\right)-\left(S-j\right)\Delta-p_j,\frac{z_j^h}{w_j^h},a_j\right)$ is only heterogeneous across households because of their skill θ^h, which determines w_j^h and in turn z_j^h. No other household-specific characteristic enters here, so that everything can be indexed by skill θ rather than household h. To make this clear, we denote with w_j^θ the wage of skill θ in city j and with z_j^θ their earnings there, and we denote the skill-specific component of utility in city j and under PBR Δ as:

$$U_j^\theta\left(\Delta\right)\equiv u\left(z_j^\theta-T\left(z_j^\theta\right)-\left(S-j\right)\Delta-p_j,\frac{z_j^\theta}{w_j^\theta},a_j\right).$$

We also use the notation $\xi^h=\varepsilon_0^h-\varepsilon_1^h$ to denote the idiosyncratic preference of household h for community 0, and denote with $H_\theta(.)$ its distribution conditional on skill θ. If preferences are uncorrelated with skill, then $H_\theta(.)=H(.)$, otherwise, distribution of preferences are skill-specific. People who move in response to

the PBR reform move from community 0 to community 1. They do so if:

$$v_0^h(0) - v_1^h(0) \geq 0 \text{ and } v_0^h(\Delta) - v_1^h(\Delta) \leq 0$$

or

$$U_1^\theta(0) - U_0^\theta(0) \leq \xi^h \text{ and } U_1^\theta(\Delta) - U_0^\theta(\Delta) \geq \xi^h$$

The number of movers in response to the PBR Δ is therefore:

$$H_\theta\left(U_1^\theta(\Delta) - U_0^\theta(\Delta)\right) - H_\theta\left(U_1^\theta(0) - U_0^\theta(0)\right).$$

Furthermore, the tax revenue impact of each mover is $T\left(z_1^\theta\right) - T\left(z_0^\theta\right)$, the revenue impact of the tax reform Δ through movers is:

$$dB_{movers} = \mathbb{E}_\theta\left\{\left[H_\theta\left(U_1^\theta(\Delta) - U_0^\theta(\Delta)\right) - H_\theta\left(U_1^\theta(0) - U_0^\theta(0)\right)\right]\left[T\left(z_1^\theta\right) - T\left(z_0^\theta\right)\right]\right\}. \tag{21}$$

where the expectation $\mathbb{E}_\theta$ is taken over the distribution of skills θ. Differentiating (**??**) and using the envelope theorem, we get:

$$\frac{dB_{movers}(\Delta)}{d\Delta} = \mathbb{E}_\theta\left\{\left[H'_\theta\left(U_1^\theta(0) - U_0^\theta(0)\right)\left(S\frac{\partial u}{\partial c}\left(c_0^\theta, \ell_0^\theta, a_0\right) + (1-S)\frac{\partial u}{\partial c}\left(c_1^\theta, \ell_1^\theta, a_1\right)\right)\right]\left[T\left(z_1^\theta\right) - T\left(z_0^\theta\right)\right]\right\}$$

Define the share of skill-θ households who live in community 1 under PBR Δ as:

$$\pi_\theta(\Delta) = \mathbb{E}\left[j^h(\Delta)|\theta\right],$$

where we have explicited the dependency of location choice j^h on Δ by writing , $j^h(\Delta)$. Note that

$$\pi_\theta(\Delta) = H_\theta\left(U_1^\theta(\Delta) - U_0^\theta(\Delta)\right),$$

therefore:

$$\pi'_\theta(0) = H'_\theta\left(U_1^\theta(0) - U_0^\theta(0)\right)\left(S\frac{\partial u}{\partial c}\left(c_0^\theta, \ell_0^\theta, a_0\right) + (1-S)\frac{\partial u}{\partial c}\left(c_1^\theta, \ell_1^\theta, a_1\right)\right).$$

We can simply rewrite the movers term as:

$$\frac{dB_{movers}(\Delta)}{d\Delta} = \mathbb{E}_\theta\left\{\pi'_\theta(0)\left[T\left(z_1^\theta\right) - T\left(z_0^\theta\right)\right]\right\}.$$

Second, the stayers term measures the change in tax revenue from household who do not move, but

adjust their labor eanings in response to the PBR. We compute the income effect term as in Saez (2002). For stayers in community 0, the behavioral response is positive - the PBR tax makes them work more -, while it is the opposite for stayers in community 1. We denote with $z_R^h = \frac{\partial z^h}{\partial R}$ the income effect, and with $z_c^h = \frac{\partial z^h}{\partial 1-\tau} - z^h \frac{\partial z^h}{\partial R}$ the substitution effect. Everything below is computed at $\Delta = 0$, though to keep notation light, we do not indicate it. We get:

$$\begin{aligned}\frac{dB_{stayers}}{d\Delta} &= \sum_{stayers} T'(z^h) \frac{z_R^h}{1 + z_c^h T''\left(z_j^h\right)} \left(j^h - S\right) \\ &= \mathbb{E}\left[T'(z^h) \frac{z_R^h}{1 + z_c^h T''\left(z_j^h\right)} \left(j^h - S\right)\right]\end{aligned}$$

Overall, the efficiency cost of the PBR tax reform due to behavioral changes is:

$$\frac{dB}{d\Delta} = \mathbb{E}_\theta \left\{\pi'_\theta(0) \left[T\left(z_1^\theta\right) - T\left(z_0^\theta\right)\right]\right\} + \mathbb{E}\left[T'(z^h) \frac{z_R^h}{1 + z_c^h T''\left(z_j^h\right)} \left(j^h - S\right)\right]$$

B.2 Desirability of PBR with optimal place-blind tax

The income tax reform that mimics the PBR is, as above:

$$\tilde{T}(z, q) = T^*(z) + q\mathring{T}(z)$$

$$\mathring{T}(z) = S - \rho(z)$$

It has the same mechanical and welfare effects as the PBR reform - by construction. We compute here the efficiency cost of the income tax reform due to behavioral changes. It is comprised of three terms: a movers term, and - for the stayers term: an income effect term, and a substitution effect term. We first consider the movers term. In the presence of a PBR Δ, the indirect utility of households in a given location is:

$$v_j^h(\Delta) = u\left(z_j^h - T\left(z_j^h\right) - \left(S - \rho\left(z_j^h\right)\right) q - p_j, \frac{z_j^h}{w_j^h}, a_j\right) + \varepsilon_j^h.$$

Again here, the first term only depends on household skill, and we write:

$$U_j^\theta(q) \equiv u\left(z_j^\theta - T\left(z_j^\theta\right) - \left(S - \rho\left(z_j^h\right)\right) q - p_j, \frac{z_j^\theta}{w_j^\theta}, a_j\right).$$

Similar to the computations above, the number of movers to community 1 in response to the tax reform

q is therefore:

$$H_\theta\left(U_1^\theta(q) - U_0^\theta(q)\right) - H_\theta\left(U_1^\theta(0) - U_0^\theta(0)\right).$$

We get:

$$\frac{dB_{movers}}{dq} = \mathbb{E}_\theta\left\{\left[H'_\theta\left(U_1^\theta(0) - U_0^\theta(0)\right)\left(\left(S - \rho\left(z_0^\theta\right)\right)\frac{\partial u}{\partial c}\left(c_0^\theta, \ell_0^\theta, a_0\right) + \left(S - \rho\left(z_1^\theta\right)\right)\frac{\partial u}{\partial c}\left(c_1^\theta, \ell_1^\theta, a_1\right)\right)\right]\left[T\left(z_1^\theta\right) - T\left(z_0^\theta\right)\right]\right\}$$

With some algebra and rearranging terms to make it comparable to the PBR term, we get:

$$\frac{dB_{movers}}{dq} = \mathbb{E}_\theta\left\{\pi'_\theta(0)\left[T\left(z_1^\theta\right) - T\left(z_0^\theta\right)\right]\left(1 - -\frac{\rho\left(z_0^\theta\right)u_{C,0}^\theta + \left(1 - \rho\left(z_1^\theta\right)\right)u_{C,1}^\theta}{Su_{C,0}^\theta + (1-S)u_{C,1}^\theta}\right)\right\},$$

where we have written:

$$u_{C,j}^\theta \equiv \frac{\partial u}{\partial c}\left(c_j^\theta, \ell_j^\theta, a_j\right)$$

We can therefore simply rewrite the movers term as:

$$\frac{dB_{movers}}{dq} = \mathbb{E}_\theta\left\{\pi'_\theta(0)\left[T\left(z_1^\theta\right) - T\left(z_0^\theta\right)\right]\left(1 - \phi^\theta\right)\right\},$$

where

$$\phi^\theta = -\frac{\rho\left(z_0^\theta\right)u_{C,0}^\theta + \left(1 - \rho\left(z_1^\theta\right)\right)u_{C,1}^\theta}{Su_{C,0}^\theta + (1-S)u_{C,1}^\theta}.$$

Turning to the stayers term, it can be written simply - as in Saez 2002 - as the sum of the substitution effect and the income effect from the tax, across households:

$$\begin{aligned}\frac{dB_{stayers}}{dq} = &-\mathbb{E}\left[T'\left(z^h\right)\frac{z_c^h}{1 + z_c^h T''\left(z_j^h\right)}\rho'\left(z^h\right)\right] \\ &-\mathbb{E}\left[T'(z^h)\frac{z_R^h}{1 + z_c^h T''\left(z_j^h\right)}\left(\rho\left(z^h\right) - S\right)\right]\end{aligned}$$

We compare these behavioral effects coming from the PBR to the ones of the Income tax reform.

$$\begin{aligned}\frac{dSWF}{d\Delta} - \frac{dSWF}{dq} = \frac{dB}{d\Delta} - \frac{dB}{dq}.& \\ &= \mathbb{E}_\theta\left\{\pi'_\theta(0)\left[T\left(z_1^\theta\right) - T\left(z_0^\theta\right)\right]\phi^\theta\right\} \\ &+ \mathbb{E}\left[T'(z^h)\frac{z_R^h}{1 + z_c^h T''\left(z_j^h\right)}\left(j^h - S\right)\right] - \mathbb{E}\left[T'(z^h)\frac{z_R^h}{1 + z_c^h T''\left(z_j^h\right)}\left(\rho\left(z^h\right) - S\right)\right] \\ &- \mathbb{E}\left[T'\left(z^h\right)\frac{z_c^h}{1 + z_c^h T''\left(z_j^h\right)}\rho'\left(z^h\right)\right]\end{aligned}$$

Under Assumption 2, we can write:

$$\begin{aligned}\mathbb{E}\left[T'(z^h)\frac{z_R^h}{1+z_c^hT''\left(z_j^h\right)}\left(j^h-S\right)\right] &= \mathbb{E}_z\left[T'(z)\mathbb{E}\left[\frac{z_R^h}{1+z_c^hT''\left(z\right)}\left(j^h-S\right)|z^h=z\right]\right] \\ &= \mathbb{E}_z\left[T'(z)\left(\mathbb{E}\left(j^h-S|z^h=z\right)\right)\mathbb{E}\left[T'(z)\frac{z_R^h}{1+z_c^hT''\left(z\right)}|z^h=z\right]\right] \\ &= \mathbb{E}_z\left[T'(z)\left(\rho\left(z^h\right)-S\right)\mathbb{E}\left[T'(z)\frac{z_R^h}{1+z_c^hT''\left(z\right)}|z^h=z\right]\right],\end{aligned}$$

where we have used Assumption 2 in the second line. The income effect term becomes identical for the tax reform and the PBR.

We get:

$$\begin{aligned}\frac{dSWF}{d\Delta}-\frac{dSWF}{dq} &= \frac{dB}{d\Delta}-\frac{dB}{dq}. \\ &= \mathbb{E}_\theta\left\{\pi'_\theta\left(0\right)\left[T\left(z_1^\theta\right)-T\left(z_0^\theta\right)\right]\phi^\theta\right\} \\ &- \mathbb{E}\left[T'\left(z^h\right)\frac{z_c^h}{1+z_c^hT''\left(z_j^h\right)}\rho'\left(z^h\right)\right]\end{aligned}$$

C Calibration Appendix

This appendix provides additional detail on the grid search method that we employ in our calibration of optimal PBR. We search over the set of feasible government policies for the one that maximizes social welfare. A feasible government policy is a triplet of PBR, place-blind lump-sum transfer, and place-blind flat tax rate under which households maximize utility subject to their personal budget constraint and under which the government does not run a budget deficit.

Under Stone-Geary preferences and a flat income tax, optimal choices are analytically known. It is therefore a simple exercise to search for the optimal feasible government policy. For each pair of potential PBR and lump-sum transfer, we search for the flat tax rate that exactly yields budget neutrality under household optimization and thus maximizes social welfare under the feasibility constraint. Figure 2 plots the social welfare of each budget-neutral triplet against the triplet's PBR.