Does competition for (human) capital discipline governments? The role of commitment

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Abstract

We argue that labor mobility does not lead to a "race to the bottom," where countries drastically cut redistributive transfers in order to attract skilled workers. The basis of our argument is that these cuts are not credible policies. We propose a two country model where competition for mobile factors is limited to credible policies. Both countries end up with positive redistribution, and the country with a technological advantage can sustain more redistribution. The model can address the interaction of redistribution and migration policies. In particular, we show that when countries have similar skill endowments but different technologies, migration policies enabling unskilled labor mobility lead to higher global welfare than policies enabling skilled labor mobility.

1 Introduction

Does increased labor mobility lead to lower redistributive transfers? It is often argued that this is the case. Countries (regions) compete to attract skilled workers by scaling down income redistribution. In equilibrium, all countries end up dismantling their redistributive policies, yet fail to attract skilled workers in significant numbers.

We argue that skilled labor mobility does not lead to such a "race to the bottom" in redistributive policies. Our argument builds on countries lacking the ability to commit to cuts in redistributive transfers. We formalize our argument using a two-country model where redistributive policies are chosen by each country's benevolent government. Importantly, we allow for technological differences across countries and do not exogenously restrict the set of available fiscal instruments. Our benchmark case features perfect skilled labor mobility.

When countries have the ability to commit to policies, we show a "race to the bottom" arises. When competition is limited to credible policies, we find that both countries end up with positive redistribution, and that the country with technological advantage can sustain more redistribution.

We also study the effects of mobility-enhancing policies under no-commitment. When countries have similar initial skill distributions but different technologies, migration policies enabling unskilled labor mobility lead to higher global welfare than policies enabling skilled labor mobility.

Finally, our results suggest a minor role for fiscal policy coordination than it has been argued. The lack of commitment is an effective restraint on policy competition.

The structure of the paper is as follows. Section 2 describes the model. Section 3 examines optimal redistribution in the autarky case, that is for a given worker distribution. Section 4 studies equilibrium redistribution when governments have the ability to commit to policies, which formalizes the race-to-the-bottom argument. Section 5 analyzes the no-commitment model. Section 6 studies the no-commitment equilibrium under alternative assumptions on mobility and section 7 concludes.

2 The Economy

We consider a world economy consisting of two countries $J = A, B$. In each country J, there are two types of workers: unskilled and skilled, denoted by subscripts $i = 1$ and $i = 2$, respectively. Each country J starts with a measure e_i^J of workers of each type. After all migration decisions have been made, the measure of workers of type i in country J is denoted n_i^J.

Definition 1 *A workers' distribution* $(n_1^A, n_2^A, n_1^B, n_2^B)$ *is feasible if*

$$n_i^A + n_i^B = e_i^A + e_i^B$$

for $i = 1, 2$ *and* $n_i^J \geq 0$ *for all* $J = A, B$ *and* $i = 1, 2$.

Of course, the initial workers' distribution $\left(e_1^A, e_2^A, e_1^B, e_2^B\right)$ is assumed to be feasible as well.

Let non-negative vector $x^J = \left(c_1^J, c_2^J, l_1^J, l_2^J\right)$ denote an allocation for country J and let $X = (x^A, x^B)$ be a world allocation. We also define $x_i^J = \left(c_i^J, l_i^J\right)$. We assume that the preferences of workers of both types are represented by utility function $U(c_i, l_i)$, where c_i are units of final good and l_i are hours worked. To save on notation we shall often write $U(x_i)$. Utility function $U(c_i, l_i)$ is assumed to be differentiable, strictly concave, and with $U_c > 0$, $U_l < 0$, $U_{cc} < 0$, and $U_{ll} < 0$. We also assume that consumption and leisure are complements: $U_{cl} \leq 0$.[1] Under these assumptions, indifference curves in the (l, c) space are increasing and strictly convex.

[1]This is a mild assumption, satisfied by the the whole family of CES utility functions. The quantitative literature in macroeconomics usually employs transformations of the Cobb-Douglas utility function that satisfy this condition. Empirical studies of labor supply commonly assume addivitely separable utility functions (MaCurdy, JPE, 1981), that is, $U(c, l) = u(c) + v(\bar{l} - l)$, where $u' > 0$, $u'' \leq 0$, $v' > 0$, $v'' > 0$, and $\bar{l} > 0$.

Unskilled and skilled labor are differentiated inputs in the production process. We assume that unskilled workers can only supply unskilled labor: they are not qualified to perform certain tasks. Skilled workers, though, can supply both skilled and unskilled labor. Throughout the paper, we restrict our attention to economies where no skilled worker passes off as unskilled in equilibrium, which limits the ability of the government to redistribute income.

Country J's production is given by $F^J\left(L_1^J, L_2^J\right)$, where $L_i^J = n_i^J l_i^J$ denotes the aggregate supply of type i labor. We assume production function F^J is differentiable, constant returns to scale, strictly concave, and satisfies $F_{12}^J > 0$ as well as appropriate Inada conditions.

We are now set to define feasible allocations.

Definition 2 *An allocation* $x^J = \left(c_1^J, c_2^J, l_1^J, l_2^J\right)$ *is feasible given* $\left(n_1^J, n_2^J\right)$ *if*

$$n_1^J c_1^J + n_2^J c_2^J \leq F^J\left(n_1^J l_1^J, n_2^J l_2^J\right)$$

and non-negativity constraints.

We want to think of skilled labor as the input with higher marginal product. To guarantee this, we shall assume that skilled workers are relatively scarce. More precisely, we set skilled-to-unskilled ratio $\bar{\eta}^J$, defined by

$$F_1^J\left(1, \bar{\eta}^J\right) = F_2^J\left(1, \bar{\eta}^J\right)$$

for $J = A, B$, as the upper bound for $\eta = n_2/n_1$.[2] As we show later, when η^J is below $\bar{\eta}^J$, there is a positive skill premium, that is, $F_2^J\left(n_1^J l_1^J, n_2^J l_2^J\right) > F_1^J\left(n_1^J l_1^J, n_2^J l_2^J\right)$.

3 Optimal Redistribution in a Closed Economy

We start by studying the problem of optimal redistribution in a country for a given distribution of workers. For notational convenience, we drop the superscripts indexing each country.

We do not impose any ex-ante constraint in the design of the tax system. Hence, we allow for non-linear tax schedules and, in particular, for progressive income taxation. However, we assume the worker's types are unobservable: the tax schedule is only function of the worker's actions. This limits the scope of redistribution. Since skilled workers can perform unskilled tasks, a very aggressive redistribution policy will lead skilled workers to pass off as unskilled and to an inefficient resource allocation.

We state the optimal redistribution policy problem as a classic Mirrlees direct taxation problem (Mirrlees, 1977). Rather than dealing with a highly-dimensional function space, the Mirrlees approach reduces the problem to choosing feasible allocations subject to a set of incentive compatibility constraints.

[2] Existence and uniqueness of $\bar{\eta}^J$ is guaranteed under assumptions $F_2(1,0) > F_1(1,0)$ and $F_2(1,k) < F_1(1,k)$ for some $k > 0$.

These constraints ensure that all workers truthfully reveal their type. In our case, only skilled workers can mislead the government. Hence, the only incentive compatibility constraint states that a skilled worker is not worse off than an unskilled worker. We show later how to decentralize these allocations as competitive equilibria with taxes. We restrict to allocations that treat workers of the same skill type identically, regardless of whether they were born in the country or not.

Definition 3 *An allocation $x = (c_1, l_1, c_2, l_2)$ 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

$$U(c_1, l_1) \leq U(c_2, l_2),$$
$$n_1 c_1 + n_2 c_2 \leq F(n_1 l_1, n_2 l_2).$$

and non-negativity constraints for x.

We can re-write the second best problem in terms of the ratio of skilled to unskilled workers $\eta \equiv \frac{n_2}{n_1}$. 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.

Problem (SBP) is quite tractable. The next proposition states we can use the first order conditions to characterize the solution.

Proposition 4 *The necessary first order conditions associated with (SBP),*

$$(1-\mu) U_c(c_1, l_1) = \lambda \tag{1}$$
$$(1-\mu) U_l(c_1, l_1) = -\lambda F_1(l_1, \eta l_2) \tag{2}$$
$$(\eta+\mu) U_c(c_2, l_2) = \lambda \eta \tag{3}$$
$$(\eta+\mu) U_l(c_2, l_2) = -\lambda \eta F_2(l_1, \eta l_2) \tag{4}$$
$$\lambda \left[c_1 + \eta c_2 - F(l_1, \eta l_2)\right] = 0 \tag{5}$$
$$\mu \left[U(c_1, l_1) - U(c_2, l_2)\right] = 0, \tag{6}$$

are also sufficient to characterize second best allocations.

Proof. Consider the alternative program

$$\max_{u_1,u_2,x} u_1 + \eta u_2 \tag{7}$$

subject to

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

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 (7). Any solution $\{u_1, u_2, x\}$ to (7) satisfies $u_1 = U(x_1)$ and $u_2 = U(x_2)$, as we argue next. Suppose, on the contrary, that x solves (7) but $u_1 < U(c_1, l_1)$ and $u_2 = U(c_2, l_2)$. Construct now an alternative allocation with the same labor times but $u_1 = U(c_1', l_1)$, with $c_1' = c_1 - \varepsilon$, $c_2' = c_2 + \varepsilon/\eta$, and $u_2' = U(c_2', l_2)$. Observe that allocation $x' = (c_1', c_2', l_1, l_2)$ satisfies the resource constraint 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 (7).

The program (7) 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 (7).

Let x be an allocation satisfying (1)-(6). It is straightforward to show that there exist α, β_1, β_2, ϕ, u_1 and u_2 such that allocations x also satisfies the necessary and sufficient conditions for (7). Hence x is a solution to (7). Given that at the optimum of this problem $u_i = U(x_i)$, it follows that x is a second best allocation as well ■

3.1 First Best Allocation

We are interested in comparing the second best allocation to the allocation solving the optimal redistribution policy in the case of complete information, or first best allocation.

Definition 5 *Given η, we say that an allocation $x = (c_1, c_2, l_1, l_2)$ is first best if it solves*

$$\max_x U(c_1, l_1) + \eta U(c_2, l_2) \tag{FBP}$$

subject to (RC) and non-negativity constraints for x.

Problem FBP is a standard concave program over a convex set. It follows that the first order conditions are necessary and sufficient. These are

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

Not surprisingly, in the first best allocation the marginal utility of consumption is equalized across worker types. In addition, the marginal rate of substitution between labor and consumption for each type of worker is equalized to the corresponding marginal product of labor:

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

where $MRS_i = -\frac{U_l(c_i, l_i)}{U_c(c_i, l_i)}$.

In terms of welfare, we have the following result.

Proposition 6 *Let $\eta < \bar{\eta}$. At the first best allocation, unskilled workers enjoy higher welfare than skilled workers:*

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

Proof. Assume x is a first best allocation with $U(c_1, l_1) \leq U(c_2, l_2)$. Consider first the case $l_2 > l_1$. Then $U(c_1, l_1) \leq U(c_2, l_2)$ implies $c_2 > c_1$. Using the properties of U,

$$U_c(c_1, l_1) \geq U_c(c_2, l_1) > U_c(c_2, l_2)$$

which contradicts x being a first best allocation as it does not satisfy the necessary first order conditions.

Consider now the case $l_1 = l_2$. Necessary first order conditions $U_c(c_1, l_1) = \lambda$ and $U_c(c_2, l_2) = \lambda$ imply $c_1 = c_2$. But since $F_1(1, \eta) < F_2(1, \eta)$, necessary first order conditions also require $-\frac{U_l(c_1, l_1)}{U_c(c_1, l_1)} < -\frac{U_l(c_2, l_2)}{U_c(c_2, l_2)}$. Hence x is not first best.

Finally, consider the case $l_1 > l_2$. First order conditions $U_c(c_1, l_1) = U_c(c_2, l_2)$ implies $c_1 < c_2$. Hence, $U(x_1) < U(x_2)$. Strict concavity of preferences implies that

$$\frac{1}{1+\eta} U(x_1) + \frac{\eta}{1+\eta} U(x_2) < U\left(\frac{1}{1+\eta} x_1 + \frac{\eta}{1+\eta} x_2\right).$$

We next show that allocation $\tilde{x}$, given by

$$\tilde{x}_1 = \tilde{x}_2 = \frac{1}{1+\eta}x_1 + \frac{\eta}{1+\eta}x_2$$

is feasible. By construction, $c_1 + \eta c_2 = \tilde{c}_1 + \eta \tilde{c}_2$. Hence $\tilde{x}$ will be feasible if

$$F\left(l_1, \eta l_2\right) \leq F(1,\eta)\frac{l_1 + \eta l_2}{1+\eta}.$$

Rearranging this expression yields

$$\frac{F\left(1, \eta \frac{l_2}{l_1}\right)}{1+\eta \frac{l_2}{l_1}} \leq \frac{F(1,\eta)}{1+\eta}.$$

This inequality holds since $\frac{l_2}{l_1} < 1$ and output per worker, $\frac{F(1,\eta)}{1+\eta}$, is an increasing function of η for $\eta < \overline{\eta}$.

Thus, allocation $\tilde{x}$ is feasible and strictly preferred to x. Hence, x is not first best ■

Interestingly, the first best allocation may not equate the utilities of both types of workers, despite the equalization of marginal utilites of consumption. Since skilled labor is more productive, skilled workers enjoy less leisure and end up being worse off.[3]

3.2 Properties of the Second Best Allocations

The first important question about second best allocations is whether they are any different from the first best allocations. In other words, does the incentive constraint (IC) bind? Our first important result states that it does.

Proposition 7 *Let $\eta < \bar{\eta}$. Then for any second best allocation, the incentive compatibility constraint (IC) is binding*

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

Moreover, (c_i, l_i) is a continuous function of η, for $i = 1, 2$.

Proof. Assume otherwise. Then the necessary first order conditions for the first and second best allocations coincide. By the sufficiency of both sets of conditions, it implies second best allocations are first best as well. But then Proposition 6 implies $U\left(c_1, l_1\right) > U\left(c_2, l_2\right)$, violating the incentive compatibility constraint

Having shown that the incentive constraint binds, continuity of (c_1, l_1, c_2, l_2) as a function of η is a direct application of the implicit function theorem. ■

[3] When utility is additive, equal marginal utilities of consumption do imply equal levels of consumption.

The result follows easily from the sufficiency of the first order conditions for first best allocations and Proposition 6. Equipped with proposition **??**, we can describe the second best allocation in greater detail. First, we confirm that there is a positive skill premium, i.e., the marginal product of a skilled worker is higher than that of an unskilled worker. Second, skilled workers work more than unskilled ones, and are "compensated" with higher consumption.

Proposition 8 *Let $\eta < \bar{\eta}$. Then in any second best allocation*

1. *There is a strictly positive skill premium.*
2. *Skilled workers consume more, $c_2 > c_1$, and supply more labor, $l_2 > l_1$, than unskilled workers.*

Proof. We first prove part 1. 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 that $c_2 > c_1$. 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 (1)-(6). To see this, use (1)-(4) to derive $MRS_1 = F_1$ and $MRS_2 = F_2$, and note that $MRS_2 > MRS_1$ implies that $F_2 > F_1$, contradicting our initial hypothesis.

Let us now prove the second part. As we know, $\eta < \bar{\eta}$ implies that $F_2 > F_1$. 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 $(c_2, l_2) >> (c_1, l_1)$ ■

Naturally, when skilled labor is no longer scarce, $\eta = \bar{\eta}$, both types of workers are treated symmetrically in the second best allocation.

Corollary 9 *When $\eta = \bar{\eta}$, the first and second best allocations coincide.*

Next, we explore how changes in a country's skill distribution affect its redistributive policies. The next proposition plays an important role in our analysis of labor mobility equilibria.

Proposition 10 *Let $\eta < \eta' < \bar{\eta}$ and let x and x' be second best allocations under η and η', respectively. Then*

$$U(c_2, l_2) < U(c_2', l_2'),$$
$$U(c_1, l_1) < U(c_1', l_1').$$

Proof. 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 $MRS\left(c_2,l_2\right)=F_2\left(l_1,\eta l_2\right)$ and preferences are strictly concave, for any $(c,l)\in A$, $U\left(c,l\right)\leq U\left(c_2,l_2\right)$, with strict equality sign iff $c=c_2$ and $l=l_2$. Therefore $\left(c_1,l_1\right)\notin A$ since the incentive compatibility constraint is binding and $l_1\neq l_2$. This implies

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

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

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

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

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

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

We next show that second best allocation x is feasible at η'. Note that

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

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

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

Since the resource constraint is binding

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

or

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

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

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

It comes as no surprise that unskilled workers are better off when skilled workers enter the country, given that the two types of labor are complementary in production.

However, skilled workers are better off too. The reason is that a higher ratio of skilled workers reduces the burden of redistribution in two ways: the entry of scarce skilled workers reduces the skill premium gap and increases the tax base, since these are workers with above average income.

The next result shows that improvements in technology increase welfare for both types of workers.

Proposition 11 *Suppose $F^A(L_1,L_2)>F^B(L_1,L_2)$ for all (L_1,L_2). For any skilled-to-unskilled ratio $\eta<\bar{\eta}$, define the second-best allocations under each production function by x^A and x^B. Then*

$$U\left(c_1^A,l_1^A\right)=U\left(c_2^A,l_2^A\right)<U\left(c_1^B,l_1^B\right)=U\left(c_2^B,l_2^B\right).$$

3.3 Decentralization

In this subsection we show that the first and second best allocations can be decentralized into a competitive equilibrium with lump sum taxation. As first and second best allocations do not coincide, neither do the corresponding decentralized taxes. Indeed, the incentive compatibility constraint can be seen as a cap on the lump sum tax on skilled workers—a bound on redistribution.

We first introduce the definition of a competitive equilibrium given a lump sum tax τ on skilled workers, which assumes a balanced government budget.

Definition 12 *Given (n_1, n_2), we say that an allocation $x = (c_1, l_1, c_2, l_2)$ is **a competitive equilibrium given** τ if there are wage rates (w_1, w_2) such that*

1. *Pair (c_1, l_1) solves the unskilled household problem*

$$\max U(c_1, l_1) \;\; s.t. \;\; c_1 \leq w_1 l_1 + \frac{n_2}{n_1}\tau,$$

2. *Pair (c_2, l_2) solves the skilled household problem*

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

3. *Wages equal marginal products:*

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

It is straightforward to show that a competitive equilibrium allocation given τ is pinned down by

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

The next proposition says that we can decentralize first and second best allocations as competitive equilibria with taxes.

Proposition 13 *For $\eta < \bar{\eta}$, the first and second best allocations are a competitive equilibrium given τ^{fb} and τ^{sb} respectively. Moreover,*

$$\tau^{fb} > \tau^{sb} > 0.$$

Proof. Both first and second best allocation equate the marginal rate of substitution to the marginal product of each type of labor. It is then trivial to show that there exist τ^{fb} and τ^{sb}. That τ^{sb} is positive follows from the first part of the proof of Proposition 10.

To show $\tau^{fb} > \tau^{sb}$, we first argue that $U\left(x_2^{fb}\right) < U\left(x_2^{sb}\right)$. To see this, assume that $U\left(x_2^{fb}\right) \geq U\left(x_2^{sb}\right)$. But Proposition 6 and **??** respectively state that $U\left(x_1^{fb}\right) > U\left(x_2^{fb}\right)$ and $U\left(x_1^{sb}\right) = U\left(x_2^{sb}\right)$. But this would imply that $\tilde{x} = \left(x_2^{fb}, x_2^{fb}\right)$ is incentive compatible and feasible and strictly better than x^{sb}.

Finally, note the skilled worker's welfare is strictly decreasing in τ: therefore $U\left(x_2^{fb}\right) < U\left(x_2^{sb}\right)$ implies $\tau^{fb} > \tau^{sb}$. ■

3.4 The size of government: a numerical example

This section illustrates the previous results by means of a numerical example. In addition, we examine the relationship between the skill distribution of the economy and the extent of redistribution.

For any allocation $x = (c_1, c_2, l_1, l_2)$, the *pre-tax income* for a worker of type i is given by $F_i(l_1, \eta l_2)\, l_i$. A natural measure of the extent of redistribution is given by *the tax paid by each skilled worker*:

$$r_1(x) = \tau(x) = F_2(l_1, \eta l_2) l_2 - c_2.$$

Note that technological differences will affect this measure of redistribution.

Another meaningful measure of redistribution is *the average tax rate on skilled workers*:

$$r_2(x) = \frac{r_1(x)}{F_2(l_1, \eta l_2) l_2} = 1 - \frac{c_2}{F_2(l_1, \eta l_2) l_2}.$$

A third commonly used measure is the *size of transfers over total GDP*:

$$r_3(x) = \frac{n_2\left(F_2(l_1, \eta l_2) l_2 - c_2\right)}{F(n_1 l_1, n_2 l_2)} = \frac{c_1 - F_1(l_1, \eta l_2) l_1}{F(l_1, l_2 \eta)},$$

where we used the government's budget constraint: $n_1(c_1 - F_1 l_1) = n_2(l_2 F_2 - c_2)$.

The particular specification we adopt in our example is the following.[4]

$$F(L_1, L_2) = (L_1 L_2)^{1/2}$$
$$U(c, l) = \frac{1}{2}\ln c + \frac{1}{2}\ln(1 - l).$$

[4] We note that for this example $\overline{\eta} = 1$. This numerical example is just for illustrative purposes. We could also formulate more general functional forms and perform a calibration exercise.

Figure 1 reports the main features of first best allocations for a wide range of values of skilled-to-unskilled ratio η. Figure 2 reports the same indicators but for second best allocations. As expected, the second-best allocation features lower output per worker and a lower skill premium than the first-best allocation. In contrast, income redistribution is uniformly higher in first-best allocations.

Besides illustrating the earlier analytical results, figure 2 shows that the tax paid by skilled workers (both in absolute terms and relative to pre-tax income) is a decreasing function of the skilled-to-unskilled ratio, both in the first-best and second-best allocations. However, the size of transfers over GDP is a hump-shaped function of η. For low values of η, increasing the abundance of skilled workers increases total production by more than the increase in total revenue.

4 Two-country equilibrium with commitment

We open our analysis of the world economy by reviewing the argument linking skilled labor mobility to drastic cuts in redistribution policy. When skilled workers are internationally mobile, countries compete for them by cutting taxes and downsizing their redistributive policies. As a result, there is a "race to the bottom." In equilibrium, all countries eliminate their income redistribution programs and yet fail to attract foreign skilled workers. An analogous argument is often used in the context of capital taxation.[5]

An important assumption in the race to the bottom argument is that countries can commit. That is to say, when a country announces a redistribution policy (foreign) skilled workers believe that the policy will not be changed once they have relocated. As we show in the next section, this assumption is indeed crucial. When relaxed, the predictions of the model about the size of redistributive policies when skilled labor is internationally mobile will be substantially altered.

For now, we assume that skilled workers can move from one country to another costlessly whereas the migration cost is prohibitively high for unskilled workers. Although clearly an extreme assumption, empirical evidence suggests a clear asymmetry in the costs of international migration of skilled and unskilled workers.

We are also interested in the relationship between cross-country productivity differences and sizes of government. For the remainder, we assume that country A has a technological advantage over country B. More specifically, we assume that

$$F^A(L_1, L_2) > F^B(L_1, L_2),$$

[5]The race to the bottom argument in capital taxation dates back to Oates (1972) and was first formalized by Zodrow and Mieszkowski (1986) and Wilson (1986). Wilson and Wildasin (2004) provides an excellent summary of the literature.

An opposite result can be found in the recent article by Cai and Treisman (2005), where technological differences across countries lead to an asymmetric equilibrium with diverging fiscal policies. They offer empirical evidence in support of this view.

for all (L_1, L_2). Observe that this is a very general formulation of technological advantage.

We are also going to assume that skilled workers are scarce. More precisely, let $e_1^{\min} = \min\{e_1^A, e_1^B\}$ and let $E_2 = e_2^A + e_2^B$. We shall assume that

$$\frac{E_2}{e_1^{\min}} < \min\{\eta^A, \eta^B\}.$$

The easiest way to think about commitment is to assume a sequential timing. First, fiscal authorities in all countries simultaneously set their redistribution policies. Second, workers decide where to live. By comparing the outcome under this timing protocol to the outcome in the alternative scenario, we can isolate the role of commitment in the race to the bottom argument.

We now state our definition of equilibrium with commitment. We assume that each country considers itself as "small" and takes as given the outside opportunities of skilled workers. In this respect, our definition is similar to the one used in Zodrow and Mieszkowski (1986) in the context of international capital taxation.[6] We restrict the set of fiscal instruments to positive lump sum taxes on skilled workers: we know from Proposition 13 that we are not ruling out first or second best allocations.

Definition 14 *An equilibrium with commitment is a pair of lump-sum taxes* $\tau^* = \left(\tau^{*A}, \tau^{*B}\right)$, *a utility level* U_2^*, *and functions* $\left\{x^J\left(\tau^J; U_2^*\right), n_2^J\left(\tau^J; U_2^*\right)\right\}_{J=A,B}$ *such that:*

1. *Given* U_2^*, *for each country* $J = A, B$ *and for all* $\tau^J \geq 0$, *allocation* $x^J\left(\tau^J; U_2^*\right)$ *is a competitive equilibrium given* τ^J *and skill distribution* $(e_1^J, n_2^J\left(\tau^J; U_2^*\right))$.

2. *Given* U_2^*, *for each country* $J = A, B$ *and for all* $\tau^J \geq 0$, *allocation* $x^J\left(\tau^J; U_2^*\right)$ *satisfies*
$$U_2\left(x_2^J\left(\tau^J; U_2^*\right)\right) \geq U_2^*.$$

3. *Given* U_2^*, *for each country* $J = A, B$,
$$\begin{aligned} &e_1^J U\left(x_1^J\left(\tau^{*J}; U_2^*\right)\right) + n_2^J\left(\tau^{*J}; U_2^*\right) U\left(x_2^J\left(\tau^{*J}; U_2^*\right)\right) \\ &\geq e_1^J U\left(x_1^J\left(\tau^J; U_2^*\right)\right) + n_2^J\left(\tau^J; U_2^*\right) U\left(x_2^J\left(\tau^J; U_2^*\right)\right) \end{aligned}$$
for all $\tau^J \geq 0$.

4. *The equilibrium skilled worker distribution is feasible:*
$$n_2^A\left(\tau^{*A}; U_2^*\right) + n_2^B\left(\tau^{*B}; U_2^*\right) = e_2^A + e_2^B.$$

[6] In our model, factors of production have elastic supplies.

In equilibrium, all skilled workers obtain U_2^* independently of their location. Note that U_2^* is endogenously determined, yet both countries take it as given: this is the essence of the "small country" assumption we make. In a way, we assume that there is a world market for skilled workers and utility level U_2 adjusts so as to clear the market.

The equilibrium definition deserves further explanation. Condition 1 maps the choice of the lump sum tax τ^J into a competitive equilibrium allocation; condition 2 makes sure that for any $\tau^J \geq 0$ a skilled worker cannot be better off by moving abroad. Condition 3 states that, in equilibrium, the redistribution policy is optimal from the point of view of each country's benevolent government, given skilled workers' outside option. We also note that the weights of the social welfare function in each country assign equal weights to all workers, regardless of their skill type or whether they were born in another country.[7]

4.1 Race to the Bottom

As expected, when skilled workers are internationally mobile and governments with credibility compete to attract them, redistributive policies become zero in both countries.

When a country reduces its tax rate on skilled labor, the utility it offers to skilled workers increases. As a result, it receives an inflow of skilled workers from the rest of the world, which brings the utility level that skilled workers receive in the country back to the world utility level. As a result of skilled migration, social welfare is higher in the country, since both skilled and unskilled workers are now better off. Realizing this, it is optimal for the country to cut its tax rate to zero and receive a large inflow of skilled workers. The same logic also applies to the other country. In equilibrium, both countries set zero tax rates and the distribution of skilled workers is such that the utility that skilled workers receive in either country in laisser-faire is equalized. So if both countries have identical technologies, the skilled-to-unskilled ratio will be equal in equilibrium in both countries. More generally, the country with a higher initial laisser-faire consumption for skilled workers receives an inflow of foreign skilled workers.

Theorem 15 *Assume that $U > 0$. In any equilibrium with commitment, lump sum taxes are zero in both countries $\tau^{*A} = \tau^{*B} = 0$.*

Proof. We derive a country's best response given a world utility level U_2^*. For simplicity, we analyze country A's problem. For any τ^A with a positive measure of skilled workers,

$$u_2\left(x_2^A\left(\tau^A; U_2^*\right)\right) = U_2^*. \tag{8}$$

Therefore, the government best response solves

$$\max_{\tau^A \geq 0} e_1^A u_1\left(x_1^A\left(\tau^A; U_2^*\right)\right) + n_2^A\left(\tau^A; u_2^*\right) U_2^*.$$

[7] For the case of inelastic labor we have checked that the equilibrium is the race to the bottom also when the social welfare function is based on the pre-migration skill distribution.

Obviously, a policy leading to an empty country is never a best response. There are no further constraints as functions x^A and n_2^A are taken as given.

The necessary first order condition here is

$$e_1^A \frac{\partial u_1\left(x_1^A\left(\tau^A; U_2^*\right)\right)}{\partial \tau^A} + \frac{\partial n_2^A\left(\tau^A; U_2^*\right)}{\partial \tau^A} U_2^* \leq 0 \tag{9}$$

with strict equality if $\tau^A > 0$.

In order to characterize the f.o.c., we differentiate (8) with respect to τ^A:

$$u_2^c\left(x_2^A\right)\left(-1 + \frac{\partial w_2^A}{\partial \tau^A} l_2^A\right) = 0.$$

The envelope theorem (or the competitive equilubrium conditions) imply that the change on labor supply has no first order impact. Since $u_2^c > 0$, it follows that

$$\frac{\partial w_2^A}{\partial \tau^A} l_2^A = 1$$

Constant returns to production imply that for all τ^A,

$$w_1^A l_1^A e_1^A + w_2^A l_2^A n_2^A = F^A\left(l_1^A e_1^A, l_2^A n_2^A\right).$$

Differentiating and using the competitive equilibrium conditions, it follows that

$$\frac{\partial w_1^A}{\partial \tau^A} l_1^A e_1^A + \frac{\partial w_2^A}{\partial \tau^A} l_2^A n_2^A = 0$$

and therefore

$$\frac{\partial w_1^A}{\partial \tau^A} l_1^A e_1^A = -n_2^A.$$

The first term in (9) is equal to

$$\begin{aligned} e_1^A \frac{\partial u_1\left(x_1^A\left(\tau^A; U_2^*\right)\right)}{\partial \tau^A} &= u_1^c\left(x_1^A\right)\left(n_2^A + \tau^A \frac{\partial n_2^A\left(\tau^A; U_2^*\right)}{\partial \tau^A} + \frac{\partial w_1}{\partial \tau^A} e_1^A l_1^A\right) \\ &= u_1^c\left(x_1^A\right)\tau^A \frac{\partial n_2^A\left(\tau^A; U_2^*\right)}{\partial \tau^A}. \end{aligned}$$

Therefore, the characterization of (9) rests on the sign of $\frac{\partial n_2^A\left(\tau^A; U_2^*\right)}{\partial \tau^A}$. Since the skilled worker welfare is strictly decreasing in τ^A, (8) implies that $\frac{\partial n_2^A\left(\tau^A; U_2^*\right)}{\partial \tau^A} < 0$, i.e., some skilled workers will leave the country if redistribution is increased. Therefore we have that for all worker allocations, the best response is $\tau^A = 0$ as

$$e_1^A \frac{\partial u_1\left(x_1^A\left(\tau^A; U_2^*\right)\right)}{\partial \tau^A} + \frac{\partial n_2^A\left(\tau^A; U_2^*\right)}{\partial \tau^A} U_2^* < 0$$

for all $\tau^A \geq 0$. Therefore Condition 3 of the equilibrium with commitment can only hold with zero lump sum taxes. ■

5 Equilibrium without Commitment

The prediction of the race to the bottom argument is at odds with reality. Costs to labor mobility within the US have been low for a long time and yet substantial differences in the size of state-level redistributive policies persist. Although much more recent, the substantial reduction in costs to labor mobility within the EU does not seem to be affecting the redistributive policies of its country members, which vary widely.This section argues that the reason may be that the race to the bottom argument is time inconsistent.

A simple way to introduce lack of commitment in the model is by reversing the timing protocol of the previous section. Let us assume that in the first period, skilled workers choose whether to stay in their country of origin or whether to move to the other country. In period 2, redistribution is determined in each country by a benevolent government given the skill distribution of its labor force.

For comparability with the previous section we maintain the assumption that only skilled workers are internationally mobile. Later on we shall examine more general mobility patterns.

We can now define an equilibrium without commitment.

Definition 16 *A no-commitment equilibrium consists of a distribution of skilled workers across countries and a pair of allocations,* $\left(n_2^A, n_2^B, x^A, x^B\right)$*, such that*

1. $(e_1^A, n_2^A, e_1^B, n_2^B)$ *is a feasible worker distribution.*

2. For $J = A, B$*, allocation* $x^J = (c_1^J, l_1^J, c_2^J, l_2^J)$ *is second best given* $\eta^J = n_2^J / e_1^J$*.*

3. Worlwide, all skilled workers receive the same level of utility.

We can characterize this equilibrium by proceeding backward. We examined extensively earlier the properties of second-best allocations for a given skilled-to-unskilled ratio. So now we just need to find out the migration decisions of skilled workers. To do so, recall that country A is assumed to have technological advantage over country B. Since skilled workers can move costlessly, the equilibrium utility of skilled workers in the two countries will be equal. The following result characterizes the equilibrium.

Theorem 17 *Assume skilled workers are scarce. For any initial worker distribution, there exists a unique no-commitment equilibrium. In the equilibrium, both countries set positive tax rates on skilled workers and* $\eta^A < \eta^B$*. When both countries have the same technology, their tax rates are equal.*

Proof. Let us proceed backward. Suppose that after migration has taken place, (η^A, η^B) is the vector summarizing the skill distributions in the two countries. Define mapping $x_2^J(\eta)$ as the consumption-leisure bundle for skilled workers in the second best allocation when country J's skilled ratio is η. Define also the mapping from skilled ratios to utility levels of skilled workers in second best allocations by $V^J(\eta) = U(x_2^J(\eta))$ for any skilled ratio η and country $J = A, B$. Earlier we demonstrated that second-best allocations are continuous functions of η. Therefore, V^J is a continuous function too. Moreover, we also established that $V^A(\eta) > V^B(\eta)$ for all $\eta < \overline{\eta} = \min\{\eta^A, \eta^B\}$. In equilibrium,

$$H(n_2^A) = V^A\left(\frac{n_2^A}{e_1^A}\right) - V^B\left(\frac{E_2 - n_2^A}{e_1^B}\right) = 0$$

for $0 \leq n_2^A \leq E_2$. Clearly, H is an increasing function. Under the assumption that

$$V^A(0) < V^B\left(\frac{E_2}{e_1^{\min}}\right)$$
$$V^B(0) < V^A\left(\frac{E_2}{e_1^{\min}}\right),$$

a unique equilibrium exists from any initial world labor distribution. In addition, when country A has technological advantage over country B, in equilibrium

$$\frac{n_2^A}{e_1^A} < \frac{E_2 - n_2^A}{e_1^B}.$$

Let us now consider the tax rates implied by the second-best allocation in each country. By proposition 7, the utility of both types of workers is equalized within each country. However, in laisser-faire, skilled workers enjoy higher utility than unskilled ones. Thus, each country is imposing positive tax rates. If both countries have the same technology then their allocations will coincide, and so will their tax rates. ■

Two empirical implications arise from this result. First, enhancing (skilled) worker mobility does not trigger a race to the bottom, understood as a reduction in the cross-sectional dispersion of the sizes of redistribution in both countries along with a reduction in their levels of redistribution. We also note that if, as a result of labor market integration, technological differences across countries were to shrink we would also observe a reduction in the cross-sectional disperision of redistribution, but its level would remain positive.

The second implication is that, starting from a symmetric initial labor distribution, we should observe migration of skilled workers from country A to country B. That is, the technologically advanced country exports skilled workers to the other country. In the context of (physical) capital mobility, this would imply that foreign direct investment flows from the high technology country to the other one.

To gain a deeper understanding of the effects of (skilled) labor mobility on the sizes of government it is instructive to examine the following numerical example. We take the same functional forms as in the numerical example in the closed-economy section. But now we assume that country A has technological advantage:

$$F^J(L_1, L_2) = E_J\,(L_1 L_2)^{1/2}$$
$$U(c,l) = \frac{1}{2}\ln c + \frac{1}{2}\ln(1-l)$$

with $E_A = 1.10 > E_B = 1$.

Using these functional forms, we perform the following exercise. We set $(e_2^A, e_2^B) = (0.4, 0.4)$ and fix $e_1^B = 1$. But we vary e_1^A from 0.5 to 2. Note that the point $e_1^A = 1$ corresponds to the initial symmetric worker distribution. For each initial worker distribution we characterize the no-commitment equilibrium. Figure 3 illustrates our results.[8] As expected, in all cases country A has a lower equilibrium skilled-to-unskilled ratio. The reason is that better technology has to be coupled with a relatively worse labor force in order for the two countries to provide the same level of utility to skilled workers.

More interestingly, note that the country with technological advantage has higher redistribution, both measured by the tax rate on the income of skilled workers and by the size of transfers relative to GDP. It follows from these results that cross-country dispersion in redistribution rates might actually increase as a result of enhanced labor mobility.[9] This is similar to Cai and Treisman (2005).

We also point out that despite the technological advantage, in this example, country A has a lower equilibrium output per capita, although utility levels of all workers are equal across countries, and across skill types. This means that the "worsening" of the skill distribution in country A due to the outflow of skilled workers more than offsets the technological advantage. This might not be so in other examples. In addition, we should keep in mind that technology in the model is exogenous whereas in the real world it is the result of conscious investments that are intensive in skilled labor. Endogenizing technological advantage could increase the skilled-to-unskilled ratio in country A and thus lead to higher per capita GDP.

As we showed in proposition 7, incentive constraints will be binding in each country. Combining this with the fact that the utility of skilled workers will be equalized across countries, we have that utility levels will be equal across the two countries. This provides a simple way to measure welfare that will prove useful later.

6 General migration costs and global welfare

In the no-commitment case, the specific pattern of labor mobility has important welfare implications.[10] Given that governments can alter these patterns by

[8] In comparing equilibrium allocations, it is important to keep in mind that the total number of workers in the world is different across equilibria.

[9] If technology differences are small and the initial worker distribution is symmetric then this will happen.

[10] This section is severely incomplete. We apologize to the reader.

means of policies targeted to reduce migration costs, for one type of workers or for both types, it is natural to investigate the welfare effects of such policies. That is the goal of this section.

First, we characterize the set of no-commitment equilibria under costless mobility for both types of workers.

Secondly, we consider the welfare effects of different labor mobility policies.

Definition 18 *An perfect mobility equilibrium without commitment consists of a distribution of skilled workers across countries and a pair of allocations,* $\left(n_1^A, n_2^A, n_1^B, n_2^B, x^A, x^B\right)$ *, such that*

1. $(n_1^A, n_2^A, n_1^B, n_2^B)$ *is a feasible worker distribution.*

2. For $J = A, B$*, allocation* $x^J = (c_1^J, l_1^J, c_2^J, l_2^J)$ *is second best given* $\eta^J = n_2^J/n_1^J$*.*

3. Worlwide, all skilled workers receive the same level of utility.

4. Worlwide, all unskilled workers receive the same level of utility.

Proposition 19 *Assume* $E_2/E_1 < \min\{\overline{\eta}^A, \overline{\eta}^B\}$*. There exists a continuum of perfect mobility equilibria. In all equilibria* $\eta^A < \eta^B$*.*

Observe that the earlier definition of equilibrium under no-commitment, where skilled workers where the only mobile factor, implies that those equilibria are a subset of perfect mobility equilibria. We can also define an unskilled mobility equilibrium as an equilibrium where only unskilled workers can move. Clearly, this is another subset of the perfect mobility equilibria.

Proposition 20 *Given an initial symmetric worker distribution, global welfare is higher in the unskilled mobility equilibrium than in the skilled mobility equilibrium.*

7 Final Remarks

We have argued that labor mobility does not lead to a "race to the bottom," where countries drastically cut redistributive transfers in order to attract skilled workers. The basis of our argument is that these cuts are not credible policies. We propose a two country model where competition for mobile factors is limited to credible policies. Both countries end up with positive redistribution, and the country with a technological advantage can sustain more redistribution. The model can address the interaction of redistribution and migration policies. In particular, we show that when countries have similar skill endowments but different technologies, migration policies enabling unskilled labor mobility lead to higher global welfare than policies enabling skilled labor mobility.

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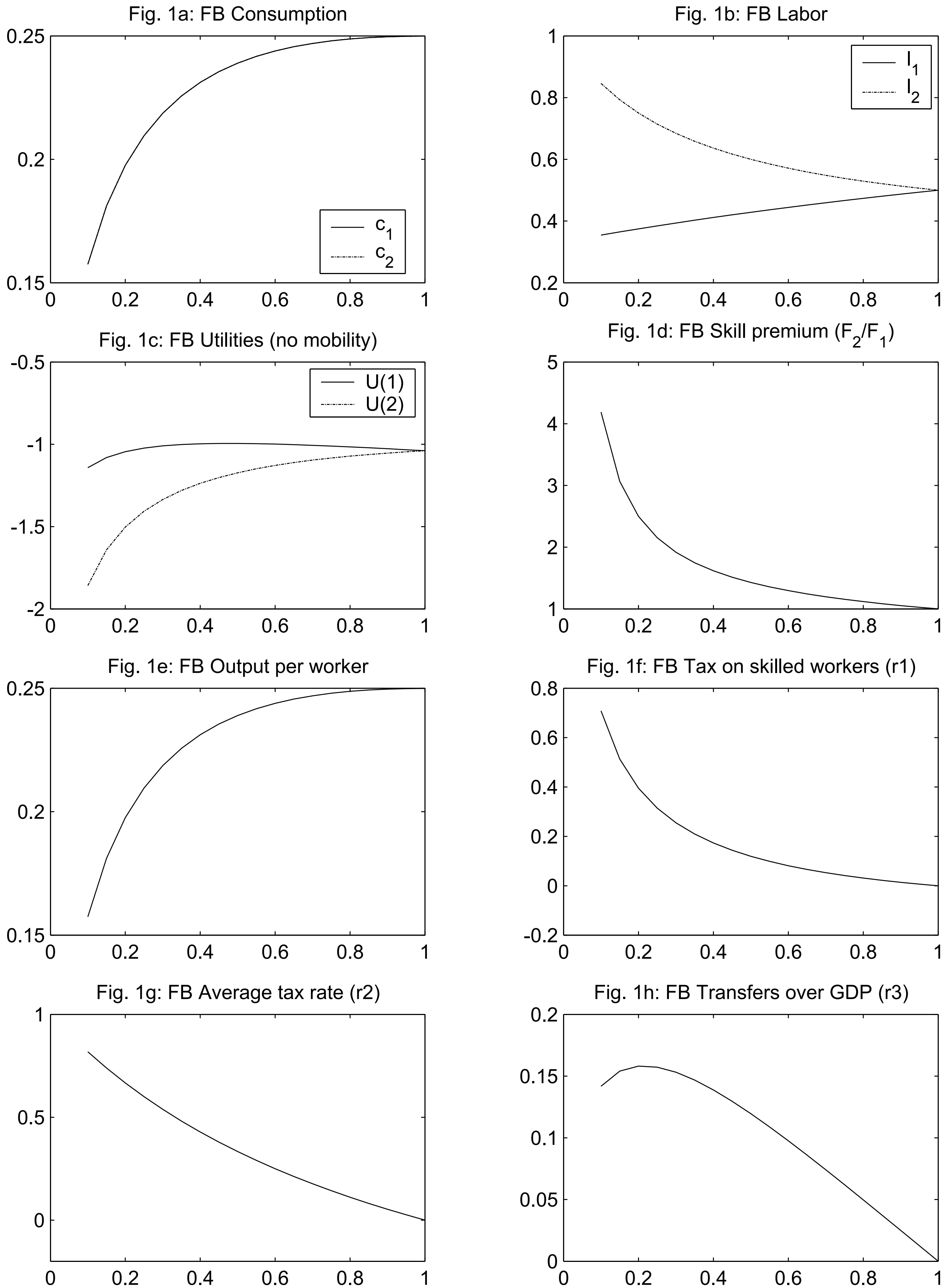

Fig. 1a: FB Consumption
0.25
0.2
0.15
0
0.2
0.4
0.6
0.8
1
c1
c2
Fig. 1b: FB Labor
1
0.8
0.6
0.4
0.2
l1
l2
Fig. 1c: FB Utilities (no mobility)
-0.5
-1
-1.5
-2
U(1)
U(2)
Fig. 1d: FB Skill premium (F2/F1)
5
4
3
2
1
Fig. 1e: FB Output per worker
Fig. 1f: FB Tax on skilled workers (r1)
0.8
0.6
0.4
0.2
0
-0.2
Fig. 1g: FB Average tax rate (r2)
1
0.5
0
Fig. 1h: FB Transfers over GDP (r3)
0.2
0.15
0.1
0.05
0

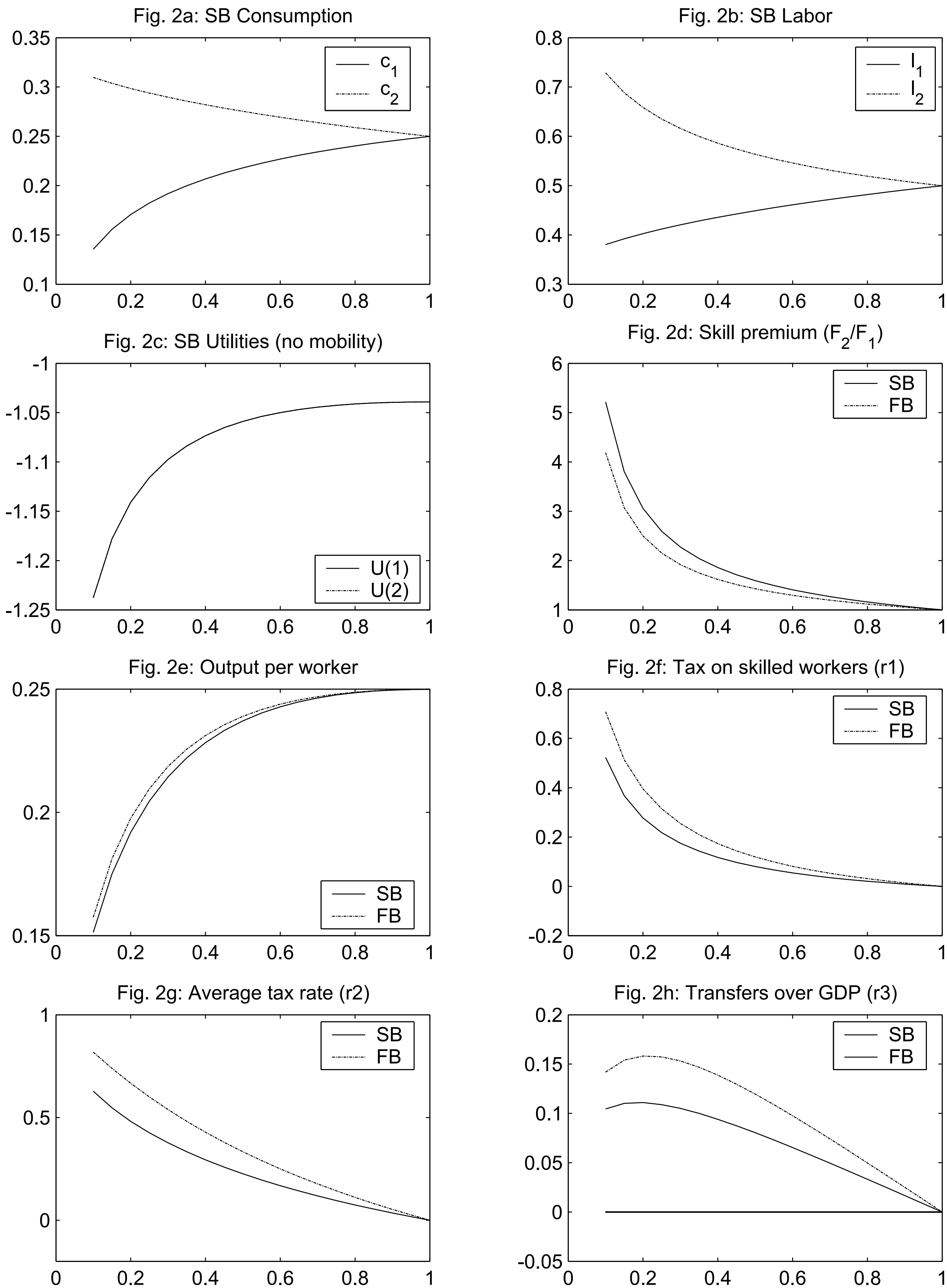
Fig. 2a: SB Consumption
c1
c2
Fig. 2b: SB Labor
l1
l2
Fig. 2c: SB Utilities (no mobility)
U(1)
U(2)
Fig. 2d: Skill premium (F2/F1)
SB
FB
Fig. 2e: Output per worker
SB
FB
Fig. 2f: Tax on skilled workers (r1)
SB
FB
Fig. 2g: Average tax rate (r2)
SB
FB
Fig. 2h: Transfers over GDP (r3)
SB
FB

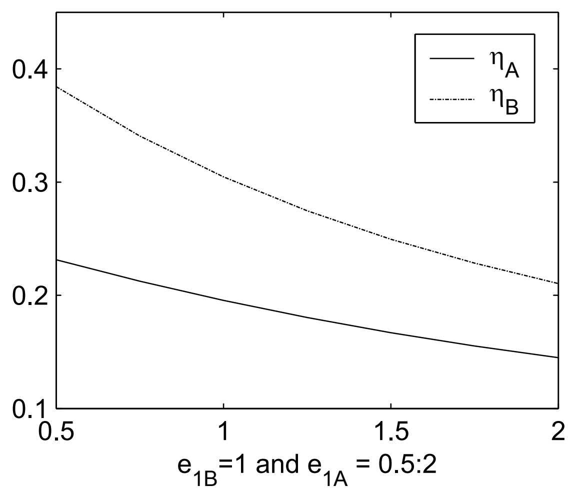

Fig. 3a: Skill distributions

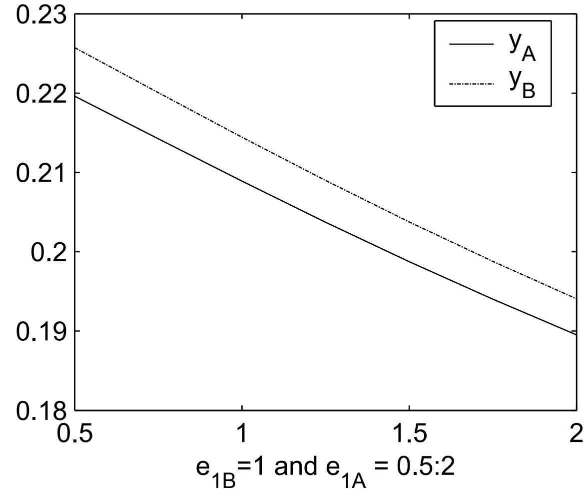

Fig. 3b: Income per capita

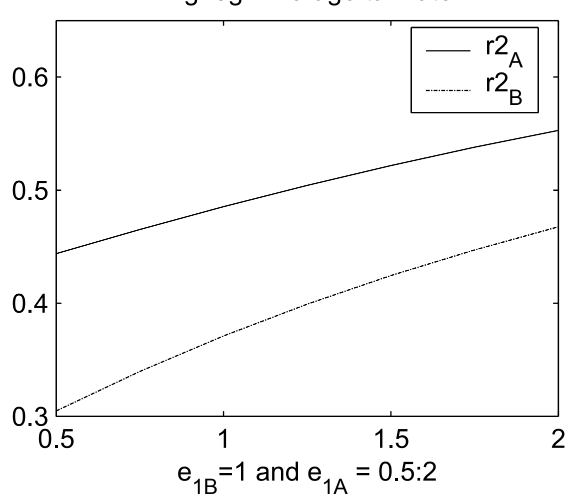

Fig. 3g: Average tax rate

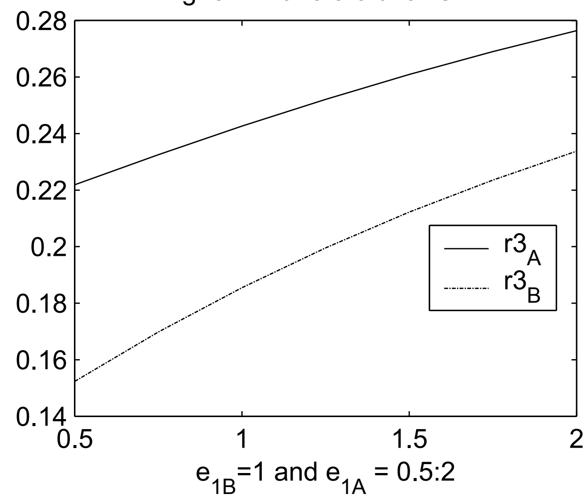

Fig. 3h: Transfers over GDP