Optimal Linear Income Tax when Agents Vote with their Feet

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Individuals, initially living in a Mirrleesian economy A, have outside options consisting in settling down in a laissez-faire country B while paying positive migration costs. We first examine the effect of the threat of migration, assuming participation constraints are taken into account for all individuals, and show that optimal linear income taxes are obtained as corner solutions. We then consider a social criterion allowing emigration of the highest-skilled individuals and show by means of an example that social welfare may rise following an increase in income redistribution, despite this resulting in the departure of the most productive individuals. Numerical simulations on French data illustrate the lack of degrees of freedom offered by linear taxation when agents can vote with their feet, which may be regarded as an argument against linear taxes.

Keywords: optimal linear income taxation, participation constraints, individual mobility

JEL classification: H 21, H 31, D 82, F 22

1. Introduction

About 34,000 income-tax payers have been leaving France each year since 2000, and 70% of them settle down in Europe or in North America DGI (2005), mostly in countries where income taxes are lower. Since these individuals paid three times more taxes than the average taxpayer, this example suggests that international differences in taxes should be regarded as one of the determinants of their migration decision-making. Such a determinant is consistent with John Hicks's idea – that the migration decision is determined by a comparison of earnings opportunities across countries, net of migration costs – on which practically all modern economic studies of migration are based (Borjas, 1999; Sjaastad, 1962).

The mobility of highly productive individuals between the most developed countries raises specific issues. First, it induces losses not only in taxes, but

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also in productive capacity in the countries that are left by these individuals. Second, governments have few alternatives but to lower taxes – that is, to reduce redistribution – to prevent the departure of high-skilled individuals. The set of instruments at the governments' disposal is thus more limited than when they face tax evasion. Chander and Wilde (1998) remark that they have "carrots" but no "sticks". There is therefore a direct conflict between their desire to maintain the national income per capita by keeping taxes down and their desire to sustain a redistribution program. Third and consequently, this mobility of individuals appears as a new constraint on the design of the optimal income tax in the developed countries.

Our purpose is to study the impact of this specific mobility on the optimal linear income tax scheme à la Mirrlees. Linear taxes have been studied by Sheshinski (1972), Atkinson (1973, 1997), Romer (1976), Dixit and Sandmo (1977), Helpman and Sadka (1978), Hellwig (1986), and Tuomala (1985), who used first-order conditions to derive formulae giving the optimal marginal rates of tax in a closed economy and studied the properties of the social optimum. Extensive numerical results have been provided by Stern (1976).

Our focus on linear income tax schemes has two justifications. First, linear taxes seem to have many advantages. From the technical point of view, it is not necessary to introduce the incentive compatibility constraints in the optimal-income-tax problem explicitly, provided the Spence–Mirrlees condition is met. In addition, linear taxes are very simple for the taxpayers as well as for the Inland Revenue: They consist indeed of the payment of a basic income to everyone, funded by a proportional tax rate on all income. Furthermore, this simplicity could favor a decrease in the compliance costs. Second, the idea of a linear tax scheme is being actively discussed in a number of countries and has been recently implemented in practice in Estonia, Latvia, Lithuania, Russia, Ukraine, Slovakia, and Romania, among others.

The effects of individual mobility on the optimal linear income tax scheme have been studied by Wilson (1982a, 1982b). These papers examine how potential emigration changes the optimal linear income tax. For this purpose, the methodology consists in comparing the tax parameters of an economy in which residents are free to migrate at will with those of an economy in which certain individuals may not enter or leave the country. The differences between the two economies isolate the effects of potential mobility on the optimal tax scheme, at productivity levels where individuals cannot change their status between resident and emigrant. The main result is that partially closing the economy raises the optimal marginal tax and minimum income.

The present paper is devoted to optimal linear income taxation when there is a continuum of individuals who differ in productivity and migration costs and face consumption–leisure choices in the absence of unemployment. It examines how the results concerning the optimum income tax schedule in a Mirrleesian economy A have to be adapted when the agents are allowed to vote with their feet and settle in a country B, whose tax policy is less redistributive, while paying a migration cost. To keep the model as simple and pure as possible, one considers that A's government intervenes for purely redistributive purposes, that B is a laissez-faire country, and that all individuals are initially staying in A. There is therefore no strategic competition on taxes between the countries. B should be regarded as the limit case of a less redistributive country. The restriction to one-way migrations is justified by our interest in the effect of the threat of migration on the progressivity of the tax schedule as stressed by Mirrlees (1971, p. 176).

We introduce type-dependent participation constraints in A's optimal-income-tax problem to model the possibility that the individuals vote with their feet. These constraints express the fact that an individual will leave A if the net utility he obtains there is less than his reservation utility, which is equal to the maximum utility he can obtain abroad, taking his migration cost into account. Such constraints have not been used in the previous models of optimal income taxation dealing with individual mobility. This is rather surprising if one considers that optimal income taxation is a principal–agent model with "false moral hazard" (Laffont and Martimort, 2002).

The social objective is more difficult to specify when the individuals are allowed to vote with their feet. It does not depend only on the government's aversion to income inequality, but also on the set of individuals whose welfare is to count (Mirrlees, 1982). We distinguish two different social criteria. From the mercantilist point of view, A's government takes the welfare of its nationals into account, whilst ensuring that every national stays in the home country. This point of view allows us to examine the effect of the threat of migration on the optimal linear tax scheme. We also consider a social criterion allowing changes in the size of A's resident population, to determine if it is always socially optimal to prevent emigration of the highly productive individuals in A's resident population.

Our approach differs therefore from Wilson (1980, 1982b) in at least three ways. First, Wilson (1980, 1982b) considers that the contribution of an individual's utility to social welfare does not depend on whether he is a resident or an emigrant. We thus look at different social welfare criteria. Second, we introduce participation constraints to examine the effects of potential emigration and address the issue of the optimal size of the resident population. Third, migration costs are explicitly taken into account.

The basic assumptions we make are the following. First, individual productivity, equal to the gross wage, does not change with the country of residence. In other words, both countries have the same production function, so that our framework differs from the literature on the brain drain, in which the key parameter is the difference in productivity (Bhagwati and Wilson, 1989). Second, migration costs depend on each individual's productivity. Productivity is thus the sole parameter of heterogeneity in the population. Third, migration costs are monotonic (increasing, constant, or decreasing) but do not increase faster than the laissez-faire utility. It should be noted that we place no restrictions on their level. On the contrary, if individuals were initially living in B, we would have to introduce an additional assumption on the level of the migration costs in order to prevent emigration of low-skilled workers from B to A, in which we are not interested presently.

The main results of the paper provide an argument against using linear income taxes when highly skilled individuals are potentially mobile for tax purposes. It does not mean that linear taxes should not be used in the presence of migration, but that the cost–benefit analysis of the restriction to linearity should take this point into account. We first focus on the mercantilist point of view to look at the effect of the threat of migration of highly skilled individuals on the optimum linear tax scheme A's government should implement. The fact that participation constraints have to be satisfied for the most demanding individuals prevents the government from reducing the utility of the other highly productive individuals to their reservation utility. These individuals are thus left with a rent. Consequently, redistribution of income within the population has to be reduced. We provide an illustration on French data to assess the loss in social welfare resulting from the openness of the economy. The magnitude of this loss emphasizes that linear taxes are in fact lacking in degrees of freedom when many constraints have to be taken into account. Since the satisfaction of the participation constraints for the most demanding individuals living in A seems to constrain the social optimum very much, we use the resident point of view to examine the consequences of allowing emigration of the highest-skilled individuals in A's resident population. It appears that the social welfare is not monotonic in the upper productivity level in A. In particular, numerical results show that letting national income per capita decrease due to emigration may be a lesser evil than reducing income redistribution sufficiently to prevent the emigration of those with highest income. There is therefore a trade-off between redistribution and population size.

The paper is organized as follows. Section 2 presents the model. Section 3 examines the properties of the optimal tax scheme in A when A's government aims at preventing emigration of its nationals. Section 4 provides numerical results concerning the French economy. Section 5 concludes.

2. The Model

The world consists of two countries, A and B. The instruments at the disposal of A's government are a minimum income m ($m \in R$) and a constant tax rate t ($0 \leq t \leq 1$) levied on earnings z. The restriction to marginal tax rates that are not greater than 1 is required for the incentive compatibility constraints to be satisfied, as stressed below. The restriction to nonnegative marginal tax rates is justified herein by our focus on purely redistributive tax policies. The linear income tax function in A is thus

$$T(z) = tz - m. \tag{1}$$

B is committed to being a laissez-faire country. Every individual is initially living in A.

2.1. Population

The individuals differ in productivity θ. The distribution function of θ, denoted F, is defined on a closed interval $[0, \overline{\theta}] \subseteq \mathbb{R}^+$, where it admits a density function $f > 0$. This distribution is common knowledge, but individual productivity is private information.

Productivity levels, and therefore wages in the absence of taxation, are independent of the country in which the individuals are working.

2.2. Individual Behavior

All individuals have the same preferences over consumption x and labor l, represented by a strictly concave utility function $U : R^+ \times [0, \bar{l}] \to R$. The following assumptions are made.

Assumption 1 U is twice continuously differentiable, strictly concave, strictly increasing in x ($U_x > 0$), and strictly decreasing in l ($U_l < 0$). It tends to $-\infty$ as x tends to 0 from above or l tends to the time endowment $\bar{l}$ from below.

Assumption 2 Leisure is a normal good.

Gross income z is given by $z := \theta l$. Each individual decides about the optimal amount of consumption and labor so as to maximize his utility subject to his budget constraint. The individual budget constraint in A reads

$$x = z - T(z) = (1 - t)z + m. \tag{2}$$

The individual budget constraint in B is simply

$$x = z. \tag{3}$$

An individual working in A maximizes U subject to (2). The corresponding first-order condition, $\theta(1 - t)U'_x + U'_l = 0$ or $l = 0$ and $\theta(1 - t)U'_x + U'_l < 0$, defines implicitly the Marshallian labor supply l_A and the consumption function x_A in A,

$$l_A := l_A(\theta; t, m) \quad \text{and} \quad x_A := \theta(1-t)l_A(\theta; t, m) + m. \tag{4}$$

The gross income function in A is thus $z_A := \theta l_A(\theta; m, t)$. Substituting x_A and l_A in U, one obtains the indirect utility in A,

$$V_A(\theta; t, m) := U(x_A, l_A). \tag{5}$$

By the envelope theorem, one gets

$$V_A'(\theta) = U_x \cdot (1-t)l_A \tag{6}$$

and

$$\partial V_A/\partial m = U_x > 0. \tag{7}$$

Hence,

$$\frac{\partial V_A}{\partial t} = -\theta l_A U_x = -\theta l_A \frac{\partial V_A}{\partial m} \leq 0. \tag{8}$$

The marginal rate of substitution between income and consumption, $s(x_A, z_A; \theta)$, in A is equal to

$$s(x_A, z_A; \theta) := -\frac{U_l}{\theta U_x}. \tag{9}$$

An individual working in B maximizes U subject to (3). His consumption function and labor supply are $x_B = x_B(\theta)$ and $l_B = l_B(\theta)$. By the envelope theorem, the indirect utility in B defined by

$$V_B(\theta) := U(x_B, l_B) \tag{10}$$

is strictly increasing in θ.

2.3. Emigration and Participation Constraints

An individual who decides to leave A has to pay a strictly positive *migration cost*, denoted c. This cost is introduced in the model as a *time-equivalent* loss in utility and corresponds to different material and psychic costs of moving: transportation of persons and household goods, forgone earnings, costs of speaking a different language and adapting to another culture, costs of leaving his family and friends, etc. If "these costs probably vary among persons, the sign of the correlation between costs and wages is ambiguous" (Borjas, 1999, p. 12).

We assume herein that migration costs depend on productivity, i.e., $c : [0, \overline{\theta}] \to R^{++}$, and that only their distribution is known to A's government. In addition,

Assumption 3 Migration costs c, monotonic and twice continuously differentiable, do not increase faster than the laissez-faire utility.

In this setting, A's government knows c if it knows θ. Assumption 3 concerns the *rate of increase* of the migration cost function c, and *no* assumption is made on the level of c. Migration costs are allowed to be constant, decreasing, or increasing provided $c'(\theta) < V'_B(\theta)$.

The *reservation utility*, defined as the maximum utility an individual living and working in A can obtain abroad, is given by $V_B - c$. Assumption 3 amounts therefore to considering that outside opportunities are increasing in productivity. An individual will leave A if and only if his utility in A is less than his reservation utility. Consequently, the *participation constraint* for the θ-individuals is defined as

$$V_A(\theta; t, m) \geq V_B(\theta) - c(\theta). \tag{11}$$

2.4. Social Objective and Tax Policy

We define a *national* as an individual born in A. Hence, all individuals have A's nationality. Some of these individuals may choose to vote with their feet and settle in B. Since the focus is on high-skilled emigration, we consider that A's resident population corresponds to an interval of types and denote by $\widehat{\theta} \in [0, \overline{\theta}]$ its supremum.

A's government intends to implement the income tax policy corresponding to the best compromise between its desire to redistribute income and its concern about limiting the disincentive effects of the tax system. It seems sensible to consider that it is not able to levy taxes in B, since the fiscal prerogative is closely linked to national sovereignty, and that it is not willing to redistribute income to the individuals in B. Focusing on purely redistributive tax schemes, the tax revenue constraint of A's government is

$$t \int_0^{\widehat{\theta}} \theta l_A(\theta; t, m) dF(\theta) \geq mF(\widehat{\theta}). \tag{12}$$

The desire to redistribute income is captured through the government's aversion to income inequality, $\rho \geq 0$. A zero aversion corresponds to a utilitarian government, and an infinite aversion to a Rawlsian one (maximin).

From the *mercantilist* point of view, A's government aims at maximizing the average social welfare of its nationals,

$$W^M_{A,\rho}(t, m) = \int_0^{\overline{\theta}} \phi_\rho(V_A(\theta; t, m)) dF(\theta), \tag{13}$$

where $\phi_{\rho \neq 1}(V_A) = V_A^{1-\rho}/(1-\rho)$ and $\phi_1(V_A) = \ln V_A$, whilst maintaining the national productive capacity in preventing emigration of its nationals. The participation constraint (11) must be taken into account for every national:

$$V_A(\theta; t, m) \geq V_B(\theta) - c(\theta) \quad \text{for all } \theta \leq \overline{\theta}. \tag{14}$$

This point of view corresponds to the idea, formulated by Jean Bodin, that "the only source of welfare is mankind itself" (Bodin, 1578).

We also consider a *resident* point of view allowing emigration of the most productive individuals. A government adopting this point of view aims at maximizing the average social welfare of its residents[1],

$$W^R_{A,\rho}(t,m;\widehat{\theta}) = \frac{1}{F(\widehat{\theta})}\int_0^{\widehat{\theta}} \phi_\rho(V_A(\theta;t,m))dF(\theta), \tag{15}$$

and does not care about its nationals if they are living in B. The participation constraints read

$$V_A(\theta;t,m) \geq V_B(\theta) - c(\theta) \quad \text{for all } \theta \leq \widehat{\theta}. \tag{16}$$

The basic idea is that an economic policy should take the welfare of the taxpayers into account. Since the welfare of the nationals living in B does not count, A's government has to choose the optimal size of its population; it thus faces "*different* number choices" (Parfit, 1984).

The Spence–Mirrlees condition is assumed to be met.

Assumption 4 $s(x_A, z_A; \theta)$ is strictly decreasing in θ.

Under Assumption 4, $z'_A \geq 0$ and then the incentive compatibility constraints are satisfied (see Hellwig, 1986). We also note that, by (6), the restriction $t \leq 1$ is required to ensure that $V'_A(\theta) = U_x \cdot (1-t)l_A$ is nondecreasing in θ. In the rest of the paper, we exclude the case where t is equal to 1, which implies zero production in A.

Consequently, the linear income tax problems we focus on may be written as

$$\begin{aligned} W^M_{A,\rho} &= \max_{t,m} W^M_{A,\rho}(t,m) \\ &\qquad \text{s.t. tax revenue constraint (12) with } \widehat{\theta} = \overline{\theta} \text{ and} \\ &\qquad \text{participation constraints (14)} \end{aligned} \tag{17}$$

from the mercantilist point of view, and

$$\begin{aligned} W^R_{A,\rho}(\widehat{\theta}^*) &= \max_{t,m,\widehat{\theta}} W^R_{A,\rho}(t,m;\widehat{\theta}) \\ &\qquad \text{s.t. tax revenue constraint (12) and} \\ &\qquad \text{participation constraints (16)} \end{aligned} \tag{18}$$

from the resident point of view.

1 This kind of social welfare functional is known to produce the so-called *mere addition paradox*: The addition of individuals whose utility is less than the average utility in the initial population is regarded as suboptimal even if this change in population size affects no one else and does not involve social injustice. However, since we are focusing on emigration of individuals whose utility is greater than the average utility in A, such a paradox cannot occur.

3. The Mercantilist Point of View

This section examines how the threat of migration for tax purposes alters the optimum linear tax scheme in A when A's government adopts the mercantilist point of view. In this case, the optimal tax scheme solves (17).

3.1. The Tax Possibility Set

We begin by expressing the participation constraints as a restriction on the feasible (t, m) pairs. For this purpose, we define $m^{PC}(\theta; t, V_B - c)$ as the minimum lump-sum element m that is required for a θ-individual to obtain his reservation utility $V_B(\theta) - c(\theta)$ in A when the marginal tax rate is t, namely

$$m^{PC}(\theta; t, V_B - c) = \min\left\{m \in R : U(\theta(1-t)l_A(\theta; t, m) + m, l_A(\theta; t, m)) \geq V_B(\theta) - c(\theta)\right\}. \tag{19}$$

$m^{PC}(\theta; t, V_B - c)$ always exists under our assumptions. Since the participation constraints (11) must be satisfied for *all* individuals, the minimum income m must be chosen so that

$$m \geq m^{PC}(t; V_B - c) := \max_{\theta \in [0, \overline{\theta}]} m^{PC}(\theta; t, V_B - c). \tag{20}$$

The upper graph of $m^{PC}(t; V_B - c)$, denoted $\Pi^{PC}(V_B - c)$, is the set of (t, m) pairs that are compatible with the participation constraints (11). Since $c(\theta) > 0$, it is obvious that the laissez-faire allocation $(t, m) = (0, 0)$ belongs to Π^{PC}.

Under Assumption 2, $\int_0^{\overline{\theta}} \theta l_A(\theta; t, m)dF(\theta) - m$ is continuously decreasing in m and bounded below $(l_A \geq 0)$ for any given $0 \leq t \leq 1$. There is thus a unique m such that the tax revenue constraint (12) is active for a given t. This constraint defines therefore a continuous function $t \to m^{TR}(t)$ on $0 \leq t \leq 1$, which is the Laffer curve. We define Π^{TR} as its lower graph and note that the laissez-faire allocation $(t, m) = (0, 0)$ belongs to this set.

The tax possibility set is defined by

$$\Pi(V_B - c) := \Pi^{PC}(V_B - c) \cap \Pi^{TR}. \tag{21}$$

The laissez-faire allocation, which belongs to this set, is always feasible.

3.2. The Social Indifference Curves

The social indifference curves capture equity. For any given level of social welfare $\overline{W}$, they are given by

$$\int_{\underline{\theta}}^{\overline{\theta}} \Phi_\rho(V_A(\theta; t, m))dF(\theta) - \overline{W} = 0 \tag{22}$$

in the (t, m) space. We note that

$$\frac{\partial}{\partial t}\int_0^{\overline{\theta}} \phi_\rho(V_A)dF(\theta) = -\int_0^{\overline{\theta}} \phi'_\rho(V_A)\left(\theta l_A \frac{\partial V_A}{\partial m}\right)dF(\theta) \leq 0, \tag{23}$$

$$\frac{\partial}{\partial m}\int_0^{\overline{\theta}} \phi_\rho(V_A)dF(\theta) = \int_0^{\overline{\theta}} \phi'_\rho(V_A)\frac{\partial V_A}{\partial m}dF(\theta) > 0, \tag{24}$$

because of (8) and (7). As a result, the social indifference curves slope up for any finite aversion to income inequality, ρ. In the Rawlsian case, A's government aims at maximizing the lump-sum tax m received by the worst-off members in A's population. The social indifference curves are therefore horizontal straight lines in the (t, m) space.

3.3. The Properties of the Solution

We start with the following obvious property.

Property 1 The tax revenue constraint (12) is always active at the social optimum.

Indeed, let us assume that there is a social optimum such that the participation constraint (11) is binding at θ^* whilst the tax revenue constraint (12) is inactive. We thus have

$$\delta = t\int_0^{\overline{\theta}} \theta l_A\big(\theta, t, m^{\mathrm{PC}}(\theta^*, t, V_B - c)\big)dF(\theta) - m^{\mathrm{PC}}(\theta^*, t, V_B - c) > 0. \tag{25}$$

Since it is possible to share out δ among the individuals while increasing their indirect utility, one obtains a contradiction.

Property 1 implies that there are *two types of social optima* when the individuals can vote with their feet. Either the participation constraints (11) are inactive for all $\theta \in [0, \overline{\theta}]$ and we are back to the closed-economy optimum, or there is at least one θ for which (11) is active. In the latter case, the social optimum is at the junction of the graphs of $m^{\mathrm{PC}}(t; V_B - c)$ and $m^{\mathrm{TR}}(t)$; as a result, we cannot rely anymore on the standard first-order conditions to characterize the optimum and derive a marginal-tax-rate formula.

Equation (20) is equivalent to the satisfaction of (11) for all $\theta \in [0, \overline{\theta}]$. The participation constraints are thus binding at productivity levels θ^* defined as

$$\theta^* \in \arg\max_{\theta\in[0,\overline{\theta}]} m^{\mathrm{PC}}(\theta; t, V_B - c). \tag{26}$$

One thus obtains the following property.

Property 2 Let $m^{\mathrm{PC}}(\theta; t, V_B - c)$ be strictly monotonic in θ. Then there is at most one θ^* where the participation constraints (11) are active. When $m^{\mathrm{PC}}(\theta; t, V_B - c)$ is strictly increasing in θ, θ^* can only be $\overline{\theta}$.

When $m = m^{\mathrm{PC}}(\theta; t, V_B - c)$, we have, by definition of $m^{\mathrm{PC}}(\theta; t, V_B - c)$,

$$U(\theta(1-t)l_A(\theta; t, m) + m, l_A(\theta; t, m)) = V_B(\theta) - c(\theta). \tag{27}$$

Differentiation of this relation yields

$$\begin{aligned}\frac{\partial m^{PC}(\theta; t, V_B - c)}{\partial \theta} &= \frac{V_B'(\theta) - c'(\theta)}{U_x} - (1-t)l_A(\theta; t, m) \\ &= \frac{1}{U_x}\left[\frac{dV_A(\theta; 0, 0)}{d\theta} - c'(\theta) - \frac{dV_A(\theta; t, m)}{d\theta}\right],\end{aligned} \tag{28}$$

where (6) has been used to obtain the latter equality. We note that, by (8),

$$\frac{\partial m^{\mathrm{PC}}(\theta; t, V_B - c)}{\partial \theta} = \frac{1}{U_x}\left[V_B'(\theta) - c'(\theta) + \frac{1-t}{\theta}\frac{\partial V_A}{\partial t}\right]. \tag{29}$$

Since $V_B'(\theta) - c'(\theta) > 0$ under assumption 3 and $\partial V_A/\partial t \leq 0$ by (8), the sign of $\partial m^{\mathrm{PC}}(\theta; t, V_B - c)/\partial\theta$ is ambiguous in the general case.

To have further insight into the monotonicity of $m^{\mathrm{PC}}(\theta; t, V_B - c)$, we look at preferences that are quasilinear in consumption,

$$U = x - v(l), \quad \text{with } v', v'' > 0. \tag{30}$$

The labor supply is thus equal to

$$l_A(\theta; t, m) = v'^{-1}(\theta(1-t)). \tag{31}$$

Since $U_x = 1$, (6) yields

$$\frac{dV_A(\theta; 0, 0)}{d\theta} - \frac{dV_A(\theta; t, m)}{d\theta} = v'^{-1}(\theta) - (1-t)v'^{-1}(\theta(1-t)). \tag{32}$$

The function $v'^{-1}(\cdot)$ is strictly increasing, since, by assumption, $v' > 0$. One thus gets $(1-t)v'^{-1}(\theta(1-t)) < v'^{-1}(\theta(1-t)) < v'^{-1}(\theta)$ provided $0 < t < 1$. By (28), $m^{\mathrm{PC}}(\theta; t, V_B - c)$ is strictly increasing in θ for all $0 < t < 1$ when $c'(\theta) \leq 0$ and preferences are quasilinear in consumption. The following property is obtained.

Property 3 Let preferences be quasilinear in consumption, and migration costs be nonincreasing. Then θ^* is $\overline{\theta}$.

4. An Illustration on French Data

This section provides numerical simulations of the optimal linear income tax in France. A linear income tax has not been yet adopted in that country, but there is a trend towards a reduction in tax rate brackets, from 13 in 1982 to 5 in 2007. In addition, a recent report by Saint-Etienne and Le Cacheux (2005) has proposed an income tax levied in three brackets. We focus on the effect of the threat of migration when the government adopts the mercantilist point of view, before looking at the resident point of view to allow emigration of the most productive individuals living in A.

4.1. The Parameters of the Economy

The government's aversion to income inequality reflects a political choice. We will consider the utilitarian and the Rawlsian cases, which are sufficiently manageable to compute the social indifference curves in the (t, m) space.

It is usual, in optimal-taxation theory, to describe the distribution of skills within the population with a lognormal (or a Pareto) distribution. We use the work of Laslier et al. (2003, appendix C) to obtain a kernel estimation of the distribution of skills in France[2], based on the data from the survey "Budget des familles", year 1995. The median individuals have productivity equal to 13,320 euros. We obtain a lognormal distribution with mean 0.2398 and variance 0.4403. Since more than 99.99% of the population has a productivity level that is less than 5 times that of the median individuals, we set the upper productivity level to 66,600 euros and distribute the remaining population according to the same lognormal distribution between 0 and 66,600 euros.

Following d'Autume (2000), who provides simulations for the optimum tax schedule in France in the absence of individual mobility, we concentrate on the special case where there are no income effects on labor supply and the elasticity of labor supply with respect to the net-of-tax wage rate is constant. If e denotes this elasticity, the utility function is given by

$$U(x, l) = x - \frac{l^{1+1/e}}{1+1/e}. \tag{33}$$

It seems sensible to choose a benchmark value of $e = 0.2$. Using (33), one gets

$$\begin{aligned} V_A(\theta; t, m) &= \frac{\theta^{1+e}(1-t)^{1+e}}{1+e} + m, \\ V_B(\theta) - c(\theta) &= \frac{\theta^{1+e}}{1+e} - c(\theta). \end{aligned} \tag{34}$$

Migration costs are the new ingredient of our model and play therefore a large part in the determination of the optimal income tax scheme. Since our model is static, these "time-equivalent" costs as well as the utility levels should be regarded as expected values. Migration costs amount to all the costs an individual will have to pay because of his choice of migration. If these costs are used in the standard economic model of migration (see

2 Since our model does not take family size into account, the population is restricted to single individuals living in France.

Borjas, 1999), there are however few empirical works concerning their level[3]. Since psychological costs are very difficult to estimate, we propose to focus on material migration costs (transportation of persons and goods, costs of visiting the previous home country from time to time to meet family and friends, etc.). As they do not vary significantly from person to person, we concentrate on constant migration costs in the rest of the paper [$c(\theta) = c$]. In the simulation results, we consider that migration costs are paid once a year. We choose a benchmark value of 9000 euros per annum, which corresponds to the costs of migration to Australia a single person faces, and we provide a sensitivity analysis. Utility levels and social welfare are expressed in euros per year.

By (34), the participation constraint (11) at θ is equivalent to

$$V_A(\theta; t, m) \geq V_B(\theta) - c \quad \Leftrightarrow \tag{35}$$

$$m \geq \frac{\theta^{1+e}}{1+e}[1-(1-t)^{1+e}] - c = m^{\mathrm{PC}}(\theta, t; V_B - c).$$

Since $m^{\mathrm{PC}}(\theta, t; c)$ is strictly increasing in θ for $0 < t < 1$, the minimum m required to satisfy all participation constraints (11) given $V_B - c$ is

$$m^{\mathrm{PC}}(t; V_B - c) = \frac{\widehat{\theta}^{1+e}}{1+e}[1-(1-t)^{1+e}] - c. \tag{36}$$

Given t, the maximum m compatible with the tax revenue constraint (12) is

$$m^{\mathrm{TR}}(t) = \frac{t(1-t)^e}{F(\widehat{\theta})} \int_0^{\widehat{\theta}} \theta^{1+e} f(\theta) d\theta. \tag{37}$$

The tax possibility set of our French economy is thus given by

$$\Pi(V_B - c) = \left\{(t, m) : m^{\mathrm{PC}}(t; c) \leq m \leq m^{\mathrm{TR}}(t)\right\}. \tag{38}$$

The social indifference curve corresponding to the social welfare level $\overline{W}$ in the (t, m) space has equation

$$m(t) = \overline{W} - \frac{1}{F(\widehat{\theta})} \frac{(1-t)^{1+e}}{1+e} \int_0^{\widehat{\theta}} \theta^{1+e} f(\theta) d\theta, \tag{39}$$

when the government of A is utilitarian, and $m = \overline{W}$ when it is Rawlsian.

4.2. The Mercantilist Point of View

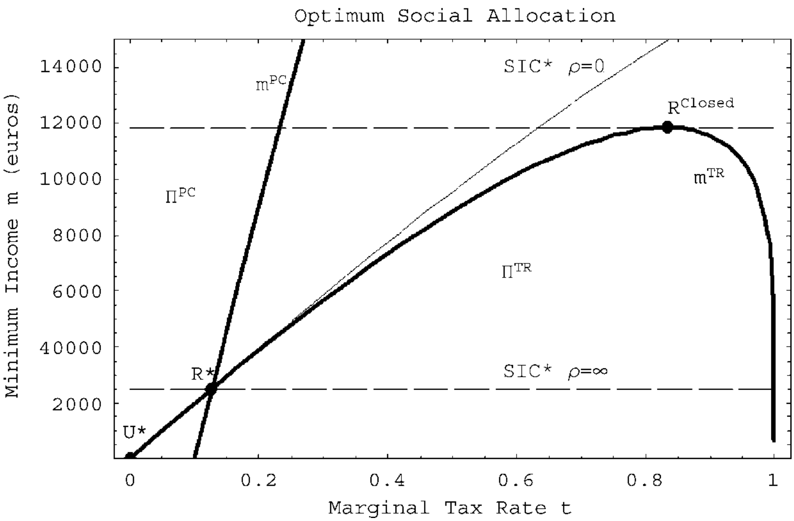
From the mercantilist point of view, the solution for the optimal linear income tax is a corner solution given by properties 1 and 3.

In figure 1, we have used (36), (37), and (39) to obtain the social optimum when migration costs are equal to 9000 euros per year. $\Pi^{\mathrm{PC}}(t, V_B - c)$ is

3 The IZA database for migration literature (http://www.iza.org/iza/en/webcontent/links/migration) provides 34 matches for "moving costs". These references are mainly theoretical or estimate the macroeconomic costs of migration.

the set of (t, m) pairs above $m^{PC}(t, V_B - c)$, whilst $\Pi^{TR}(t)$ is the set of (t, m) below the Laffer curve $m^{TR}(t)$. The tax possibility set of the economy is the intersection of both sets and is therefore significantly restricted compared with the one obtained in a closed economy $[\Pi^{TR}(t)]$. The social indifference curves associated with the highest feasible social welfare are drawn in the utilitarian (SIC* $\rho = 0$) and Rawlsian (SIC* $\rho = \infty$) cases. The utilitarian optimum (U^*) is the same as in a closed economy and corresponds to laissez-faire. The Rawlsian optimum (R^*) differs from the optimum that would be obtained in a closed economy (R^{Closed}).

Figure 1
Social Optimum Allocation in the French Economy ($c(\theta) = 9000$ euros per year)



When A's government is Rawlsian, there is a decrease in social welfare by 79% because of potential individual mobility. The indirect social welfare, equal to the minimum income m, amounts to 2493 euros per year, versus 11,846 euros if the economy were closed. Table 1 contrasts these figures with the ones obtained when A's government is not restricted to setting linear tax schemes. The loss in social welfare at the optimum due to the restriction to linear taxes is striking. Computational methods used are presented in the Appendix.

In fact, by properties 1 and 2, both instruments of the linear tax policy have to be adjusted so that the participation constraints are satisfied for the most productive $\overline{\theta}$-individuals and the tax revenue constraint is binding. Since the

Table 1

Linear versus Nonlinear Optimal Tax Schemes in the French Economy (mercantilist point of view, Rawls, c $(\theta) = 9000$ euros per year)

Social welfare	Closed economy	Open economy	Loss in welfare
Nonlinear tax	13,089	12,566	−4.0%
Linear tax	11,846	2,493	−79.0%
Loss in welfare	−9.5%	−80.2%	–

participation constraint has to be binding at $\overline{\theta}$, the highly productive individuals with $\theta < \overline{\theta}$ receive a utility greater than their reservation utility and are therefore left with a rent for staying in A (cf. figure 2). This overcompensation explains why the redistribution in favor of the less productive individuals is hugely reduced.

The magnitude of the reduction in minimum income, that is, in social welfare, depends on the cost of migration (cf. figure 3 and table 2). The higher the migration cost, the lower the reservation utility at $\overline{\theta}$ and thus the lower the rent left to the highly skilled workers. When the migration cost

Figure 2

Mercantilist Indirect Utility V_A, Reservation Utility $V_B - c$, and Indirect Utility in Closed Economy V_A^C (parameters of the French economy, $c(\theta) = 9000$ euros per year)

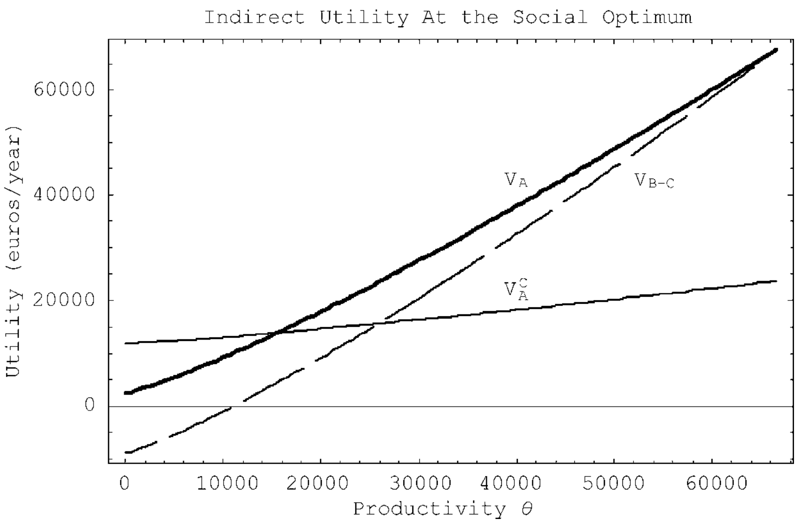


Figure 3
Indirect Social Welfare with Respect to Migration Costs from the Mercantilist Point of View for a Linear Tax Scheme (solid line) and a Nonlinear Tax Scheme (dashed line)

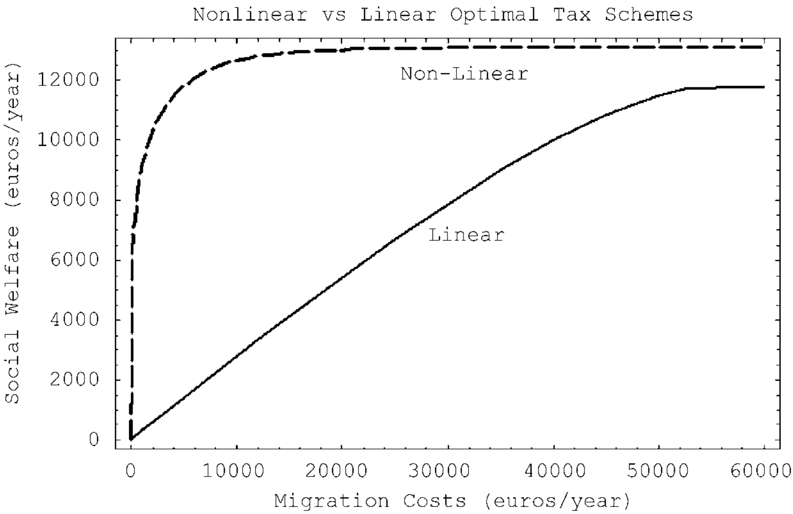


Table 2
Optimal Tax Scheme in Our French Economy (c (θ) = 9000 euros per year)

	Closed economy	With potential mobility								
c	–	0	3,000	6,000	9,000	12,000	18,000	25,000	35,000	55,500
t	83.3%	0	4.2%	8.4%	12.6%	17.0%	25.6%	35.9%	51.0%	83.3%
m	11,846	0	848	1,688	2,493	3,330	4,915	6,683	8,991	11,846
$W^M_{A,\infty}$	11,846	0	848	1,688	2,493	3,330	4,915	6,663	8,991	11,846

Notes: $\overline{c}$, m, and $W^M_{A,\infty}$ are expressed in euros per year.

becomes sufficiently high, the participation constraint is no longer active at $\overline{\theta}$, so that the difference in social welfare between the linear and nonlinear solutions is the same as in the closed economy framework[4].

4 In figure 3 and in the linear case, the elasticity of social welfare with respect to migration costs is at first almost constant, and then no longer so. Since θ^* is $\overline{\theta}$ by property 3, (36) and (37) show that an increase in migration costs results in $m^{PC}(t; V_B - c)$ going down while $m^{TR}(t)$ is unaltered. Note that, in figure 1, $m^{TR}(t)$ is almost a straight line for low marginal tax rates. Consider a slight increase in c, say at $c = 9000$. We know that the

In conclusion, these simulations confirm the theoretical properties detected in the last section. Linear taxes seem to lack degrees of freedom when the government adopts the mercantilist point of view.

4.3. The Trade-Off between Redistribution and Population Size from the Resident Point of View

We now examine if preventing emigration of all high-skilled individuals is socially optimal. Indeed, the presence in A of individuals with high outside opportunities seems to constrain the mercantilist optimal tax scheme significantly. We thus study how a change in the supremum of A's resident population, $\widehat{\theta}$, alters the tax possibility set and the social welfare from the resident point of view.

4.3.1. The Changes in the Tax Possibility Set

The changes in the tax possibility set are obtained by differentiation of (36) and (37):

$$\frac{\partial m^{\mathrm{PC}}(t; V_B - c)}{\partial \widehat{\theta}} = \widehat{\theta}^{e}[1 - (1-t)^{1+e}] > 0, \tag{40}$$

$$\frac{\partial m^{\mathrm{TR}}(t)}{\partial \widehat{\theta}} = t(1-t)^{e} \frac{f(\widehat{\theta})}{F(\widehat{\theta})} \left[\widehat{\theta}^{1+e} - \frac{1}{F(\widehat{\theta})} \int_0^{\widehat{\theta}} \theta^{1+e} dF(\theta) \right] > 0, \tag{41}$$

for all $0 < t < 1$. A reduction in $\widehat{\theta}$ results in a decrease in $m^{\mathrm{PC}}(t; V_B - c)$, which enlarges the set of tax schedules compatible with the participation constraints (11), as well as in a decrease in $m^{\mathrm{TR}}(t)$, which reduces the set of tax schedules compatible with the tax revenue constraint (12).

4.3.2. The Optimal Size of A's Resident Population

For simplicity, we focus on the Rawlsian case of our French economy to examine the trade-off between redistribution and population size.

We begin by noting that if the individuals had not the possibility of threatening to emigrate, it would always be socially optimal to add more productive individuals to A's resident population. Indeed, when no participation constraints have to be taken into account, adding more productive individuals to A's resident population slackens the tax revenue constraint (12), resulting in an increase in minimum income and social welfare. In other words, the

new corner solution is on $m^{\mathrm{TR}}(t)$ and that social welfare amounts to $m^{\mathrm{PC}}(t; V_B - c)$, since the objective is Rawlsian. Hence, the elasticity of social welfare with respect to migration costs is almost constant. This is no longer the case when $m^{\mathrm{PC}}(t; V_B - c)$ ceases to be almost linear.

social welfare obtained in a closed economy when $\widehat{\theta}$ is the supremum of the resident population,

$$W^C_{A,\rho}(\widehat{\theta}) := \max_{t,m} W^R_{A,\rho}(t, m; \widehat{\theta}) \text{ s.t. tax revenue constraint (12)}, \tag{42}$$

is monotonically increasing in $\widehat{\theta}$. An increase in population size is thus welfare-improving.

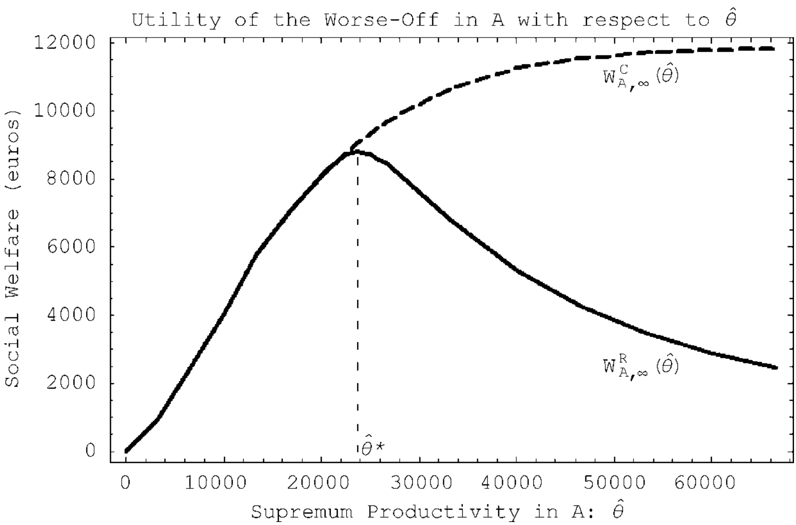
Figure 4 contrasts $W^C_{A,\infty}(\widehat{\theta})$ with the social welfare $W^R_{A,\rho}(\widehat{\theta})$ obtained from the resident point of view when the individuals with productivity greater than $\widehat{\theta}$ are allowed to emigrate. The parameters are those of our French economy with a constant migration cost of 9000 euros per year. Three points are worth noting.

First, the social welfare is not monotonic in $\widehat{\theta}$ when individuals are allowed to vote with their feet. The maximum social welfare is not obtained when the government prevents emigration of the most productive individuals who are initially living in A. Consequently, the mercantilist point of view is not the best in terms of social welfare.

Second, it is socially optimal to reduce $\widehat{\theta}$ to $\widehat{\theta}^* \approx 23{,}710$ euros. The minimum income amounts then to ≈ 8795 euros/year. The openness of the economy results therefore in a decrease in social welfare by 25.8%, versus 79% from the mercantilist point of view. In addition, the reduction in minimum

Figure 4

Indirect Social Welfare in A with Respect to $\widehat{\theta}$ (Rawls, parameters of the French economy, $c(\theta) = 9000$ euros per year)



income with respect to the mercantilist case with nonlinear taxes amounts to 27.3%.

Third, A's optimum resident population corresponds to $\approx 77.9\%$ of its initial population. Implementing a more redistributive tax schedule, despite this inducing the departure of the upper 22.1% of the national population, increases social welfare. That corresponds to the emigration of more than 13 million people from France. The magnitude of this figure depends obviously on some simplifying assumptions we made. It would be reduced if B were more redistributive or if different types of labor were complements. It should therefore be regarded as merely illustrative of the trade-off between redistribution and population size that may occur when income taxes are linear.

5. Conclusion

The mobility of highly skilled individuals for tax purposes adds a special conflict – between the government's desire to maintain the national income per capita by keeping taxes down and its desire to sustain the redistribution program – to the basic trade-off between equity and efficiency formulated by Mirrlees (1971). Our aim has been to examine the effect of this mobility on the optimal linear tax scheme that should be implemented in a Mirrleesian economy A.

When A's government adopts the mercantilist point of view and the social optimum is not the same as in a closed economy, the optimal linear tax scheme is a corner solution. The choice of A's government is thus very limited. In addition, the satisfaction of the participation constraints for the most demanding individuals is only possible if a rent is left to the other highly skilled individuals. This is detrimental to redistribution within A's resident population. Numerical simulations on French data have shown that the loss in welfare resulting from the restriction to linearity of the tax scheme can be substantial. Linear income taxes seem to lack degrees of freedom when the government wishes to prevent a reduction in the national income per capita. This lack might be even more acute if migration costs depended on more than one parameter.

The study of the resident point of view has revealed that there is a trade-off between redistribution and population size. In particular, we have given an example in which the social welfare function is not monotonically increasing with respect to the upper productivity level in A's resident population. That means that implementing a linear income tax scheme that results in the emigration of the most productive individuals initially living in A may be socially optimal. Emigration in not a source of gains in itself; it is rather a negative but still tolerable effect of the optimal policy.

Our simulations on French data depend on substantial assumptions. They are, however, illustrative. In particular, the magnitude of the optimal emigration we found stresses that the effects of the trade-off between the desire to redistribute income and the desire to maintain the national income per capita is not insignificant.

The advantages of a linear income tax are often emphasized. In a nutshell, it is the simplest income tax scheme that can be implemented. It has been alleged that it should decrease the compliance costs of the income tax, and they are significant, amounting to $75 billion in the United States, for instance (Slemrod, 1995).

Our main findings may be regarded as an argument *against* the restriction to linearity of the tax scheme. Jan Tinbergen taught us that for economic policy to work, there need to be at least as many policy instruments as there are policy goals. When taxes have to be linear, there are only two instruments at the government's disposal. The tax policy is therefore insufficiently flexible to face a large number of constraints. The effect of participation constraints on the optimal nonlinear income taxes is addressed in Simula and Trannoy (2006a) and Simula and Trannoy (2006b).

6. Appendix

We first present the methodology used to compute the optimum Rawlsian allocations for a given value of $\widehat{\theta}$ ($\widehat{\theta} = \overline{\theta}$ from the mercantilist point of view).

When the government is restricted to setting linear income taxes, the optimum tax schedule is obtained as follows:

1. We use $m^{\mathrm{PC}}(t; V_B - c)$ and $m^{\mathrm{TR}}(t)$ to determine the tax possibility set $\Pi(V_B - c)$.
2. We compute the optimal tax schedule that would be implemented in a closed economy. It is the solution to $\arg\max_{0 \leq t \leq 1} m^{\mathrm{TR}}(t)$.
3. If this allocation does not belong to $\Pi(V_B - c)$, we know by properties 1 and 3 that the optimal allocation we are looking for is at the junction of $m^{\mathrm{PC}}(t; V_B - c)$ and $m^{\mathrm{TR}}(t)$. The optimal tax schedule is thus the solution in (t, m) of the system of equations (36)–(37).

When income taxes can be nonlinear, the government's program of optimization consists in determining z_A and x_A that maximize its social objective subject to

$$\left.\begin{aligned} V_A'(\theta) &= -\frac{z_A(\theta)}{\theta} u_z'(x_A(\theta), z_A(\theta); \theta) \\ z_A'(\theta) &\geq 0 \\ V_A(\theta) &\geq V_B(\theta) - c(\theta) \end{aligned}\right\} \quad \text{for all} \quad 0 \leq \theta \leq \widehat{\theta}, \tag{43}$$

and to the tax revenue constraint (12). The constraints in (43) are the first- and second-order conditions for incentive compatibility and the participation constraints, respectively. We employ a set of sufficient conditions in order to build the optimal tax schemes. The main difficulties are that (i) the participation constraints can be binding in any subset of $[\theta, \widehat{\theta}]$, even at isolated points; (ii) the adjoint variable associated with the first-order condition for incentive compatibility can have jump discontinuities. In fact, it turns out that when migration costs are constant, we manage to construct optimal tax schemes that have the following property.

Assumption 5 Under the optimal tax scheme, there is no bunching ($z'_A > 0$), the adjoint variable associated with the first-order condition for incentive compatibility is continuous, and there is a productivity level θ_* from which the participation constraints are binding.

Lemma 1 in Simula and Trannoy (2006c) states the sufficient conditions for a tax scheme to be optimal provided assumption 5 holds. Manipulating these conditions, it is possible to establish that the optimal marginal tax rates are given by

$$\frac{T'}{1-T'} = \left(1 + \frac{1}{e^H(\theta)}\right)\frac{F(\theta_*) - F(\theta)}{\theta f(\theta)} \quad \text{for} \quad \theta < \theta_* \quad \text{and}$$
$$0 \quad \text{for} \quad \theta_* \leq \theta \leq \widehat{\theta} \tag{44}$$

when migration costs are constant. We then proceed as follows to compute the optimal allocation:

1. We choose a value of θ_*.
2. We use (44) to compute T', and derive l_A.
3. We integrate the first-order condition for incentive compatibility between 0 and θ to obtain
$$V_A(\theta) = V_A(0) + \int_0^\theta V'_A(\tau)d\tau. \tag{45}$$
We note that, by (33), $T(\theta l_A) = \theta l_A - V_A - v(l_A)$, and we substitute this expression in the the tax revenue constraint to get $V_A(0)$. Plugging $V_A(0)$ into (45), we obtain $V_A(\theta)$ for all $\theta \leq \widehat{\theta}$.
4. We check that the participation constraints are satisfied. If not, we go back to step 1 and change the value of θ_* by an increment.
5. We check that the other sufficient conditions and Assumption 5 are satisfied. If such is the case, our candidate tax scheme is socially optimal given $\widehat{\theta}$.

Further details are given in Simula and Trannoy (2006c).

To determine the optimum $\widehat{\theta}$ when we examine the resident point of view, we resort to the methodology described above to compute social welfare for a large number of $\widehat{\theta} \in [0, \overline{\theta}]$.

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