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Migration, wages and income taxes

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Abstract We analyze labor migration flows between two countries (regions) with different-sized populations and different levels of productive efficiencies to determine the effects of such flows on income taxation. The residents are heterogeneous because they incur different migration costs, although they are otherwise identical. Each resident compares her post-tax revenue at home with that obtained abroad, including migration costs, and each country's government maximizes tax receipts. We study the existence of an equilibrium for any configuration of wages and for any difference in the relative sizes of the countries (regions). Then, we compute and characterize the equilibrium, whenever it exists, for any set of parameters, sizes and wage differentials. Finally, we show that equilibrium migration flows affect the level of income taxation in both the origin and destination countries.

Keywords Migration · Income tax · Fiscal competition

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1 Introduction

Over the most recent two decades, the removal of political and economic barriers among member states in the EU has resulted in increasing mobility for the factors of production, including labor. A large body of literature has analyzed the main drivers of international migration and identified various redistributive policies of EU member states to which migrants are highly sensitive.[1] The idea that individuals decide where to live by comparing net income levels in their country of origin with those of potential destination countries is now commonly accepted in the theoretical literature and has been validated in the empirical literature. A natural companion question involves the impact of migrations on optimal taxes. As early as, Oates (1968) argued that the combination of international factor mobility and tax competition among countries might lead to a "race-to-the-bottom" in which governments would reduce tax rates to attract mobile factors of production—or to disincentive their emigration—ultimately resulting in negative effects on welfare state benefits due to smaller public budgets. These negative effects are particularly painful in high-tax countries whose tax bases are shrinking due to migrants' movement to low-tax jurisdictions.[2]

Recent advances in this field show that these theories do not hold in some circumstances. For example, when accounting for heterogeneous migrants, i.e., unskilled versus skilled workers, international fiscal competition has resulted in higher taxes than international fiscal coordination. Typically, when high-productivity and capital-rich countries provide substantial welfare state benefits, then unskilled migrants will be attracted to these countries. As a consequence, more redistributive taxes must be implemented in these destination countries (Razin 2013). This increase in the fiscal burden on native-born citizens resulting from the arrival of migrants helps explain why liberalizing migration is more difficult than international trade to coordinate among countries.

Other elements can also affect the race-to-the-bottom process and have serious fiscal policy implications. In particular, asymmetries in population size and/or productivity should also be expected to play an important role in the interactions among national fiscal mechanisms. For instance, with respect to international size asymmetry, a smaller country is expected to be more aggressive in tax competition than a larger rival because the smaller country has less revenue to lose if some of its native citizens leave and stands to gain a larger tax base than its larger rivals from lowering its tax rates. Nonetheless, the argument is no longer quite so simple if country size asymmetries are combined with productivity asymmetries.

To disentangle the influences of both size and productivity asymmetries among countries, a model is needed to capture how income taxes and migration flows are

[1] See, e.g., Wildasin (1988, 1991, 2006), Myers (1990), Epple and Romer (1991), Wellisch (2000), Hansen and Kessler (2001), Piaser (2003), and Puy (2003), among others.

[2] Hamilton and Pestieau (2005) and Simula and Trannoy (2010) are two papers that analyze the role of migration in fiscal competition depending on the type of migrants, namely skilled versus unskilled workers.

interrelated "in equilibrium" under such asymmetries. In this study, we thus develop a two-country model with asymmetric productive efficiencies and asymmetric population sizes. Formally, our model resembles that developed by Kanbur and Keen (1993) in which agents live in two asymmetric countries with respect to size and become involved in cross-border shopping. There are important differences, however, between our study and Kanbur and Keen (1993). In our framework, agents may decide to leave the origin country and migrate to the other country in spite of incurring a positive migration cost: A higher gross wage abroad acts as a powerful magnet for migrants, and larger income tax pressure operates as a strong repellent. Hence, each resident compares the amount of her post-tax revenue obtained at home with that obtained abroad, including the costs to be incurred due to migration.[3] Further, individuals in each country are heterogeneous with respect to their attachment to the home country: As a result, the cost of moving abroad is heterogeneous across the population of residents. Some are strongly linked to their relatives living in their home country, whereas others are considerably more mobile, simply because they are less attached to the people living around them. National traditions, patriotism, historical origins and meteorological conditions are other values to be considered that have varying degrees of influence across the citizens of a given country.[4] Accordingly, individuals placed in otherwise similar situations seem to be heterogeneous in their willingness to move abroad to find better economic conditions.

Each country's government seeks to maximize its tax revenue, and countries are assumed to play a two-stage game in this regard. In the first stage, each government is assumed to set its income tax and to take into account the possible migration flow initiated as a consequence of its fiscal pressure. In the second stage, residents in each country decide whether to stay in their own country or to migrate, thereby affecting the tax bases in both their origin and destination countries.

Our main findings are as follows. Smaller countries are host countries for migration in the presence or absence of a productivity advantage. In the absence of a large productivity gap in their favor, smaller countries reduce income taxes. However, the well-known result from the tax competition literature—that smaller countries always undercut taxes vis-a-vis larger countries—may not be true for income taxes. Indeed, we show that with a high comparative advantage, the smaller country can tax income more than the larger country and still maintain a higher net wage than that of the larger country.[5] Finally, when migrants leave low-productivity countries for high-productivity countries, migration reduces income tax rates in the origin country and increases income tax rates in the destination country, when compared with a tax equilibrium with no productivity gap. Conversely, when migrants quit high-productivity

[3] These ingredients of the model recall the well-known Tiebout model (1956) that is designed to analyze the assignment of heterogeneous individuals among different jurisdictions through local taxes. However, a major difference between the two approaches is that individuals in our model are assigned a specific country at the outset and thus already have a country when having to decide whether to move or stay.

[4] See Marchiori et al. (2012) and Beine and Parsons (2012) for climatic determinants of international migration.

[5] Nielsen (2002) also derives the possibility of a "reverse commuting" equilibrium from the small country to the large. In that paper, however, the cause is the different marginal cost of public funds between the countries.

countries in favor of low-productivity countries, migration increases income tax in the origin country and decreases income tax in the destination country, when compared with the scenario with no productivity gap.[6]

In summary, our paper provides a twofold contribution to the literature. First, it contributes to the theory of labor migration by providing a framework in which individual choices to migrate from one country to another are aggregated and simultaneously influence their respective governments when deciding to set income tax rates. Using a stylized model to obtain a closed solution, we are able to identify the equilibrium income tax rates chosen by the governments and the size and direction of migration flows between countries. Second, our paper contributes to the tax competition literature (Wilson 1980, 1982, 1992). We show that the benefit of smallness can continue to hold in the case of labor migration and depends on the productivity gap between countries. Finally, our approach in this paper allows us to consider the effects of countries' structural discrepancies—such as size and productivity—on national income taxes when these countries are engaged in fiscal competition.

The paper is organized as follows. The model is detailed in the next section. In Sect. 3, we characterize the equilibrium. Section 4 presents our conclusions.

2 The model

Consider two countries of asymmetric sizes whose governments impose income taxes on their residents. The governments' goal is tax revenue maximization. The population in each country is uniformly distributed over types, and the set of types is represented in each country by the [0, 1] interval. In this unit interval, types are ranked according to the migration cost when moving from one's own country to the other, similar to Mansoorian and Myers (1993). This cost is assumed to be equal to x for individuals of type x, $x \in [0, 1]$. Thus, migration cost is the only source of heterogeneity among the agents. Let s_i denote the population density in the origin country and s_j the population density in the destination country, with $s_i + s_j = 1$.[7]

Each type of resident is supposed to be endowed with one unit of labor sold on a (national) competitive labor market. In country i, labor demand comes from a continuum of firms with an identical constant returns to scale production function $\alpha_i z$, $i = S, L$. Then, competitive wages w_S and w_L are given by $w_S = \alpha_S$ and $w_L = \alpha_L$. Residents are free to decide where to live after comparing the net income that they will earn in each country. We denote by t_i, $i = S, L$, the tax in country i, $t_i \in [0, w_i]$. The income tax revenue of the government is represented as $s_i t_i$ in country i and $s_j t_j$ in country j, with $i \neq j$, $i = S, L$, $j = S, L$.

We define hereafter a game, with players consisting of the two governments and the residents of both countries. The set of strategies for each government i, $i = S, L$ is the set of taxes $t_i \in [0, w_i]$ that satisfies the constraint that $t_i \in [0, w_i]$. As for

6 Notably, this finding is in line with Razin (2013), which discusses at length this type of migration effect in terms of migrants' skills.

7 We will not use the equality $s_i + s_j = 1$ to substitute one of the two population sizes to keep track of the size difference $s_j - s_i$ throughout the model.

the residents in country i, the strategy set consists of two elements: stay in country i or move to country j, with $i \neq j$. The payoffs of this game are defined as follows. Let t_i be the strategy selected by government i. Then, the payoffs of country i and j are given by $s_i t_i$ and $s_j t_j$, respectively, with $i \neq j, i = S, L$ and $j = S, L$. Now consider that the set of residents selecting the strategy stay in country i. Then, it is easy to see that the set of residents' types x in country i who have selected the strategy to move to country j is necessarily given by the interval $[0, x]$ with x defined by $w_i - t_i = w_j - t_j - x$. Those who have selected the strategy to remain in country i are defined by the complementary interval $[x, 1]$. It is clear that it is necessary and sufficient that the value of x is strictly positive to obtain a non-null set of residents in i choosing the strategy move to country j. A Nash equilibrium is a pair of strategies (t_i^*, t_j^*) for the governments to which corresponds a positive migration flow $x^* > 0$ and a strategy for each resident in each country such that no government can unilaterally increase its payoff by selecting another strategy, whereas no resident is willing to move abroad (to stay at home) when he has chosen to stay at home (to move abroad).

3 Equilibrium analysis

When migration occurs from country i to country j, the last citizen type willing to leave from i to j obtains as the solution of the equation $w_i - t_i = w_j - t_j - x$, namely

$$x = (t_i - t_j) - (w_i - w_j). \tag{1}$$

Thus, a migration from i to j is possible at equilibrium if and only if $x(t_i^*, t_j^*) > 0$, with $x(t_i^*, t_j^*)$ now satisfying Eq. (1). *Mutatis mutandis*, when migration occurs from j to i, then

$$x = (t_j - t_i) + (w_i - w_j). \tag{2}$$

Clearly, the size and direction of migration depends not only on the difference between taxes, but also on the difference, if any, between productivity levels, or equivalently, between wages in the two countries.

The resulting payoff of government in country $i, i = S, L$, is

$$\Pi_i(t_i, t_j) = \begin{cases} t_i s_i (1 - x) & \text{if } (t_i - t_j) - (w_i - w_j) \geq 0; \\ t_i \left(s_i + s_j x\right) & \text{if } (t_j - t_i) + (w_i - w_j) \geq 0. \end{cases} \tag{3}$$

Substituting (1) in the first line and (2) in the second, in "Appendix 1," we show that the best response function of a smaller country is

$$t_S(t_L) = \begin{cases} \frac{1}{2} t_L + \frac{w_S - w_L + 1}{2} & \text{if } t_L < \sqrt{\frac{s_s}{s_L}} + w_L - w_s; \\ \frac{1}{2} t_L + \frac{s_S}{2 s_L} + \frac{w_S - w_L}{2} & \text{if } \; t_L > \sqrt{\frac{s_s}{s_L}} + w_L - w_s. \end{cases} \tag{4}$$

Alternatively, the best response function of a large country is

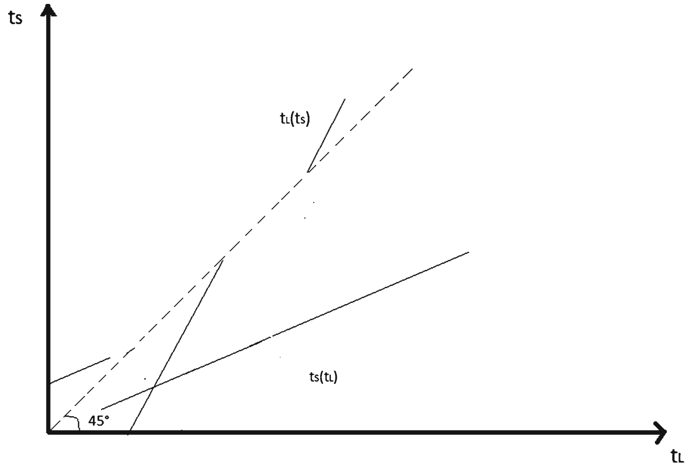

Fig. 1 $w_L = w_S$

$$t_L(t_S) = \begin{cases} \frac{1}{2}t_S + \frac{1}{2}(w_L - w_S + 1) & \text{if } t_S \leq 1 + w_S - w_L; \\ t_S + w_L - w_S & \text{if } 1 + w_S - w_L \leq t_S \leq \frac{s_S}{s_L} + w_S - w_L; \\ \frac{1}{2}t_S + \frac{1}{2}\left(\frac{s_L}{s_S} + (w_L - w_S)\right) & \text{if } t_S \geq \frac{s_S}{s_L} + w_S - w_L. \end{cases} \tag{5}$$

As in Kanbur and Keen (1993), the best response functions are quite different from one another. The best response of a smaller country shows a discontinuity. As t_L increases, the best response of the smaller country is at first to increase t_S above t_L which is optimal as long as taxes are so low that undercutting does not pay. However, when t_L is quite large and a certain level of taxes is reached, namely $\sqrt{\frac{s_S}{s_L}} + w_L - w_S$, the smaller country has an incentive to undercut taxes because the amount of tax revenue to be levied from migrants offsets the tax revenue lost from natives. Hence, a smaller jurisdiction faces a greater potential of migrants and is thus faced with a more (tax) elastic demand. This phenomenon is absent for the larger country. As a consequence, its best response is a continuous function.

However, as opposed to Kanbur and Keen (1993), in our setup, the best response functions depend on the differences in productivities between the countries. To illustrate the effect of these productivities on taxes, we represent graphically the best replies in the plane (t_L, t_S). In this illustration, migration occurs from the larger to the smaller country. Assume first, in Fig. 1, that $w_L = w_S$. Our model is reminiscent of Kanbur and Keen (1993) if $w_L = w_S$.[8] Under this condition, best replies in (4) and (5) depend only on the size asymmetry of the countries. It follows that the intersection of best replies occurs below the 45 line, which implies that $t_S^* < t_L^*$: Smaller countries slash taxes because the amount of income brought by immigrants offsets lower tax rates. Assume now that countries show different levels of productivity; for instance, $w_L < w_S$ (see Fig. 2). Compared to Fig. 1, the tax equilibrium remains qualitatively

[8] We are indebted to a referee to have highlighted this interesting remark for us.

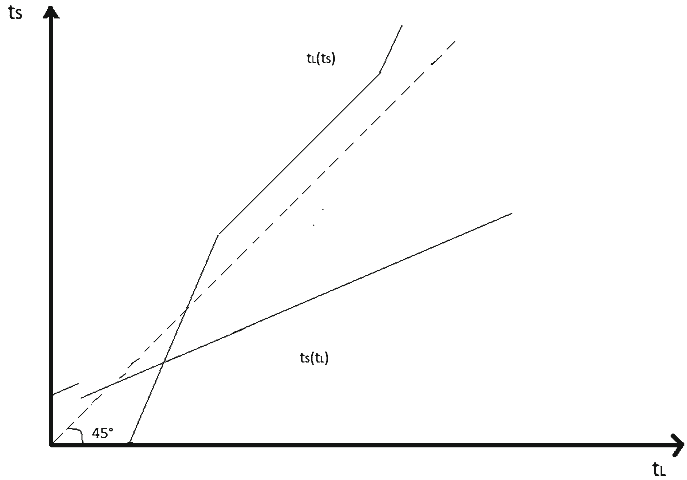

Fig. 2 $w_L < w_S$

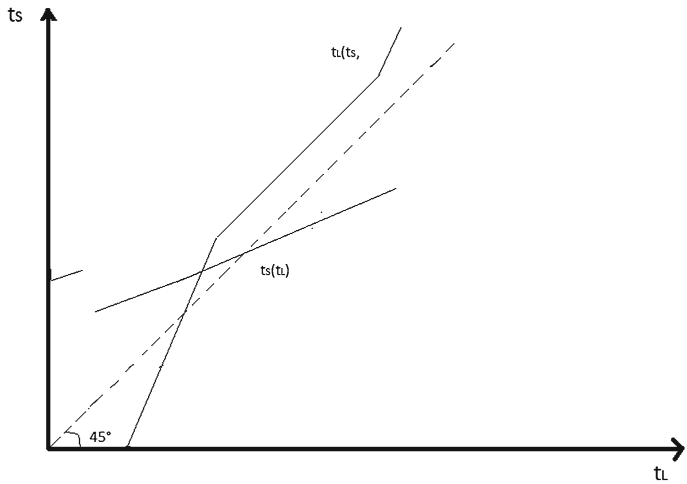

Fig. 3 $w_L << w_S$

the same. Hence, if the difference in productivities remains low, then the result of Kanbur and Keen (1993) may yet be valid. In Fig. 3, we continue to assume that $w_L < w_S$ but now the difference in wages is larger than in Fig. 2. While the strategy to undercut the larger country remains, the smaller country can now tax more than the larger country, as long as the net income in the smaller country remains higher than the net income in the larger country. We will explore below whether this property is satisfied at the Nash equilibrium.

At the interior candidate equilibrium, governments select the following taxes

$$t_S^* = \frac{2s_S + s_L}{3s_L} - \frac{w_L - w_S}{3} \quad \text{and} \quad t_L^* = \frac{s_S + 2s_L}{3s_L} + \frac{w_L - w_S}{3}. \tag{6}$$

The corresponding migration flow is equal to

$$x(t_S^*, t_L^*) = \frac{1}{3}\left(w_S - w_L + \frac{s_L - s_S}{s_L}\right).$$

Taxes take admissible values, namely $t_S^* \in (0, w_S)$ and $t_L^* \in (0, w_L)$ if and only if

$$-\frac{s_S + 2s_L}{s_L} \leq w_L - w_S \leq \frac{2s_S + s_L}{s_L} \text{ and } w_S > \frac{2s_L + s_S}{s_L}. \quad (7)$$

The above set is not empty because $-\frac{s_S+2s_L}{s_L} < \frac{2s_S+s_L}{s_L}$ for any s_S and s_L in the interval (0, 1) and any w_S.[9]

In the set $w_L - w_S < -\frac{s_S+2s_L}{s_L}$, the candidate equilibrium taxes are $t_L^* = 0$ and $t_S^* = \frac{1}{2}\left(\frac{s_S}{s_L} + w_S - w_L\right)$ with $x^* = \frac{1}{2}\frac{s_L(w_S-w_L)-s_S}{s_L}$. Finally, for $w_L - w_S > \frac{2s_S+s_L}{s_L}$, the candidate equilibrium taxes are $t_S^* = 0$ and $t_L^* = \frac{1}{2}(w_L - w_S + 1)$ with $x^* = \frac{1}{2}(w_L - w_S - 1)$.

It remains to be shown whether a Nash equilibrium exists. Recall that the best response of the smaller country shows a discontinuity, whose presence jeopardizes the existence of an equilibrium. Let us define

$$A \equiv \frac{2s_L + s_S - 3s_L\sqrt{\frac{s_S}{s_L}}}{2s_L} < \frac{2s_S + s_L}{s_L}.$$

Then, we show the following[10]

Proposition 1 *In the set* $-\frac{s_S+2s_L}{s_L} \leq w_L - w_S \leq A$, *a unique interior Nash equilibrium exists with migration from the larger to the smaller country given by*

$$t_S^* = \frac{2s_S+s_L}{3s_L} - \frac{w_L-w_S}{3} \text{ and } t_L^* = \frac{s_S+2s_L}{3s_L} + \frac{w_L-w_S}{3} \text{ and } x(t_S^*, t_L^*) = \frac{w_S-w_L}{3} + \frac{s_L-s_s}{3s_L}.$$

In the set $w_L - w_S < -\frac{s_S+2s_L}{s_L}$, *a unique Nash equilibrium exists with migration from the larger to the smaller country given by*

$$t_L^* = 0 \text{ and } t_S^* = \frac{1}{2}\left(\frac{s_S}{s_L} + w_S - w_L\right) \text{ and } x^* = \frac{1}{2}\frac{s_L(w_S-w_L)-s_S}{s_L}.$$

No Nash equilibrium exists for $w_L - w_S > A$.

Proof See "Appendix 3." □

Some remarks are in order. First, it is worth noting that in the set of values in which an equilibrium exists, *migration occurs only from the larger to the smaller country.*

[9] Nonetheless, whenever $w_S \leq \frac{2s_L+s_S}{s_L}$, then, in a subset of the interval, $-\frac{s_S+2s_L}{s_L} \leq w_L - w_S \leq \frac{2s_S+s_L}{s_L}$, countries select to tax the entire wage (see "Appendix 2" for the detailed analysis).

[10] To keep the analysis readable, we provide the equilibrium analysis for the case $w_S \leq \frac{2s_L+s_S}{s_L}$ in "Appendix 4."

In fact, migration from the smaller to the larger occurs when $w_L - w_S > \frac{s_L - s_S}{s_L}$. This condition is incompatible with $w_L - w_S < A$, because $A < \frac{s_L - s_S}{s_L}$ for any s_L and s_s in (0, 1). [11]

Second, in our setup, as opposed to Kanbur and Keen (1993), the tax equilibrium may not exist. The intuition for this result is as follows. On the one hand, in the presence of a large productivity advantage for the larger country, the smaller country "delays" its strategy of tax undercutting (in fact, the point of discontinuity of its best reply depends positively on $w_L - w_S$). For the smaller country, it is optimal to select a higher tax than the larger country for a wider set of tax levels, compared with the scenario $w_L = w_S$. It is as if the productivity advantage of the larger country invalidates the convenience of tax undercutting. Although some citizens emigrate to the foreign country, undercutting t_S will not offset the difference $w_L - t_L$. On the other hand, the larger country replies "faster" with $t_L(t_S) = t_S + (w_L - w_S)$ due to its productivity advantage. Ultimately, tax undercutting occurs when the best reply of the larger country is $t_L = t_S + (w_L - w_S)$, but this destroys the existence of the equilibrium!

Finally, what is the role of size asymmetry? To answer this question, we can determine the tax equilibrium when $s_i = s_j = \frac{1}{2}$, while keeping different income levels. The candidate equilibrium taxes are then given by

$$t_i^* = \frac{1}{3}\left(w_i - w_j\right) + 1 \quad \text{and} \quad t_j^* = \frac{1}{3}\left(w_i - w_j\right) + 1. \tag{8}$$

The corresponding value of $x(t_i^*, t_j^*) = \frac{1}{3}(w_i - w_j)$, which is positive if and only if $w_i > w_j$. Hence, we posit the following:

Corollary 1 *In the absence of population size asymmetry, an interior equilibrium exists that is given by (8) with migration from the most productive to the less productive country.*

Finally, some comparative statics on equilibrium taxes in (6) reveals that the equilibrium tax in country i, $i = S, L$ positively depends on the wage differential $w_i - w_j$. Further, equilibrium taxes in both countries depend positively on the size of the destination country. Evidently, the smaller the country of destination, the higher the incentive to undercut taxes for this country and therefore the smaller equilibrium taxes (because taxes are strategic complements).

3.1 Kanbur and Keen (1993) revisited

In this section, we analyze the difference between the equilibrium taxes in (6) selected by the governments. More specifically, we are interested in the sign of

$$t_L^* - t_S^* = \frac{1}{3}\left(\frac{s_L - s_S}{s_L} + 2\left(w_L - w_S\right)\right). \tag{9}$$

[11] Note that in the set $w_L - w_S > A$, it is possible to identify Nash equilibria in mixed strategies, but the analysis is quite intricate.

As Fig. 1 shows, in the absence of a difference in productivities among countries, the smaller country faces a higher tax elasticity of the tax base: Decreasing taxes improves tax receipts because the tax revenue collected from migrants is higher than the money lost from natives. Nonetheless, when there are differences in productivities, there may be surprising results. In the absence of differences in productivities, $w_S = w_L$, we have

$$t_L^* - t_S^* = \frac{1}{3}\frac{s_L - s_S}{s_L} \text{ and } x^* = \frac{1}{3}\frac{s_L - s_S}{s_L}. \tag{10}$$

Investigating these two expressions, we claim as follows

Proposition 2 *In the absence of a difference in productivities between countries, the unique equilibrium of the tax game corresponds to a migration flow from the larger to the smaller country, with* $t_S^* < t_L^*$.

Proof Follows immediately from the sign of (10). □

Hence, as in Kanbur and Keen (1993), if countries do not differ in productivity levels, the only equilibrium strategy of the smaller country is to undercut the larger country with respect to taxes. At equilibrium, because the smaller country selects lower income taxes and wages are equal, it is obvious to conclude that the migration flows originate from the country with the lower net income with the other country as destination. At equal wages, the direction of migration is fully determined by the relative level of taxes.

We now turn our attention to the scenarios in which countries differ in productivity levels and thus in wages. Using (6) to study the sign of the difference $t_L^* - t_S^*$, we have

$$t_L^* < t_S^* \quad \text{if and only if} \quad w_S - w_L > \frac{s_L - s_S}{2s_L}. \tag{11}$$

This condition of w_L lies in the admissible set (7) because $\frac{s_S - s_L}{2s_L} < \frac{s_L - s_S}{s_L}$ which reveals that the equilibrium of migration from the larger to the smaller country is characterized by $t_L^* < t_S^*$ if and only if the condition in (11) holds. Otherwise, if $w_S - w_L < \frac{s_L - s_S}{2s_L}$, the equilibrium of migration from the larger to the smaller country is characterized by $t_L^* > t_S^*$. It is straightforward that this property also holds for the equilibrium in which $t_L^* = 0$ and $t_S^* = \frac{1}{2}\left(\frac{s_S}{s_L} + w_S - w_L\right)$.

Hence, we summarize our results in the following proposition:

Proposition 3 *A smaller country that is a destination country for migrants sets a higher income tax than the larger country of origin, if it shows a much higher productivity level than the larger country, i.e., if* $w_S - w_L > \frac{s_L - s_s}{2s_L}$. *Conversely, if* $w_S - w_L < \frac{s_L - s_s}{2s_L}$, *then the smaller country sets a lower income tax than the larger country.*

The novel approach of this proposition lies in its first part: The smaller jurisdictions do not always have to undercut taxes to attract migrants. In fact, our result concerning income taxation in smaller countries departs from the previous literature on capital mobility (Bucovetsky 1991; Wilson 1986) and cross-border shopping (Kanbur and

Keen 1993). As we explained above, this literature highlights the benefit of smallness: Smaller countries gain in the competition for mobile capital because they undercut their larger rivals with respect to taxes, taking advantage of a higher elasticity of tax receipts. It turns out that this result does not always hold true when labor is mobile and when the gross salary in the larger country is much smaller than the gross salary paid in smaller countries. Our result resembles the results obtained in some recent papers on mobile capital, such as Justman et al. (2002), Zissimos and Wooders (2008), Hindriks et al. (2008) or Pieretti and Zanaj (2011). In these papers, smaller countries can fix higher capital taxes than the larger countries as long as they supply a higher level of public infrastructure that compensates for the higher taxes. Similarly, in our paper, we find that a smaller country can set higher income taxes than a larger country when it has a higher level of productivity.

3.2 Migration and income taxation

In this section, using the interior equilibrium in taxes, we study the effects of migration on taxes, taking as a benchmark the scenario in which the level of productivity among countries is the same. To this end, we must compare taxes in (6) and taxes corresponding to the scenario $w_S = w_L$, namely $\tilde{t}_L^* = \frac{2s_L+s_S}{3s_S}$ and $\tilde{t}_S^* = \frac{s_L+2s_S}{3s_L}$. We find as follows

Proposition 4 *When migrants leave lower-productivity countries and move to higher-productivity countries, migration causes an increase in the income tax in the destination country and a decrease in the income tax in the origin country, compared with the equilibrium tax when countries are characterized by the same level of wages.*

Proof Comparing (6) with $\tilde{t}_L^* = \frac{2s_L+s_S}{3s_S}$ and $\tilde{t}_S^* = \frac{s_L+2s_S}{3s_L}$, we find $t_L^* - \tilde{t}_L^* = \frac{w_L-w_S}{3}$ and $t_S^* - \tilde{t}_S^* = \frac{w_S-w_L}{3}$. Hence, if $w_L < w_S$, then $t_L^* < \tilde{t}_L^*$ and $t_S^* > \tilde{t}_S^*$. □

This scenario recalls the result in Razin (2013). Migrants may increase taxes in the destination country, which is why natives may be against migratory flows. Nonetheless, in our paper, the mechanism that leads to this result is different. We identify two different drivers for migrants to move from an origin country to a destination country. First, a high relative productivity efficiency acts as a powerful attractor because it immediately affects wages. Accordingly, the higher the productivity in a country, the stronger the incentive for native-born citizens to stay in this country and for those citizens living in the other country to migrate there. Nonetheless, migration is also affected by a second driver, namely income tax, with a relatively high income tax acting as a repellent to migrants. As a result, the migration flow observed between countries is dependent on the relative strength of these drivers, and net income is the decision criterion for migrants when selecting their strategy. Thus, a highly productive country can set a relatively high income tax and continue to be attractive for migrants whenever the net income resulting from its fiscal burden is larger than that in the alternative country.

Conversely, we posit as follows:

Proposition 5 *When migrants leave higher-productivity countries and move to lower-productivity countries, migration leads to a decrease in income tax in the destination country and an increase in income tax in the origin country, compared with the equilibrium tax when countries show the same level of wages.*

Proof Being $t_L^* - \tilde{t}_L^* = \frac{w_L - w_S}{3}$ and $t_S^* - \tilde{t}_S^* = \frac{w_S - w_L}{3}$, if $w_L > w_S$, then $t_S^* < \tilde{t}_S^*$ and $t_L^* > \tilde{t}_L^*$. □

When gross wages are different, migration mitigates the difference in net wages. Furthermore, as the tax competition occurs between countries with different wages, the race-to-the-bottom analogy no longer applies. In fact, compared with the benchmark in which countries share the same productivity, countries react in the opposite way in their fiscal behavior: Whereas the larger country reduces its fiscal burden at equilibrium, the smaller country increases its income tax. Thus, it weakens the incentive for both countries to coordinate their fiscal regimes, thereby preventing the adoption of tax harmonization measures.

4 A brief discussion of our main assumptions

Let us now briefly discuss two key assumptions of our approach: exogenously given wages and tax revenue-maximizing governments.

First, we develop our analysis by assuming that the difference in wages between countries is exogenously given and that migration does not directly affect this difference. Neglecting this aspect in the analysis has its drawbacks but might be justified by observing that strong local disparities in wages remain in Europe, in spite of the process of integration among European countries and the removal of barriers to free movement of physical and human capital (Eurostat 2013). Even worse, the impact of integration has been uneven, thereby amplifying the existing inequalities among European countries and regions within countries (Bradley et al. 2005). A key explanation for these discrepancies lies in local differences in productive efficiency, which derive mainly from country-specific institutions. In this view, institutions are responsible for enhancing productivity by providing local public goods (like infrastructure) and local property rights: Poor institutions lead to poor efficiency in production for a country (or a region) (Acemoglu et al. 2005). Notably, this view meets with approval not only in the academic community but also among policy makers: Article 174 of the Treaty on the Functioning of the EU states as follows: “the Union shall aim at reducing disparities between the levels of development of the various regions and the backwardness of the least favoured regions.” Consistent with this statement, the EU devotes one-third of the total European budget to the so-called EU Regional Policy—or the Cohesion Policy—thereby testifying to an awareness that the free movement of goods and/or factors induced by integration does not suffice to remove local disparities. Thus, assuming that wages are country specific and exogenously given enables us to clarify how structural characteristics impact migration. This issue seems to be particularly salient when taking into account the recent European enlargement process: In 2004, eight new member states from Central and Eastern Europe acceded to EU membership, followed in 2007 by Bulgaria and Romania. As an immediate consequence of these new accessions, economic disparities have been exacerbated with a concurrent change in the spatial distribution of wealth. The greater part of EU regional policy funds, known as structural and cohesion funds, are addressed to the most disadvantaged European regions and are mainly devoted to developing large-scale infrastructure and innovations for enhancing efficiency. This enlargement process represents a challenge for the criteria of regional policy and risks to frustrate the (questioned) propelling effects coming from Cohesion funds because it reinforces cross-country inequalities in the EU.[12]

From this perspective, our analysis complements the large strand of literature that studies whether (real) wages are affected by migration (see Longhi et al. 2008, for a survey). Although the argument that migrants reduce the real wages and employment opportunities of native workers is rather widespread, the empirical evidence gathered so far does not lead to clear results regarding the effects of migration on local labor markets. Furthermore, the impact of migration in a specific country may not be generalized to other countries because it depends *inter alia* on specific structural characteristics of the destination country, such as the skill mix, the type of unions, the unemployment rate and the migration policy. For example, migration typically increases housing prices in the destination country (Saiz 2006) with possible negative effects on the real wages of workers. Nonetheless, as this rise in housing prices represents an income transfer from migrants to natives—the owners of houses—the net effect on income of natives can also be positive! For example, in Ottaviano and Peri (2006), the small negative wage effect from migration is more than offset by the positive effect on housing prices from which natives benefit due to their higher house ownership rates. Additionally, the type of migrants—skilled versus unskilled—can play a role in defining the effects of migration into the host country. The negative impact seems to be stronger when unskilled workers are taken into account, whereas it turns out to be moderate in the case of high-skilled workers (Borjas 2003; Borjas and Katz 2005; Borjas 2006). Note, however, that even when the analysis is performed by considering both the geographical location and the education level of workers (migrants and native workers), sometimes migration is found to have only a small impact on wages (Card 2001); however, in certain other cases, large negative effects have been found (Borjas et al. 1997) to emerge.

The second assumption involves the objective function of the governments. For analytical tractability, we assume that governments are tax revenue maximizers. This assumption should not be read as equivalent to assuming Leviathan governments. Governments in our paper do not have as their primary interest to maximize tax revenues to raise rents/bribes or to enhance the power of government officials. Instead, in our view, they tax to provide essential public goods as schools, transport infrastructure and hospitals—public goods that affect the welfare of citizens without necessarily changing their wages.

[12] See Pellegrini et al. (2013) on the effectiveness of the Regional Policy.

5 Conclusion

In this paper, we have analyzed the optimal taxation set by two countries with asymmetric population sizes and different productivities when residents in each country can freely move from one country to another, and choices to migrate depend on the net income corresponding to the optimal income taxes. Thanks to the simplicity of the model, we were able to develop our analysis by explicitly computing the equilibrium values of the main variables at play: income taxes and the direction and size of migration flows. The parameters used to obtain this description are the populations' sizes and the productivity (wage) available in each of the two countries. On the one hand, the income tax values in each country mutually depend on one another because their level modifies the incentives to migrate between the two countries. On the other hand, the migration flow determines the optimal taxation in each country. The equilibrium tax rates are then described in the entire set of possible combinations of relative size and relative wage existing in each.

This model could be used to test whether its theoretical findings are indeed supported by the data. For instance, it might be interesting to analyze how the data fit the proposition made by previous authors that no migration occurs from a smaller to a larger country. Countries such as Luxemburg and Portugal, or Ireland and Poland, respectively, might be used as examples for such an empirical analysis.

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Appendix 1: Best responses

The payoff function in (3) rewrites as

$$\Pi_i(t_i, t_j) = \begin{cases} t_i s_i \left(1 - \left((t_i - t_j) - (w_i - w_j)\right)\right) & \text{if } t_i \geq t_j + (w_i - w_j); \\ t_i \left(s_i + s_j \left((t_j - t_i) - (w_j - w_i)\right)\right) & \text{if } t_i \leq t_j + (w_i - w_j). \end{cases}$$

To derive the best response functions, we proceed in steps.

STEP 1. Let us first define the piece of the best response when migrants quit country i, namely when $t_i \geq t_j + w_i - w_j$. When the tax of country i is strictly higher than $t_j + (w_i - w_j)$, we maximize the payoff function $t_i s_i \left(1 - \left((t_i - t_j) - (w_i - w_j)\right)\right)$, finding

$$t_i(t_j) = \frac{1}{2}t_j + \frac{w_i - w_j + 1}{2}. \tag{12}$$

Since $t_i \geq t_j + w_i - w_j$, then it must hold $\frac{1}{2}\left(t_j + w_i - w_j + 1\right) \geq t_j + (w_i - w_j)$, which happens if $t_j \leq 1 + w_j - w_i$. Therefore, when migrants quit country i, the best response function of country i is

$$t_i(t_j) = \begin{cases} \frac{1}{2}t_j + \frac{w_i - w_j + 1}{2} & \text{if } t_j \leq 1 + w_j - w_i \\ t_j + w_i - w_j & \text{if } t_j \geq 1 + w_j - w_i \end{cases}$$

For later use, we calculate the corresponding payoff

$$\Pi_i(t_i, t_j) = s_i \left(\frac{1}{2} t_j + \frac{1}{2} w_i - \frac{1}{2} w_j + \frac{1}{2} \right)^2, \tag{13}$$

if $t_j \leq 1 + w_j - w_i$ and

$$\Pi_i(t_i, t_j) = \left(t_j + w_i - w_j \right) s_i, \tag{14}$$

if $t_j \geq 1 + w_j - w_i$.

STEP 2. We now determine the best reply of country i were migrants entering country i, namely for $t_i \leq t_j + w_i - w_j$. Similarly to above, when $t_i < t_j + w_i - w_j$, the piece of best response is

$$t_i(t_j) = \frac{1}{2} t_j + \frac{s_i}{2s_j} + \frac{w_i - w_j}{2}.$$

Since $t_i(t_j) \leq t_j + (w_i - w_j)$, we find $\frac{s_i}{s_j} + w_j - w_i \leq t_j$. Hence, the best reply of country i, were migrants entering this country, is

$$t_i(t_j) = \begin{cases} t_j + w_i - w_j & \text{if } t_j \leq \frac{s_i}{s_j} + w_j - w_i; \\ \frac{1}{2} t_j + \frac{s_i}{2s_j} + \frac{w_i - w_j}{2} & \text{if } t_j \geq \frac{s_i}{s_j} + w_j - w_i. \end{cases}$$

The corresponding payoff of country i is

$$\Pi_i(t_i, t_j) = \left(t_j + w_i - w_j \right) s_i, \tag{15}$$

if $t_j \leq \frac{s_i}{s_j} + w_j - w_i$. And

$$\Pi_i(t_i, t_j) = \frac{1}{4} \frac{\left(s_i + s_j t_j + s_j w_i - s_j w_j \right)^2}{s_j}, \tag{16}$$

if $t_j \geq \frac{s_i}{s_j} + w_j - w_i$.

STEP 3. To build the **overall** best response, we shall now consider the corresponding payoff in the intervals:

- $t_i < min \left\{ 1 + w_j - w_i; \frac{s_i}{s_j} + w_j - w_i \right\}$. Comparing (13) and (15), we find that the best response in this interval is

$$t_i(t_j) = \frac{1}{2} t_j + \frac{w_i - w_j + 1}{2};$$

- $t_i > max \left\{ 1 + w_j - w_i; \frac{s_i}{s_j} + w_j - w_i \right\}$. Comparing the payoffs (14) and (16), we find that the best response in this interval is

$$t_j(t_i) = \frac{1}{2}t_j + \frac{s_i}{2s_j} + \frac{w_i - w_j}{2};$$

- when $\frac{s_i}{s_j} < 1$, there exists an intermediate, non-empty, interval given by

$$\frac{s_i}{s_j} + w_j - w_i < t_j < 1 + w_j - w_i.$$

The payoff (13) is higher than the payoff (16) for $w_j - w_i - \sqrt{\frac{s_i}{s_j}} < t_j < w_j - w_i + \sqrt{\frac{s_i}{s_j}}$. Furthermore $w_j - w_i - \sqrt{\frac{s_i}{s_j}} < \frac{s_i}{s_j} + w_j - w_i < w_j - w_i + \sqrt{\frac{s_i}{s_j}} < 1 + w_j - w_i$ holds. Therefore, when i is a small country, the best response always discontinues at $w_j - w_i + \sqrt{\frac{s_i}{s_j}}$ and writes as in (4).

- When $\frac{s_i}{s_j} > 1$, we have $w_j - w_i - \sqrt{\frac{s_i}{s_j}} < 1 + w_j - w_i < w_j - w_i + \sqrt{\frac{s_i}{s_j}} < \frac{s_i}{s_j} + w_j - w_i$.

Being (13) smaller than the payoff (16) for $t > w_j - w_i + \sqrt{\frac{s_i}{s_j}}$ and $t < w_j - w_i - \sqrt{\frac{s_i}{s_j}}$, the best reply of a large country continues and writes as (5).

Appendix 2: Admissible set

The nonnegativity conditions for equilibrium taxes in (6) are:

$$t_S^* \geq 0 \Leftrightarrow \frac{2s_S + s_L}{3s_L} - \frac{w_L - w_S}{3} \geq 0 \Leftrightarrow \ w_L - w_S \leq \frac{2s_S + s_L}{s_L},$$
$$t_L^* \geq 0 \Leftrightarrow \frac{s_S + 2s_L}{3s_L} + \frac{w_L - w_S}{3} \geq 0 \Leftrightarrow w_L - w_S \leq -\frac{s_S + 2s_L}{s_L},$$

implying

$$-\frac{s_S + 2s_L}{s_L} \leq w_L - w_S \leq \frac{2s_S + s_L}{s_L}.$$

Taxes-non–higher-than-wages conditions are:

$$t_S \leq w_S \Leftrightarrow \frac{2s_S + s_L}{3s_L} - \frac{w_L - w_S}{3} \leq w_S \Leftrightarrow w_L - w_S \geq \frac{2s_S + s_L}{s_L} - 3w_S,$$
$$t_L \leq w_L \Leftrightarrow \frac{s_S + 2s_L}{3s_L} + \frac{w_L - w_S}{3} \leq w_L \Leftrightarrow w_L - w_S \geq \frac{s_S + 2s_L}{2s_L} - \frac{3w_S}{2}.$$

Hence,

$$w_L - w_S \geq w_M \equiv max\left(\frac{s_S + 2s_L}{2s_L} - \frac{3w_S}{2}; \frac{2s_S + s_L}{s_L} - 3w_S\right).$$

Two cases may arise: **(i)** Either in the set (7), taxes are always smaller than wages, or **(ii)** in a subset of (7), taxes exceed wages [it is easily verified that taxes are not always higher than wages in the set (7)].

Case (i). This case occurs when w_M is smaller than the lower bound of (7), namely

$$\frac{s_S + 2s_L}{2s_L} - \frac{3w_S}{2} < -\frac{s_S + 2s_L}{s_L} \Leftrightarrow w_S > \frac{2s_L + s_S}{s_L};$$
$$\frac{2s_S + s_L}{s_L} - 3w_S < -\frac{s_S + 2s_L}{s_L} \Leftrightarrow w_S > \frac{s_L + s_s}{s_L}.$$

with $\frac{2s_L+s_S}{s_L} > \frac{s_L+s_s}{s_L}$. Hence, when $w_S > \frac{2s_L+s_S}{s_L}$, in the set (7) taxes are both non-negative and smaller than wages.

Case (ii). This case may occur when $\frac{s_L+s_S}{s_L} < w_S < \frac{2s_L+s_S}{s_L}$. Then, two intervals exist in (7). First, for $-\frac{s_S+2s_L}{s_L} < w_L - w_S < \frac{2s_S+s_L}{s_L} - 3w_S$, taxes are $t_S^* = w_S$ and $t_L^* = w_L$. Whereas for $\frac{2s_S+s_L}{s_L} - 3w_S < w_L - w_S < \frac{2s_S+s_L}{s_L}$, both taxes are smaller than wages.

This case occurs also when $\frac{s_S+2s_L}{s_L} < w_M < \frac{2s_S+s_L}{s_L}$ namely $w_S < \frac{s_L+s_s}{s_L}$. In this range of values of w_S, two intervals exist in the admissible set, as well. First, (i.e., $-\frac{s_S+2s_L}{s_L} < w_L - w_S < \frac{2s_S+s_L}{s_L} - 3w_S$), $t_S^* = w_S$ and $t_L^* = w_L^*$, then (i.e., $\frac{2s_S+s_L}{s_L} - 3w_S < w_L - w_S < \frac{2s_S+s_L}{s_L}$), $t_S^* < w_S$ and $t_L^* < w_L$.

Appendix 3: Existence of an equilibrium

A necessary and sufficient condition that guarantees the existence of equilibrium is that the best reply of the larger country, evaluated at the discontinuity point, is smaller than the best response of the smaller country.[13] Indeed, when this condition is satisfied, the best responses, which have slopes smaller than one, will intersect in the positive quadrant, guaranteeing the existence of the tax equilibrium. The necessary and sufficient condition is satisfied if it holds:

$$\frac{1}{2s_L}\left(\begin{array}{l} s_s + s_L\left(\sqrt{\frac{s_s}{s_L}} + w_L - w_s\right) \\ +s_L w_s - s_L w_L \end{array}\right) > 2\left(\sqrt{\frac{s_s}{s_L}} + w_L - w_s\right) - w_L + w_s - 1,$$

which boils down to

$$w_L - w_S < A.$$

Hence, if the wage differential is upper bounded, i.e., $w_L - w_S < A$, then an equilibrium in taxes always exists. For illustration, an equilibrium does not exist in Fig. 4 where $s_s = 0.2, s_L = 0.8, w_L = 5.1$ and $w_S = 2$. While in Fig. 5, for $s_s = 0.2, s_L = 0.8, w_s = 2.3, w_L = 2,$ being the necessary condition satisfied, the tax equilibrium exists.

[13] This condition is always satisfied, guaranteeing always an equilibrium in the seminal paper of Kanbur and Keen (1993).

Fig. 4 No equilibrium exists

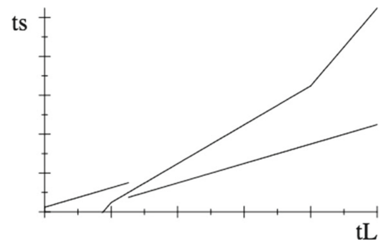
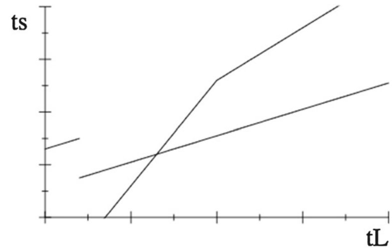


Fig. 5 The tax equilibrium exists



Appendix 4: Equilibrium analysis when $w_S \leq \frac{2s_L+s_S}{s_L}$

As we showed in "Appendix 2", when $w_S \leq \frac{2s_L+s_S}{s_L}$, countries may tax the whole wage. The question we answer in this section is: Can $t_L^* = w_L$ and $t_S^* = w_S$ be a Nash equilibrium? To answer, we shall check the compatibility of $w_S \leq \frac{2s_L+s_S}{s_L}$ with the area in which an interior equilibrium exists, namely $-\frac{s_S+2s_L}{s_L} < w_L - w_S < A$. By direct comparison, it is readily verified that for $w_S < \frac{s_S+s_L\sqrt{\frac{s_S}{s_L}}}{2s_L}$ (where $\frac{s_S+s_L\sqrt{\frac{s_S}{s_L}}}{2s_L} < \frac{2s_L+s_S}{s_L}$), we have $A < \frac{2s_S+s_L}{s_L} - 3w_S$. Then, in the set $-\frac{s_S+2s_L}{s_L} < w_L - w_S < A$ the Nash equilibrium is $t_S^* = w_S, t_L^* = w_L$ and $x^* = 0$.

For $\frac{s_S+s_L\sqrt{\frac{s_S}{s_L}}}{2s_L} < w_S < \frac{2s_L+s_S}{s_L}$, in the set $w_L - w_S < \frac{2s_S+s_L}{s_L} - 3w_S$, the Nash equilibrium is $t_S^* = w_S, t_L^* = w_L$ and $x^* = 0$, whereas in the set $\frac{2s_S+s_L}{s_L} - 3w_S < w_L - w_S < A$ the Nash equilibrium is given by (6).

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