

# Credible Redistributive Policies and Migration across US States\*

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## Abstract

Does worker mobility undermine governments' ability to redistribute income? This paper analyzes the experience of US states in the recent decades. We build a tractable model where both migration decisions and redistribution policies are endogenous. We calibrate the model to match skill premium and worker productivity at the state level, as well as the size and skill composition of migration flows. The calibrated model is able to reproduce the large changes in skill composition as well as key qualitative relationships of labor flows and redistribution policies observed in the data. Our results suggest that regional differences in labor productivity are an important determinant of interstate migration. We use the calibrated model to compare the cross-section of redistributive policies with and without worker mobility. The main result of the paper is that interstate migration has induced substantial convergence in tax rates across US states, but no race to the bottom. Skill-biased in-migration has reduced the skill premium and the need for tax-based redistribution in the states that would have had the highest tax rates in the absence of mobility.

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# 1 Introduction

Does worker mobility undermine governments' ability to redistribute income? This paper analyzes the experience of US states in the recent decades. We build a tractable model where both migration decisions and redistribution policies are endogenous. Our calibrated model reproduces the main qualitative features of net migration flows across US states.

The question of factor mobility and public policies dates back to Tiebout (1956) but it is just as relevant nowadays. Nothing epitomizes this recurring debate better than the European integration process. From the glacial pace of labor market integration to the now-charismatic Polish plumber, some European politicians have argued that worker mobility is a threat to progressive income taxation and to the welfare state.<sup>1</sup>

The US provides an excellent case study in worker mobility and redistribution policy. US states are capable of dictating their redistribution policies and, indeed, there is substantial variation in both tax levels and welfare benefits across states (Meyer, 2000). In addition, labor flows across US states are large and well documented (Coen-Pirani, 2006). Thus the experience of the US is very informative regarding the determinants of redistribution policy in an environment of high worker mobility.

We use a model where both labor flows and redistribution policy are endogenous.<sup>2</sup> A defining feature of our model is that policies must be credible, that is, they must meet the redistributive demands of the final resident population.<sup>3</sup> This way we rule out promises of unrealistically low taxation, which no government would choose to validate once workers have already incurred in the cost of moving. These non-credible promises are often at the core of the “race to the bottom” arguments. We emphasize that policy competition is still present in our model, albeit curtailed, as workers decide whether and where to move by comparing after-tax incomes.

In our framework migration decisions and redistribution policy are endogenous yet the model remains tractable and adept for applied analysis. The three main features of our framework are the following. First, we allow for region-specific technology in order to capture the large variation in worker productivity and skill wage premium across US states. Second, we do not exogenously restrict the set of fiscal instruments and, in particular, we do not rule out progressive taxation. Finally, we allow for realistic worker mobility.

We calibrate the model to match state-level values of skill premium, output per worker,

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<sup>1</sup>When the EU expanded in May 2004, twelve of the fifteen existing members imposed restrictions on migrants from Eastern Europe. The impact of worker mobility was also prominently featured in the French referendum on the EU constitution (see *The Economist*, A severe crise d'identité, 5/28,2005).

<sup>2</sup>This model is analyzed in detail in Armenter and Ortega (2007).

<sup>3</sup>Thus, our analysis is better suited to environments where migrants acquire political rights automatically. Certainly, this is the case for interstate migrants in the US.

and migration flows. The main data sources are the 2000 US Census and the Regional Economic Accounts of the Bureau of Economic Analysis. Our first claim is that our model can reproduce the main qualitative features of the data regarding the direction and skill composition of net migration flows. First, labor productivity differences play a key role in explaining labor flows. Second, the cross-state migration patterns of skilled and unskilled workers are very similar; the large majority of states experienced either a net inflow of both skilled and unskilled workers, or a net outflow of both types of workers. In addition, skilled workers are highly over-represented among interstate migrants. The calibrated model is also able to predict the large observed changes in state skill composition, the key driving force behind income redistribution in our model. Finally, we capture some qualitative cross-sectional relationships between redistributive policies and economic fundamentals.

We evaluate the impact of worker mobility on redistribution policies as follows. First, we use our calibrated model to compute the policies that would have arisen in absence of worker mobility. The resulting cross-section of policies is then compared to the equilibrium with worker mobility.

We find that worker mobility has induced substantial convergence in tax rates, with no downward pressure, among US states. In our calibrated model, the states that have experienced the largest worker inflows are states with initially scarce skilled labor but relatively high labor productivity. In autarky, these states would have displayed a high skill premium and, consequently, would have taxed skilled workers heavily. The skill-biased nature of migration flows has reduced the skill premium and the need for tax-based redistribution in these states. Despite lowering their tax rates, these states can afford the same level of transfers, per recipient, thanks to the larger tax base.

## 1.1 Literature review

For several decades economists have been interested in tax competition among local/regional governments when workers are geographically mobile. Initially, the main question was the efficiency properties of this decentralized allocation mechanism. In the context of local public goods provision, Tiebout (1956) provides a setup where the allocation is efficient. A few decades later, Bewley (1981) formally restated Tiebout's claim and argued that the conditions to obtain efficiency are quite strong.

Work in this area has continued over the last few decades. Wilson and Wildasin (2004) provide a comprehensive review. In most of this work, often in the context of capital flows, only one factor of production is allowed to move. Cremer and Pestieau (1998) analyze a model with endogenous social security under two scenarios. In the first, only rich workers can migrate while, in the second, only poor workers are mobile. Their results show that the predictions of the model are very different in the two cases.

Lately there has been a surge in the study of the causes and consequences of internal migration flows using US data. The strands of this literature more closely related to our paper are the following.

A recent line of research in Macroeconomics studies internal migration flows. Building on Blanchard and Katz (1992), Coen-Pirani (2006) describes the main facts on (gross) migration flows across US states during the postwar period, with an emphasis on the time series properties. He builds a general equilibrium model with search, where net migration arises as a result of local labor demand shocks. Two-way migration is due to idiosyncratic matches at the individual level. His estimates show that the model is able to reproduce the main features of the data. In particular, he finds that net migration flows are strongly correlated to differences in state-level average wages.

Using a similar framework, Lkhagvasuren (2005) studies differences in state-level unemployment rates. In his analysis the emphasis is on the migration choices of unemployed workers. Hassler et al (2005) also study the determinants of worker mobility in a model with unemployment. However, they use a very different approach, where unemployment benefits are endogenously determined. In their model, workers with lower geographical mobility vote for high unemployment benefits and their attachment to a region increases over time. This mechanism gives rise to multiple equilibria and provides an explanation for observed differences in worker mobility across countries. While in some cases benefits are low, workers are highly mobile, and unemployment rates are low, in others the opposite happens.

Recent work in Labor economics also studies internal migration. Kennan and Walker (2006) estimate a multi-location search model using individual-level panel data from the NLSY. Their analysis pays special attention to sequential migration choices, including return migration. Their results clearly show that workers relocate (across US states) in response to poor individual income realizations. Their analysis is restricted to workers with a high-school degree that did not attend college.

Dahl (2002) estimates a multi-location model of one-time migration. He argues that available estimates of returns to education at the state-level are likely to be biased due to self-selection along unobserved individual characteristics. He builds a Roy model with multiple locations and estimates it using data from the 1990 US Census. In his analysis, a migrant is defined as an individual that resides (in 1990) in a state different from his or her state of birth. He provides estimates of the 51 by 51 transition matrices from each US state to each other state, disaggregated by education levels. His results confirm that skilled workers are more mobile, that bilateral in-migration flows are more skill-biased in states with higher skill premium, and that amenities are important determinants of migration. He also finds that self-selection introduces an upward bias in OLS estimates of state-level returns to education. Corrected estimates still display a large cross-sectional variation in returns to education.

Bayer and Jussen (2006) estimate the monetary cost of migration across US states in the context of a dynamic model that explicitly accounts for self-selection. They estimate the model using state-level data on interstate migration provided by the Internal Revenue Service. They find that the cost of migration is about twice the average annual household income, substantially lower than previous estimates.

Also with a labor economics focus, Meyer (2000) studies the effect of differences in welfare benefits at the state-level on migration, the so-called welfare migration. He uses US Census data for 1980 and 1990, and defines a migrant as an individual that changed state of residence within the last five years. His measure of benefits is the sum of two programs: Aid for Families with Dependent Children (AFDC) and Food Stamps, adjusted for housing costs (rent plus utilities). His estimates suggest that welfare migration exists but it is small.

A third line of research aims at explaining the large differences in the concentration of college-educated workers across US states. Bound et al (2004) examine whether states with more colleges and universities have larger numbers of college-graduate residents. Their analysis combines Census data with surveys conducted by the Department of Education. Their findings suggest that no relationship between the production and the stock of educated workers in a state. In other words, college-educated workers seem to be highly geographically mobile.

Hendricks (2004) is another attempt to explain state differences in skill composition. His paper has three parts. First, using Census data, he shows that states where educated workers are more abundant are specialized in skill-intensive sectors and use skilled workers more intensively across all industries. However, skill premia are not lower in these states. Next, he presents a simple model where skilled workers are perfectly mobile and states differ in the relative demand for skilled labor. He then argues that the calibrated model can account for 90% of the differences in skill composition across US states. The third part of the paper presents a model of human capital agglomeration economies where technology differences at the state level arise endogenously.

Glaeser and Saiz (2003) also examine the connection between human capital and productivity at the local level. Specifically, they study the determinants of city growth in the US in the last few decades. Their main finding is that the fraction of skilled workers in a city (or metropolitan area) is a strong predictor of population growth. This relationship is present only among declining cities, suggesting that skills are crucial in the ability of a city to adapt to a negative idiosyncratic productivity shock.

## 2 Set Up

We consider a world economy consisting of  $R = \{1, 2, \dots, R\}$  regions. In each region  $r \in R$ , there are two types of workers: unskilled and skilled, denoted by subscripts  $i = 1$  and  $i = 2$ , respectively. Each region  $r$  starts with a measure  $e_i^r > 0$  of workers of each type. After all migration decisions have been made, the measure of workers of type  $i$  in region  $r$  is denoted  $n_i^r$ .

**Definition 1** *A world distribution of workers  $n = \{n_1^r, n_2^r\}_{r \in R}$  is feasible if*

$$\sum_{r \in R} n_i^r = \sum_{r \in R} e_i^r$$

for  $i = 1, 2$  and  $n_i^r \geq 0$  for all  $r \in R$ ,  $i = 1, 2$ .

Let non-negative vector  $x^r = (c_1^r, c_2^r, l_1^r, l_2^r)$  denote an allocation for region  $r$  where  $c_i^r$  and  $l_i^r$  denote consumption and hours worked by an agent of type  $i$  in region  $r$ . We let  $x = \{x^r\}_{r \in R}$  be a world allocation. We assume that the preferences of workers of both types are represented by a separable utility function  $U(c_i, l_i) = u(c_i) - v(l_i)$ , with  $u' > 0$ ,  $u'' < 0$ ,  $v' > 0$  and  $v'' > 0$ . To save on notation we shall often write  $U(x_i^r)$  with the understanding that  $x_i^r = (c_i^r, l_i^r)$ .

Unskilled and skilled labor are differentiated inputs in the production process. We assume that unskilled workers can only supply unskilled labor as they are not qualified to perform certain tasks. Skilled workers, though, can supply either skilled or unskilled labor. Throughout the paper, we restrict our attention to economies where skilled labor is the scarce factor.

Production of the non-tradeable consumption good in region  $r$  is given by  $F^r(n_1^r l_1^r, n_2^r l_2^r)$ . We assume production function  $F^r$  is differentiable, constant returns to scale, strictly concave, and satisfies  $F_{12}^r > 0$  as well as the appropriate Inada conditions.

In order to be precise about what we mean by “scarce,” let  $\eta^r = n_2^r/n_1^r$  be the ratio of skilled to unskilled workers. Let  $\bar{\eta}^r$  be given by

$$F_1^r(1, \bar{\eta}^r) = F_2^r(1, \bar{\eta}^r).$$

For commonly used production functions, there exists a unique value of  $\bar{\eta}^r$ .<sup>4</sup> Skilled labor is scarce in region  $r$  as long as  $\eta^r < \bar{\eta}^r$ , which we assume for all regions from now on.

We are now set to define feasible allocations.

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<sup>4</sup>We need  $F_2^r(1, 0) > F_1^r(0, 1)$  and  $F_2^r(1, \kappa) < F_1^r(1, \kappa)$  for some  $\kappa > 0$ .

**Definition 2** A world allocation  $x$  is feasible given  $n = \{n_1^r, n_2^r\}_{r \in R}$  if

$$n_1^r c_1^r + n_2^r c_2^r \leq F^r(n_1^r l_1^r, n_2^r l_2^r)$$

and hours worked and consumption are non-negative, for all  $r \in R$ .

### 3 Redistribution Policy

Redistribution policy in our model is decided by a regional fiscal authority which looks after the welfare of its residents. We start then by studying the problem of optimal redistribution policy for a given workforce  $(n_1, n_2)$ . For notational convenience, we drop the superscripts indexing each region.

We do not exogenously restrict the tax instruments available to the fiscal authority. In particular, we allow for non-linear tax schedules and hence progressive income taxation. We assume, though, that workers' types are unobservable so the tax schedule can only be a function of the workers' actions. This restricts the set of redistribution policies. Since skilled workers can perform unskilled tasks, a very aggressive redistribution policy would lead skilled workers to pass off as unskilled.

We proceed as follows. First, we state the optimal redistribution policy problem as a classic Mirrlees (1971) direct taxation problem. The Mirrlees approach reduces the problem to choosing feasible allocations subject to a set of incentive compatibility constraints. These constraints ensure that all workers truthfully reveal their type. Second, we show that we can decentralize the resulting allocation as a competitive equilibrium with a lump sum tax on skilled workers—its precise level given by the incentive compatibility constraint. Finally we describe the key properties of the allocation.

In our economy only skilled workers can mislead the government by supplying unskilled labor. Thus the only incentive compatibility constraint states that a skilled worker is no worse off than an unskilled worker.

**Definition 3** Feasible allocation  $x = (c_1, l_1, c_2, l_2)$  is incentive compatible if

$$U(c_1, l_1) \leq U(c_2, l_2).$$

The optimal redistribution policy problem is then to pick the incentive compatible allocation which provides the highest social welfare given the current workforce  $(n_1, n_2)$ .<sup>5</sup> We label the resulting allocation as *second best*.

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<sup>5</sup>Note that the workforce includes not only "native" workers but also migrants from other regions that are now living in the region.

**Definition 4** An allocation  $x$  is second best given  $(n_1, n_2)$  if it solves

$$\max n_1 U(c_1, l_1) + n_2 U(c_2, l_2)$$

subject to

$$\begin{aligned} U(c_1, l_1) &\leq U(c_2, l_2), \\ n_1 c_1 + n_2 c_2 &\leq F(n_1 l_1, n_2 l_2), \end{aligned}$$

and non-negativity constraints for consumption and hours worked.

We can re-write the second best problem in terms of the ratio of skilled to unskilled workers  $\eta = n_2/n_1$ . Constant returns to scale imply that  $F(n_1 l_1, n_2 l_2) = n_1 F(l_1, \eta l_2)$  and therefore second best allocations also solve

$$\max U(c_1, l_1) + \eta U(c_2, l_2) \tag{SBP}$$

subject to

$$c_1 + \eta c_2 \leq F(l_1, \eta l_2) \tag{RC}$$

$$U(c_1, l_1) \leq U(c_2, l_2) \tag{IC}$$

and non-negativity constraints.

The characterization of second best allocations is not difficult. Policy models with linear tax rates are often hindered by implementability constraints shaping non-convex choice sets. In contrast, we can assert the necessity and sufficiency of the first order conditions associated with the problem. The next result states that second best allocations can be decentralized in terms of a lump sum tax on skilled workers.

**Proposition 5** Let  $x$  be a second best allocation given  $\eta$ . Then there exists a lump sum tax  $\tau$  and wage rates  $(w_1, w_2)$  such that allocation  $x$  can be decentralized as a competitive equilibrium:

1. Pair  $(c_1, l_1)$  solves the problem of unskilled households:

$$\max U(c_1, l_1) \text{ s.t. } c_1 \leq w_1 l_1 + \eta \tau,$$

with  $c_1 \geq 0, l_1 \geq 0$ .

2. Pair  $(c_2, l_2)$  solves the problem of skilled households:

$$\max U(c_2, l_2) \text{ s.t. } c_2 \leq w_2 l_2 - \tau,$$

with  $c_2 \geq 0, l_2 \geq 0$ .



3. *Wages equal marginal products:*

$$\begin{aligned}w_1 &= F_1(l_1, \eta l_2) \\w_2 &= F_2(l_1, \eta l_2).\end{aligned}$$

**Proof.** In the Appendix ■

Hence second best allocations can be implemented with a very simple, non distortionary tax system. The precise value of the lump sum tax  $\tau$  is a function of the skill ratio as well as the production technology.

We collect below the key properties of second best allocations.

**Proposition 6** *Let  $x$  be a second best allocation given  $\eta$ ,*

1. *The incentive compatibility constraint (IC) is binding:*

$$U(c_1, l_1) = U(c_2, l_2).$$

2. *There is a strictly positive skill premium:*

$$w_1 < w_2.$$

3. *Skilled workers consume more,  $c_2 > c_1$ , and supply more labor,  $l_2 > l_1$ , than unskilled workers.*

4. *The tax is strictly positive:  $\tau > 0$ .*

**Proof.** In the Appendix ■

It is clear that the fiscal authority would like to redistribute income from skilled to unskilled workers more aggressively. In the second-best allocation, consumption and wages are higher for skilled workers. However, the need to provide the right incentives to skilled workers limits the amount of redistribution. As a result, second-best allocations are fully characterized by the binding incentive and resource constraints, together with the equality of marginal rates of substitution to marginal products of labor for both types.

We finish this section with an important result. Consider an inflow of skilled workers into a region. In a laissez-faire economy, a larger ratio of skilled workers makes unskilled workers better off and skilled workers worse off. However, this is not true for second best allocations: *both* types of workers are strictly better off with a higher skill ratio. The higher skill premium leads to a lower skill premium and a lower lump sum tax.

**Proposition 7** *Let  $\eta < \eta' < \bar{\eta}$  and let  $x$  and  $x'$  be second best allocations under  $\eta$  and  $\eta'$ , respectively. Then  $U(c_2, l_2) < U(c'_2, l'_2)$  and  $U(c_1, l_1) < U(c'_1, l'_1)$ . Moreover, second best allocations are decentralized with lump sum taxes  $\tau > \tau'$  and feature skill premia  $w_2/w_1 > w'_2/w'_1$ .*

**Proof.** In the Appendix ■

The mechanics behind the result are simple. The incentive compatibility constraint is binding for all  $\eta < \bar{\eta}$ . It is not possible that the welfare of unskilled workers increases with  $\eta$  without a parallel increase in the welfare of skilled workers. Otherwise the incentive compatibility would be violated. Intuitively, the increase in the relative supply of skilled labor reduces the skilled wage (and increases the unskilled wage). Thus skilled workers need to be compensated with a tax cut to prevent them from taking unskilled jobs.

## 4 Labor Mobility and Credible Policy Equilibrium

This section defines an equilibrium with endogenous migration and redistribution. We start by describing migration decisions. Each worker in each region  $r$  receives one opportunity to move,  $(r', m)$ , specifying a destination region  $r' \neq r$  and a migration cost  $m$  in terms of utility. Each region generates migration opportunities equally, that is, a fraction  $1/(R-1)$  of workers born in region  $r$  receive opportunities to migrate to each other region  $r'$ . Hence, the number of  $i$ -type workers from  $r$  with an opportunity to move to  $r' \neq r$  is given by

$$\frac{e_i^r}{R-1},$$

for  $i = 1, 2$ .

Migration cost  $m$  is idiosyncratic, drawn from a distribution with c.d.f.  $D_i(m)$  for  $i = 1, 2$  with  $D'_i(m) > 0$  for all  $m \geq 0$ . We allow the distribution to be worker-type specific. The equilibrium condition requires that if a worker born in region  $r$  with migration opportunity  $(r', \bar{m})$  chooses to migrate, all workers with opportunities  $(r', m)$  with lower migration costs,  $m \leq \bar{m}$ , will migrate as well.

Let  $\delta_i(r, r')$  be the fraction of workers of type  $i = 1, 2$  moving from  $r$  to  $r'$ . The whole matrices of (gross) migration flows from one region to the others can then be summarized by functions  $\delta_i : R^2 \rightarrow [0, 1]$  for  $i = 1, 2$ . We will let  $\delta_i(r, r) = 0$ .

Given migration flows  $\delta_i$  and worker type  $i = 1, 2$ , the native workforce that remains in region  $r$  is given by

$$e_i^r \left( 1 - \sum_{r' \in R} \delta_i(r, r') \right).$$

Total inflows into region  $r$  are given by

$$\sum_{r' \in R} \delta_i(r', r) e_i^{r'}.$$

Hence, the final workforce in region  $r$  is

$$n_i^r = e_i^r \left( 1 - \sum_{r' \in R} \delta_i(r, r') \right) + \sum_{r' \in R} \delta_i(r', r) e_i^{r'} \quad (1)$$

for  $i = 1, 2$ .

It will be useful to define the mobility cost incurred by marginal migrants. For each pair of regions  $(r, r')$ , we can define the highest mobility cost paid by a migrant as follows. Given migration flows  $\delta_i$ , the marginal migration cost from  $r$  to  $r'$  is given by

$$\mu_i(\delta_i(r, r')) = D_i^{-1}(\delta_i(r, r')).$$

We note that  $\mu_i(x)$  is unbounded as  $x \rightarrow 1$ . Moreover,  $\mu_i(x)$  is differentiable, for  $x > 0$ , and  $\mu_i'(x) > 0$ .

Before proceeding further, we define a world equilibrium for any given set of feasible policies  $\{\tau_r\}_{r \in R}$ . Recall from the previous section that second best allocations can be decentralized with lump sum taxes.

**Definition 8** *A world equilibrium given policies  $\{\tau_r\}_{r \in R}$  is a world allocation, a pattern of migration flows  $\delta_i : R^2 \rightarrow [0, 1]$ , for  $i = 1, 2$ , and a world worker distribution  $\{n_1^r, n_2^r\}_{r \in R}$  such that*

1. *For every  $r \in R$ ,  $x_r$  is a competitive equilibrium given  $\tau_r$  and  $\{n_1^r, n_2^r\}$ ,*
2. *The worker distribution is feasible and satisfies (1).*
3. *For each  $r \in R$ , all individually profitable moves from  $r$  to  $r'$  have taken place, that is,*

$$U(x_i^{r'}) - U(x_i^r) \leq \mu_i(\delta_i(r, r')),$$

*with equality if  $\delta_i(r, r') > 0$ , for all  $r' \neq r$  and  $i = 1, 2$ .*

We have already discussed Condition 2. Condition 3 states the optimality of the migration decisions. Migration takes place from region  $r$  to  $r'$  until the marginal migrant is indifferent. Migration (from  $r$  to  $r'$ ) does not take place at all if it is not profitable for the potential

migrant with zero mobility costs:  $U(x_i^{r'}) - U(x_i^r) < 0$ . Note that each individual migrant takes policies (allocations) as given.

Next we define our concept of policy equilibrium. We view the final workforce composition as the key determinant of redistribution policy. As a result, our policy equilibrium requires allocations to be second best given the distribution of workers.

It is useful to visualize our equilibrium concept as a sequential game. First, workers decide where to go; then each region decides its policy. The requirement that allocations are second best is akin to subgame perfection, which rules out non-credible redistribution promises. Regions still engage in tax competition to attract skilled workers. However, their policy announcements are restricted by their technology and labor endowments.

**Definition 9** *A credible policy equilibrium is a world equilibrium such that for every  $r \in R$  allocation  $x^r$  is second best given  $\{n_1^r, n_2^r\}$ .*

Here we describe some features of equilibrium migration flows. We shall come back to them later on, when we introduce the data on migration flows.

First, migration flows are one-way. If in equilibrium any workers migrate from region  $r$  to region  $r'$ , it cannot be the case that workers from region  $r'$  are moving to region  $r$ . This is because mobility costs are positive. This observation makes clear that ours is a theory of net migration.<sup>6</sup>

Secondly, in equilibrium both types of workers move in the same direction. Specifically, if unskilled workers are migrating from region  $r$  to region  $r'$ , then skilled workers are doing likewise. This result follows from the fact that, in equilibrium, the utility of both types of workers is equated in each region.

The previous remarks imply that each region will suffer outflows of workers toward all other regions with higher equilibrium utility. Ranking states in increasing equilibrium utilities, the equilibrium migration matrices, for both types of workers, will only have positive entries above the main diagonal.

A direct implication of the last remark is that equilibrium total migration rates out of a region are decreasing in the level of utility of each region. Specifically, given migration rates  $\delta_i(r, r')$ , we define total out-migration rates by

$$\Delta_i(r) = \sum_{r' \in R} \delta_i(r, r').$$

We collect these results into one proposition that needs no proof.

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<sup>6</sup>Coen-Pirani (2006) and Lkhagvasuren (2005) study models with matching frictions that give rise to two-way migration.

**Proposition 10** *Let  $\delta$  and  $x$  be part of a credible policy equilibrium. Relabel regions in increasing equilibrium utility. Then*

1. Migration is one-way:

$$\delta_i(r, r') \delta_i(r', r) = 0,$$

for  $i = 1, 2$ .

2. Both skilled and unskilled move in the same direction:  $\delta_1(r, r') > 0$  if and only if  $\delta_2(r, r') > 0$ .
3. Bilateral net outflow  $\delta_i(r, r') \geq 0$  if and only if  $r < r'$ .
4. Total out-migration rates are weakly decreasing:  $\Delta_i(r) \geq \Delta_i(r')$  for  $r < r'$ .

## 5 Calibration

We now use our model to study the determination of migration flows and redistribution policies in US states.<sup>7</sup> First, we calibrate the model to capture the large heterogeneity among US states in terms of technology and labor endowments. These differences will play a key role for the main results of the paper.

### 5.1 Functional Forms

We assume that each state's aggregate production function belongs to the CES family:

$$F^r(L_1, L_2) = \theta_r((1 - \alpha_r)L_1^\rho + \alpha_r L_2^\rho)^{1/\rho}$$

where  $\theta_r > 0$ ,  $0 < \alpha_r < 1$ , and  $\rho \leq 1$ .<sup>8</sup> It is worth pointing out that the labor productivity parameter,  $\theta_r$ , captures not only possible regional technology differences but also differences in any factors of production other than labor. Additionally, regional differences in industrial composition may also lead to differences in aggregate production functions at the state level.

We assume the utility function is logarithmic,

$$U(c, l) = \ln(c) + \ln(1 - l).$$

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<sup>7</sup>We focus on 50 states, after discarding the District of Columbia because of its special status and its high level of integration with the surrounding states.

<sup>8</sup>The elasticity of substitution is given by  $\sigma = 1/(1 - \rho)$ .

Finally, we assume that idiosyncratic mobility costs are drawn from Pareto distributions:

$$m \sim D(m|k_j) = 1 - (1 + m)^{-k_j},$$

where  $m \geq 0$ , and  $k_j > 0$ . We note that higher values of  $k_j$  imply higher mobility (lower mobility costs).

## 5.2 Parameter values

There are two sets of parameters of interest: the ones describing the state-specific aggregate production functions and those characterizing the mobility cost distributions. The latter will be discussed in the next section, when we introduce the data on interstate migration.

Our calibration of production functions follows closely Hendricks (2004).<sup>9</sup> In principle, there are 101 parameters: a pair  $(\theta_r, \alpha_r)$  for each state and a common value of  $\rho$ . Ciccone and Peri (2004) use data on skill premium differences across US states to estimate the elasticity of substitution between skilled and unskilled labor. Based on their results, we set  $\rho = 0.4$ , implying an elasticity of substitution of 1.67. The remaining parameters are chosen to match the values in the data for skill premium and output per worker in each state.

More specifically, for each state, we solve for the allocation and the two technology parameters  $(c_1, l_1, c_2, l_2, \theta_r, \alpha_r)$  that satisfy the 4 conditions for second-best allocation together with

$$\begin{aligned} \frac{F\left(1, \eta_r^d \frac{l_2}{l_1}; \theta_r, \alpha_r, \rho\right)}{1 + \eta_r^d \frac{l_2}{l_1}} &= y_r^d \\ \frac{F_2\left(1, \eta_r^d \frac{l_2}{l_1}; \theta_r, \alpha_r, \rho\right)}{F_1\left(1, \eta_r^d \frac{l_2}{l_1}; \theta_r, \alpha_r, \rho\right)} &= \pi_r^d, \end{aligned}$$

where  $\eta_r^d$ ,  $y_r^d$  and  $\pi_r^d$  denote, respectively, the values in the data for the skilled-to-unskilled ratio, worker productivity and the skill premium in region  $r$ .<sup>10</sup>

Let us now briefly describe these data. The appendix contains a comprehensive description of the sample and the variable definitions. Our measure of worker productivity is state GDP divided by the employment in year 2000. According to our calculations, average worker productivity was \$56,430. The top 5 states were Delaware, Connecticut, New York, New

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<sup>9</sup>He calibrated state-specific CES production functions for US states (and for metropolitan areas), using data up to 1990.

<sup>10</sup>The other four conditions are the equality between MRS and marginal product for each type of worker, and the binding resource and incentive constraints.

Jersey, and Massachusetts, with an average of \$77,500. At the other end, the bottom 5 states were Vermont, Oklahoma, Mississippi, North Dakota, and Montana, with an average of \$43,600. Figure 1 summarizes the data. Naturally, there is a positive correlation between the fraction of skilled workers in a state’s workforce and its output per worker.

To estimate state-level skill composition and skill premium we use data from the US Census 2000. Our sample contains only individuals age 25-45; old enough to have completed college but young enough so that migration is not driven by retirement considerations. We consider individuals with a completed college degree as skilled. All the rest are classified as unskilled. We take the fraction of skilled workers *residing* in each state in year 2000 as a measure of the relative supply of skilled workers in the state.<sup>11</sup> In our sample, the skill fraction ranges from 0.17 to 0.38, with an average value of 0.26. The top 5 states by skill fraction were Maryland, Colorado, New Jersey, Connecticut, and Massachusetts. The bottom 5 were West Virginia, Nevada, Mississippi, Arkansas, and Kentucky. Table 1 reports the values for each state.

Our measure of skill premium is the ratio of hourly wages for college graduates (skilled) and workers without a college degree (unskilled). For the sake of comparability, we estimate state-specific wages using a sub-sample of individuals with comparable demographics, described in detail in the appendix. Figure 2 summarizes the results. The average skill premium in our sample is 1.66. The 5 states with the highest skill premium were Connecticut, Virginia, New York, Arkansas, and Georgia, with an average of 1.86. The bottom 5 states were Alaska, Montana, North Dakota, Wisconsin, and Hawaii, with an average of 1.43.

Using these data, we solve the previous (non-linear) system of equations for each of the 50 states considered. We find substantial heterogeneity in the technology parameters across US states. On average, the skill-bias parameter ( $\alpha$ ) takes a value of 0.50, ranging from 0.40 to 0.61. This parameter can be interpreted as a measure of the relative demand for skilled labor in the state and, together with the relative supply, determines the skill premium. Differences in the skill-bias parameter may reflect state differences in sectoral composition. We find a strong correlation (0.86) between the relative supply of skilled workers and the skill-bias parameter across US states, suggesting that states with relatively high demand for skilled labor also have a relatively high supply of it. As a result, there is no systematic relationship between skill bias (relative demand for skilled labor) and skill premium.<sup>12</sup> Figure 3 in the appendix illustrates this point.

Turning to the labor productivity parameter ( $\theta$ ), we find an average value of 2.72 and tremendous variation across states, ranging from 1.86 to 4.31. In our results states with a

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<sup>11</sup>We note that both US-born and foreign-born residents are part of the labor force.

<sup>12</sup>This result confirms the findings in Hendricks (2004). Our calibration uses more recent data and we allow for differences both in skill bias and in labor productivity.

higher fraction of skilled workers also tend to have higher labor productivity, as illustrated by figure 4.<sup>13</sup>

## 6 Interstate migration

### 6.1 Definitions

Following Aghion et al (2005) and Dahl (2002), we define a migrant as a worker that resides (in year 2000) in a state different from his state of birth. We can summarize the relevant migration data using transition matrices  $M_1$  and  $M_2$ . The typical element in these matrices,  $M_i(r, s)$ , reports the number of individuals of skill type  $i$  that were born in state  $r$  and live in state  $s$  in year 2000. We can now define *net migration* matrices  $N_i = M_i - M_i'$ , where the typical element

$$N_i(r, s) = M_i(r, s) - M_i(s, r)$$

is the net out-migration from state  $r$  to state  $s$ , for workers of skill type  $i = 1, 2$ . Using these data we can construct the *labor endowments* for each state as

$$e_i^d(r) = \sum_{s=1}^R M_i(r, s), \quad (2)$$

that is, by adding over all possible destinations including the state of origin.<sup>14</sup> Similarly, we can use the previous data to construct the *labor force* (after migration) for each state:

$$n_i^d(r) = \sum_{s=1}^R M_i(s, r), \quad (3)$$

for  $i = 1, 2$ , where we are now adding over all regions of origin.

We measure the *fraction of skilled workers*, before and after migration, by

$$\begin{aligned} \sigma_e^d(r) &= \frac{e_2^d(r)}{e_1^d(r) + e_2^d(r)} \text{ and} \\ \sigma_n^d(r) &= \frac{n_2^d(r)}{n_1^d(r) + n_2^d(r)}, \end{aligned}$$

respectively. Finally, it will be helpful to define *the skill fraction gain* from migration by

$$SG^d(r) = \sigma_n^d(r) - \sigma_e^d(r). \quad (4)$$

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<sup>13</sup>The correlation coefficient is 0.52.

<sup>14</sup>The  $d$  superscript stands for data.



By defining migrants in reference to their state of birth, we are leaving foreign-born workers out of the analysis. This omission could be potentially important, given the size of the foreign-born group and its highly uneven distribution across US states. We show below that this is not the case. We back up this claim by carrying out the analysis using also an alternative approach to characterize interstate migration that includes foreign-born workers. We assume that states were endowed with *equal* numbers of foreign-born workers and take their state of residence from the data. In this manner, foreign-born workers are treated symmetrically to US-born ones.<sup>15</sup> Specifically, we modify the previous definitions of labor endowments and labor force as follows:

$$\begin{aligned}\tilde{e}_i^d(r) &= e_i^d(r) + \bar{f}_i \\ \tilde{n}_i^d(r) &= n_i^d(r) + f_i(r),\end{aligned}$$

where  $f_i(r)$  is the number of foreign-born workers, of skill type  $i$ , living in region  $r$ , and  $\bar{f}_i$  is the corresponding average across all states. Skill fractions  $\tilde{\sigma}_e^d(r)$  and  $\tilde{\sigma}_n^d(r)$ , and skill fraction gain  $\widetilde{SG}^d(r)$  are defined analogously.<sup>16</sup> Let us now turn to the data.

## 6.2 State-level skill distributions

Let us begin by examining the cross-section of *labor endowments* and, in particular, the fraction of skilled workers by state of birth. Figure 5 illustrates the large dispersion in skill composition across states. The average fraction of skilled workers across US states is 0.26, ranging from 0.19 to 0.36. The three states with lowest values are Kentucky, West Virginia, and Arkansas, while the three with highest skill fractions are New York, Connecticut, and Massachusetts. Including the foreign-born population reduces slightly the dispersion.<sup>17</sup>

Next, let us turn to the cross-section of skilled workers in the *workforce*, namely, when we sort individuals by state of residence in year 2000. Figure 6 reports the results. We note that the dispersion is larger than in figure 1, with values ranging from 0.17 to 0.38.

Finally, let us examine the skill fraction gain implied by the data, as defined in expression (4). As shown in figure 7, interstate migration has had a large effect on skill composition at the state level: some states have gained 6 percentage points, while others have lost likewise.<sup>18</sup>

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<sup>15</sup>In the US, naturalization usually takes 10 years. Given the long time period implicit in our approach, it seems sensible to treat US-born and foreign-born workers equally.

<sup>16</sup>Which of the two approaches is more correct depends on the interplay between the migration decisions of native and foreign-born workers. For references on whether immigrants geographically displace natives see Borjas et al (1997) and Card and DiNardo (2000).

<sup>17</sup>The average fraction of college educated is roughly similar among foreign-born and US-born individuals.

<sup>18</sup>Including the data on foreign-born workers has little effect on the skill fraction gains. The correlation coefficient between the values implied by the two approaches is 0.88.

We show in the next section that our calibrated model can account for the large changes in skill composition at the state level.

## 7 Model evaluation

The purpose of this section is to evaluate the performance of the calibrated model in predicting the cross-sections of redistributive policies and net migration flows.

It is important to keep in mind that the main use of the model will be to measure the impact of interstate migration on state-level redistribution. The credibility of that exercise crucially depends on the ability of the model to explain the observed changes in the fraction of skilled workers at the state level. We shall pay special attention to this aspect of migration flows. We anticipate that the model captures relatively well the main qualitative features of the data regarding redistributive policies and net migration.

### 7.1 Cross-section utility levels

Let us begin by computing the cross-section of equilibrium utility levels. This is the key input to generate equilibrium bilateral migration flows.

We compute equilibrium utilities in the following manner.<sup>19</sup> For each state, we compute the second-best allocation, using the technology parameters obtained in the previous section and the skill composition observed in the data.<sup>20</sup> Table 2 reports the ranking of states by equilibrium utility. Montana, North Dakota, and Mississippi are the states with lowest utility. At the other extreme, New York, Connecticut, and Delaware are the three states with the highest utility.

Recall that states differ in technology and in labor endowments. Theoretically, differences in utility could arise from differences in either of these; both more skilled labor endowments and higher labor productivity imply higher levels of utility. However, in practice, labor productivity differences are the key variable. The simple correlation coefficient between the vector of utilities and the vector of labor productivity is 0.98.<sup>21</sup>

For the remainder of the paper it will be helpful to order states in increasing level of utility. For instance, Montana is indexed by 1 and Delaware by 50.

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<sup>19</sup>Recall that in equilibrium all workers residing in a given state enjoy the same level of utility.

<sup>20</sup>Here we are implicitly assuming that the geographical distribution of workers over regions of residence in the data coincides with the one implied by the equilibrium. Later in this section we show that this is not a bad approximation. The appendix presents an extension of the model that allows for a perfect match.

<sup>21</sup>A quick look at figure 1 reveals the strong similarity between the distributions by worker productivity and by equilibrium utility.

## 7.2 Implications for migration flows

Let us start by examining the performance of the model in predicting interstate migration flows. We focus on three important features that were spelled out in section 4.<sup>22</sup>

### 7.2.1 Direction of net flows

The model predicts that, in net terms, both types of workers go in the same direction. In other words, in equilibrium, a region that receives a net inflow of skilled workers from another region will also receive a net inflow of unskilled workers from that region. In terms of the net out-migration matrices in the data,

$$N_1(r, s) > 0 \text{ if and only if } N_2(r, s) > 0,$$

for all pairs of states  $(r, s)$ .

Let us now examine whether this holds in the data. Given that we consider  $R = 50$  regions, the total number of (unordered) pairs of states is  $R(R - 1)/2 = 1,225$ .

We find that in 83% of the cases net out-migration for both types of workers went in the same direction. Figures 8 and 9 report net out-migration rates, the empirical counterpart of  $\delta_i(r, s)$ , that is,

$$\frac{N_i(r, s)}{e_i^d(r)}.$$

Most states fall in the top-right or bottom-left quadrants of the figure and deviations from this pattern are quantitatively very small. In our view, this finding is quite revealing. It strongly suggests that the internal migration decisions of skilled and unskilled workers are strongly aligned. In particular, relative skill scarcity seems to play no role at all.

### 7.2.2 Total out-migration rates

As discussed in the theory sections, the model implies that total out-migration rates,  $\Delta_i(r)$ , are decreasing functions of the state's utility rank, for both types of workers. That is, states with a lower rank (utility) should display the largest net outflow rates for both types of workers. Let us examine whether this implication of the model is borne by the data.

We choose to focus on total migration flows into a state from all other states. The reason is that total flows are a sufficient statistic for changes in a region's skill distribution. This is our object of interest since it is the channel through which migration affects redistribution

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<sup>22</sup>We shall focus on the subsample of individuals born in the US. In this manner our results do not depend on how we allocate foreign-born workers to the labor endowments of each state. The previous section showed that the main features of the data are robust to the inclusion of foreign-born workers.

in our model. At any rate, the appendix contains an extension of the model that allows for a quantitative match of the data on bilateral flows.

**Gross out-migration rates** We view our model as a theory of net migration but it is instructive to look first at gross rates. Specifically, we use our data to build the *total out-migration rate* for skill type  $i$  and region  $r$  in the following manner:

$$TOR_i(r) = \frac{1}{e_i^d(r)} \sum_{s \neq r} M_i(r, s) = 1 - \frac{M_i(r, r)}{e_i^d(r)},$$

for skill type  $i = 1, 2$ .

Figure 10 summarizes the relationship between states' equilibrium utility and total out-migration rates. In the figure, we have classified the 50 states by deciles of equilibrium utility. That is, decile 1 contains the 5 states with lowest utility and decile 10 the 5 states with the highest utility.<sup>23</sup> The figure plots the mean values for each decile.

Two features stand out from figure 10. First, the out-migration probabilities of skilled workers are substantially higher than those for unskilled workers. The average out-migration probability for skilled workers is 0.53, 47% higher than for the unskilled (0.37). Next, we note the generally decreasing pattern of the out-migration probabilities as a function of equilibrium utility. As predicted by the model, states with lower equilibrium utility suffered very large outflows of workers of both types, with skilled workers displaying the largest total (gross) out-migration rates. It is also worth noting that the states in the top 2 utility deciles display rather large outflows. We come back to this point below.

Overall, our model reproduces qualitatively the decreasing pattern of total out-migration rates as a function of equilibrium utility. In quantitative terms, we note that while the model predicts zero out-migration probabilities for the state with the highest utility, this is not true in the data.

Let us now use these data on out-migration probabilities to calibrate the parameters of the migration cost distributions. First, let us note that equilibrium total out-migration rates for the state with the lowest utility are given by

$$\Delta_i(1) = \frac{1}{R-1} \sum_{r \geq 2} D(U_r^* - U_1^* | k_i),$$

for  $i = 1, 2$ , where  $U_r^*$  denotes the equilibrium utility in region  $r$ . As noted earlier, higher values of Pareto parameter  $k_i$  imply higher out-migration rates. As shown in figure 10, the

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<sup>23</sup>Table 2 reports the ranking of states by equilibrium utility.

mean total out-migration rates for the states in the first utility decile are

$$(\Delta_1^d(1), \Delta_2^d(1)) = (0.43, 0.61).$$

Given data on the vector of equilibrium utilities (and the fact that  $R = 50$ ), we solve for the values of the Pareto parameters.<sup>24</sup> We find

$$(k_1, k_2) = (2.04, 3.54).$$

**Net out-migration rates** Let us start by constructing total net out-migration rates, for each type of worker, using our data:

$$TNOR_i(r) = \frac{1}{e_i^d(r)} \sum_{s \neq r} N_i(r, s) = 1 - \frac{n_i^d(r)}{e_i^d(r)},$$

where we are making use of expressions (2) and (3).

Figure 11 plots these variables as a function of state equilibrium utility. Again, we group states by utility deciles. States in lower utility deciles suffered net outflows of both types of workers. Most states in higher utility deciles experienced net inflows of both types. Decile 10 (Massachusetts, New Jersey, New York, Connecticut, and Delaware) is an exception. The states in this decile experienced (small) net outflows of both types of workers even though, according to the model, they should have attracted large net flows from other regions. Clearly, some determinants of net migration flows are still missing in our model.<sup>25</sup>

Importantly, figure 11 also shows that net migration flows are *skill-biased*, as was the case for gross flows. That is to say, for the states suffering net out-flows, net out-migration rates of skilled workers are higher than for unskilled workers. Instead, for states experiencing net in-flows, net out-migration rates of skilled workers were lower, that is, higher net *in*-migration rates.

### 7.2.3 Changes in skill composition

We have just seen that two important implications of the model regarding interstate migration are qualitatively borne by the data: net migration flows of both types of workers go in the same direction and net out-migration rates are generally decreasing in equilibrium utility, for both types of workers.

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<sup>24</sup>By focusing on the first decile we use data on all destination states.

<sup>25</sup>The surprisingly low number for decile 7 is due to the huge inflows of workers, relative to its size, experienced by Nevada. When this state is dropped from the decile, the mean values become -0.06 for unskilled and -0.09 for skilled.

We now turn to the performance of the model in predicting changes in the skill composition at the state level, the key dimension for the purposes of the next section. In our model, changes in redistributive tax  $\tau$  reflect the effect of migration on the region's skill distribution. In particular, a region that suffers a reduction in its fraction of skilled workers will raise  $\tau$  in response to the larger skill premium. Conversely, regions that end up with a higher fraction of skilled workers will see a lower skill premium and a reduced need for tax-based redistribution.

Figure 12a reports the actual skill fraction gain and the one predicted by the model. The model predicts remarkably well the changes in skill composition. Note that the actual skill fraction gain is, roughly, an increasing function of equilibrium utility. According to the model, this is due to the combination of two facts. First, states with higher equilibrium utility experience a larger net inflow of workers (of both types). Second, migration is skill-biased, that is, skilled workers are more mobile than unskilled ones. As a result, higher utility deciles experience larger gains in skill fraction. We also point out that the top decile clearly deviates from this pattern but, surprisingly, the model is able to capture this fact.<sup>26</sup> Figure 12b shows that the results are virtually unchanged if we include the foreign-born in the data.

The success of the model in predicting the changes in skill composition is just a reflection of successfully predicting the cross-section of the fractions of skilled workers that reside in each state. Figure 13 illustrates this point.

Finally, we point out that regional differences in labor productivity are the key driving force behind net migration flows in our model. In other words, we could have predicted state gains in skill fraction using exclusively the cross-section of labor productivities ( $\theta$ ).

### 7.3 Implications for redistributive policies

We now compute the equilibrium level of redistribution in each region and compare the resulting cross-section to the one in the data. We examine implications both in terms of taxes and redistributive transfers.

#### 7.3.1 Taxes

In our stylized economy, income redistribution is carried out using a simple income tax schedule. But, in reality, many taxes can be used to finance redistributive transfers. For this

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<sup>26</sup>A closer look at the data reveals that the states in the top decile have suffered net outflows and, as a result, they have experienced a loss in their skill fraction. In the model these states have experienced large net inflows of workers. However, the skill fraction of the inflows would have been lower than the skill fraction among the state-born workers, resulting in a lower skill fraction.

reason we believe that the most appropriate empirical counterpart of the tax in the model is the total tax revenue collected in a state (using several tax instruments) as a fraction of state income.

Let us now turn to the data. We consider two measures of tax revenue for 2000. The first is total personal current taxes (federal, state, and local) over state income. This is mainly income taxes. The second is state (and local) personal current taxes plus property tax, also over state income. We also look at income tax rates as follows. We compute the tax that a typical skilled family would have to pay in each of the US states, as a fraction of their pre-tax income.<sup>27</sup> More details are provided in the appendix.

Table 3 collects summary statistics. On average, total personal taxes are 13.26% of state income. Differences across states are quite large, ranging from 9.84% to 19.23%. With respect to income tax rates (on skilled households), the average is 0.27, and ranges between 0.23 and 0.30. We note that explaining the data along this dimension is quite a challenging task given that some states have a zero (state) income tax rate, despite being highly heterogeneous in their economic primitives.<sup>28</sup>

We can compute the analog measures in our calibrated economy. The distribution of tax revenue over state income predicted by the model turns out to be quite similar to the one in the data, with a mean of 11.03% and ranging from 7.22% to 16.14%. The distribution of income tax rates is also similar to the one in the data, although the model predicts a somewhat larger dispersion.

Let us now turn to the cross-section of policies predicted by the model. We find a significant positive relation between tax revenue over state income and the fraction of skilled workers among the residents in the state, as figure 14 illustrates. This figure is a bit surprising given that in our model taxation is only used as a means to redistribute income and that the skill premium is the only source of income inequality. We note that calibrated technologies differ across regions and that there is a tax base effect. For a given individual tax, states with a higher fraction of skilled (rich) workers obtain a higher total tax revenue.

The data also displays the same pattern, as shown by figure 15. The model is able to predict the high taxes of states like New York, Connecticut, or Massachusetts.

Let us now compare the cross-sectional implications of the model regarding average income tax rates (on skilled workers) to the data. In the model, states with a higher skill fraction in equilibrium have lower tax rates, as can be seen in figure 16. Figure 17 illustrates that there is no significant relationship between income tax rates and skill fractions in the data.

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<sup>27</sup>We note that this is the total income tax rate, including state and federal tax. We use NBER's TAXSIM code to compute state income taxes. See the appendix for details.

<sup>28</sup>Alaska, Florida, Nevada, South Dakota, Texas, Washington, and Wyoming have no state income tax. In addition, New Hampshire and Tennessee only tax capital income.

### 7.3.2 Redistributive transfers

Next, we compute the cross-section of equilibrium redistributive transfers across all regions. We base our comparison with the data on the size of redistributive transfers per recipient, a variable that can be measured directly. Following Meyer (2000), we define transfers per recipient as the sum of the payments in year 2000 of the two main welfare benefits (Food Stamps and Temporary Aid for Needy Families). These are largely decided at the state level. The appendix contains further details on these variables.

As can be seen in table 3a, the average transfer is \$6,099, and ranges from \$3,879 (Alabama, South Carolina) to \$11,877 (Alaska and California). In comparison, the model predicts an average transfer of \$8,686, somewhat larger than the average in the data.

Next, we compare the cross-sections of transfers per recipient in the data and the model. The model predicts that states with a higher fraction of skilled residents will implement a larger transfer per recipient, as can be seen in figure 18. The data also features a significant positive relationship between redistributive transfers per recipient and the skilled fraction among the residents in the state, as shown in figure 19.<sup>29</sup>

## 8 Worker mobility and redistribution policies

Has interstate migration led to convergence in redistributive policies? To address this question we use our model to compute redistribution policies in autarky (no mobility). For this we use the geographical distribution of workers by state of birth. We then use the model to compute redistribution policies using the geographical distribution of workers by state of residence in the data.<sup>30</sup> The state-specific technology parameters are the same in the two scenarios.<sup>31</sup> We then compare the two cross-sections of redistributive policies.

Our results indicate that worker mobility has had virtually no impact on redistributive transfers, while it has induced considerable convergence in tax rates. Figures 20 and 21 illustrate this finding. Autarky income tax rates are on the horizontal axis of figure 20, and equilibrium tax rates on the vertical axis. Clearly, the states that would have had the

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<sup>29</sup>Differences in the size of transfers in the data still remain if we control for regional differences in price levels. Official estimates of the price level by state are hard to come by. We use the ACCRA cost of living index (<http://www.coli.org/>) produced for the main cities in the US to construct an approximation to state-level price indexes. The correlation coefficient between the unadjusted cross-section of transfers and the price-adjusted one is 0.98. We thank Daniele Coen-Pirani for sharing his data with us.

<sup>30</sup>As shown in the previous section the equilibrium cross-section for the fraction of skilled residents is very close to the cross-section in the data.

<sup>31</sup>We note that these parameters were calibrated using the geographical distribution of workers by state of residence, together with data on the skill premium and worker productivity.



highest tax rates in autarky also display the highest tax rates under mobility. However, their tax rate is substantially lower in the equilibrium with mobility. Analogously, tax rates under worker mobility are higher than in autarky for states with the lowest autarky tax rates. Overall, interstate worker migration has generated substantial convergence in tax rates. Table 4 compares the two distributions. While in autarky tax rates range from 0.12 to 0.37, under mobility the range is 0.19-0.34. The mean tax rate is practically unchanged, at 0.26, suggesting that worker mobility did not introduce downward pressure on tax rates.

Similarly, figure 23 compares the cross-sections of transfers per recipient with and without worker mobility. Our results clearly suggest that interstate worker migration has had virtually no effect on this measure of redistributive transfers; the equilibrium values are almost on the 45 degree line. This finding suggests that the often-voiced concerns that worker mobility triggers to a "race to the bottom" in income redistribution policies seem misplaced.

The intuition behind our finding is the following. First of all, we note that migration flows have induced a large skill fraction *gain* in states that, in autarky, would have had the highest tax rates. Figure 22 illustrates this point. Virginia and Georgia are the two states with the highest autarky tax rates and, at the same time, their skill fraction has increased by more than five percentage points. Conversely, North Dakota and Iowa feature the lowest autarky tax rates and have suffered a skill loss of the same magnitude. Figures 23 and 24 show that states with high autarky tax rates are characterized by high autarky skill premia arising from skill-scarce labor endowments.

We point out that the reason behind the large skill fraction gain in the states that have experienced gains in skill fraction lies in their high labor productivity parameters (equilibrium utility). To illustrate this point, consider the two states with the largest gain in skill fraction (Virginia and Georgia) and the two states with the largest loss (North Dakota and Iowa) in figure 22.<sup>32</sup> Table 2 reports the classification of all states by utility (labor productivity) deciles. As expected, labor productivity is very low in North Dakota and Iowa, while very high in Georgia, and Virginia. Respectively, they fall in deciles 1, 2, 8, and 9. As we saw earlier, regions with high labor productivity attract both types of workers. Since skilled workers are more geographically mobile, regions that have enjoyed net inflows of workers have also experienced an increase in their skill fraction.<sup>33</sup>

As a result of the gain in skill fraction, these high productivity states have experienced reductions in their skill premium and, hence, less of a need for tax-based redistribution, relative to autarky. The reduction in tax rates did not lead to lower transfers (per recipient) because of the larger tax base; a higher skill fraction is a higher number of relatively rich

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<sup>32</sup>Maryland had a skill fraction gain almost as large as Virginia. We do not think it is a representative case because of its proximity to DC. In any case, its relative labor productivity is very high too.

<sup>33</sup>Recall that the changes in state-level skill composition are the result of worker relocation, not of general changes in skill composition at the national level.

workers.

Let us examine more in detail why transfers per recipient appear insensitive to changes in skill composition at the state level. It is straightforward to see that the changes in transfers are bound to be smaller than the changes in taxes. The budget constraint of the regional government implies that for a given income tax  $\tau$ , the transfer handed out to the unskilled in the region has to be  $\tau\eta$ . As a result, states experiencing an increase in  $\eta$  will have both a larger tax base and a lower skill premium. The resulting lower wage inequality leads to a lower redistributive tax. The size of the transfer,  $\tau\eta$ , will fall by less than the tax and might even increase. The net effect depends on parameter values. In our calibration, the two effects almost balance out. In response to an increase in skill fraction, the fiscal authority chooses to hold the size of the transfer practically constant and to reduce the tax on skilled workers.<sup>34</sup>

It is worth pointing out that figure 22 is completely at odds with the race to the bottom logic. In this figure, states with high autarky tax rates, mainly due to low relative endowments of skilled labor, have disproportionately gained skilled workers. Worker migration in our calibrated model has been driven by regional labor productivity differences. For instance, the large labor productivity of Virginia and Georgia relative to the skill fraction of its labor endowments has been the main factor behind the large net gains in skilled workers.

## 9 Conclusions

The goal of this paper was to study the effect of worker mobility on redistributive policies in US states. We have presented a model where both redistribution policy and labor flows are endogenous. We find that the calibrated model reproduces some key qualitative facts about net migration flows and redistribution policy. Our main finding is that worker mobility has induced substantial convergence, but no downward pressure, in tax rates. At the same time we find that transfers per recipient are virtually unaffected.

Our analysis makes clear that differences in labor productivity are the key determinant of income, labor flows, and transfers per recipient. The large regional differences in productivity observed in the data appear to be much more important in determining net migration flows than redistributive policies. Consequently, the future of national welfare states in Europe will crucially depend on the evolution of labor productivity in the member states.

Naturally, our results beg the question of what are the sources behind regional differences in labor productivity and what drives their evolution over time. Hendricks (2004) has proposed an explanation based on agglomeration economies in human capital. In the

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<sup>34</sup>We also note that differences in the size of the transfer across states also reflect regional differences in labor productivity.

light of our results, this explanation is not suitable for the case of US states. We find that some states were extremely successful in attracting workers from other states despite having very poor skill endowments.<sup>35</sup> And, conversely, some of the states with the most skilled endowments displayed very low in-migration rates.<sup>36</sup> Clearly, more work is needed to account satisfactorily for regional differences in labor productivity.

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<sup>35</sup>Arizona, Georgia and Virginia experienced very large gains in skill fraction due to interstate migration, as illustrated by figure 27. The skill fraction of their state-born populations was, respectively, 0.20, 0.21, and 0.25, as reported in table 1. The mean value across all states was 0.26.

<sup>36</sup>North Dakota, Iowa, Wisconsin, and New York suffered a reduction in the skill fraction of their populations as a result of interstate migration. The skill fractions of their state-born populations were, respectively, 0.32, 0.30, 0.29, and 0.35, that is, well above the average of 0.26.

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# Appendix

## A Proofs

Proposition 5 follows from simple manipulation of the first order conditions associated with problem (SBP). The key step is to show they are necessary and sufficient.

**Proposition 11** *The first order conditions associated with problem (SBP) are necessary and sufficient to characterize the second best allocations.*

**Proof.** The first order conditions of problem (SBP) are

$$\begin{aligned}
 (1 - \mu)U_c(c_1, l_1) &= \lambda \\
 (1 - \mu)U_l(c_1, l_1) &= -\lambda F_1(l_1, \eta l_2) \\
 (\eta + \mu)U_c(c_2, l_2) &= \lambda \eta \\
 (\eta + \mu)U_l(c_2, l_2) &= -\lambda \eta F_2(l_1, \eta l_2) \\
 \lambda [c_1 + \eta c_2 - F(l_1, \eta l_2)] &= 0 \\
 \mu [U(c_2, l_2) - U(c_1, l_1)] &= 0
 \end{aligned}$$

for  $\lambda \geq 0$  and  $\mu \geq 0$ .

Consider the alternative program

$$\max_{u_1, u_2, x} u_1 + \eta u_2 \tag{5}$$

subject to

$$\begin{aligned}
 u_1 &\leq u_2, \\
 u_1 &\leq U(x_1), \\
 u_2 &\leq U(x_2), \\
 c_1 + \eta c_2 &\leq F(l_1, \eta l_2).
 \end{aligned}$$

We show that an allocation  $x$  is second best if and only if there exists  $u_1$  and  $u_2$  such that  $\{u_1, u_2, x\}$  solve (5). If any solution  $\{u_1, u_2, x\}$  to (5) satisfies  $u_1 = U(x_1)$  and  $u_2 = U(x_2)$ , our claim follows trivially. Assume that  $x$  solves (5) but  $u_1 < U(c_1, l_1)$  and  $u_2 = U(c_2, l_2)$  (obviously  $u_2 < U(c_2, l_2)$  will never be a solution). Construct now an alternative allocation with the same work hours but  $u_1 = U(c'_1, l_1)$ , with  $c'_1 = c_1 - \varepsilon$ ,  $c'_2 = c_2 + \varepsilon/\eta$ , and  $u'_2 =$

$U(c'_2, l_2)$ . Allocation  $x' = (c'_1, c'_2, l_1, l_2)$  satisfies (RC) but  $u_2 \leq U(c_2, l_2) < u'_2$  and  $u_1 \leq u_2 < u'_2$ . Clearly,  $\{u_1, u'_2, x'\}$  contradicts  $\{u_1, u_2, x\}$  being a solution to (5).

The program (5) is concave over a convex set, hence the necessary first order conditions

$$\begin{aligned}
1 &= \alpha + \beta_1 \\
\eta &= \beta_2 - \alpha \\
\beta_1 U_c(x_1) &= \phi \\
\beta_2 U_c(x_2) &= \eta\phi \\
-\beta_1 U_l(x_1) &= \phi F_1(l_1, \eta l_2) \\
-\beta_2 U_l(x_2) &= \eta\phi F_2(l_1, \eta l_2) \\
\alpha [u_1 - u_2] &= 0 \\
\beta_1 [u_1 - U(x_1)] &= 0 \\
\beta_2 [u_2 - U(x_2)] &= 0 \\
\phi [c_1 + \eta c_2 - F(l_1, \eta l_2)] &= 0
\end{aligned}$$

are also sufficient for the solution to program (5).

Let  $x$  be an allocation satisfying the first order conditions associated with problem (SBP). It is straightforward to show that there exist  $\alpha, \beta_1, \beta_2, \phi, u_1$  and  $u_2$  such that allocation  $x$  also satisfies the necessary and sufficient conditions for (5). Hence  $x$  is a solution to (5) and  $x$  is a second best allocation. ■

It turns out to be convenient to prove first that the incentive compatibility constraint is binding under second best allocations and then move to the decentralization result.

**Proposition 12** *Let  $\eta < \bar{\eta}$ . Then for any second best allocation  $x$  given  $\eta$ , the incentive compatibility constraint (IC) is binding:*

$$U(c_1, l_1) = U(c_2, l_2).$$

**Proof.** Assume otherwise. Sufficient first order conditions from (SBP) are then

$$\begin{aligned}
u'(c_1) &= u'(c_2) \\
MRS_i(c_i, l_i) &= F_i(l_1, \eta l_2) \text{ for } i = 1, 2,
\end{aligned}$$

where  $MRS_i = v'(l_i)/u'(c_i)$ . Hence  $c_1 = c_2$ . If  $l_2 > l_1$ , the incentive compatibility constraint (IC) would be violated. If  $l_1 \geq l_2$ , then

$$F_1\left(1, \frac{\eta l_2}{l_1}\right) < F_2\left(1, \frac{\eta l_2}{l_1}\right)$$

as skilled labor is the scarce factor. First order conditions imply then  $v'(l_1) < v'(l_2)$  but this contradicts  $l_1 \geq l_2$ . ■

Equipped with Propositions 11 and 12, we can characterize the second best allocation with four equations. The first order conditions associated with problem (SBP) yield that the labor supply is not being distorted, that is,

$$MRS_i(c_i, l_i) = F_i(l_1, \eta l_2) \text{ for } i = 1, 2.$$

Hence, the second best allocations are fully characterized by the marginal rate of substitution equating the marginal product of each worker, the incentive compatibility constraint (IC) and the binding resource constraint (RC).<sup>37</sup>

**Proof of Proposition 5.** It is straightforward to show that a competitive equilibrium allocation given  $\tau$  is pinned down by

$$\begin{aligned} MRS(c_1, l_1) &= F_1(l_1, \eta l_2), \\ MRS(c_2, l_2) &= F_2(l_1, \eta l_2), \\ c_1 + \eta c_2 &= F(l_1, \eta l_2), \\ c_2 &= F_2(l_2, \eta l_2) l_2 - \tau. \end{aligned}$$

It is clear that the skilled (unskilled) welfare is decreasing (increasing) with  $\tau$ . Hence there is a value of  $\tau$  such that the incentive compatibility constraint (IC) binds. The resulting competitive equilibrium allocations are second best by Proposition 11 and 12. ■

**Proof of Proposition 6.** Proposition 12 has already proved property 1. We start with property 2. Assume that second best allocation  $x$  has

$$F_1\left(1, \eta \frac{l_2}{l_1}\right) \geq F_2\left(1, \eta \frac{l_2}{l_1}\right).$$

The properties of  $F$  and  $\eta < \bar{\eta}$ , imply  $l_2 > l_1$ . The incentive compatibility constraint implies then that  $c_2 > c_1$ . Strict concavity of  $U$  implies that if  $c_2 > c_1$ ,  $l_2 > l_1$ , then  $-\frac{U_l(c_2, l_2)}{U_c(c_2, l_2)} > -\frac{U_l(c_1, l_1)}{U_c(c_1, l_1)}$ . But then  $x$  is incompatible with the necessary first order conditions of problem (SBP) since  $MRS_2 > MRS_1$  implies that  $F_2 > F_1$ , contradicting our initial hypothesis.

Now we prove the third property. By first order conditions for second best allocation,  $MRS(c_2, l_2) > MRS(c_1, l_1)$ . Since  $U(c_1, l_1) = U(c_2, l_2)$  and indifference curves are strictly convex, we have that  $(c_2, l_2) \gg (c_1, l_1)$

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<sup>37</sup>This only holds for  $\eta \leq \bar{\eta}$ .



Property 4 also follows. Assume  $\tau \leq 0$ . Because skilled workers are scarce, they will be strictly better off, contradicting property 1. ■

**Proof of Proposition 7.** We first prove that for any  $\eta < \bar{\eta}$ , second best allocations  $x$  satisfy  $c_2 < F_2(l_1, \eta l_2)$ . Consider the set  $A = \{(c, l) : c \leq F_2(l_1, \eta l_2)(l - l_2) + c_2\}$ . Since  $MRS(c_2, l_2) = F_2(l_1, \eta l_2)$  and preferences are strictly concave, for any  $(c, l) \in A$ ,  $U(c, l) \leq U(c_2, l_2)$ , with equality sign iff  $c = c_2$  and  $l = l_2$ . Therefore  $(c_1, l_1) \notin A$  since the incentive compatibility constraint is binding and  $l_1 \neq l_2$  as Proposition 8 indicates. This implies

$$c_1 > c_2 + F_2(l_1, \eta l_2)(l_1 - l_2)$$

and since  $F_1(l_1, \eta l_2) < F_2(l_1, \eta l_2)$ ,

$$c_1 - F_1(l_1, \eta l_2)l_1 > c_2 - F_2(l_1, \eta l_2)l_2.$$

Using constant returns to scale, the resource constraint can be written as

$$(c_1 - F_1(l_1, \eta l_2)l_1) + \eta(c_2 - F_2(l_1, \eta l_2)l_2) = 0$$

therefore  $c_2 < F_2(l_1, \eta l_2)l_2$ .

We next show that second best allocation  $x$  is feasible at  $\eta'$ . Note that

$$F(l_1, \eta' l_2) - F(l_1, \eta l_2) = F_2(l_1, \hat{\eta} l_2)l_2(\eta' - \eta)$$

where  $\hat{\eta} \in [\eta, \eta']$  by the Taylor theorem. Using the concavity of  $F$ ,

$$F(l_1, \eta' l_2) - F(l_1, \eta l_2) > F_2(l_1, \eta' l_2)l_2(\eta' - \eta).$$

Since the resource constraint is binding

$$F(l_1, \eta' l_2) - c_1 - \eta c_2 > F_2(l_1, \eta' l_2)l_2(\eta' - \eta)$$

or

$$F(l_1, \eta' l_2) - c_1 - \eta' c_2 > (F_2(l_1, \eta' l_2)l_2 - c_2)(\eta' - \eta).$$

Since we proved that  $F_2(l_1, \eta' l_2)l_2 - c_2 > 0$ , allocation  $x$  satisfies the resource constraint with strict inequality sign when  $\eta'$ .

By continuity, there exists  $\hat{c}_2 > c_2$  such that  $F(l_1, \eta' l_2) > c_1 + \eta' \hat{c}_2$ . It is clear then that  $\hat{x} = \{c_1, \hat{c}_2, l_1, l_2\}$  is feasible and incentive compatible with  $U(c_1, l_1) + \eta U(c_2, l_2) < U(c_1, l_1) + \eta U(\hat{c}_2, l_2)$ . Since allocations  $x'$  cannot do worse than  $\hat{x}$ , and the incentive constraint is binding for  $\eta'$ , the result follows. ■

## B Data

### 1. US Census 2000.

Our data is a 5% sample of the 2000 US Census extracted using IPUMS. We restrict our analysis to individuals in the age interval 25-45; old enough to have obtained a college but young enough to avoid migration driven by retirement motives. Individuals with a college degree are defined as skilled workers.

We characterize the skill distribution of the labor force in each state by sorting our sample by state of residence in 2000. Clearly, some of these individuals have been born in the state and some out of state. The latter group contains individuals born in other states and individuals born outside of the U.S.

We characterize net interstate migration as follows. For each skill type, we define net in-migration into a state as the number of residents in that state in year 2000 minus the number of individuals born in the state. Aghion et al (2005) and Dahl (2005) characterize net migration flows in a similar manner. More specifically, we build the labor endowments of each state by sorting the individuals in our sample by state of birth and assigning to each of them their educational attainment year 2000.

Clearly, the total number of residents in the US as a whole will be larger than the total number of US-born individuals due to the large number of foreign-born workers living in the US in year 2000. As a result, practically all US states have experienced a net inflow of workers of both types.<sup>38</sup>

To enhance comparability of skill premia across states, we estimate state-level hourly wages restricting to a highly homogeneous subsample. In particular, we restrict to white males, age 25-45, that are part of the workforce.

### 2. Bureau of Economic Analysis, Regional accounts.

We compute output per worker by dividing state personal income in year 2001 by total employment in the state in the same year.

Our measures of tax revenue are also from the BEA. We consider two measures of tax revenue, both averaged over the period 2000-2002. The first is total personal current taxes (federal, state, and local) over state income. This is mainly the income tax. The second is state (and local) personal current taxes plus property tax, also over state income.

### 3. NBER's Taxsim.

To compute average income tax rates, for skilled workers, we use NBER's income tax simulator (Taxsim) to compute the tax that a typical skilled family would have to pay in each of the US states, keeping family income constant. We then compute the average tax

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<sup>38</sup>It is well known that immigrants are highly concentrated in a few gateway states, such as California, Texas, Florida, Chicago, and New York. However, there is some evidence of a recent shift in location patterns of immigrants in the last few years.

income tax rate of a skilled worker dividing by pre-tax income. In particular, we assume that a typical family is a two-person household with a joint income of \$200,000. The exact figure does not matter much, only the fact that it is kept constant across all states. Leigh (2005) also uses Taxsim in an interesting application.

#### **4. US Department of Health and Human Services.**

Following Meyer (2000), we consider two types of redistributive transfers: Temporary Aid to Needy Families (TANF) and Food Stamps (FS). States have had considerable autonomy in deciding the size of TANF and FS transfers particularly since 1996 when Aid for Families with Dependent Children (AFDC) was replaced by TANF.

Using data from the US Department of Health and Human Services, we define each state's transfer as the sum of TANF (and similar state programs) and Food Stamps for a family of 3 with no income in each state in year 2000. The average transfer across all states was 6,101 USD per household. The same family would have received 3,879 USD in Alabama, the state with the lowest transfers. At the other end of the spectrum, this family would have received 11,877 USD in Alaska or 10,278 USD in California, the states with the highest transfers.

## C Region-specific amenities

While our model is able to match several facts on total net flows, it performs poorly in terms of bilateral net worker flows among U.S. states. This is perhaps not surprising given that the original model was not intended to reproduce bilateral flows but to explain the impact of factor mobility into fiscal policy. We have focused on after-tax income, ignoring many other determinants of location decisions. In particular, geographical factors were unaccounted for. In this subsection we briefly document how to extend the model in order to match the observed bilateral net flows.

Conceptually, the model needs to be extended along two different dimensions. On the one hand, for a significant number of pairs of states, both types of workers flow (in net terms) from a state with high utility, according to our model, to states with lower utility. We address this issue by incorporating new determinants of the utility from living in a region (amenities). On the other hand, the size of bilateral migration flows varies a lot across pairs of states. Most likely, this is related to the geographic structure of states. That is, one would expect states with common borders to generate larger net flows than states far apart. We deal with this size issue by generalizing our concept of "migration opportunities".

First, we introduce a region-specific utility factor—which we call “amenity” for simplicity. Now the relevant utility of region  $r$  is  $A_r = \lambda_r U(c_i^r, l_i^r)$ . Amenities give us the degree of freedom necessary to tweak the ranking of regions. The structure of bilateral net flows imposed by the world equilibrium is, however, unchanged: workers of both types must flow in the same direction and only from lower to higher ranked regions. In terms of the matrix of net flows, only its upper triangular component can be captured by the model.

Next, we allow for a non-uniform distribution of “migration opportunities”: now a fraction  $h_i(r, r')$  of workers of type  $i = 1, 2$  born in region  $r$  receive an opportunity to move to region  $r'$ , with  $\sum_{r' \in R} h_i(r, r') = 1$ . We need to do so in order to match some particularly large bilateral flows—usually associated with geographical proximity. The probabilities are type-specific to capture the heterogeneity in the skill bias of bilateral net flows.

We proceed as follows. We choose the amenities’ factor  $\lambda_r$  such that the resulting ranking of regions maximizes total net bilateral flows captured by the model. For over 80% of the pairs (by count), skilled and unskilled bilateral net rates share the same sign. These pairs reflect a much larger percentage of total flows. Out of these pairs, we find that we can capture in excess of 90% of the net bilateral flows despite having only 49 degrees of freedom to match 1225 bilateral flows.<sup>39</sup> The estimated utilities  $A_r$ , jointly with our choice of parameters  $k_1$  and  $k_2$ , determine the “acceptance” probability for each pair  $(r, r')$ . We then choose  $h_i(r, r')$ ,

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<sup>39</sup>Structural estimation of interstate migration, as in Dahl (2002), requires pair-specific amenities, effectively using 1,225 degrees of freedom.

as well as the actual value of  $A_r$ , such that we match exactly the bilateral net flow rates.

We view both additional features as natural and very successful extensions of the model. Without adding too much structure, we are able to account for the vast majority of worker flows. The ranking implied by the amenities corrects for the anomalies observed before. For example, the states of New York and New Jersey are assigned low amenity values. We then move to analyze the model cross-state implications for fiscal policy given the empirical workforce distribution. Table 2 reports the resulting ranking.

## D Accounting for foreign-born workers

Let the data on US-born individuals be summarized by matrices

$$M_i = \begin{pmatrix} M_i(1, 1) & M_i(1, 2) & M_i(1, 3) \\ M_i(2, 1) & M_i(2, 2) & M_i(2, 3) \\ M_i(3, 1) & M_i(3, 2) & M_i(3, 3) \end{pmatrix}$$

for  $i = 1, 2$ , where we use  $R = 3$  as an illustration. Let  $f_i(r)$  denote the type- $i$  foreign-born workers *residing* in region  $r$ , and define

$$\bar{f}_i = \frac{1}{R} \sum_{r=1}^R f_i(r)$$

as the sample means, for  $i = 1, 2$ .

We treat the foreign-born as if they had been born in the country, spread uniformly across all regions. That is, we define the labor endowments of region  $r$  by

$$\tilde{e}_i(r) = \sum_{s=1}^R M_i(r, s) + \bar{f}_i,$$

for  $i = 1, 2$ . We can now define the matrices that summarize all the relevant data by

$$\begin{aligned} \widetilde{M}_i &= \begin{pmatrix} M_i(1, 1) + f_i(1) & M_i(1, 2) & M_i(1, 3) \\ M_i(2, 1) & M_i(2, 2) + f_i(2) & M_i(2, 3) \\ M_i(3, 1) & M_i(3, 2) & M_i(3, 3) + f_i(3) \end{pmatrix} \\ &= M_i + I_R f_i, \end{aligned}$$

where  $I_R$  is an identity matrix of dimension  $R$  and  $f_i = (f_i(1), \dots, f_i(R))'$ .

Let us now define bilateral gross flows between each pair of states. Let the gross out-migration rate from region  $r$  to region  $s$  be given by

$$\widetilde{OR}_i(r, s) = \frac{\widetilde{M}_i(r, s)}{\widetilde{e}_i(r)}.$$

We also define the total gross out-migration rate by

$$\begin{aligned} \widetilde{TOR}_i(r) &= \frac{1}{\widetilde{e}_i(r)} \sum_{s \neq r} \widetilde{M}_i(r, s) \\ &= \frac{\widetilde{e}_i(r) - \widetilde{M}_i(r, r)}{\widetilde{e}_i(r)} = 1 - \frac{M_i(r, r) + f_i(r)}{\sum_{s=1}^R M_i(r, s) + f_i}. \end{aligned}$$

Let us now define net flows. The net flows into a state originate either in another state (inflow of natives) or in the rest of the world (inflow of foreign-born). Respectively,

$$\begin{aligned} N_i(r, s) &= M_i(r, s) - M_i(s, r) \\ \widetilde{N}_i(r, s) &= N_i(r, s) + (0 - f_i(r)) = N_i(r, s) - f_i(r). \end{aligned}$$

In matrix form,  $\widetilde{N}_i = M_i - M_i' - I_R f_i$ .

We can now define the total net out-migration rate by

$$\begin{aligned} \widetilde{TNOR}_i(r) &= \frac{1}{\widetilde{e}_i(r)} \sum_{s=1}^R \widetilde{N}_i(r, s) \\ &= \frac{\sum_{s=1}^R N_i(r, s)}{\widetilde{e}_i(r)} - \frac{f_i(r)}{\widetilde{e}_i(r)}. \end{aligned}$$

# E Figures and Tables

Figure 1

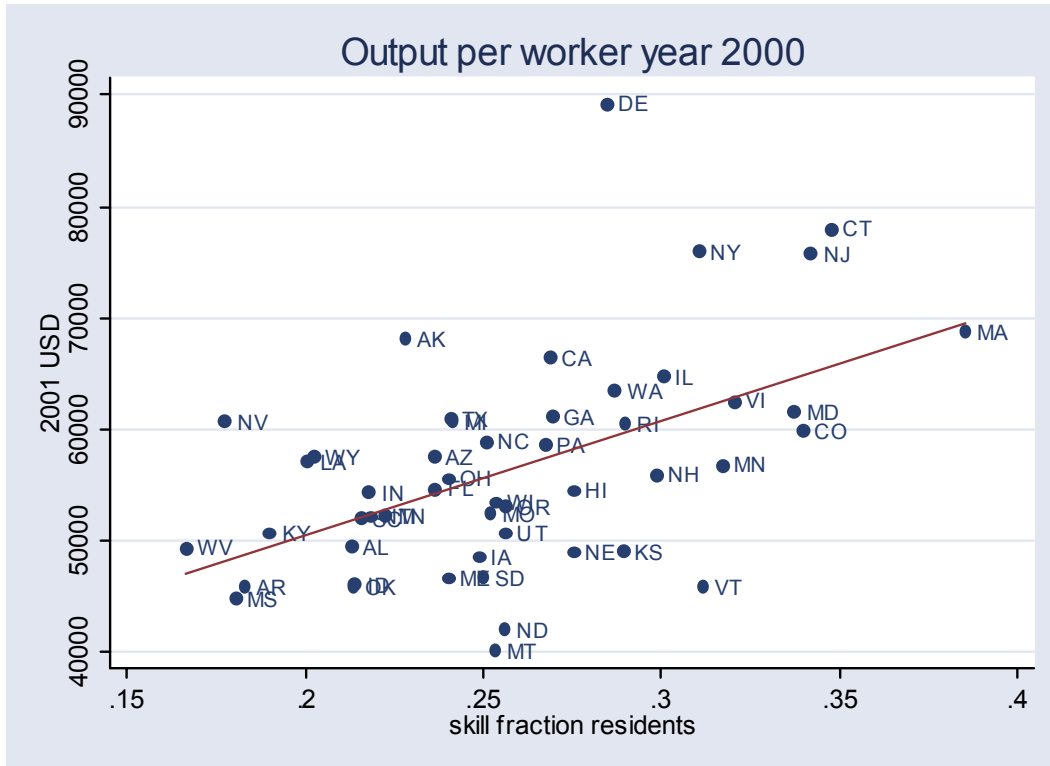


Figure 2

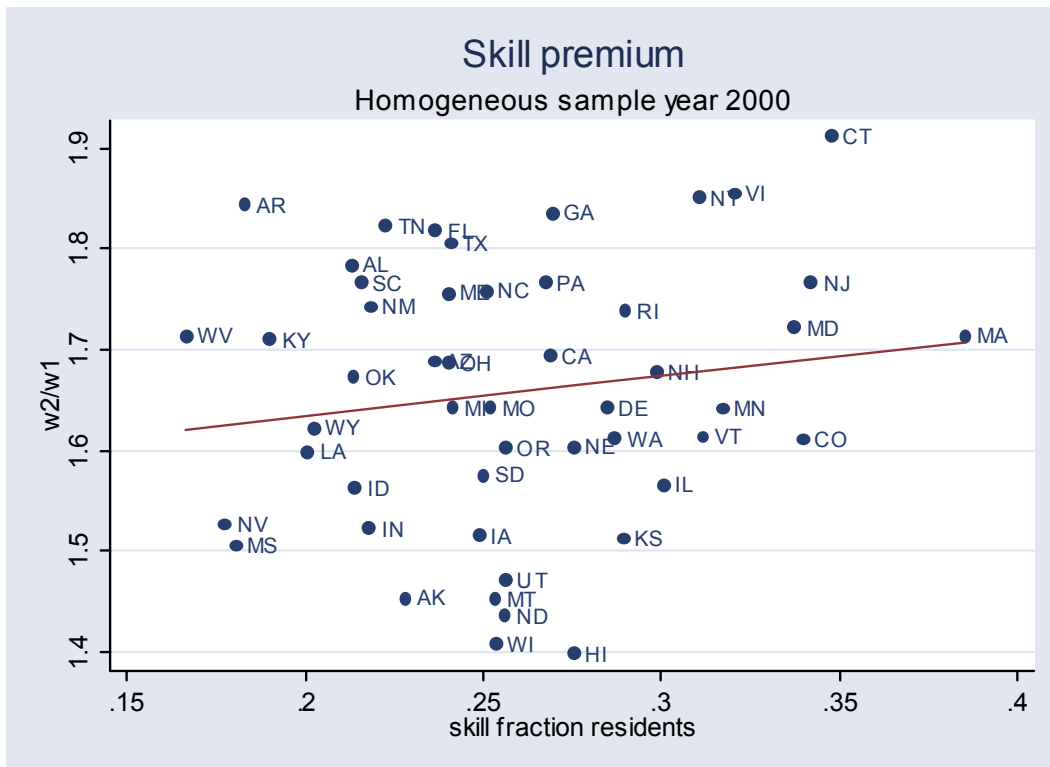


Figure 3

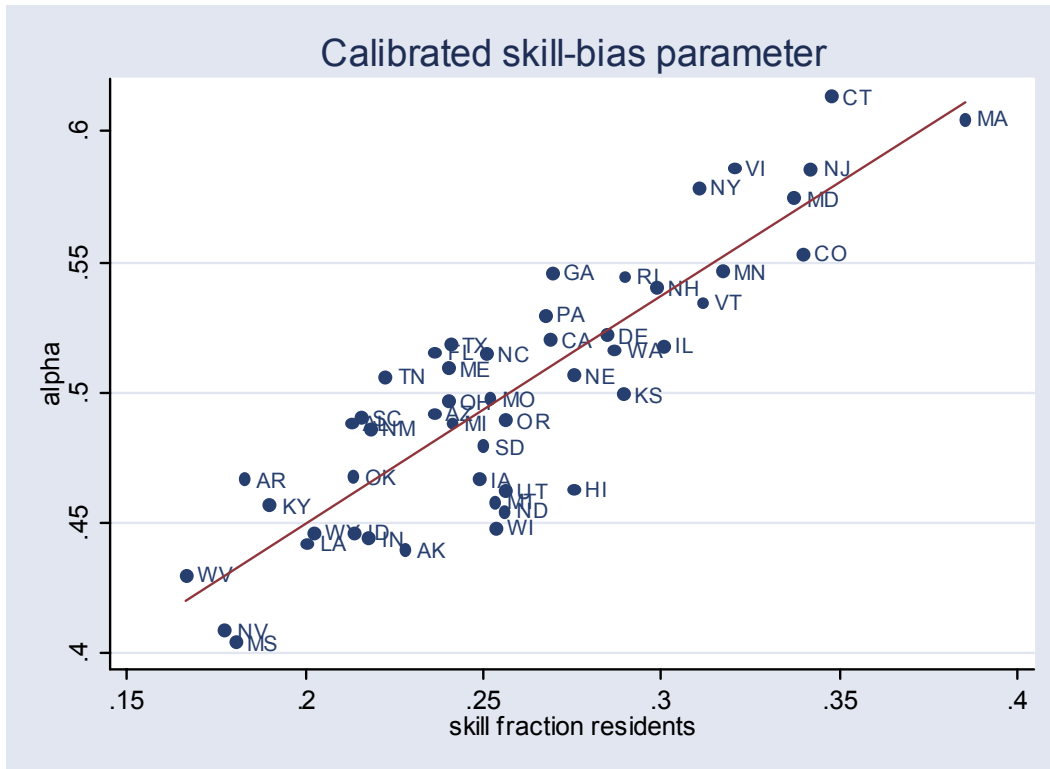


Figure 4

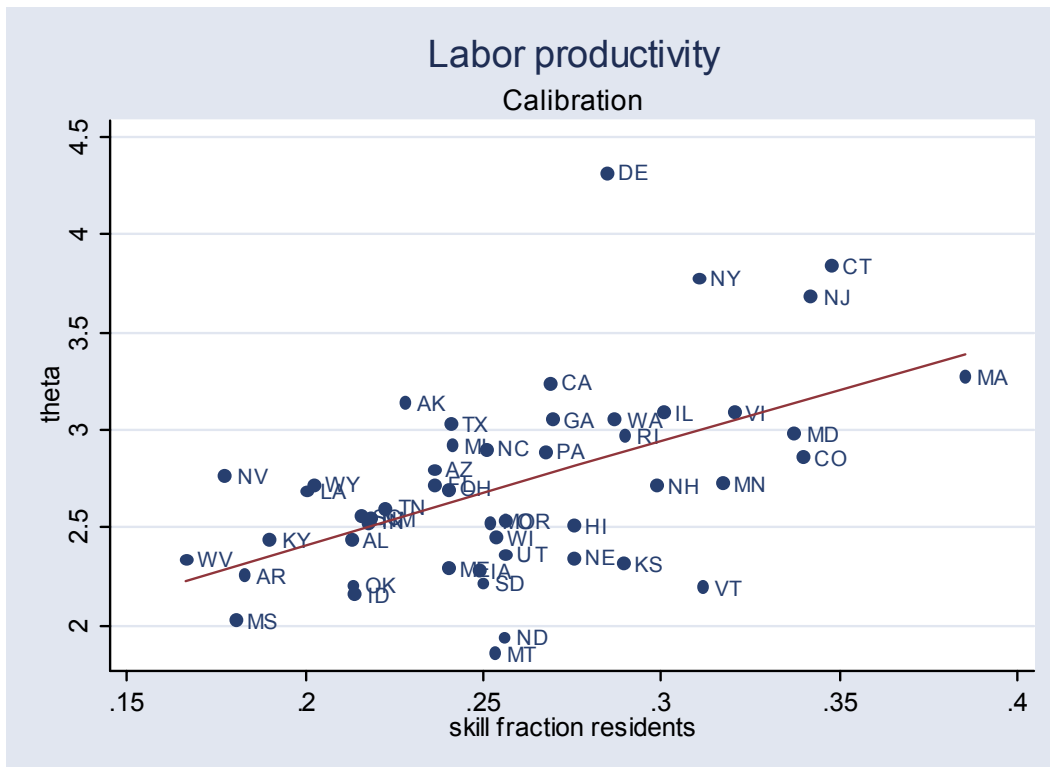






Figure 7

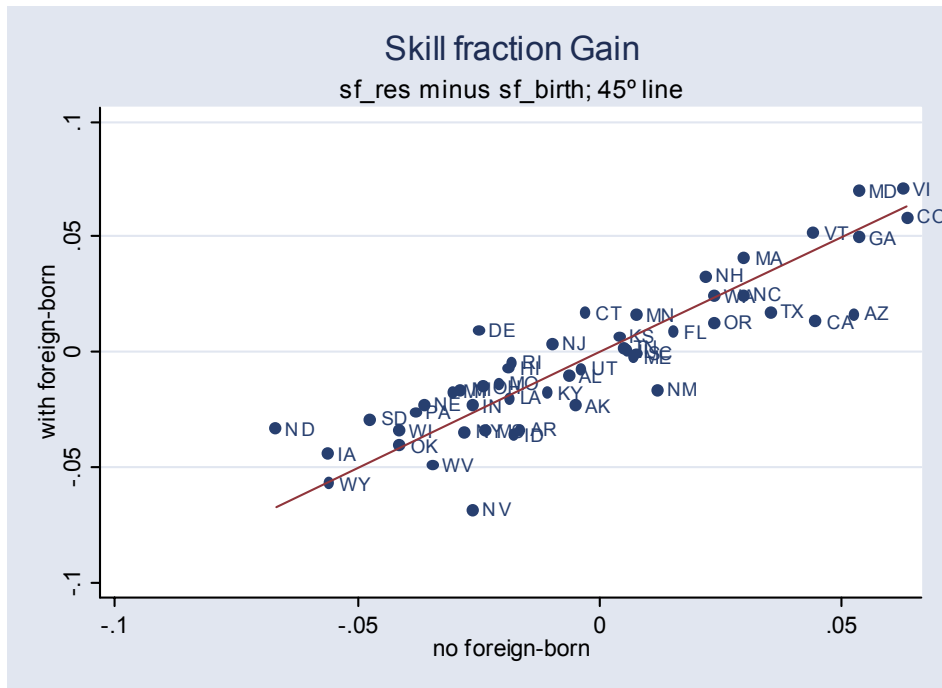


Figure 8

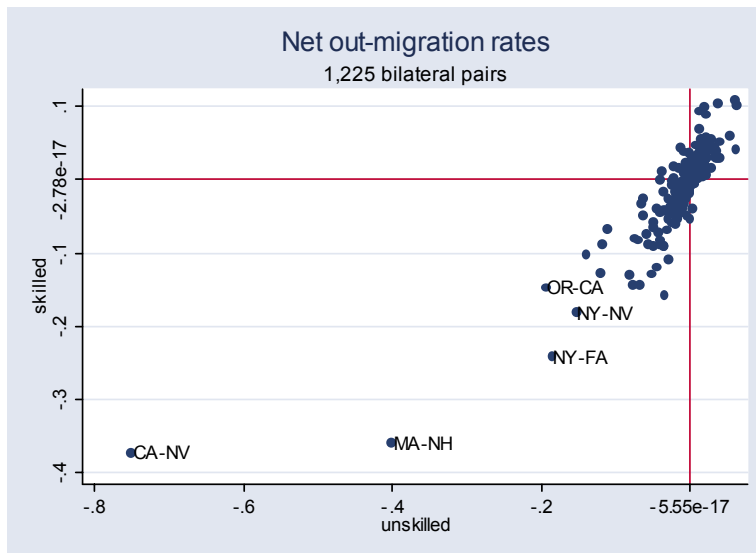


Figure 9

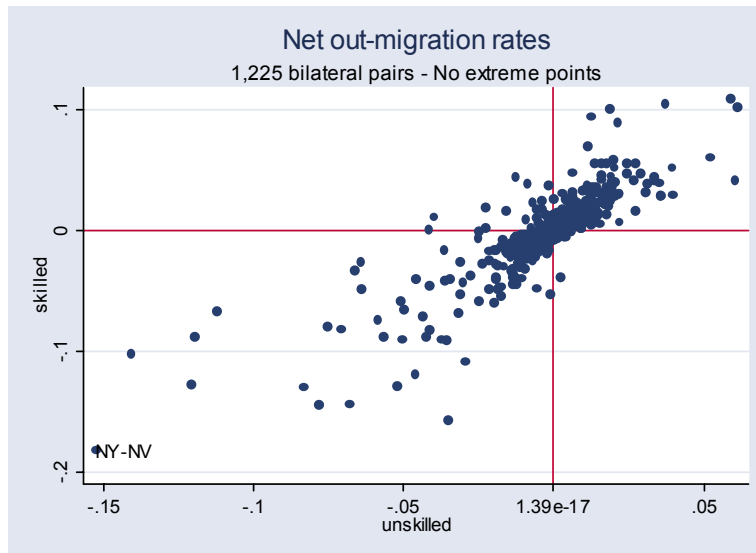


Figure 10

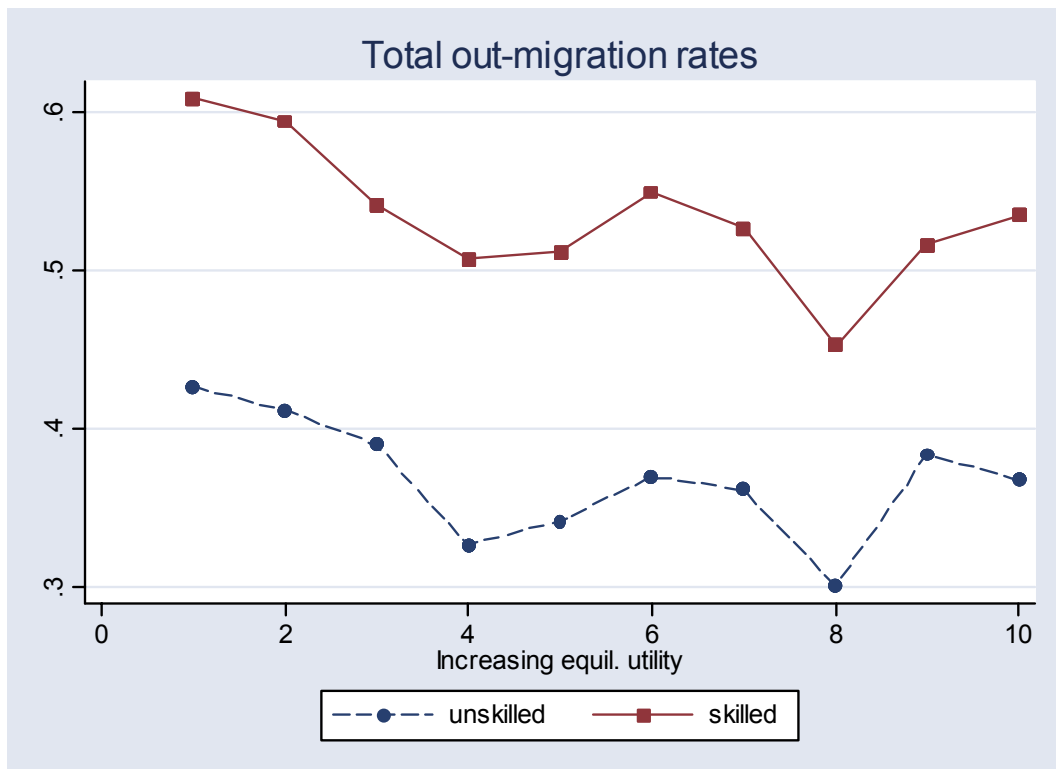


Figure 11

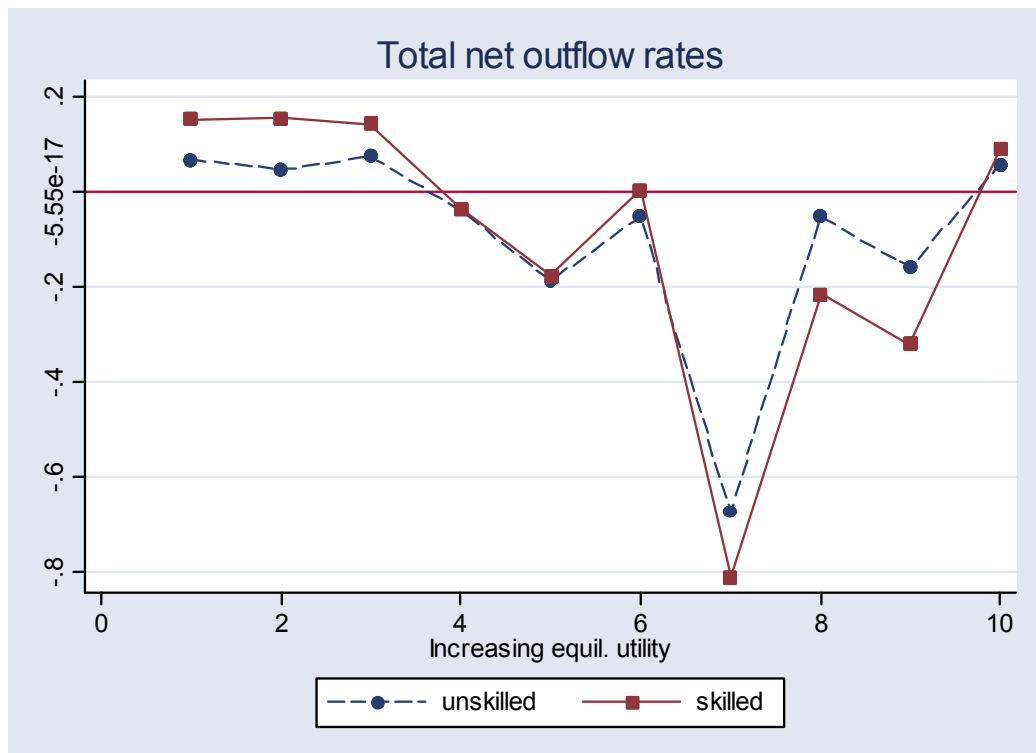


Figure 12a

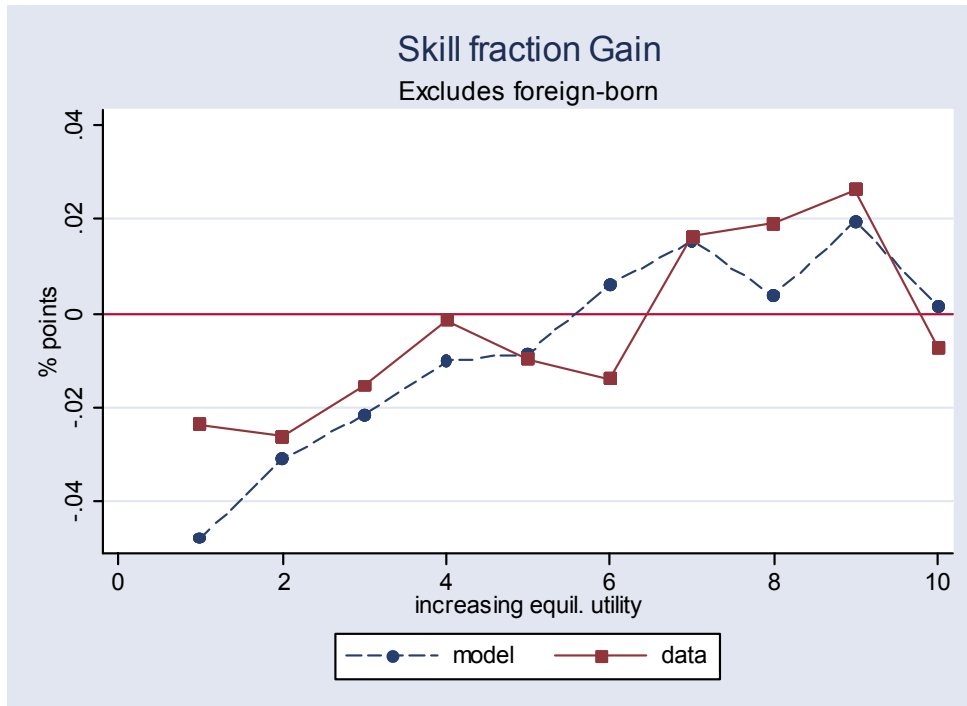


Figure 12b

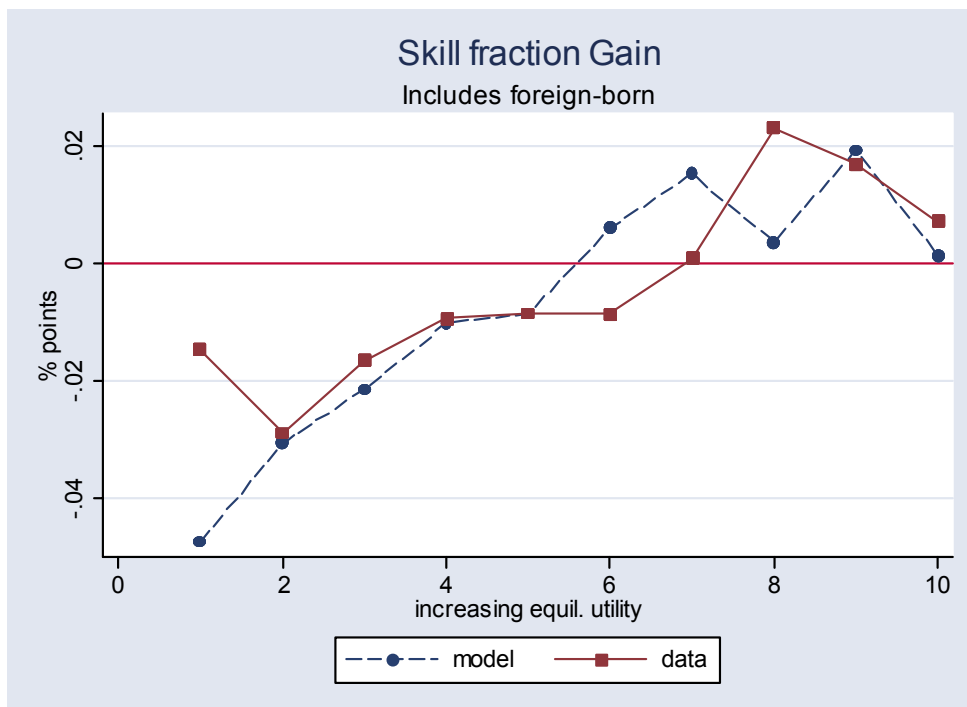


Figure 13

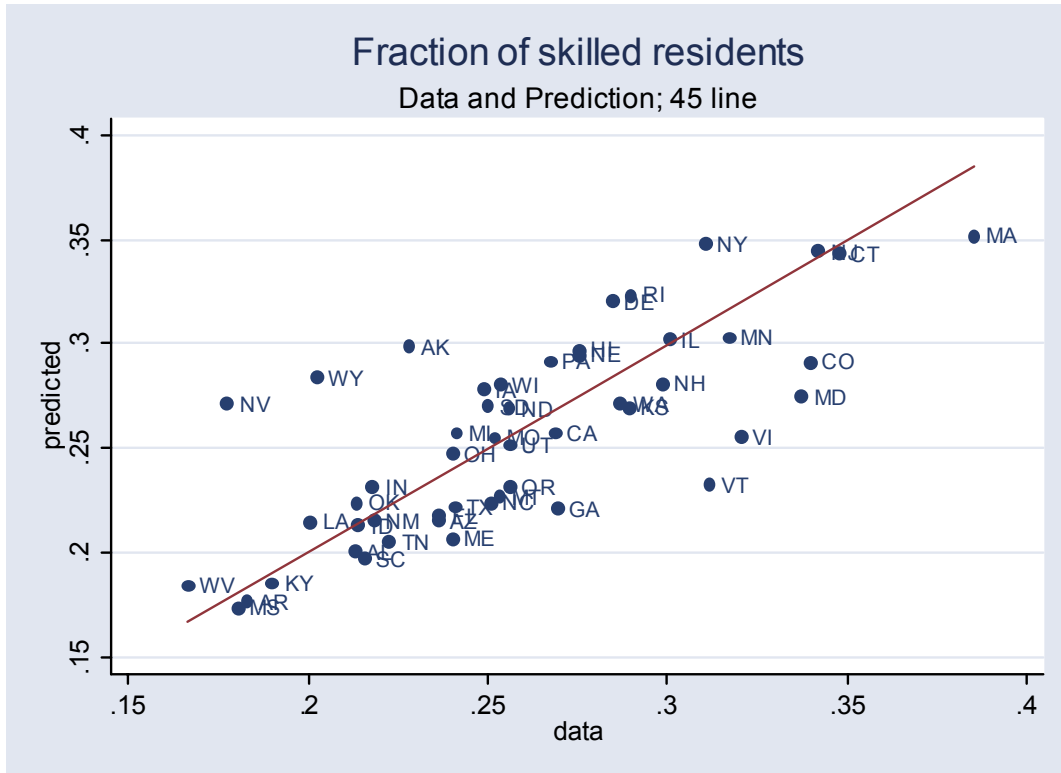


Figure 14

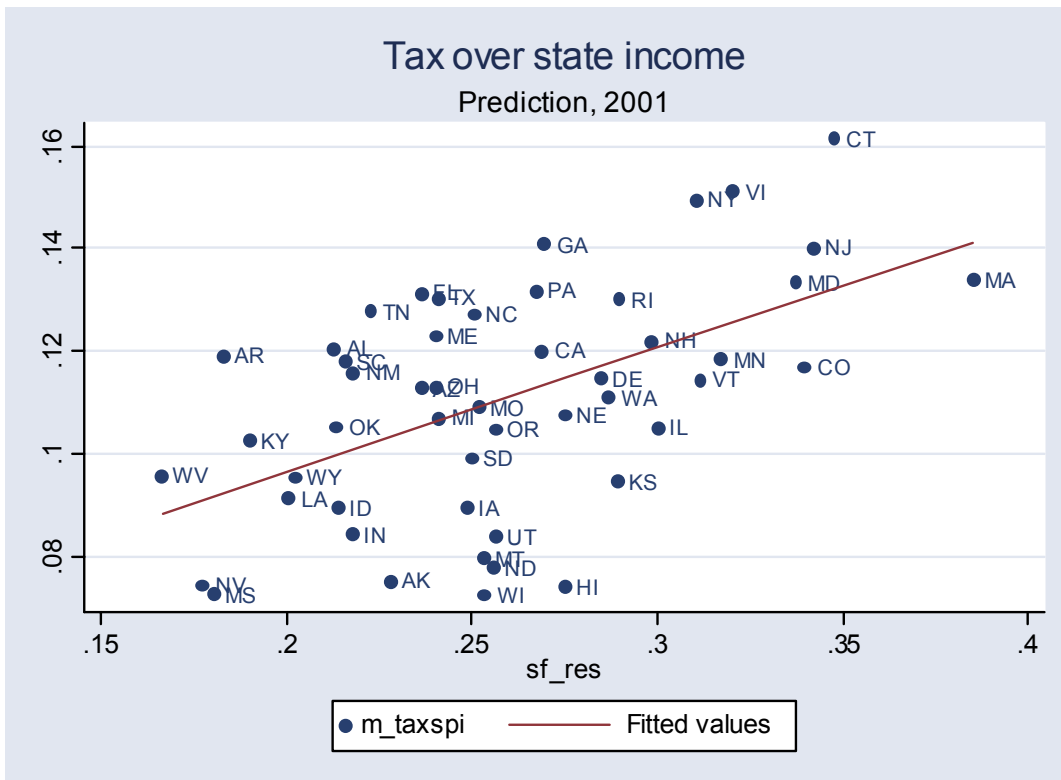


Figure 15

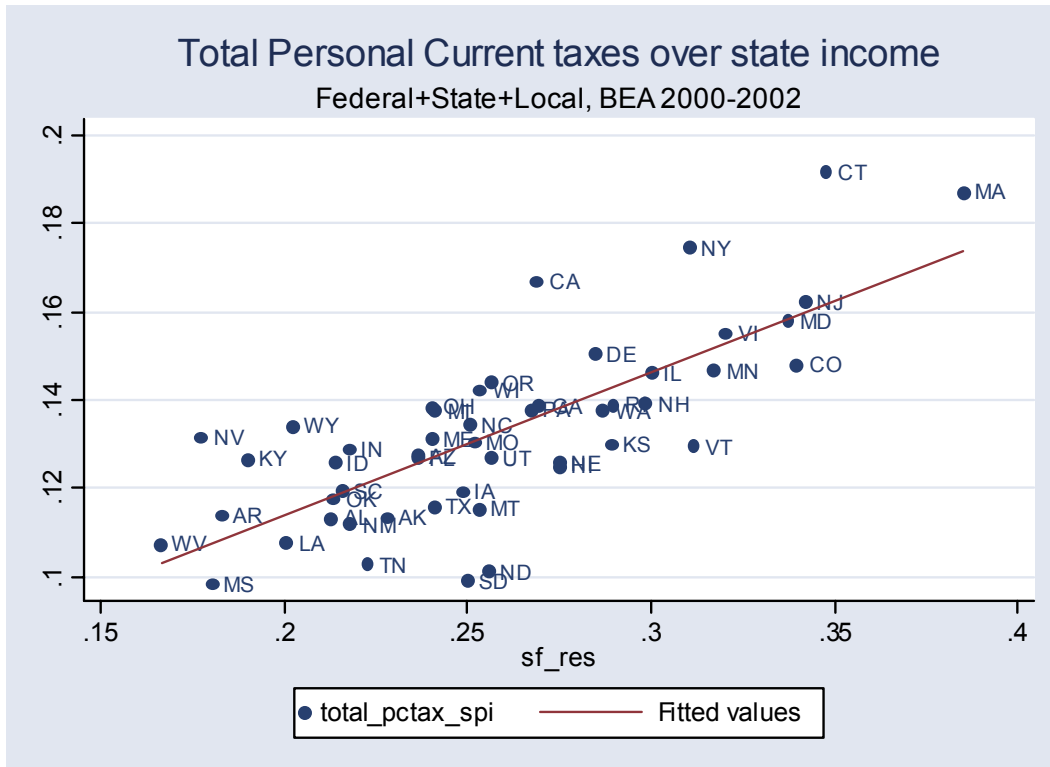


Figure 16

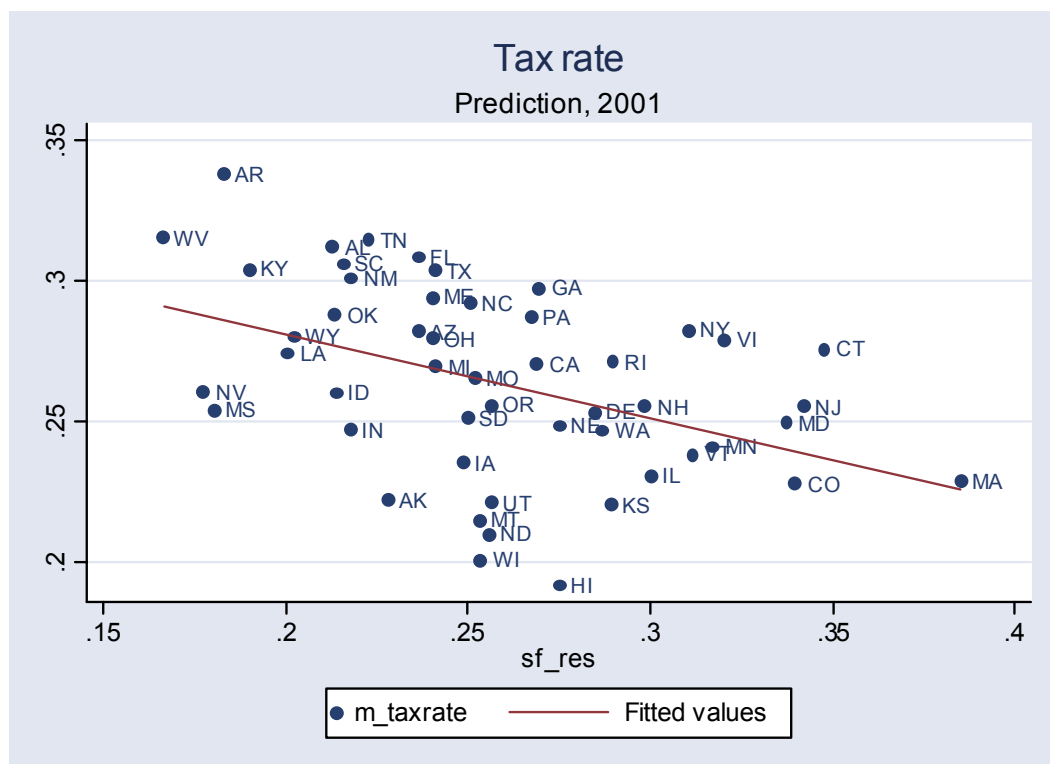


Figure 17

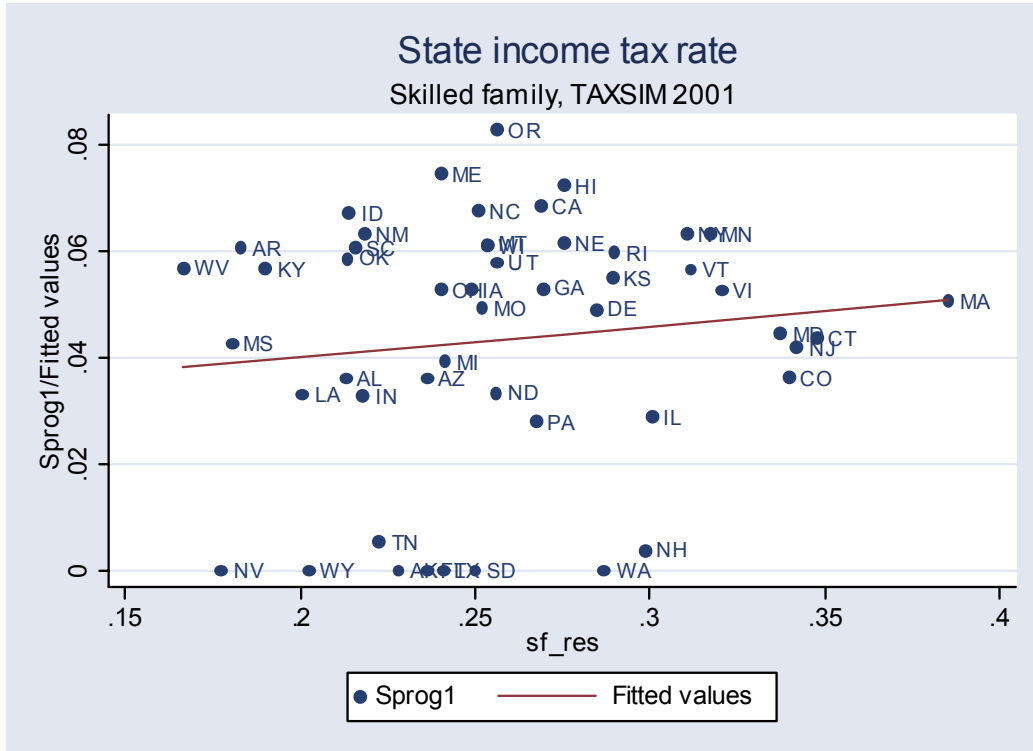


Figure 18

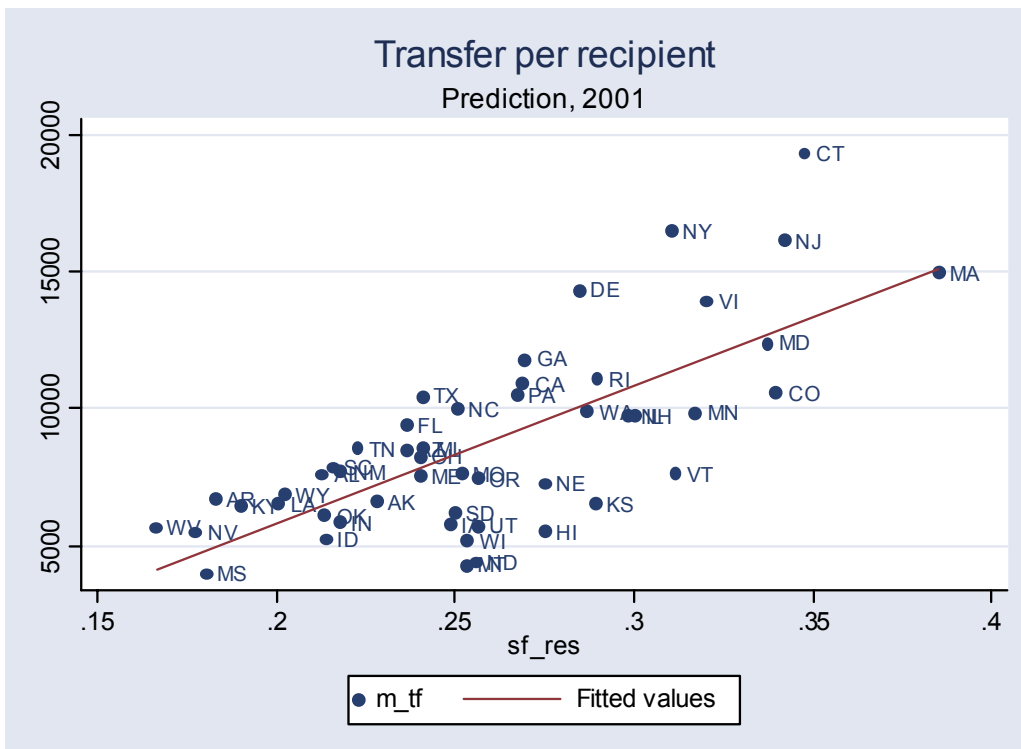


Figure 19

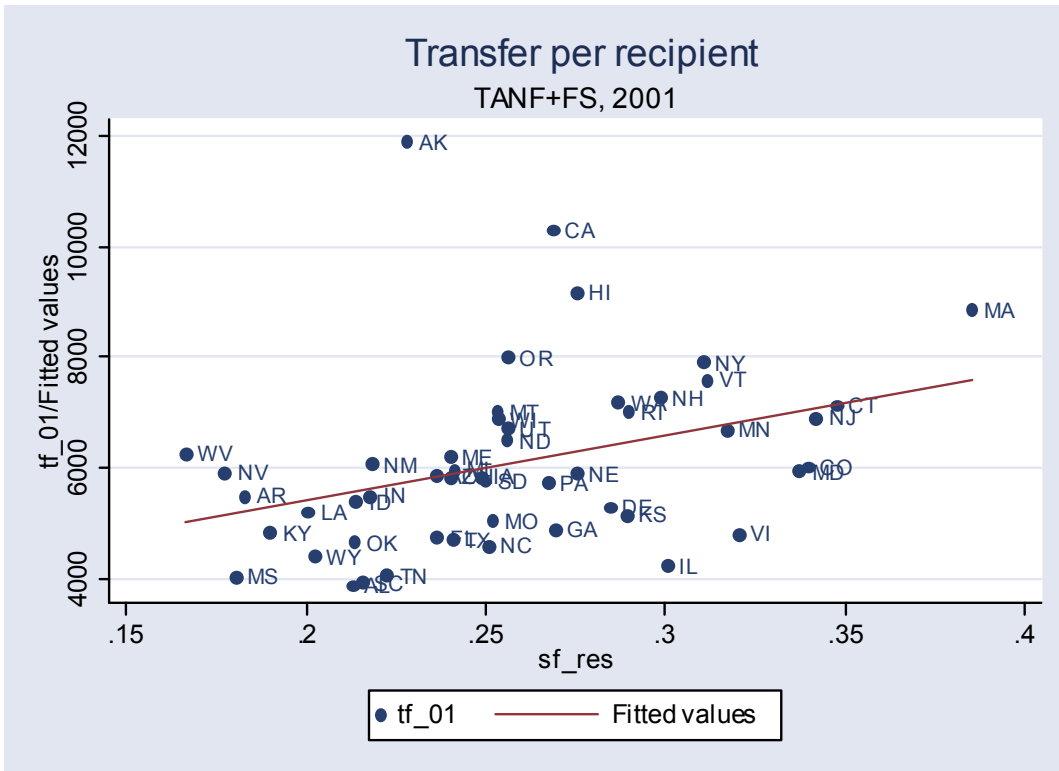


Figure 20

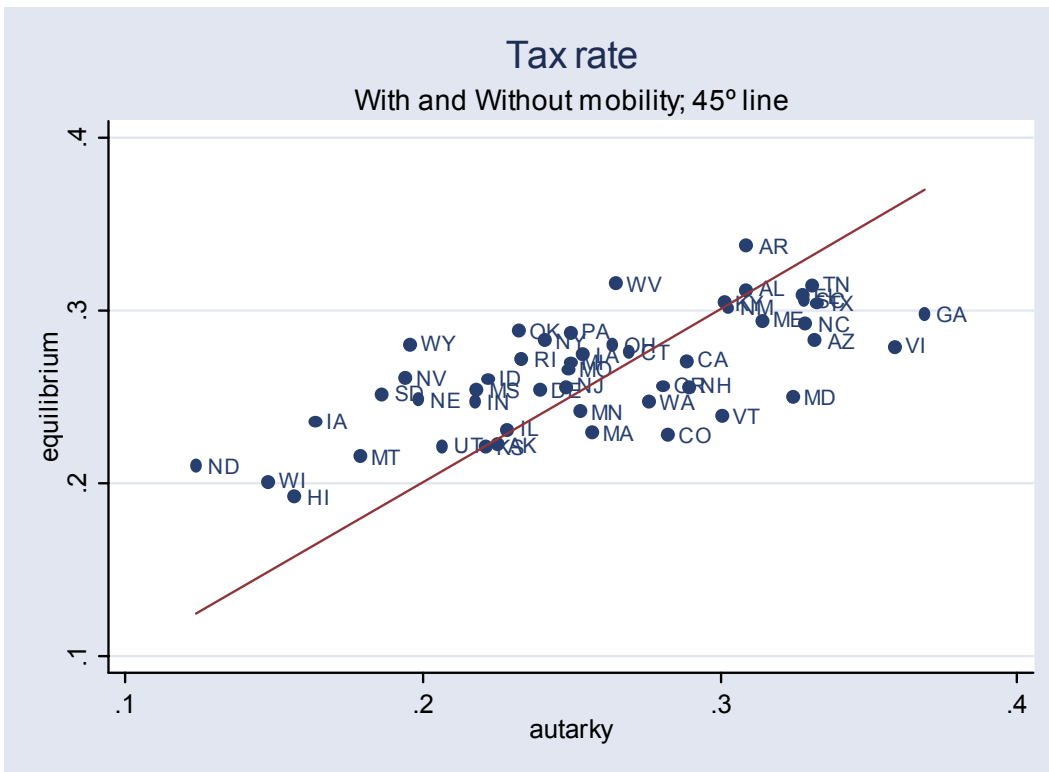




Figure 21

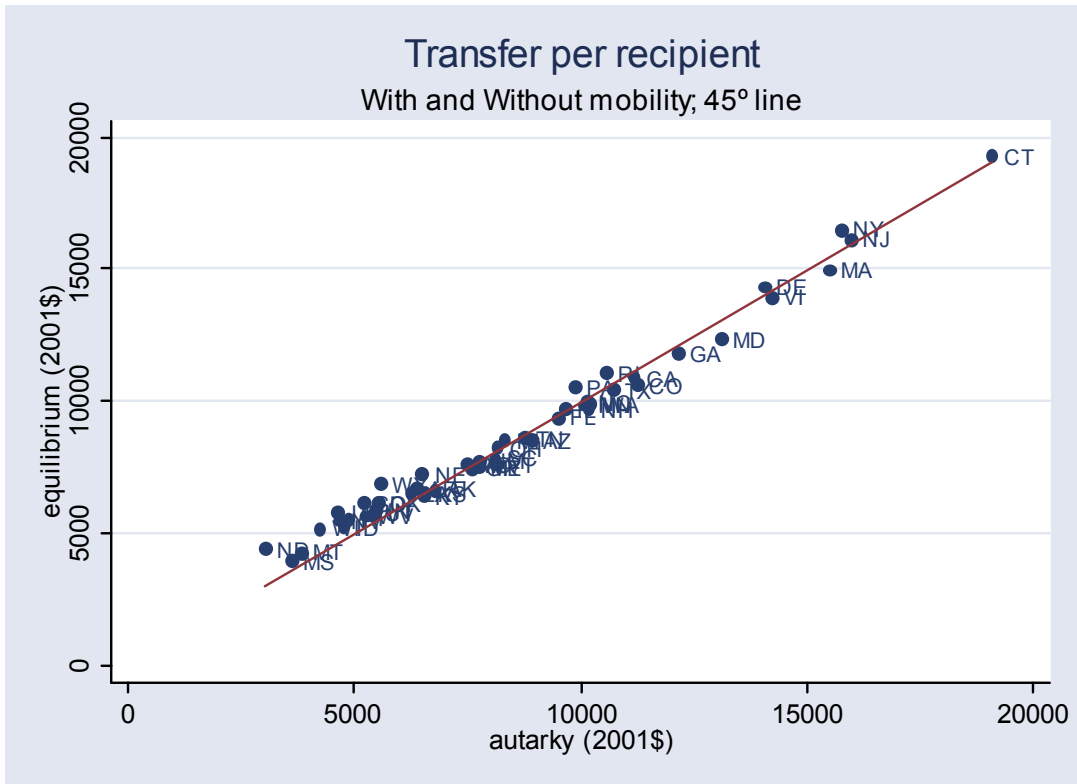


Figure 22

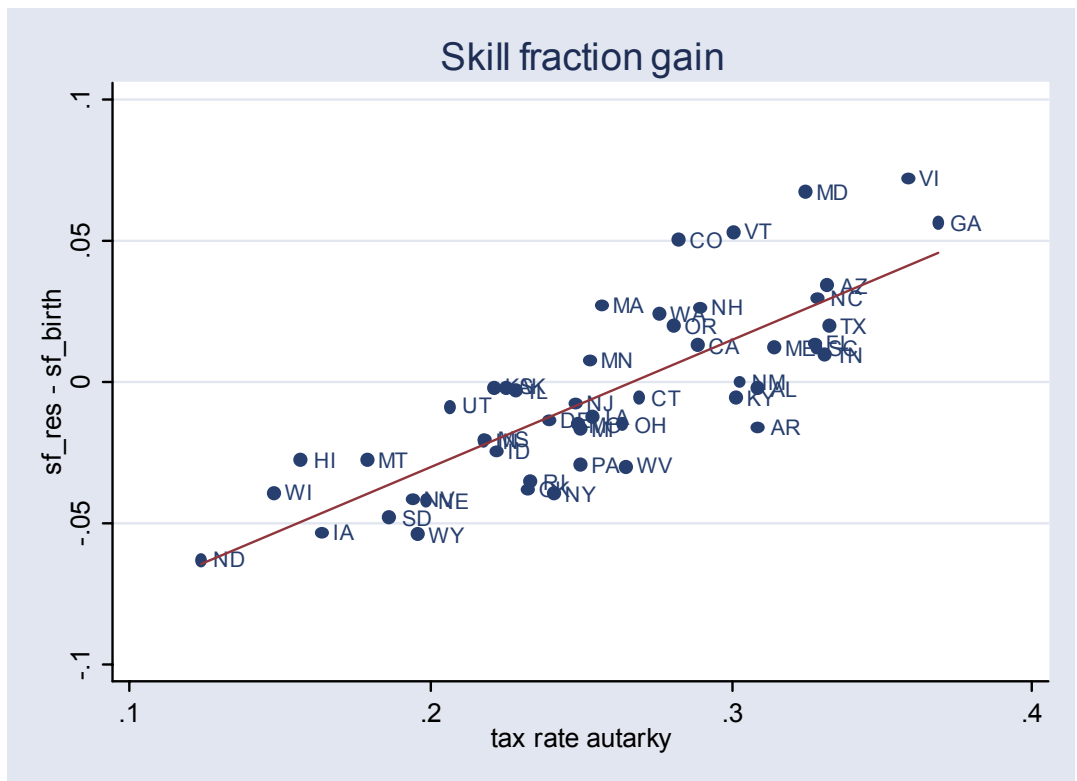


Figure 23

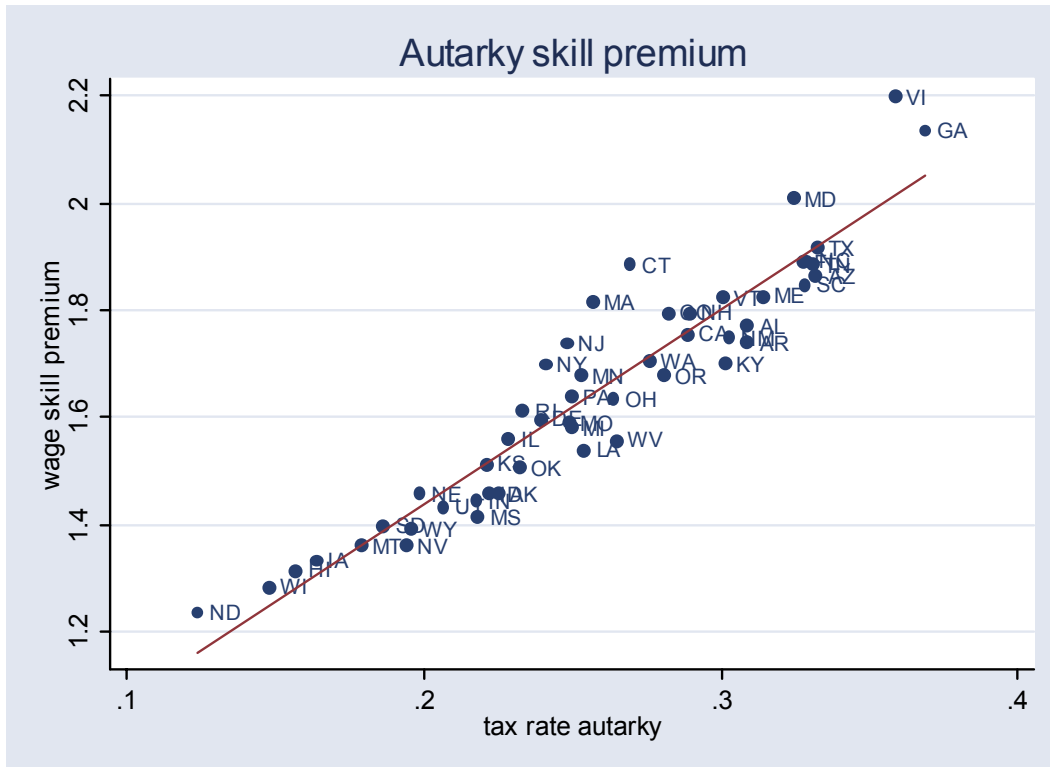


Figure 24

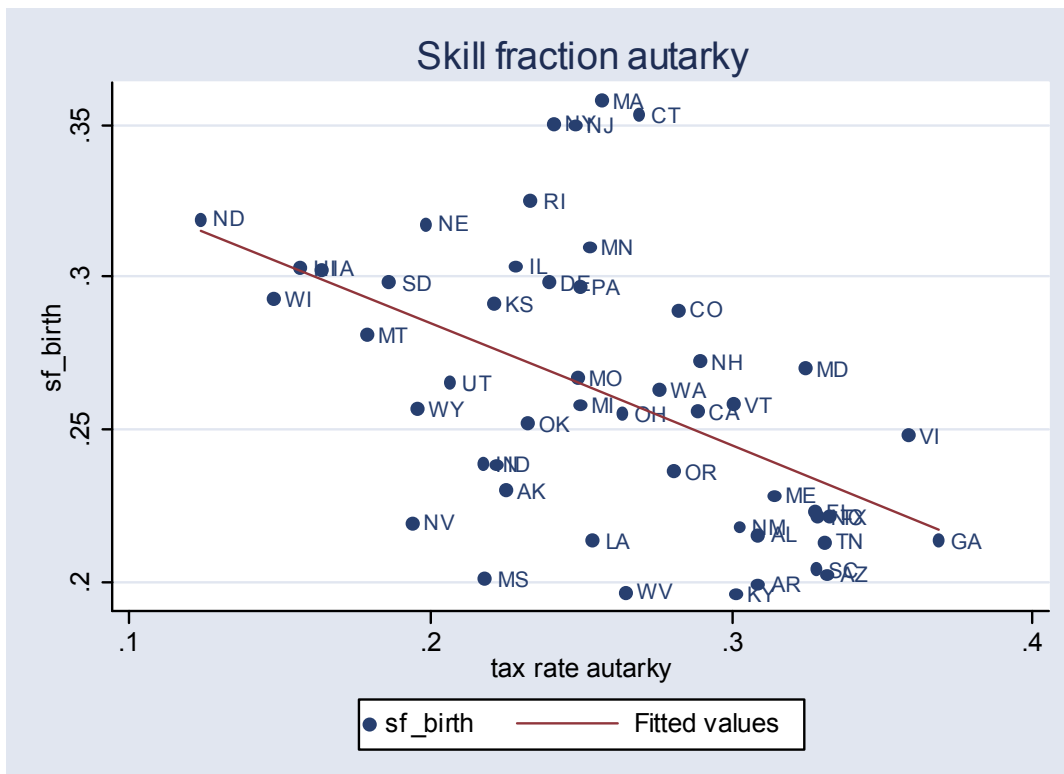


Figure 25

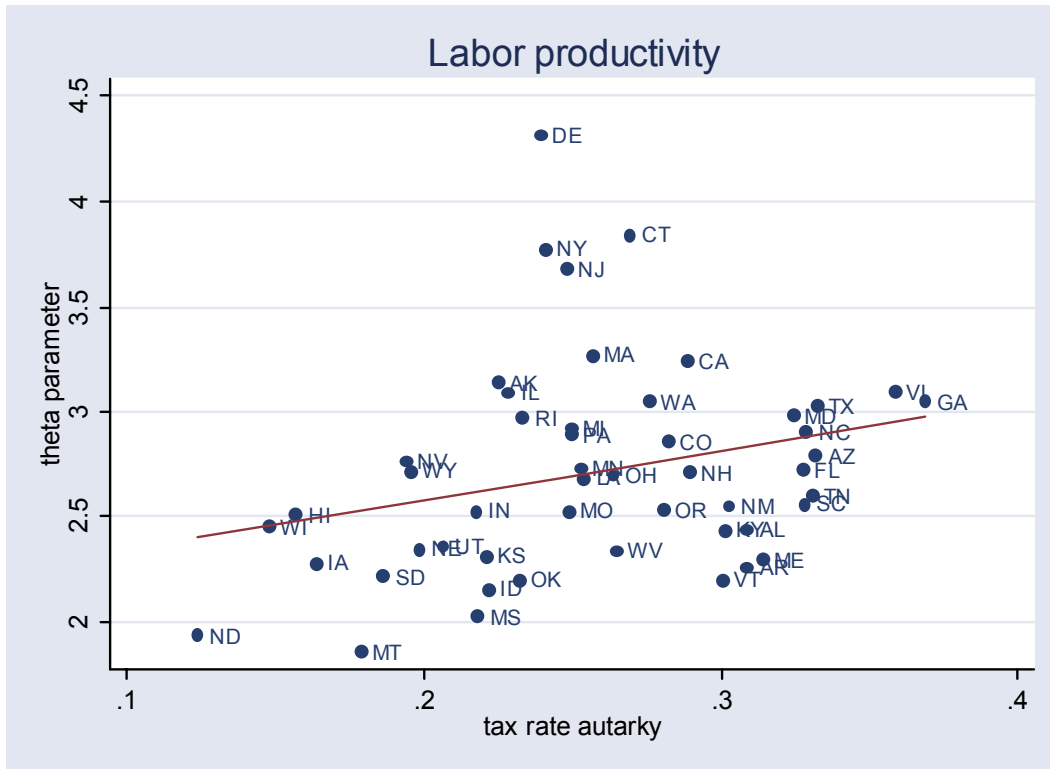


Table 1

[1] Fraction of skilled in state-born population. [2] Fraction of skilled in state-resident population in 2000. [3] Fraction of foreign born living in the state in 2000. [4] Fraction of skilled in state-resident population in 2000, excluding foreign-born individuals. [5] Skill premium. [6] Output per worker. [7] Probability of out-migration for unskilled workers. [8] Probability of out-migration for skilled workers.

Source: 2000 US Census and BEA regional accounts.

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
State	sf_birth	sf_res	fb	sfres_nofb	skp2000	workerprod	p_out_u	p_out_s
Alabama	0.22	0.21	0.04	0.26	1.78	49430	0.30	0.46
Alaska	0.23	0.23	0.10	0.29	1.45	68116	0.57	0.79
Arizona	0.20	0.24	0.20	0.34	1.69	57496	0.37	0.56
Arkansas	0.20	0.18	0.05	0.22	1.84	45759	0.37	0.50
California	0.26	0.27	0.39	0.43	1.69	66336	0.32	0.35
Colorado	0.29	0.34	0.13	0.54	1.61	59796	0.42	0.53
Connecticut	0.35	0.35	0.15	0.54	1.91	77903	0.36	0.54
Delaware	0.30	0.28	0.09	0.38	1.64	89223	0.38	0.65
Florida	0.22	0.24	0.23	0.31	1.82	54528	0.34	0.50
Georgia	0.21	0.27	0.11	0.36	1.84	61028	0.26	0.41
Hawaii	0.30	0.28	0.25	0.40	1.40	54382	0.43	0.56
Idaho	0.24	0.21	0.09	0.28	1.56	45964	0.48	0.66
Illinois	0.30	0.30	0.18	0.45	1.57	64692	0.36	0.47
Indiana	0.24	0.22	0.05	0.27	1.52	54210	0.31	0.52
Iowa	0.30	0.25	0.05	0.33	1.51	48475	0.38	0.61
Kansas	0.29	0.29	0.09	0.42	1.51	48929	0.46	0.58
Kentucky	0.20	0.19	0.03	0.23	1.71	50553	0.30	0.48
Louisiana	0.21	0.20	0.05	0.24	1.60	57098	0.29	0.47
Maine	0.23	0.24	0.04	0.31	1.76	46559	0.34	0.56
Maryland	0.27	0.34	0.15	0.48	1.72	61502	0.34	0.53
Massachusetts	0.36	0.39	0.17	0.63	1.71	68701	0.35	0.45
Michigan	0.26	0.24	0.07	0.30	1.64	60614	0.27	0.45
Minnesota	0.31	0.32	0.08	0.46	1.64	56658	0.27	0.42
Mississippi	0.20	0.18	0.03	0.22	1.50	44723	0.39	0.53
Missouri	0.27	0.25	0.05	0.33	1.64	52294	0.32	0.50
Montana	0.28	0.25	0.03	0.33	1.45	39994	0.49	0.65
Nebraska	0.32	0.28	0.07	0.39	1.60	48860	0.42	0.57
Nevada	0.22	0.18	0.24	0.24	1.53	60593	0.51	0.66
New Hampshire	0.27	0.30	0.06	0.41	1.68	55825	0.38	0.59
New jersey	0.35	0.34	0.25	0.51	1.77	75655	0.38	0.52
New Mexico	0.22	0.22	0.14	0.30	1.74	52063	0.45	0.64
New York	0.35	0.31	0.28	0.47	1.85	75983	0.37	0.52
North Carolina	0.22	0.25	0.09	0.33	1.76	58808	0.24	0.40
North Dakota	0.32	0.26	0.03	0.34	1.44	41880	0.51	0.68
Ohio	0.26	0.24	0.04	0.30	1.69	55446	0.29	0.48
Oklahoma	0.25	0.21	0.07	0.27	1.67	45739	0.35	0.53
Oregon	0.24	0.26	0.14	0.35	1.60	52932	0.38	0.51
Pennsylvania	0.30	0.27	0.06	0.35	1.77	58440	0.27	0.49
Rhode Island	0.33	0.29	0.16	0.44	1.74	60482	0.40	0.56
South Carolina	0.20	0.22	0.05	0.27	1.77	51983	0.28	0.46
South Dakota	0.30	0.25	0.03	0.33	1.57	46597	0.49	0.65

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
State	sf_birth	sf_res	fb	sfres_nofb	skp2000	workerprod	p_out_u	p_out_s
Tennessee	0.21	0.22	0.05	0.28	1.82	52108	0.28	0.45
Texas	0.22	0.24	0.22	0.34	1.81	60812	0.23	0.31
Utah	0.27	0.26	0.12	0.35	1.47	50592	0.32	0.47
Vermont	0.26	0.31	0.05	0.43	1.61	45755	0.39	0.65
Virginia	0.25	0.32	0.13	0.45	1.86	62449	0.34	0.54
Washington	0.26	0.29	0.16	0.40	1.61	63437	0.33	0.44
West Virginia	0.20	0.17	0.02	0.19	1.71	49270	0.44	0.62
Wisconsin	0.29	0.25	0.05	0.34	1.41	53346	0.24	0.47
Wyoming	0.26	0.20	0.05	0.25	1.62	57466	0.62	0.79
min	0.20	0.17	0.02	0.19	1.40	39994.00	0.23	0.31
mean	0.26	0.26	0.11	0.35	1.66	56429.68	0.37	0.53
max	0.36	0.39	0.39	0.63	1.91	89223.00	0.62	0.79
sdev	0.05	0.05	0.08	0.09	0.13	9782.51	0.09	0.10

Table 2

[1] Decile by (increasing) equilibrium utility. [2] State. [3] Ranking by utility. [4] Ranking by amenity-corrected utility. [5] Rough measure of relative amenity.

[1]	[2]	[3]	[4]	[5]
utility decile	state	rank_U	rank_A	[6]=[5]-[4]
1	Montana	1	25	24
1	North Dakota	2	1	-1
1	Mississippi	3	10	7
1	Oklahoma	4	36	32
1	Vermont	5	21	16
2	Idaho	6	40	34
2	Arkansas	7	32	25
2	South Dakota	8	7	-1
2	Maine	9	16	7
2	Iowa	10	6	-4
3	Kansas	11	22	11
3	Nebraska	12	15	3
3	West Virginia	13	5	-8
3	Alabama	14	28	14
3	Utah	15	35	20
4	Kentucky	16	23	7
4	South Carolina	17	37	20
4	New Mexico	18	31	13
4	Missouri	19	26	7
4	Tennessee	20	38	18
5	Oregon	21	47	26
5	Wisconsin	22	17	-5
5	Indiana	23	13	-10
5	Hawaii	24	24	0
5	Florida	25	43	18
6	Ohio	26	9	-17
6	New Hampshire	27	29	2
6	Minnesota	28	20	-8
6	Louisiana	29	19	-10
6	Wyoming	30	27	-3
7	Arizona	31	49	18
7	Pennsylvania	32	3	-29
7	North Carolina	33	39	6
7	Colorado	34	44	10
7	Nevada	35	50	15
8	Michigan	36	12	-24
8	Rhode Island	37	8	-29
8	Texas	38	41	3
8	Georgia	39	48	9
8	Maryland	40	33	-7
9	Virginia	41	42	1
9	Washington	42	45	3
9	Illinois	43	11	-32
9	California	44	34	-10
9	Alaska	45	46	1

[1] utility decile	[2] state	[3] rank_U	[4] rank_A	[5] [6]=[5]-[4]
10	Massachusetts	46	18	-28
10	New jersey	47	4	-43
10	New York	48	2	-46
10	Connecticut	49	14	-35
10	Delaware	50	30	-20

Table 3a

<b>Data</b>	mean	st.dev.	min.	max.
Total personal current tax / State Income	0.13	0.02	0.10	0.19
State and local taxes plus property tax/ State Income	0.03	0.01	0.00	0.05
Average income tax rate skilled family (TAXSIM)	0.27	0.02	0.23	0.30
Redistributive transfer (TANF+FS)	\$ 6,099	\$ 1,608	\$ 3,879	\$ 11,877

Table 3b

<b>Equilibrium</b>	mean	st.dev.	min.	max.
Taxes/State Income	0.11	0.02	0.07	0.16
Tax rate on skilled workers	0.26	0.03	0.19	0.34
Transfer per recipient	\$ 8,686	\$ 3,404	\$ 3,956	\$ 19,288
<b>Autarky</b>				
Tax rate on skilled workers	0.26	0.06	0.12	0.37
Transfer per recipient	\$ 8,544	\$ 3,624	\$ 3,038	\$ 19,084

Table 4: Cross-section of tax rates with worker mobility and without (autarky).

	<b>Autarky</b>	<b>Mobility</b>
min	0.1236	0.1921
mean	0.2576	0.2642
max	0.3688	0.3375
range	0.2452	0.1454
sdev	0.0572	0.0332