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Optimal income tax under the threat of migration by top-income earners

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ABSTRACT

We examine how allowing individuals to emigrate to pay lower taxes changes the optimal nonlinear income tax scheme in a Mirrleesian economy. An individual emigrates if his domestic utility is less than his utility abroad, net of migration costs — utilities and costs both depending on productivity. A simple formula, that complements Saez's formula obtained in closed economy, is derived for the marginal tax rates faced by top-income earners. It depends on the labour elasticity, the tax rate abroad and the migration costs expressed as a fraction of the utility obtained abroad. The Rawlsian marginal tax rates, obtained for the whole population, illustrate a curse of the middle-skilled. Simulations are provided for the French economy.

1. Introduction

In his 1971 seminal article, Mirrlees assumes that migrations are impossible but emphasizes that "since the threat of migration is a major influence on the degree of progression in actual tax systems, at any rate outside the United States, this is [an] assumption one would rather not make" (Mirrlees, 1971, p. 176). This threat of migration is certainly even more topical after four decades of increasing globalization. We focus on the international mobility of highly skilled: in 2000, the latter were 6 times more likely to emigrate than low-skilled (Docquier and Marfouk, 2005). In the OECD, many governments are actually worried about the departure of highly-skilled individuals for tax havens (OECD, 2002, 2008) and less redistributive countries. For example, about 34000 income taxpayers have left France each year since 2000 to relocate to countries with lower income taxes, like the UK, Luxembourg, Switzerland or North America (DGI, 2005). Before emigrating, these individuals paid three times more taxes than the average French taxpayer. According to the German Chamber of Commerce, the same story applies to Germany, which was left by 145000 income taxpayers in 2005. The possibility that highly skilled vote with their feet with a view to paying lower taxes appears therefore as a new constraint on the design of the optimal income tax. A specific conflict thus arises between the desire to maintain national income per capita in keeping taxes down and the aim to sustain the redistribution programme.[2]

This article studies the optimal nonlinear income tax in a Mirrleesian economy with a continuum of citizens who have type-dependent outside options consisting in emigrating to a less redistributive country whose tax policy is given. The home government wants to redistribute incomes from the more to the less productive individuals as in Mirrlees model, but also takes account of participation constraints for the individuals it wants to keep at home. An individual chooses to emigrate if his indirect utility at home is lower than his best outside option.[3] Because many empirical studies have shown that the propensity to migrate increases with the skill level, it is sensible to assume that more productive individuals have more

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[2] Governments have a more limited set of instruments than when they face tax evasion (see Chander and Wilde (1998), Sandmo (1981), Slemrod and Kopczuk (2002)). They have indeed few alternatives but to reduce taxes to prevent the departure of highly skilled: they can use "carrots" but no "sticks".

[3] This is in accordance with Hicks's idea that migration decisions are based on the comparison of earnings opportunities across countries, net of moving costs, which is the cornerstone of practically all modern economic studies of migration (Borjas, 1999, Sjaastad, 1962).

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attractive outside options.[4] In this case, the reservation utility, i.e., the minimum utility the domestic government should give to keep an individual at home, is increasing in productivity. We ensure this is the case by assuming that the cost of migration, expressed in terms of utility, depends on productivity and does not increase faster than the indirect utility abroad. Productivity is thus the only parameter of heterogeneity within the population. Because individuals have type-dependent outside options, the optimal income tax scheme in the home country must satisfy type-dependent participation constraints. We borrow these constraints from recent papers in contract theory (see Lewis and Sappington (1989), Maggi and Rodriguez-Clare (1995), and Jullien (2000)) and introduce them in Mirrlees problem.

We model an asymmetric situation in which the tax policy of a highly redistributive country is challenged by the low-tax or no-tax policy of one of its neighbours. There is no competition in taxes in the sense that the foreign country does not modify its tax policy depending on the domestic tax schedule. The model is designed to cast light on the main forces of highly skilled emigration caused by a significant asymmetry in tax levels between home and abroad. Hence, it is considered that foreigners do not emigrate to the home country. Also, both countries have the same production function because we do not want individual productivities, and thus pre-tax wages, to depend on the residence country.[5]

In order to highlight the main economic effects and intuitions, we choose to restrict attention to the case where there is no income effect on labour supply. Individual preferences over consumption and leisure are thus represented by a quasilinear-in-consumption utility function. Since most of the empirical studies give credence to small income effects relative to substitution effects as regards labour supply (Blundell, 1992, Blundell and MaCurdy, 1999), this case provides a relevant benchmark, which has been extensively used in the literature since the influential work by Diamond (1998).[6] In addition, we concentrate on the situation where the home country's policymaker maximises the well-being of its worst-off citizens (maximin).[7] Hence, we look at the most progressive tax scheme in the home country and examine to which extent it is altered in response to the tax policy abroad.[8]

Our main findings can be summarized as follows. Very simple formulae are derived for the top optimal marginal tax rates. They are valid for any social welfare function. We show that the top marginal tax rates are constant if and only if the costs of migration are linear, i.e., consist of a fixed cost (transportation costs, moving costs, etc.) and a cost proportional to the indirect utility abroad. The proportional cost corresponds to the income increment that is needed in order to make an individual perfectly indifferent between home and abroad. In this important case, the top marginal tax rates only depend on (i) the migration costs expressed as a fraction of the utility abroad, (ii) the tax rate in the foreign country and (iii) the elasticity of labour supply. This formula is compared to Saez's (2001) one. Moreover, we derive Rawlsian optimal marginal tax rates taking the threat of migration into account. Two qualitative features of the closed-economy optimal marginal tax rates are lost: they can be non-positive at interior points and strictly negative at the top. Consequently, individual mobility does not only render the tax schedule less progressive, but can also make the tax liability decreasing with gross earnings. In fact, participation constraints favour a decrease in the optimal marginal tax rates even for individuals below the productivity levels where there is an actual threat of migration. This new effect distorts the optimal marginal tax rates in such a way that optimal average tax rates are compatible with the participation constraints of the individuals threatening to emigrate.

Numerical simulations calibrated with French data are provided to quantify to which extent individual mobility alters the whole optimal tax schedule and to examine if the actual top marginal tax rate is optimal. First, they emphasize that the optimal marginal and average tax rates are significantly modified, compared to the closed-economy benchmark, even when there are very few people threatening to emigrate. In particular, the optimal average tax rates can start to decrease far below the income level from which potential mobility occurs. Consequently, when individuals are allowed to vote with their feet, there is a "curse of the middle-skilled" — consisting in them being taxed the most in proportion to gross income.

In addition, our simulations for the optimal top marginal tax rate suggest the actual French marginal tax rate – equal to 40% – might be too high to prevent French top-income earners from emigrating to very close tax havens like Monaco, Andorra, Liechtenstein and the Channel Islands. By contrast, the East-European countries, like Slovakia, Estonia or Lithuania, with a flat income tax schedule and a low marginal tax rate, do not represent a current threat for the sustainability of the French tax policy.

As far as we know, Osmundsen (1999) is the first to examine income taxation with type-dependent participation constraints. This article studies how highly-skilled individuals distribute their working time between two countries. Because it directly uses the model developed by Maggi and Rodriguez-Clare (1995), there is no individual trade-off between consumption and leisure (as in Mirrlees (1982)). Following Mirrlees (1971), our model takes this trade-off into account. In a recent article, Krause (2009) has examined income taxation and education policy when there exist conflicting incentives for individuals to understate and overstate their productivity. Highly-skilled individuals are better educated and can thus benefit from higher outside options when emigrating. Using quasilinear-in-leisure preferences and a two-type model, different possible regimes are identified but no optimal tax scheme is characterized. Moreover, several articles have adopted the viewpoint of tax competition, restricting attention to personalised lump-sum taxes (Leite-Monteiro, 1997), considering a two-type population as in Stiglitz (1982) (Hamilton and Pestieau, 2005, Huber, 1999, Piaser, 2007) or a population with many types (Brett and Weymark, 2008, Morelli et al., 2008).

The article is organized as follows. The next section sets up the model. Section 3 studies the properties of the optimal income tax rates for the individuals threatening to emigrate. Section 4 characterizes the complete optimal tax schedule. In each case, we provide numerical simulations using French data. Section 5 concludes.

2. The model

The world consists of two countries, the home country A and the foreign country B. All individuals are initially living in country A. Country A's government implements a redistributive tax policy and country B is committed to being a laissez-faire country or, more generally, a country with a low constant marginal tax rate, t_B.[9] Governments provide no public goods. Both countries have the same production function with constant returns to scale. Hence, productivity levels, equal to pre-tax wage rates, are independent of the country in which an individual is working.

Individuals differ in productivities θ, which are private information. The cumulative distribution function of θ, denoted F, is common knowledge. It is defined on $[\underline{\theta}, \overline{\theta}] := \Theta \subseteq \mathbb{R}^+$, where it admits a continuous and strictly positive density f.

[4] See Docquier and Marfouk (2005), Gordon and McCormick (1981), Hanson (2005), Inoki and Surugan (1981), Nakosteen and Zimmer (1980), Sahota (1968), Schwartz (1973).

[5] The mobility of highly skilled for tax purposes induces both losses in taxes and in productive capacities in the left countries. It differs from the "brain drain" (Bhagwati, 1976, Bhagwati and Partington, 1976) because its key parameter is not the change in productivity resulting from emigration.

[6] See Atkinson (1990), Boadway and Pestieau (2007), d'Autume (2000), Piketty (1997), Saez (2001, 2002), Salanié (1998).

[7] See Boadway and Jacquet (2008) for a recent study of the optimal tax scheme under the maximin in the absence of individual mobility.

[8] Simula and Trannoy (2009) distinguish various social objectives to deal with individual mobility and investigate whether governments should design tax schedules to prevent highly-skilled from emigrating.

[9] As in most tax havens, there is no social benefit and, thus, no basic income in country B.

2.1. Individual behaviour

All individuals have the same preferences over consumption x and labour ℓ. They are represented by the cardinal utility function U: $\mathbb{R}^+ \times \mathbb{R}^+ \to \mathbb{R}$, with $U(x, \ell) = x - v(\ell)$. The disutility of labour $v(\ell)$ is increasing and convex. Preferences are thus quasilinear in consumption as in Diamond (1998). In the following, we illustrate our results using a disutility of labour v: $\mathbb{R}_+ \to \mathbb{R}_+$ with $v(\ell) = \ell^{1+1/e}/(1+1/e)$.[10] Note that e is the constant elasticity of labour supply with respect to the net-of-tax wage rate.

A θ-individual working ℓ units of time has gross income $z := \theta\ell$. His personalised utility function in the gross-income/consumption space is

$$u(x, z; \theta) := U(x, z/\theta) = x - v(z/\theta). \tag{1}$$

Hence, his marginal rate of substitution of gross income for consumption at the (x, z)-bundle is $s(z; \theta) := v'(z/\theta)/\theta$.

Each individual decides about the optimal amount of consumption and labour to maximise his utility subject to his budget constraint $x = z - T(z)$, where $T(z)$ is the income tax function in country A. The labour supply of a θ-individual living in country A is equal to

$$\ell_A(\theta) = v'^{-1}(\theta(1 - T'(z))). \tag{2}$$

The corresponding consumption level is denoted $x_A(\theta)$ and the indirect utility in A $V_A(\theta) := U(x_A(\theta), \ell_A(\theta))$. Because country B has a constant marginal tax rate, the indirect utility there, denoted $V_B(\theta)$, is strictly increasing and convex with respect to productivity.

2.2. Emigration and participation constraints

If an individual leaves country A, he incurs a strictly positive *migration cost*, denoted c. Given the cardinality of individual preferences, this cost can be expressed as a loss in consumption, due to different material and psychic costs of moving: application fees, transportation of persons and household's goods, forgone earnings, costs of speaking a different language and adapting to another culture, costs of leaving one's family and friends, etc. Because the model is static, these costs represent the discounted value of all the costs of migration on the life cycle. These migration costs "probably vary among persons [but] the sign of the correlation between costs and wages is ambiguous," as noted by Borjas (1999, p. 12). Hence, we consider that they depend on productivities.

Only the distribution of productivities is known to country A's government. Yet, because migration costs depend on productivities, the policymaker knows the migration costs $c(\theta)$ when he knows θ. Thanks to this specification, there is only one parameter of heterogeneity within the population.

The *reservation utility* is the maximum utility that an individual staying in country A can obtain abroad. It is thus equal to the indirect utility in the foreign country, net of the cost of migration, $V_B(\theta) - c(\theta)$. We require the following:

Assumption 1. c:$\Theta \to \mathbb{R}^{++}$ is a C^2 function satisfying $c'(\theta) < V_B'(\theta)$.

This assumption amounts to considering that the outside opportunities are increasing in productivity, which is in accordance with most empirical studies.[11] Note also that it places no restriction on the *level* of the migration costs.

[10] This assumption is introduced for convenience. It can easily be relaxed.

[11] Many empirical studies have found that the propensity to migrate increases with productivity (Docquier and Marfouk, 2005, Gordon and McCormick, 1981, Hanson, 2005, Inoki and Surugan, 1981, Nakosteen and Zimmer, 1980, Sahota, 1968, Schwartz, 1973). For instance, within the EU, the migration rate of the skilled population is 8.1% versus 4.8% for the unskilled one (Docquier and Marfouk, 2005).

Two particular cases are singled out because they capture important features of the real world: *constant* and *proportional* migration costs. In addition, they make the mathematical formulae more transparent.

In the constant case, the cost of migration is a fixed cost, independent of the individual type and of any other variable. The focus is placed on material costs such as moving costs, transportation costs to visit his family and friends in the home country, etc.

In the proportional case, the cost is proportional to the indirect utility received abroad. It corresponds to the following thought experiment: how much extra money should I receive to compensate for the fact that I am not living in my home country, assuming that I would be doing the same job in both countries? The emphasis is placed on the psychological dimension of living abroad (for example, home sickness, cost of adapting to a foreign culture, etc.). It is rather natural to assume that the compensation is roughly proportional to the utility level obtained abroad, which is herein expressed in money; we write $c(\theta) = \alpha V_B(\theta)$, with $0 < \alpha < 1$. The upper bound $\alpha < 1$ follows from Assumption 1. For example, if $\alpha = 20\%$, an individual is indifferent between \$120000 abroad and \$100000 at home. Hence, he should receive at least 20000 extra dollars abroad to decide to leave his home country. This specification of the migration costs is in accordance with the common practice, for large organizations, to propose a compensation package for its employees to agree to expatriate.

The constant and proportional cases can be combined in the *linear case*:

$$c(\theta) = c + \alpha V_B(\theta). \tag{3}$$

The constant term c may stand for material costs of migration while α captures home attachment. The example of the French civil service illustrates this specification: the wages of civil servants working overseas are increased by 40% (French West Indies) to 108% (French Polynesia); moreover, the airfare to come back to France with his family is offered to every civil servant once a year.

The *location rent* of a θ-individual is the excess of his indirect utility in A over his reservation utility,

$$R(\theta) := V_A(\theta) - V_B(\theta) + c(\theta).$$

An individual stays in A if and only if his location rent is positive, i.e., $R(\theta) \geq 0$. He thus leaves A when $R(\theta) < 0$.

2.3. Social criterion and tax policy

Country A's government is a Rawlsian policymaker who intends to redistribute income, from the more to the less productive individuals, with a view to maximising the welfare of his worst-off citizens, subject to three sorts of constraints.

First, because of asymmetric information, A's government must ensure that the income tax schedule $T(z_A)$ is incentive compatible. By the revelation principle, the conditions for incentive compatibility are

$$u(x_A(\theta'), z_A(\theta'); \theta) \leq u(x_A(\theta), z_A(\theta); \theta) \quad \text{for all} \quad (\theta, \theta') \text{ in } \Theta^2. \tag{4}$$

As shown by Mirrlees (1971), the necessary conditions for (4) to be satisfied are:

$$V_A'(\theta) = \frac{z_A(\theta)}{\theta^2} v'\left(\frac{z_A(\theta)}{\theta}\right) \text{for every } \theta \text{ in } \Theta. \tag{FOIC}$$

These so-called first-order incentive compatibility conditions (FOIC) specify at which rate the indirect utility V_A must be locally increased to induce individual truthtelling. They imply that more productive individuals have higher utility in country A. Consequently, the worst-off citizens are the least productive ones. Sufficiency is guaranteed by a global monotonicity condition of gross income (Ebert, 1992):

$$z_A'(\theta) \geq 0 \text{ for every } \theta \text{ in } \Theta. \tag{SOIC}$$

In addition to informational constraints, country A's government must take participation decisions into account. Because highly-skilled individuals incur strictly positive migration costs in case of migration, it is always possible to extract positive taxes from them without inducing them to emigrate. Hence, under the maximin, it makes sense to prevent emigration to keep the state prosperous and levy taxes to increase redistribution in favour of the worst-off society's members. The tax policy is thus designed under the following participation constraints:

$$R(\theta) \geq 0 \text{ for all } \theta \text{ in } \Theta. \tag{PC}$$

Because A's government does not know who are the agents for whom the location rent $R(\theta)$ is zero, the participation constraints (PC) and the first-order incentive compatibility conditions (FOIC) have to be taken simultaneously into account for all A's residents.[12]

The last constraint is the government budget constraint:

$$\int_\Theta [z_A(\theta) - x_A(\theta)]\, dF(\theta) \geq 0. \tag{TR}$$

It captures the fact that the tax policy is purely redistributive. Because utility is increasing in consumption, it must be binding at the optimum.

The optimal nonlinear income tax problems can thus be summarized as follows.

Problem 1. Choose an income tax schedule $T(z_A)$ to maximise social welfare $W = V_A(\underline{\theta})$ subject to the conditions for incentive compatibility (FOIC) and (SOIC), the participation constraints (PC) and the government budget constraint (TR).

In the closed-economy version of Problem 1, there are no participation constraints. Let $V_A^{c\ell}(\theta)$ be the optimum indirect utility in autarky. If $V_A^{c\ell}(\theta) \geq V_B(\theta) - c(\theta)$ for every θ in Θ, allowing individuals to emigrate does not alter the social optimum obtained in autarky. For this reason, we study Problem 1 in the interesting cases where there are individuals for whom $V_A^{c\ell}(\theta) < V_B(\theta) - c(\theta)$ and, for later reference, call θ^* the minimum productivity for which participation constraints (PC) are binding.[13]

Problem 1 raises two main difficulties compared to its closed-economy analogue. First, the participation constraints (PC) can a priori bind on any subset of the resident population, even at isolated points, because the location rent $R(\theta)$ is not necessarily monotonic. Second, from the viewpoint of control theory, these constraints are "pure state constraints" because they do not directly involve control variables. The adjoint variable associated to them, denoted ι, may thus have jump discontinuities. Technically, in solving Problem 1, we assume that the adjoint variable ι has a finite number of jump discontinuities and is C^1 elsewhere.[14]

We proceed in two steps to study the impact of the threat of migration on country A's optimum tax scheme. We first derive properties which are satisfied for the individuals for whom the participation constraints are active. We then characterize the tax schedule for the other individuals. This presentation is adopted to emphasize that the optimal tax structure consists of links between pieces of both solutions.

[12] If the participation constraints (PC) were not type-dependent, it would be necessary and sufficient to check that they are satisfied at $\underline{\theta}$ since (FOIC) ensures that the optimal utility path is non-decreasing.

[13] Note that there can be productivities above θ^* for which the participation constraints $R(\theta) \geq 0$ are inactive.

[14] As is usual, we focus on continuous mechanisms which possibly exhibit kinks at a finite number of points corresponding to jumps of the marginal tax rates.

3. Optimal tax schedule for the individuals threatening to emigrate

3.1. Optimal marginal tax rates

We first derive properties which are satisfied by all optimal tax schemes for the individuals threatening to emigrate. For this purpose, we consider an interval I, of positive length, on which the participation constraints (PC) are active. By definition, for every individual in this interval, the location rent is zero ($R(\theta) \equiv 0$); consequently, the indirect utility in A and the reservation utility have the same slope ($V_A'(\theta) = V_B'(\theta) - c'(\theta)$). Combining this equality with the first-order incentive compatibility conditions (FOIC), gross income is determined as follows:

$$z_A(\theta) = \frac{\theta^2 [V_B'(\theta) - c'(\theta)]}{v'(z_A(\theta)/\theta)} \text{ every for } \theta \text{ in } I. \tag{5}$$

This allows us to derive a condition under which the sufficient conditions for incentive compatibility (SOIC) are satisfied on I. Indeed, by differentiation of (5),

$$z_A'(\theta) \geq 0 \Leftrightarrow \theta \frac{V_B''(\theta) - c''(\theta)}{V_B'(\theta) - c'(\theta)} \geq -1 \text{ for } \theta \text{ in } I. \tag{6}$$

Hence, there is *no bunching* on a non-degenerate interval I on which individuals threaten to emigrate provided (6) holds. Note that bunching cannot occur when the reservation utility is convex. Because V_B is convex under quasilinear preferences, bunching does not hold with the linear migration costs (3).

To gain further insights, we rearrange (5) and make use of the first-order condition (3) to get the labour supply of the individuals threatening to emigrate:

$$z_A(\theta) = \frac{\theta^2 [V_B'(\theta) - c'(\theta)]}{v'(\ell_A(\theta))} \Leftrightarrow \ell_A(\theta) = \frac{V_B'(\theta) - c'(\theta)}{1 - T'(z_A(\theta))}. \tag{7}$$

Moreover, when the disutility of labour is isoelastic, one gets:

$$\ell_A(\theta) = \theta^e [1 - T'(\theta \ell_A(\theta))]^e \tag{8}$$

and

$$V_B(\theta) = \frac{\theta^{1+e}}{1+e}(1 - t_B)^{1+e}. \tag{9}$$

Combining (7) and (8), the following proposition is obtained.

Proposition 1. *When the disutility of labour is isoelastic, the optimal marginal tax rates faced by individual threatening to emigrate are:*

$$T'(\theta \ell_A(\theta)) = 1 - \theta^{-\frac{e}{1+e}} [V_B'(\theta) - c'(\theta)]^{-\frac{1}{1+e}} \text{ for } \theta \text{ in } I. \tag{10}$$

This formula is well-defined thanks to Assumption 1; it does not rest on any additional assumption on the reservation utility. The sign of the marginal tax rates is determined by the slope of the migration costs, the constant marginal tax rate abroad t_B and the elasticity of labour supply e. Indeed:

Corollary 1.

$$T'(z_A(\theta)) \gtreqless 0 \Leftrightarrow c'(\theta) \gtreqless \theta^e \left[(1 - t_B)^{1+e} - 1\right].$$

When country B's implements the laissez-faire ($t_B = 0$), this inequality is very simple since it reduces to:

$$T'(z_A(\theta)) \gtreqless 0 \Leftrightarrow c'(\theta) \gtreqless 0 \text{ for } \theta \text{ in } I. \tag{11}$$

Hence, when the costs of migration are non-increasing, the theorem stating that the optimal tax function is strictly increasing at all income levels (Seade, 1982) does no longer hold. When the costs of migration are strictly decreasing in productivity, the optimal marginal tax rates faced by the individuals threatening to emigrate are strictly negative. These features contrast with two results obtained in closed economy, stating that: (i) the optimal marginal tax rates are non-negative (Mirrlees, 1971) and (ii) the optimal marginal tax rate is zero at the top if the production distribution has an upper bound (Sadka, 1976, Seade, 1977). Moreover, the optimal average tax rate and the optimal tax function are strictly decreasing in productivity on I. Therefore, progressivity of the optimal tax schedule does not only collapse because of potential mobility; the tax liability itself becomes strictly decreasing. This means that there are middle-skilled individuals insufficiently talented to leave the country who pay higher taxes than more productive individuals.

In the following proposition, we investigate under which conditions on migration costs and marginal tax rates faced by taxpayers abroad, the marginal tax rates of those threatening to emigrate are constant, i.e., under which conditions the optimal nonlinear income tax is linear on I.

Proposition 2. *(i) Suppose that the tax in B is linear. Then, the marginal tax faced by individuals threatening to emigrate is constant if and only if their migration costs are linear as in (3). (ii) Suppose that migration costs are linear. Then, the marginal tax faced by individuals threatening to emigrate is constant if and only if the tax in B is linear.*

Proof. See the Appendix. □

It is common practice for policymakers to restrict themselves to piecewise linear tax schemes. Such a practice might be supported by the above result stating that the nonlinear income tax must at least have a bracket where marginal tax rates are constant provided the migration cost as well as the foreign tax are linear. Moreover, it gives credence to the particular focus that we place on linear migration costs. The nonlinear income tax must at least have a bracket where marginal tax rates are constant provided the migration cost as well as the foreign tax are linear. Presumably, individuals threatening to emigrate include top-income earners. In that case, under the above assumptions, the marginal tax rate is constant at the top of the income distribution. This is reminiscent of an assumption introduced by Saez (2001), according to which the policymaker sets a flat marginal tax rate above a given high income level. If this income corresponds to the threshold above which individuals threaten to emigrate, we have derived conditions under which this flat marginal tax rate is actually a property of the nonlinear optimal tax scheme.[15]

We now consider constant and linear migration costs to have further insights into the determinants of the marginal tax rates faced by those threatening to emigrate.

3.1.1. Constant migration costs

Let us first consider that migration costs are constant on I. In that case, it is easy to show that $T(z_A(\theta))=c(\theta)$. The optimal tax function has thus a flat section corresponding to potentially mobile individuals paying taxes equal to their costs of migration. Consequently, because of the threat of migration, the optimal tax schedule becomes regressive: highly-skilled individuals for whom the participation constraints are binding pay less taxes in proportion to gross income than lower skilled individuals.

[15] We have shown in Simula and Trannoy (2006a) that the linear income tax imposes too much restriction to be optimal on the full range of the income distribution.

3.1.2. Linear migration costs

When migration costs and t_B are linear, the indirect utility in B is:

$$V_B(\theta) = \frac{\theta^{1+e}}{1+e}(1-t_B)^{1+e}. \tag{12}$$

so that (10) reduces to the following simple formula.

Proposition 3. *Assume that the disutility of labour is isoelastic and the costs of migration are linear. Then, the optimal marginal tax rates faced by individuals threatening to emigrate are equal to*:

$$T'(z_A) = 1-(1-t_B)(1-\alpha)^{\frac{1}{1+e}} \tag{13}$$

The marginal tax rate is therefore linearly increasing in the marginal tax rate abroad t_B, increasing in the migration cost α and decreasing in the elasticity of labour supply e. When country B implements the laissez-faire, formula (13) particularizes as:

$$T'(z_A) = 1-(1-\alpha)^{\frac{1}{1+e}} \tag{14}$$

It is worth comparing formulae (13) and (14) with those derived by Saez (2001).

In closed economy, Saez (2001) considers that the policymaker sets a flat marginal tax rate above a high level of income $\overline{z}$. Denoting the mean of incomes above $\overline{z}$ by z_m, the ratio $z_m/\overline{z}$ is almost constant for top-incomes in many countries. The upper tail of the income distribution can thus be approximated by a Pareto distribution of parameter a satisfying $a/(a-1)=z_m/\overline{z}$. Under the same assumptions as those adopted herein (Rawlsian policymaker, constant elasticity of labour supply and no income effect on labour supply), he shows that the optimal top marginal tax rate in closed economy $T'_{c\ell}(\overline{z})$ verifies:

$$T'_{c\ell}(\overline{z}) = \frac{1}{1+ea}.$$

When migration costs are very large, top-income earners do not threaten to emigrate and the marginal tax rates in open economy thus coincide with those in autarky. This is the case when α is larger than $1-[ea/(1+ea)]^{1+e}$. For example, if $e=0.5$ and $a=2$ (Pareto tail in the US), this threshold is quite large, equal to 65%, and is even larger for a less elastic labour supply.

In summary, the following formula gives a simple answer to the problem of the optimal marginal tax rate for high-income earners. It is implemented on French data in the next subsection.

Proposition 4. *Assume that the disutility of labour is isoelastic and the costs of migration are linear. Then, the optimal top-income marginal tax rates in open economy T'_O are given by*:

$$T'_O(z_A) = \min\{T'(z_A), T'_{c\ell}(\overline{z})\}. \tag{15}$$

3.2. Is the French top-income tax rate optimal?

Our model is well-suited to examine whether the French top-income tax rate – equal to 40% – is optimal. First, according to Laroque (2005), the objective pursued by the French government in recent years seems to be close to a Rawlsian criterion. Second, France is confronted with the fiscal competition of different neighbour countries: tax havens like Monaco and Andorra, or less redistributive countries like Switzerland and Luxembourg. More generally, the top income marginal tax rates are around 40% in the UK and 35% in the US, while a number of Eastern European countries have introduced flat taxes (e.g., 21% in Estonia or 19% in Slovakia) (KPMG, 2008).

For the French economy, the Pareto index a is approximately equal to 2.25; the value of the taxable income elasticity is around 0.15

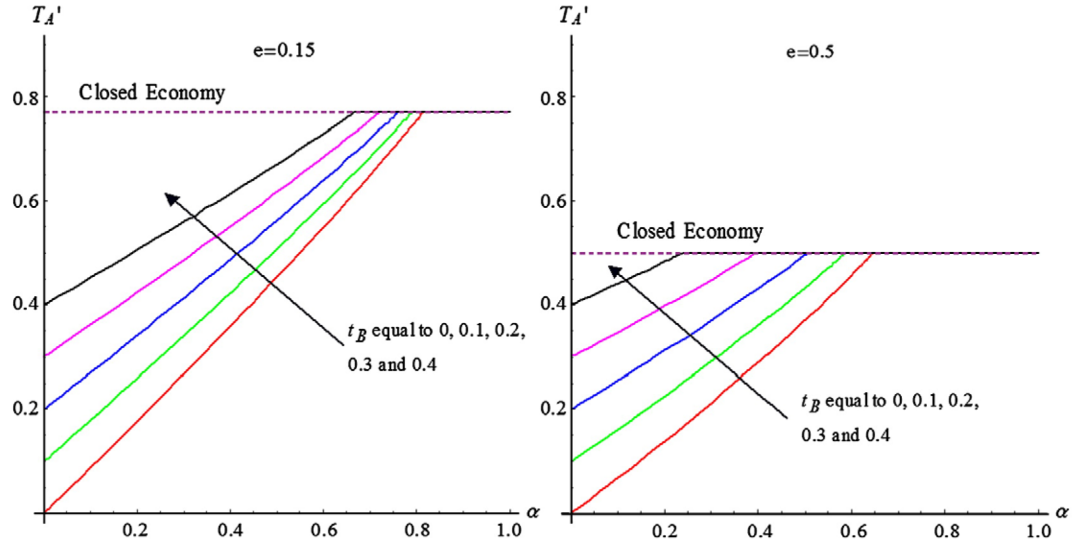

Fig. 1. Top Flat Marginal Tax Rates under the Threat of Migration (Proportional Migration Costs).

for the top 0.1% of the income distribution, but might be equal around 0.5 for self-employed (Landais, 2008). Hence, we provide simulations for both values. Simulations are shown in Fig. 1 for t_B ranging between 0 and 0.4.

Assume that the actual French income tax scheme is optimal in the sense that it solves Problem 1. The question at stake is: for which values of the parameters the actual top marginal tax rate of 40% is obtained? We consider that the migration costs are linear.

When top-income earners are perfectly mobile ($\alpha = 0$), the actual top marginal tax rate is almost optimal only if the tax competition takes place with countries implementing the same top-income tax rate.

Regarding the competition with tax havens, it is optimal if the migration cost parameter is equal to $\alpha = 0.44$ when $e = 0.15$ and $\alpha = 0.53$ when $e = 0.5$. These migration costs seem to be quite large regarding tax havens at the gate of France like Monaco,[16] Andorra, Liechtenstein and the Channel Islands. Consequently, the actual French marginal tax rate would be too high to prevent French top-income earners from emigrating to these countries.

For countries farther away, like Slovakia where flat tax rates are around 20% over the whole income range, the French schedule is a best response when the migration cost parameter is equal to $\alpha = 0.28$. We have no empirical evidence regarding the value of α for French citizens emigrating to this country. Yet, it seems relatively low, which might suggest that Slovakia does not represent a current threat for the sustainability of the French tax policy.

If this exercise is necessarily illustrative, it shows the direct applicability of the tax formula derived above for top-income earners threatening to emigrate. We now examine the implications of the threat of migration for the remaining individuals.

4. Optimal tax schedule

4.1. Optimal marginal tax rates

We proceed by studying the optimal income tax problem without focusing on the individuals who threaten to emigrate. From now on, we concentrate on the case where the elasticity of labour supply is constant.

For expositional purposes, we follow the first-order approach and, thus, ignore the sufficient condition for incentive compatibility (SOIC), which can be verified ex post. Because $V_A(\theta) = x_A(\theta) - v(\ell_A(\theta))$ by definition of the indirect utility in A, the government budget constraint (TR) can be rewritten as $\int_\Theta [\theta\ell_A(\theta) - V_A(\theta) - v(\ell_A(\theta))]\,dF(\theta)$ and $x_A(\theta)$ eliminated from the optimization programme. Problem 1 is therefore equivalent to

$$\max_{\{V_A,\ell_A\}} V_A(\underline{\theta}) \text{ s.t. } \int_\Theta [\theta\ell_A(\theta) - V_A(\theta) - v(\ell_A(\theta))]\, f(\theta)\, d\theta \geq 0, \tag{16}$$
$$V_A'(\theta) = \ell_A(\theta) v'(\ell_A(\theta)) / \theta,$$
$$R(\theta) \geq 0.$$

The control variable is $\ell_A(\theta)$ and the state variable is $V_A(\theta)$. We call $\iota(\theta)$ the costate variable and $\pi(\theta)$ the multiplier of the participation constraint $R(\theta) \geq 0$. The Hamiltonian and Lagrangian are:

$$H = V_A(\underline{\theta}) + \gamma[\theta\ell_A(\theta) - V_A(\theta) - v(\ell_A(\theta))]\, f(\theta) + \iota(\theta) \frac{\ell_A(\theta)}{\theta} v'(\ell_A(\theta)) f(\theta), \tag{17}$$
$$L = H + \pi(\theta) R(\theta).$$

By Theorem 2 in Seierstad and Sydsaeter (1987, p. 332–335),[17] the necessary conditions for an interior maximum are:

$$\partial H / \partial \ell_A = \gamma[\theta - v'(\ell_A(\theta))] f(\theta) + \iota(\theta)\left(\frac{v'(\ell_A(\theta))}{\theta} + \frac{\ell_A(\theta)}{\theta} v''(\ell_A(\theta))\right) = 0, \tag{18}$$

$$\partial L / \partial V_A = -\iota'(\theta) \Leftrightarrow \iota'(\theta) = \gamma f(\theta) - \pi(\theta), \tag{19}$$

$$\iota(\overline{\theta}) \geq 0 (= 0 \text{ when } R(\overline{\theta}) > 0), \tag{20}$$

$$1 + \iota(\theta) \leq 0 (= 0 \text{ when } R(\underline{\theta}) > 0), \tag{21}$$

$$\pi(\theta) \geq 0 \ (= 0 \text{ when } R(\theta) = 0). \tag{22}$$

First, note that the least productive individuals must be better off in country A than in the laissez-faire country because the policy-maker's objective is to maximise $V_A(\underline{\theta})$. Hence, the location rent $R(\underline{\theta})$

[16] In fact, a convention stipulates that French citizens living in Monaco pay the same income tax as in France.

[17] The necessary conditions are often stated for state variables which are fixed at the initial point, which is not the case presently. We have used Seierstad and Sydsaeter (1987, Theorem 5, p. 185, Eq. (30b)) to obtain (21).

is strictly positive and, by (21), $\iota(\underline{\theta})=-1$. Integrating $\iota'(\theta)$ between $\underline{\theta}$ and θ, we obtain:

$$\iota(\theta) = \iota(\overline{\theta}) - \int_\theta^{\overline{\theta}} [\gamma f(\tau) - \pi(\tau)] d\tau = \iota(\overline{\theta}) + \int_\theta^{\overline{\theta}} \pi(\tau) d\tau - \gamma[1-F(\theta)]. \quad (23)$$

Because of the interaction between the participation constraint and the incentive compatibility constraint at the top, the transversality condition at the top (20) is not that the costate variable $\iota(\overline{\theta})$ is equal to zero (even when $\overline{\theta}$ tends to infinity). In fact, $\iota(\overline{\theta})$ represents the cost of a slight increase in the outside option $V_B(\overline{\theta})-c(\overline{\theta})$ of the top individuals. Consequently, we may regard

$$\Pi(\theta) := \frac{1}{1-F(\theta)} \frac{\iota(\overline{\theta}) + \int_\theta^{\overline{\theta}} \pi(\tau) d\tau}{\gamma} \quad (24)$$

as the average cost, in terms of social welfare, of a slight uniform increase in the outside options for all individuals with productivity above θ. Note that this cost is positive. Combined with the fact that $T'(z_A(\theta))=1-v'(\ell_A(\theta))/\theta$ and $e=v'(\ell_A(\theta))/[\ell_A(\theta)v''(\ell_A(\theta))]$, the following proposition is obtained from (18).

Proposition 5. *The optimal marginal income tax rates are*:

$$\frac{T'(z_A(\theta))}{1-T'(z_A(\theta))} = \left(1+\frac{1}{e}\right)\left(\frac{1-F(\theta)}{\theta f(\theta)}\right)(1-\Pi(\theta)) \text{ for every } \theta \text{ in } \Theta. \quad (25)$$

In order to cast light on the underlying economic effects, we now present a direct proof of Proposition 5 using a small tax income perturbation around the optimum schedule as in Piketty (1997) or Saez (2001).

Direct proof

For convenience, we assume that $\underline{\theta}=0$. Hence, the maximin objective coincides with the maximization of tax receipts in country A. Let us consider that all individuals face the optimum schedule and that the marginal tax rate is slightly increased by dT' for the individuals with incomes between z and $z+dz$. This perturbation has three effects on social welfare, captured through changes in tax revenue G.

Mechanical effect

All individuals with incomes above z pay additional taxes, equal to $dT'\times dz$. Since their proportion is given by $1-F(\theta_z)$, the increase in tax receipts amounts to:

$$dG^+ := (1-F(\theta_z)) \times dT' \times dz. \quad (26)$$

Elasticity effect

Because the net-of-tax wage rate of the individuals with income between z and $z+dz$ decreases from $\theta_z(1-T')$ to $\theta_z(1-T'-dT')$, i.e., by $dT'/(1-T')$%, these $f(\theta_z)\times d\theta$ individuals reduce gross income by $e\times dT'/(1-T')\times z\times f(\theta_z)d\theta$. The resulting loss in tax revenue is thus $dG_1^- := T'\times e\times dT'/(1-T')\times z\times f(\theta_z)d\theta$. Using the fact that $d\theta = dz/[\ell\times(1+e)]$ by definition of e, we have:

$$dG_1^- = \frac{T'}{1-T'}\frac{e}{1+e} \times \theta_z \times f \times dT' \times dz. \quad (27)$$

Participation effect

Individuals already threatening to emigrate prior to the tax reform have to receive further compensation for staying in A. Because preferences are quasilinear in consumption, every individual threatening to emigrate must receive $dT'\times dz$ additional euros to stay in A. Because $(1-F(\theta_z))\times\Pi(\theta_z)$ is the total cost of a uniform increase in the location rent above θ_z before the tax reform, tax receipts are decreased by:

$$dG_2^- := [1-F(\theta_z)] \times \Pi(\theta_z) \times dT' \times dz. \quad (28)$$

There are also new individuals for whom the location rent, which decreases from $R(\theta)$ to $R(\theta)-dT'\times dz$, becomes negative. These individuals must receive a compensation equal to $dT'\times dz-R(\theta)$, which is inferior to $dT'\times dz$ because their location rent $R(\theta)$ was previously strictly positive. The corresponding reduction in tax receipts is $[1-F(\theta_z)]\times d\Pi(\theta_z)\times[dT'\times dz-R(\theta)]$, which is second-order compared to the other changes, and thus can be neglected.

At the social optimum, the small tax reform has no first-order effect. Hence, we must have $dG^+=dG_1^-+dG_2^-$, from which (25) is obtained. □

The marginal tax rates in open economy are therefore the product of three factors. The two first factors in (25) are well known: the first captures efficiency; the second takes demographic components into account. The third factor is new and captures the participation effect. The optimal marginal tax rate formula (25) allows us to directly compare the marginal tax rates in open economy with those obtained in closed economy, equal to:

$$\frac{T'_{c\ell}}{1-T'_{c\ell}} = \left(1+\frac{1}{e}\right)\left(\frac{1-F(\theta)}{\theta f(\theta)}\right). \quad (29)$$

Corollary 2. *Because $\Pi(\theta)$ is positive, the participation effect reduces all marginal tax rates with respect to autarky.*

Hence, the decline in the marginal tax rates also takes place on a range of gross incomes preceding that on which individuals hesitate to leave the country. This is because increasing the marginal tax rates at θ makes the compensation of all more productive individuals threatening to emigrate more expensive in terms of social welfare. To gain further insights, it is useful to define θ^* as the *minimum productivity for which there are individuals threatening to emigrate*. The shadow cost $\pi(\theta)$ of the participation constraint $R(\theta)\geq 0$ is thus equal to zero up to this threshold. This implies that:

$$\Pi(\theta) = \frac{1-F(\theta^*)}{1-F(\theta)}\Pi(\theta^*) \text{ for } \theta \leq \theta^*. \quad (30)$$

Because this expression is strictly increasing, the average compensation required to satisfy the participation constraints goes up when θ is closer to θ^*.

The threat of migration has also an impact on the curvature of the tax scheme. Indeed, if T'' and $T''_{c\ell}$ denote the derivative of T' and $T_{c\ell}$ with respect to θ in open and closed economy respectively, routine computations yield: $T''=T''_{c\ell}\times(1-\Pi(\theta))-T_{c\ell}\times\Pi'(\theta)$. Below θ^*,

$$\Pi'(\theta) = f(\theta)\frac{1-F(\theta^*)}{(1-F(\theta))^2}\Pi(\theta^*) > 0. \quad (31)$$

Therefore, $T''<T''_{c\ell}$.

Corollary 3. *In open economy and for a given skill level θ below θ^*, marginal tax rates always increase at a slower pace than in autarky.*

A simple application of this result pertains to a population with Pareto distribution. In this case, the demographic factor in (25) is constant, equal to $1/a$. The optimal tax rates in autarky are thus constant. It is no longer the case with the threat of migration, where the optimal tax is decreasing up to θ^*.

As previously noted, the optimal tax scheme is the junction between two kinds of pieces: those describing marginal tax rates faced by individuals threatening to emigrate and those for which the participation constraints are inactive. In general, the set on which participation constraints are active may consist of several (disjoint) intervals.

It is interesting to take stock of the previous results when there is a cutoff income above which individuals threaten to emigrate. Marginal tax rates are then given by:

$$\frac{T'(z_A(\theta))}{1-T'(z_A(\theta))} = \begin{cases} \left(1+\frac{1}{e}\right)\frac{1/\gamma - F(\theta)}{\theta f(\theta)} & \text{for } \theta<\theta^*, \\ \theta^{\frac{e}{1+e}}[V_B'(\theta)-c'(\theta)]^{-\frac{1}{1+e}}-1 & \text{for } \theta\geq\theta^*. \end{cases} \tag{32}$$

It can be proved that this is the case when migration costs are constant and $t_B = 0$. Hence, by (25) whose first two factors are strictly positive, it must be $\Pi(\theta) = 1$. Because $\pi(\theta)$ is non-negative, the implication is that the participation constraints are binding for all richer individuals, with productivity above θ, if they are active for the θ-individuals.

4.2. Empirical application

We already know that individual mobility is harmful to progressivity and significantly alters the qualitative properties of the optimal non-linear income tax schedule. It remains to *quantify* the magnitude of the changes with respect to the closed-economy model. In particular, we want to examine whether potential mobility of a few highly-skilled individuals has more than a negligible effect on the optimal policy. For this purpose, we calibrate country *A*'s economy so that it roughly corresponds to the French one.

4.2.1. Calibration

Following Mirrlees (1971) and Tuomala (1990), it is standard to use a lognormal distribution to describe the distribution of productivities. Yet, as shown by Diamond (1998) and Saez (2001), the upper tail of the income distribution is better described by a Pareto distribution. We employ a lognormal distribution for the lower part of the productivity distribution and complete it with a Pareto tail.

The parameters of the lognormal distribution are obtained using the true distribution of job skills among employed as portrayed in Fig. 4 in Laslier et al. (2003).[18] We get a mean of 0.2398 and a variance of 0.4403.[19]

As recently shown by Landais (2008), the value of the Pareto index of the *income* distribution is slightly higher in France than in the US, between 2 and 2.25 in France against 2 in the US (Saez, 2001). So as not to overestimate the number of highly skilled who vote with their feet, we choose the thinnest upper tail, i.e., a value of 2.25. For a given elasticity of labour supply e, the underlying *skill* distribution has a Pareto index equal to $a = 2.25 \times (1+e)$ and a density $f(\theta) = K/\theta^{1+a}$. Regarding the elasticity of labour supply, we choose $e = 0.2$ as in d'Autume (2000). Hence, $a = 2.7$.

We choose the scale parameter K and the boundary between the lognormal and Pareto distributions in such a way that the entire distribution is continuously differentiable. We normalize productivity levels so that the median individual has productivity equal to the median income in 1995, i.e., 13 320 euros.

Migration costs are the new ingredient of our model. They correspond to all the costs an individual has to pay because of his choice of migration. Because the model is static, these costs as well as the utility levels should be regarded as expected values. Very few empirical work have studied the individual costs of migration.[20] We use constant costs as a benchmark and calibrate them so as to reflect plausible scenarios as regards the proportion of individuals threatening to emigrate: 10%, 5%, 3%, 1%, 0.5% and 0.1%. We obtain migration costs equal to 11 150, 18 200, 25 100, 46 000, 64 050 and 114 800 euros per annum respectively.

4.2.2. Results

Figs. 2–4 and Table 1 in the Appendix contrast the second-best optimal allocations for constant migration costs in the six scenarios described above. For instance, when 3% of the population threaten to emigrate, the social welfare, equal to the redistributive budget under the maximin, is reduced by 4.4%. The individuals paying the maximum average tax have gross income $\hat{z}_A = 52\,593$€/year. The optimal average tax rates are decreasing above this level, even if the participation constraints are only active for individuals with gross income above $z_A^* = 68\,796$€/year. The range of decrease corresponds to 4.4% of the population. Even if the individual and social utility levels do only slightly vary compared to the benchmark, Fig. 2 emphasizes that the changes in the tax schedule are very noticeable, even when the proportion of potentially mobile individuals is very low.

Specifically, even if the average tax rate profile is already single-peaked in closed-economy, the corresponding graphs are far more hump-shaped when the threat of migration goes up (Fig. 2—Middle). The

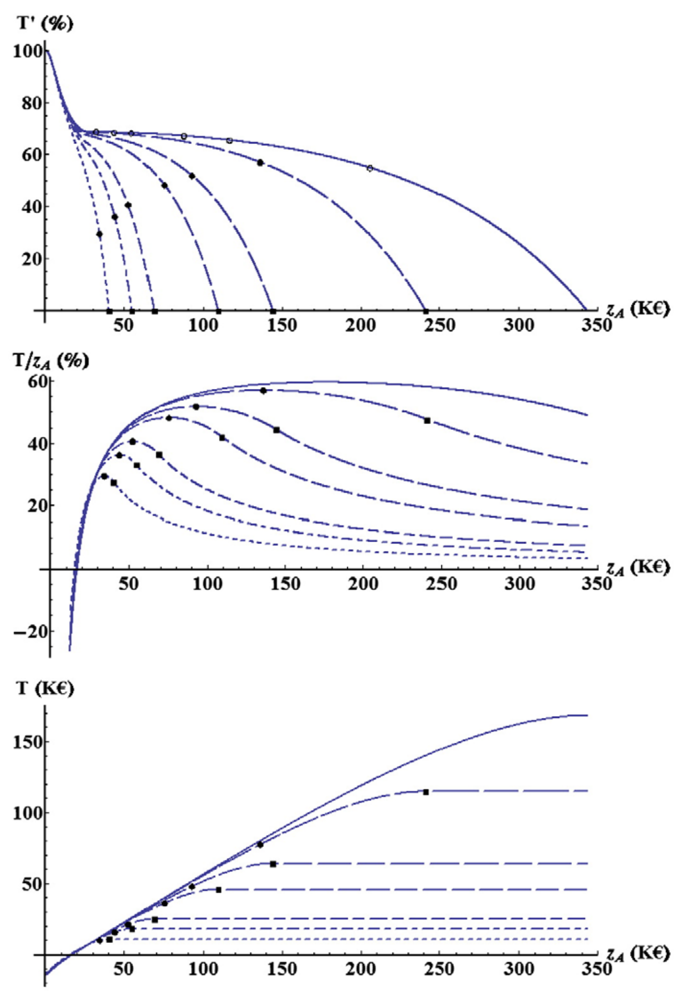

Fig. 2. Constant Migration Costs. (Top) Optimal Marginal Tax Rates; (Middle) Optimal Average Tax Rates; (Bottom) Optimal Taxes. The solid line refers to the closed-economy benchmark. Otherwise, the less dotted the line, the lower the threat of migration: 10%; 5%; 3%; 1%; 0.5% and 0.1% respectively. Empty circles on the top panel correspond to the choice the θ^*-individuals would make if the economy were closed for the different migration costs; squares to $\hat{z}_A$; black circles to z_A^*.

[18] The data come from the French survey data "Budget des familles", year 1995. Our estimations are in tune with those of Hungerbühler et al. (2006).

[19] Since our model does not take the family size into account, the population is restricted to single individuals. To describe the French economy, Hungerbühler, Lehman, Parmentier, and Van der Linden (2006) use a mean of 0.2 and a variance of 0.4.

[20] For instance, the IZA Database for Migration Literature provides 34 matches for "moving costs" (http://www.iza.org/iza/en/webcontent/links/migration). These references are mainly theoretical or estimate the macroeconomic costs of migration.

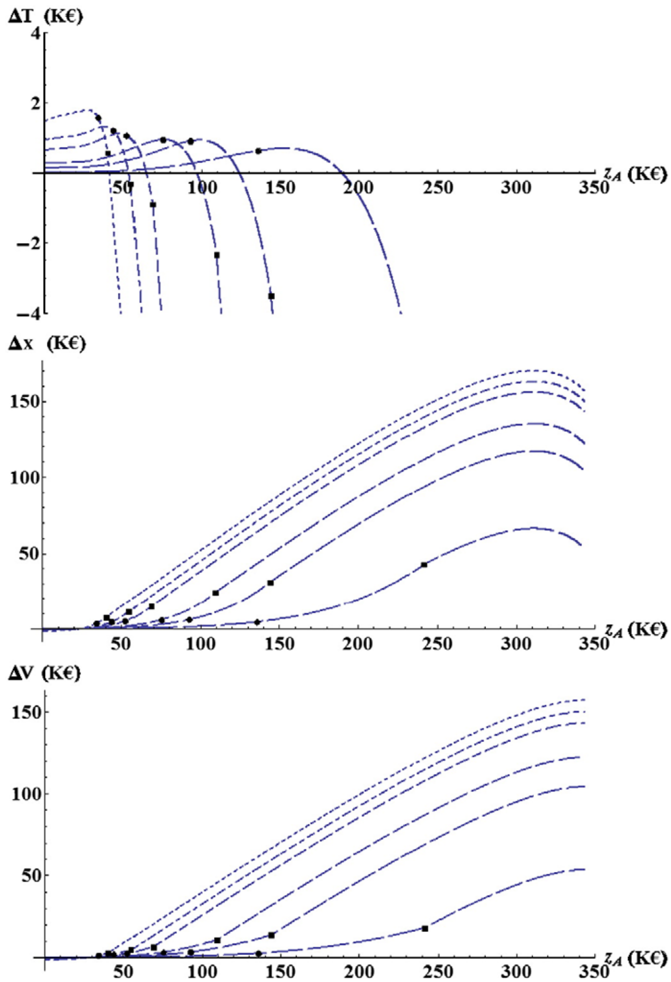

Fig. 3. Constant Migration Costs. Increase w.r.t closed-economy benchmark: (Top) Taxes; (Middle) Consumption; (Bottom) Utility. The less dotted the line, the lower the threat of migration: 10%; 5%; 3%; 1%; 0.5%, 0.1% respectively. Squares correspond to $\hat{z}_A$; circles to z_A^*.

lower bound $\hat{z}_A$ of the range of gross income from which the average tax rate is decreasing (cf. the black circles) is smaller than the gross income z_A^* from which the participation constraints are active (cf. the squares).

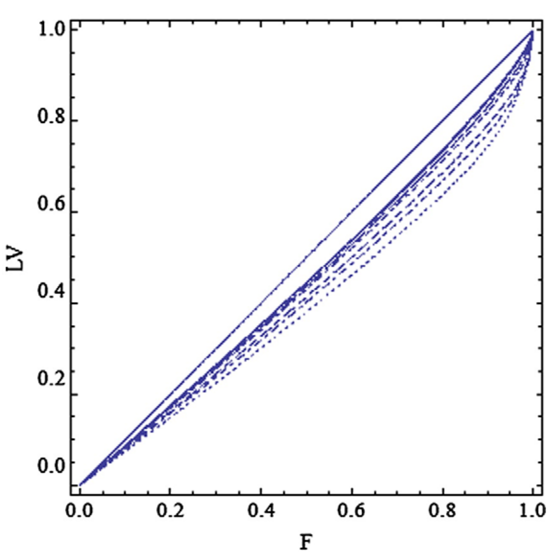

Fig. 4. Constant Migration Costs. The less dotted the line, the lower the threat of migration: 10%; 5%; 3%; 1%; 0.5%, 0.1% respectively. The solid line below the 45°-line pertains to the closed-economy benchmark.

Interestingly, the smaller the proportion of the population threatening to emigrate, the larger the gap between $\hat{z}_A$ and z_A^* as well as the ratio

$$\frac{1-F(\theta_{\hat{z}_A})}{1-F(\theta_{z_A^*})}. \tag{33}$$

The latter is approximately equal to 1.2, 1.3, 1.5, 1.8, 2.1, and 3.7 for potential emigration by 10%, 5%, 3%, 1%, 0.5%, and 0.1% of the population.

Table 1
Optimum allocations (Maximin, $e=0.2$, constant migration costs).

Threat by 0% of the population (Benchmark), $W=14797$€						
$F(\theta)$	V_A		z_A	$T(z_A)$	$T'(z_A)$	$T(z_A)/z_A$
0.05	14822€		3991€	−10858€	96.0%	−272.0%
0.50	15724€		13952€	−2303€	71.1%	−16.5%
0.95	25102€		52087€	+24244€	68.4%	+46.5%
Threat by 10% of the population						
$W=13329$€ (Loss = −9.9%); $\hat{z}_A=34462$€; $z_A^*=40570$€; $1-F(\theta_{\hat{z}A})=12.4\%$.						
$F(\theta)$	V_A	$\Delta V_A\%$	z_A	$T(z_A)$	$T'(z_A)$	$T(z_A)/z_A$
0.05	13357€	−9.9%	4077€	−9309€	95.5%	−228.3%
0.50	14423€	−8.3%	14448€	−631€	72.8%	−4.4%
0.95	43518€	+73.4%	65595€	+11145€	00.0%	+17.0%
Threat by 5% of the population						
$W=13868$€ (Loss = −6.3%); $\hat{z}_A=44142$€; $z_A^*=55088$€; $1-F(\theta_{\hat{z}A})=6.8\%$.						
$F(\theta)$	V_A	ΔV_A	z_A	$T(z_A)$	$T'(z_A)$	$T(z_A)/z_A$
0.05	13895€	−6.3%	4033€	−9890€	95.8%	−245.3%
0.50	14871€	−5.4%	14186€	−1273€	75.1%	−9.0%
0.95	36466€	+45.3%	65595€	+18196€	00.0%	+27.7%
Threat by 3% of the population						
$W=14146$€ (Loss = −4.4%); $\hat{z}_A=52593$€; $z_A^*=68796$€; $1-F(\theta_{\hat{z}A})=4.4\%$.						
$F(\theta)$	V_A	ΔV_A	z_A	$T(z_A)$	$T'(z_A)$	$T(z_A)/z_A$
0.05	14172€	−4.4%	4016€	−10184€	95.9%	−253.6%
0.50	15118€	−3.9%	14090€	−1592€	76.0%	−11.3%
0.95	29886€	+19.1%	62979€	+24529€	18.4%	+38.9%
Threat by 1% of the population						
$W=14520$€ (Loss = −1.9%); $\hat{z}_A=75302$€; $z_A^*=109444$€; $1-F(\theta_{\hat{z}A})=1.8\%$.						
$F(\theta)$	V_A	ΔV_A	z_A	$T(z_A)$	$T'(z_A)$	$T(z_A)/z_A$
0.05	14545€	−1.9%	3999€	−10573€	96.0%	−264.4%
0.50	15461€	−1.7%	13997€	−2006€	76.8%	−14.3%
0.95	26002€	+3.6%	54529€	+24918€	60.3%	+45.7%
Threat by 0.5% of the population						
$W=14650$€ (Loss = −1.0%); $\hat{z}_A=92766$€; $z_A^*=144200$€; $1-F(\theta_{\hat{z}A})=1.1\%$.						
$F(\theta)$	V_A	ΔV_A	z_A	$T(z_A)$	$T'(z_A)$	$T(z_A)/z_A$
0.05	14615€	−0.99%	3995€	−10707€	96.0%	−268.0%
0.50	15584€	+0.89%	13975€	−2146€	76.9%	−15.4%
0.95	25499€	+1.6%	53223€	+23703€	64.8%	+46.2%
Threat by 0.1% of the population						
$W=14775$€ (Loss = −0.14%); $\hat{z}_A=135998$€; $z_A^*=241357$€; $1-F(\theta_{\hat{z}A})=0.4\%$.						
$F(\theta)$	V_A	ΔV_A	z_A	$T(z_A)$	$T'(z_A)$	$T(z_A)/z_A$
0.05	14800€	−0.14%	3992€	−12117€	96.1%	−271.4%
0.50	15703€	−0.13%	13811€	+13957€	77.1%	−16.3%
0.95	25183€	+0.32%	51065€	+23434€	71.4%	+46.5%

Note: "Loss" in social welfare W w.r.t. autarky; $\hat{z}_A := z_A$ such that $T(z_A)=z_A$ maximum; $z_A^* := \min z_A$ with (PC) active; $(\hat{z}_A; z_A^*)$ = range of decrease in $T(z_A)=z_A$ before (PC) active; $1-F(\theta_{\hat{z}A})$ = % agents with $T(z_A)=z_A$ decreasing; $\Delta V_A :=$ change in V_A w.r.t. benchmark.

For example, when the threat of migration only concerns the top 0.1% of the income distribution, there are six times more individuals for whom the average tax rate is decreasing. In this respect, the threat of migration seems to have a multiplicative power all the stronger as fewer people would like to emigrate. It is really a feature that only simulations may reveal.

Fig. 3 contrasts the open and closed optimal allocations from a distributional viewpoint. The highly skilled appear as the real winners, since they pay less taxes (Fig. 3—Top) and have higher utility (Fig. 3—Bottom). The situation of the low-skilled does not worsen as much as one could expect as shown in the Middle Panel of Fig. 3. Yet, they are the only group of the population which suffers from a loss in disposable income and well-being. It is only when the threat of migration concerns a relatively large group (the last twentile) that the loss becomes quite large.

Individuals with gross income close to $\hat{z}_A$ are actually the real losers in terms of taxes because their loss in taxes is always close to the largest one.[21] Nevertheless, they slightly benefit from the openness of the economy in terms of utility. In fact, the decline in marginal tax rates allows them to increase their gross and net income sufficiently to overbalance the resulting loss in leisure (Fig. 3—Middle). Consequently, the deterioration of the middle-skilled workers' situation in terms of taxes does not translate into losses in individual welfare as observed in the first-best. In spite of this rather comforting result, inequality of utilities deepens (Fig. 4).

5. Conclusion

Key qualitative features of the optimal income tax policy obtained in closed economy do no longer hold when highly-skilled individuals are allowed to vote with their feet. A small tax reform perturbation around the optimum has a new participation effect, which does not only favour a decrease in the optimal marginal tax rates; it can also make them strictly negative. Consequently, the optimal average tax rates as well as the optimal tax liabilities can be decreasing.

Numerical simulations show that the threat of migration has a significant impact even when the proportion of potentially mobile individuals is very low. They also reveal that if the highly skilled are the real winners, the welfare of the low-skilled is not very significantly reduced because quite high taxes can still be levied on the middle-skilled. Hence, our qualitative and quantitative results convey the idea of a curse of the middle-skilled workers: because they are the richer among those who are not rich enough to threaten to leave the country, they incur the larger part of the deadweight loss of taxation.

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[21] This "curse of the middle-skilled" is even stronger when migration costs are decreasing in productivity: the optimal income tax schedule is not only less progressive but also such that the highly-skilled pay total taxes lower than the middle-skilled. Cf. Simula and Trannoy (2006b).

Appendix A

Proof of Proposition 2. With the notation $D(\theta) := V_B(\theta) - c(\theta)$, one gets: $T'(\theta\ell_A(\theta)) = 1 - \theta^{-\frac{e}{1+e}}[D'(\theta)]^{\frac{1}{1+e}}$. Hence,

$$T_A'' = 0 \Leftrightarrow [D'(\theta)]^{\frac{1}{1+e}}\left[-\frac{e}{\theta} + D'(\theta)^{-1}D''(\theta)\right] = 0 \Leftrightarrow D'(\theta) = 0 \text{ or } D''(\theta) = \frac{e}{\theta}D'(\theta). \tag{A.1}$$

The general solution is:

$$D(\theta) \equiv V_B(\theta) - c(\theta) = \beta\frac{\theta^{1+e}}{1+e} + k. \tag{A.2}$$

(i) By assumption, t_B is linear. So, substituting (9) in (A.2) and rearranging,

$$c(\theta) = V_B(\theta)\left[1 - \frac{\beta}{(1-t)^{1+e}}\right] - k. \tag{A.3}$$

(ii) By assumption, migration costs are linear: $c(\theta) = \alpha V_B(\theta) + c$. Hence, by (A.2), $V_B(\theta) = \left(\beta\frac{\theta^{1+e}}{1+e} + k\right)/(1-\alpha)$. Then,

$$V_B'(\theta) = \frac{\beta}{1-\alpha}\theta^e. \tag{A.4}$$

In addition, given a nonlinear income tax schedule in B, V_B can be written as: $V_B = \theta\ell_B(\theta) - t_B(\theta\ell_B(\theta)) - v(\ell_B(\theta))$, where $\ell_B(\theta)$ is the optimal labour supply in B. Therefore, $V_B'(\theta) = \ell_B(\theta)[1 - t_B'(\theta\ell_B(\theta))]$. Because $\ell_B(\theta) = \theta^e[1 - t_B'(\theta\ell_B(\theta))]^e$, one gets:

$$V_B'(\theta) = \theta^e[1 - t_B'(\theta\ell_B(\theta))]^{1+e}. \tag{A.5}$$

Equating (A.4) and (A.5),

$$\frac{\beta}{1-\alpha}\theta^e = \theta^e[1 - t_B'(\theta\ell_B(\theta))]^{1+e} \Leftrightarrow t_B'(\theta\ell_B(\theta)) = 1 - \left(\frac{\beta}{1-\alpha}\right)^{\frac{1}{1+e}},$$

which is constant. □

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