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Federalism, Freedom of Movement, and Fiscal Equalization

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Abstract. In this paper, we take up the question why a group of sovereign countries is willing to form a federation even if residents of the high–income region suspect potential immigrants to be net beneficiaries of the tax and transfer system. We argue that income uncertainty alone cannot satisfactorily explain the formation of federations, since in many existing and developing federations income differences are both large and persistent. In the model presented here remaining separated involves costs for the high–income region, which can be regarded as a proxy for the efficiency loss caused if mobile factors cannot reallocate. A fiscal equalization scheme that shares the resources saved by limiting costly migration between the regions can make both regions better off.

1 Introduction

What are the economic motives that induce a group of sovereign countries to form a federation? Many countries in the world (for example, Australia, Austria, Brasil, Canada, India, Germany, Mexico, Nigeria, Switzerland, USA, and Venezuela) have federal structures in common. Moreover, since the Maastricht treaty was signed, the European Union could be considered as some kind of supranational federal state, even though some basic elements of a state still are missing. Among the many features most federal states share, in this paper, we want to focus on two important characteristics of federations: *freedom of movement* and *fiscal equalization.*

First, while most countries pursue rather restrictive immigration policies, complete freedom of movement within a federation's territory is a central feature of federalist countries. In fact, freedom of movement is, with certain restrictions, one of the major subject–matters of the system of treaties of the European Union. The European Community Charter of Fundamental Social Rights for Workers, for example, lays down that "every worker of the European Community shall have the right to freedom of movement throughout the territory of the Community, subject to restrictions justified on grounds of public order, public safety or public health." According to Eurobarometer[1], citizens of the member states of the European Union place "free movement of people for travelling" and "free movement of people for working/studying" on the second place when asked for the two most positive aspects of the European Union. On the other hand, 80% of the citizens of the EU member states would give priority to the fight against illegal immigration, a number that is distinctly larger than the 55% of US citizens that consider controlling

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[1]For Eurobarometer 56.3, 15926 people in the 15 member states of the EU were interviewed from January 22nd to February 28th, 2002, on behalf of the European Commission.

and reducing illegal immigration as a very important goal of the US[2].

Second, the constitutions of many federations involve a categorial equity argument, and therefore call for fiscal equalization among their member states. Categorial equity exists "when all citizens have fair access to public services that are thought to be particularly important to their opportunities in life" (Ladd and Yinger, 1994, p. 212). For example, in Part III of Canada's Constitutional Act of 1982 it can be read that "Parliament and the legislatures, together with the government of Canada and the provincial governments, are committed to (a) promoting equal opportunities for the well–being of Canadians... and (c) providing essential public services of reasonable quality to all Canadians". Consequently, the Constitutional Act specifies that "Parliament and the Government of Canada are committed to the principle of making equalization payments to ensure that provincial governments have sufficient revenues to provide reasonably comparable levels of public services at reasonably comparable levels of taxation". Another typical example is Germany, where Article 106 of its Grundgesetz demands that equal living conditions be preserved among the laender.[3]

The paper is organized as follows. In the next section, we briefly review the most relevant literature. Section 3 sets up the basic model of two sovereign countries having to choose their fiscal arrangements. As in the case of the European Union and its joining candidates, separation is the status

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[2]According to the American Public Opinion and US Foreign Policy 1999 Report carried out by the Chicago Council of Foreign Relations.

[3]The laenderfinanzausgleich, Germany's fiscal equalization scheme, a three–step procedure involving VAT–equalization, redistribution of tax returns across the laender, and federal grants, is a model case of a very strict interpretation of the categorial equity precept, as, after fiscal equalization, none of the German laender is left with less than 99.5% of its so–called fiscal need (the average of the per–capita tax revenues of all laender).

quo option and the other two options available are federalism and a unitary state, that redistributes all resource rents equally. In Section 4, we allow for interjurisdictional transfers. Section 5 concludes the paper.

2   A Brief Review of the Literature

What are the benefits of forming a federation (which will be considered here as accepting that people obtain an unrestricted right to take residence wherever they want) and, on top of that, of committing to fiscal equalization payments? In the simplest case, from a mobile worker's view, remaining separated could be regarded as a situation where migration costs are prohibitively high while forming a federation means less or even zero migration costs. Thus, if regions (states, laender) are exposed to random income shocks which are less than perfectly correlated, freedom of movement reduces the income risk of mobile workers. In other words, federations may provide insurance against income risk by pooling region–specific income risks (compare Wildasin, 1995). Alternatively, a federal (centralized) system of transfers and taxes could be used to automatically redirect resources towards regions that are hit by idiosyncratic shocks (compare, for example, De Grauwe, 1992; Eichengreen, 1993; see also Persson and Tabellini, 1996; and, for an opposite view, Alesina and Perotti, 1998). In the literature on monetary integration, this idea has been labelled "fiscal coinsurance" (Eichengreen, 1993, see also Ingram, 1959).

The fiscal coinsurance literature therefore bolsters up the "classical" view that income redistribution should be centralized (Stigler, 1957, Oates, 1968, 1972, 1977, Musgrave, 1969, 1971) due to the different fiscal externalities (see Buchanan and Goetz, 1972; and Flatters et al., 1974) which are associated

with fiscally induced migration. However, increasing economic integration (decreasing migration costs) puts limits not only to the regional governments' abilities to pursue their own redistributive goals, it also reduces the benefits of centralized redistribution policies. Wildasin (1995) showed that freedom of movement not only reduces the income risk of mobile workers but also, due to the reallocation of workers to regions where they are most productive, increases overall output. Centralized redistribution policies that would give full insurance to workers would erase incentives for migration and thus lead to an inefficient outcome.

Is it better than to let people migrate freely? In most western societies (and not only there) many people *believe* that immigrant workers and their families are net beneficiaries of the tax and transfer system of their country of destination, that is, they are able to derive advantage from the social and public services provided but contribute less through the tax system. According to Eurobarometer 56.3, 53% of the Germans expect substantial immigration to Germany due to EU enlargement. Not less than 76% of them perceive immigration as negative. Among the top reasons to take up a negative attitude towards immigration are an expected increase of unemployment due to immigration (85%) and that immigrants could take an unfair advantage of social services (68%). Similar results were obtained for the other member states of the EU. On the other hand, Eurobarometer opinion polls show that a majority of EU citizens support EU enlargement nevertheless.[4]

Whether the misgivings with respect to immigration are true or not, if

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[4]For Eurobarometer 57, 15987 interviews were carried out between March 29th and May 1st, 2002. 50% of respondents declared themselves in favor of EU enlargement while only 30% were against. In Germany, the support rate was a bit lower than the EU average. Only in France the number of people against EU enlargement was larger than the number of supporters.

original residents fear to be among the losers of free migration, it is likely that the governments of potential immigration countries are willing to limit immigration. However, once a federation is formed, there is no way to legally forestall migration among its member regions. The only solution is to limit immigration indirectly by transferring resources from the destination region of migration to its region of origin, that is, a *regionalized* transfer system that takes into account not only own residents but also includes the residents of other regions (compare Wildasin, 1991, 1994; see also Pfingsten and Wagener, 1997).

Bucovetsky (1998) studied the cost and preference conditions under which sovereign countries will form a federation, a unitarian state, or rather stay separated. In his model setup, uncertainty about resource rents, ex ante differences in the expected resource rents, and risk aversion are the driving forces that may induce sovereign countries to choose the federation option. More specifically, federalism will be chosen if and only if the representative agent in the country with higher expected income is risk averse and migration costs lie within a interval which is determined by the agent's preference ordering between separation and a unitarian state. If fiscal equalization is possible, the "rich" region will offer an transfer to the "poor" region which just completely eliminates migration and thus, by saving resources, makes federalism a more attractive option.

How important is income uncertainty for the formation of federations? We completely eliminate income uncertainty by assuming that resource rents in both countries are given constants. We believe that there is a strong empirical case for such an assumption. In many federations, the relative positions of the regions are rather stable both with respect to their per–capita GDP and their per–capita tax revenues. During the 1991–2000 decade, the

ranking of the German laender according to per–capita GDP has hardly changed. In any of these years, city–state Hamburg outperformed all other laender both with respect to per–capita GDP and tax revenues, followed by Hesse, and Bremen (which had distinctly lower per–capita tax revenues than Bavaria and Baden–Wuerttemberg), while the five East German laender did not even reach half of Hamburg's per–capita GDP and only about one sixth of its per–capita tax revenues. Similar pictures arise for other federal states. The situation is even more extreme for the member states of the European Union and its joining candidates. For example, in 1998 Luxemburg exhibited a per–capita GDP of no less than 49,670 USD, while an average citizens of joining candidate Poland contributed only 3,871 USD to Poland's total GDP. Thus, since region specific income shocks are relatively small as compared to the large and persistent income differences within federations, income uncertainty and risk aversion alone cannot satisfactorily explain the formation of federations.

In Bucovetsky's (1998) model, separation is costless for the regions. Thus, by neglecting the potential benefits from free migration, as the author himself concedes, the case is biased against federalism. Therefore, in the model presented in the next section, the driving force that induces regions to form a federation is the efficiency loss caused by separation rather than income uncertainty.

3 The Model

As outlined above, we consider a model of two regions whose governments are sovereign in their choices of fiscal arrangements. Three fiscal arrangements are possible: separation (S), federalism (F), and a unitary state (U).

In this section, we assume that neither government is able to make any kind of unilateral transfer to the other region, whatever is the constitutional arrangement. Residents are assumed identical to one another with respect to their preferences. Thus, a region's sole decision criterion is the utility of its representative agent.

We assume that the incomes of the regions are common knowledge, and that there is no uncertainty about the amount of income available in each region. The initial population of each region is the same, and it is normalized to 1.[5] One of the two regions is the low–income region, denoted by L, and its income y_L is set to one, while the income of the high–income region, denoted by H, is given by $y_H = \rho$, where $\rho > 1$. The normalization of incomes does not matter since we choose a utility function which is linear in income.[6] The income difference between the high–income region and the low–income region could result from different natural resource endowments, technical progress, etc. The OECD PISA study has shown that the educational or skill level is not necessarily correlated with GDP. For example, in literacy, Germany's score (484) did not excel Hungary's and Poland's scores (480 and 479, respectively) significantly.

A representative agent's utility is given by

$$U_i = U_i(y_i) = y_i, \quad i = \{L, H\}. \tag{1}$$

Under any fiscal arrangement people, in principle, are allowed to move from region L to region H. Migration, however, is not costless, where we

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[5]Since income is equally shared by all residents of a region, that is we implicitly assume that the income of a region represents a private good to the residents of that region, this assumption is justifiable to simplify matters. If income was not rival in consumption, that is, if income had the features of a pure or congested public good, different population size would obviously matter.

[6]This parallels Bucovetsky's (1998) assumption of constant relative risk aversion.

assume that migration costs are positive and do not exceed the income difference between the regions:

$$0 < c < \rho - 1. \tag{2}$$

Thus, moving from L to H gives one a share of the higher income of region H but involves costs of c. In the equilibrium, some proportion n of the people born in L will have chosen to move, and the equilibrium rate of migration is given by the solution to the equation

$$\frac{\rho}{1+n} - c = \frac{1}{1-n}. \tag{3}$$

Obviously, the migration rate n is a decreasing function of the migration costs c and an increasing function of the income difference between the regions.

The assumption that *total* resource rents are unaffected by migration is central to the model. While income differences, for example, between the member states of the European Union and its joining candidates are reality, this assumption reflects the widespread belief that immigrants were net beneficiaries of the tax and transfer system of their country of destination (and that income is a fixed "cake"). Consequently, there is less income to be distributed among the original residents of the high–income region. By no means we want to claim the correctness of this statement. However, in this model agents act as if this belief was true.

Regarding the two marginal cases ruled out by equation (2), we would have

$$n = \frac{\rho - 1}{\rho + 1}, \tag{4}$$

if $c = 0$, that is, residents born in L would move to H until the income difference is levelled out and both regions exhibit an income of $\frac{\rho+1}{2}$. No migration at all would occur if $c = \rho - 1$, that is,

$$n = 0. \tag{5}$$

The first fiscal arrangement we consider is *separation*. As in Bucovetsky (1998) separation represents the status quo option. That is, if no bilateral fiscal agreement is reached, the regions will remain separated, and no region has the power to force another region into deviating from this status quo. For region H separation means that it commits itself to take measures of border protection such as border controls, building fences, and return transport of immigrants to their home region, in order to prevent immigration. To simplify matters, we assume that these measures give rise to costs proportional to the equilibrium migration rate, and that H always chooses that level of border protection that just completely prevents immigration.[7] The latter assumption means that we consider the pure cases of separation and federalism only. Border protections costs may be interpreted as a proxy for the efficiency loss caused by separation that was not taken into account by Bucovetsky's (1998) model. Of course, in the real world, limiting or eliminating migration will also affect total GDP. However, as noted above, we assume in our model that the representative agent perceives his region's income as a fixed "cake" which has to be sliced among all residents of that region.

If region H decides to take measures of border protection, then the residents of L cannot emigrate successfully from their home region, and their utility is given by

$$U_L^S = 1. \tag{6}$$

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[7]Data on the direct cost of limiting (illegal) immigration is available for most countries. Germany's federal government, for instance, plans to spend about 1.74 billion Euro for measures of border protection etc. in 2002 (a bit less than 1 per mill of GDP). However, limiting immigration involves several indirect costs. For example, as of December 2001, Germany sheltered more than 230,000 foreigners (mostly people who were not granted asylum) who were waiting for their return transport.

The utility of a representative resident of region H is given by

$$U_H^S = \rho - \beta \times n, \tag{7}$$

where we assume $0 < \beta < \rho + 1$. That is, even if migration costs were zero and, thus, border protection costs were very large, region H would still be better off than region L under separation, since $n|_{c=0} = \frac{\rho-1}{\rho+1}$.

If the fiscal arrangement is a *unitary state*, each region will dispose of the average income of both regions $\bar{y} = \frac{\rho+1}{2}$ equating the regions' utilities

$$U_L^U = U_H^U = \bar{y}. \tag{8}$$

Of course, region L is always better off in U than in S since $\bar{y} > 1$ by $\rho > 1$. Consequently, residents of L would not see an advantage in moving to region H. Residents of region H, however, are better off in U than in S if and only if the income loss caused by the costs of border protection is larger then the income loss due to amalgamation (which is half of the income difference), that is, $U_H^U > U_H^S$ if and only if $\beta n > \rho - \frac{\rho+1}{2} = \frac{\rho-1}{2}$.

Eventually, if the fiscal arrangement is *federalism*, H waives his possibility of preventing immigration. Since residents of region L now freely decide at given migration costs whether they want to move to region H, the regions' utilities are given by

$$U_L^F = \frac{1}{1-n} \tag{9}$$

and

$$U_H^F = \frac{\rho}{1+n}, \tag{10}$$

respectively. Obviously, residents of region L are better off in F than in S since $n > 0$ for $c < \rho - 1$, but they are worse off than in U since $n < \frac{\rho-1}{\rho+1}$ for $c > 0$. Residents of region H are better off in F than in U since $n < \frac{\rho-1}{\rho+1}$. Whether or not they are better off in F than in S depends on the cost

structure. It is clear, however, that H is better of in F than in S if U is weakly preferred to S since F is always preferred to U.

Summarizing the above discussion, we see that residents in region L have a unique preference ordering which is $U \succ_L F \succ_L S$. For region H, we have to consider five possible preference orderings depending on the cost structure: i) $S \succ_H F \succ_H U$, ii) $S \sim_H F \succ_H U$, iii) $F \succ_H S \succ_H U$, iv) $F \succ_H S \sim_H U$, and v) $F \succ_H U \succ_H S$. The two yardsticks we want to apply in order to classify the options are individual rationality and Pareto optimality. Individual rationality requires that a region chooses that option from a set of given options which maximizes the utility of its residents. Pareto optimality requires that no fiscal arrangement is chosen for which there is another fiscal arrangement available that would place at least one region in a better position than under the fiscal arrangement chosen.

U would be a Pareto optimal fiscal arrangement since it is not possible to place one of the regions in a better position without placing the other region in a worse position when switching to F or S. However, it is not individually rational for region H to choose U as it is dominated either by F or by S or by both. Thus, U is not a feasible fiscal arrangement. S is Pareto optimal in case i) only. Individual rationality is obvious, since only S remains in the core. In case ii) S is individually rational for H but it is not Pareto optimal since L could be placed in a better position, if F was chosen. F is Pareto optimal in any case. However, it is individually rational for H to choose F in cases ii) to v) only. Summing up, if both regions behaves individually rational then the resulting fiscal arrangement is Pareto optimal if and only if S is chosen in case i) and F is chosen in all other cases.

Proposition 1 summarizes the above discussion and shows under which cost conditions federalism will be chosen.

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Proposition 1 *Federalism is always a Pareto optimal fiscal arrangement. It is individually rational to choose federalism, if and only if either*

    i) $\beta \geq \rho$ *or*

    ii) $\frac{\rho+1}{2} < \beta < \rho$ *and* $0 < c < \bar{c}$, *where* $\bar{c} = \beta \frac{\rho+1-2\beta}{\rho-2\beta}$.

The proof is given in the Appendix.

Insert Figure 1 about here

Figure 1 graphically depicts the case $\rho = 1.8$, $\beta = 1.5$ (assuming constant total after–migration incomes). Since $\frac{\rho+1}{2} < \beta < \rho$ the curves of $U_H^F(c)$ and $U_H^S(c)$ intersect at $\bar{c} = 0.25$. For migration costs below 0.25, region H strictly prefers federalism to separation, since border protection costs are higher than the income loss caused by immigration. Analogously, if migration costs exceed 0.25, separation is strictly preferred to federalism. In the case $c = 0.25$, region H is indifferent between federalism and separation. However, since $U_L^F(0.25) > U_L^S(0.25)$ Pareto optimality would require region H to choose federalism.

Until now, we have assumed that the representative agent correctly believes total income of his region to be left unchanged by migration. Since his choice of a fiscal arrangement is done before migration takes place, this assumption has no consequences for the rationality of his decision (even if it was based on wrong beliefs). However, as far as we are concerned with Pareto optimality, we have to distinguish carefully between *ex ante* and *ex post* efficiency. If the representative agent is wrong, Proposition 1 only demonstrates that choosing federalism is efficient from an *ex ante* point of view. If total

income in both regions is a concave function of population size, more migration will occur than under the constant–income assumption and the sum of incomes will be larger than $1 + \rho$. This will make both separation and a unitary state less and federalism more attractive for the high–income region. Hence, under realistic assumptions, federalism will also be efficient from an ex–post point of view.

4 Fiscal Equalization

In this section, we lift the assumption that transfers are not possible between the regions. Now, we allow region H to voluntarily make an aggregate transfer T to region L. We assume that the native residents of region H contribute equally to the transfer. Likewise, we assume that the native residents of region L share the transfer received equally. After the government of H has fixed the size of the transfer, the residents of L decide whether they want to move. Hence, the income of region H is given by

$$y_H = \frac{\rho - T}{1 + n} \, , \tag{11}$$

the income of region L is given by

$$y_L = \frac{1 + T}{1 - n} \, , \tag{12}$$

and the migration rate is determined by the equation

$$y_L = y_H - c \, . \tag{13}$$

From equation (13) it is obvious that the representative agent in region H will choose exactly that level of transfer T that maximizes the income of someone born in the low–income region y_L, since this policy also maximizes the income of someone born in the high–income region $y_H = y_L + c$. As

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Bucovetsky (1998) put it: "No matter how high the migration costs, there will be complete unanimity that transfers which increase y_L should be implemented" (p. 311). The optimum size of the transfer is easily determined. Since the aggregate income of the federation after migration is $\rho + 1 - nc$, the optimum policy will be to choose a transfer that just completely eliminates migration. Thus, a transfer has to be chosen that minimizes n. If all residents agree on the optimum transfer, aggregate per–capita income will be maximized. Solving (13) for T at $n = 0$ yields the optimum transfer

$$T^\star(c) = \frac{\rho - 1 - c}{2} \ , \tag{14}$$

which is, of course, a decreasing function of the migration costs.

For the high–income region, there is no incentive to make transfers higher than $T^\star$. Choosing a $\tilde{T}$ slightly larger than $T^\star$ redistributes income from the H region to the L region without affecting aggregate income. However, there is no reason why residents in H should voluntarily give up a share of income higher than necessary to maximize their own incomes. Finally, if $\tilde{T} > \frac{\rho - 1 + c}{2}$, reverse migration would occur.

Consider the case that the fiscal arrangement is federalism. Will it then be attractive to both regions to agree upon a fiscal equalization scheme instead of migrating? The answer, as Proposition 2 states, is unambiguously yes.

Proposition 2 *Federalism with fiscal equalization, where the aggregate transfer is fixed to $T^\star$, is a Pareto improvement as compared to federalism without fiscal equalization.*

The proof is given in the Appendix.

The intuition behind Proposition 2 is that it is cheaper for residents of region H to compensate the residents of region L for renouncing for their right to emigrate than to share their income with those who would immigrate

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in absence of such a compensation. Analogously, with the compensation, residents in region L are better off if they stay at home since their home income plus the compensation is larger than what is to be expected after moving to region H, given the costs of migration. Obviously, the efficiency gain is due to the saving of the migration costs nc.

Since fiscal equalization makes federalism a more attractive option than without such a compensation, it is obvious to conjecture that federalism will be the preferred fiscal arrangement for larger intervals of migration costs and border protection costs. As compared to separation, choosing federalism with fiscal equalization augments total income by βn. However, unlike in the previous case where we compared federalism with and without fiscal equalization, it is not ensured that both regions will gain from choosing federalism. The following proposition shows under which cost conditions it will be individually rational for both regions to choose federalism.

Proposition 3 *For both regions, it is individually rational to choose federalism with fiscal equalization, if and only if either*

i) $\beta \geq \frac{\rho+1}{2}$ *or*

ii) $\frac{\rho+1+2\sqrt{\rho}}{4} \leq \beta < \frac{\rho+1}{2}$ *and*
$\frac{\rho-1-\sqrt{(\rho-1)^2-8\beta(\rho+1)+16\beta^2}}{2} \leq c \leq \frac{\rho-1+\sqrt{(\rho-1)^2-8\beta(\rho+1)+16\beta^2}}{2}.$

The proof is given in the Appendix.

Insert Figure 2 about here

Figure 2 graphically depicts the case $\rho = 1.8$, $\beta = 1.5$. Although we have chosen the same parameter values as in Figure 1, the utility curve

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of the high–income region under federalism (with fiscal equalization) now strictly dominates the utility curve under separation on the whole interval of migration costs $(0, 0.8)$.

Insert Figure 3 about here

Figure 3 illustrates that our conjecture that federalism will become more attractive to both countries if fiscal equalization is possible was right. For cost combinations above the upper solid line (Region I) federalism will always be preferred to separation irrespective of whether fiscal equalization is possible. Cost combinations below the lower solid line (Region II) imply that separation will always be preferred to federalism. Between both solid lines there exists a region (Region III) where federalism is chosen by both regions only if fiscal equalization is possible. Thus, fiscal equalization unambiguously enlarges the parameter space for which federalism is the resulting fiscal arrangement. Along the solid lines, the high–income region is indifferent between federalism and separation. Since federalism is the Pareto optimal fiscal arrangement, in these cases, federalism should be chosen by the high–income region.

5 Conclusion

In this paper, we took up the question why a group of sovereign countries is willing to form a federation and, going beyond that, to commit to fiscal equalization payments. We have argued that income uncertainty and risk aversion (compare Bucovetsky, 1998) alone cannot satisfactorily explain this phenomenon, since income differences in existing federations, such as Ger-

many and Canada, as well as in developing federations, such as the European Union and its joining candidates, are both too large and too persistent over time to induce "rich" countries to amalgamate with "poor" countries. In our model, remaining separated involves an efficiency loss for the high–income region since it has to take costly measures of border protection etc. in order to forestall immigration. These costs may be seen as a proxy for the efficiency loss that is caused by preventing the efficiency improving reallocation of workers. On the other hand, if immigrants are net beneficiaries of the tax and transfer system in their country of destination, the government of the high–income region may want to limit immigration. As we have shown, a possible solution for this trade–off is a transfer from the high–income to the low–income region that just completely eliminates migration. With fiscal equalization, border protection costs and migration costs are saved, and these rents can by shared by the low–income region and the high–income region, making both regions better off.

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Appendix

Proof of Proposition 1. First, we show Pareto optimality of federalism. The necessary condition for Pareto optimality is given by $U_H^F > U_H^U$, since $U_L^U > U_L^F$. Thus, $\frac{\rho}{1+n} > \frac{\rho+1}{2}$, or $n < \frac{\rho-1}{\rho+1}$ which is obviously true for all $c > 0$, since n is a strictly monotonous decreasing function of c with its maximum $n = \frac{\rho-1}{\rho+1}$ at $c = 0$.

Consider case i) of the proposition now. Individual rationality of federalism requires $U_H^F \geq U_H^S$, or $\frac{\rho}{1+n} \geq \rho - \beta n$. We define

$$\Delta U_H^F = U_H^F - U_H^S = \frac{\rho}{1+n} - \rho + \beta n . \tag{15}$$

Obviously, for $\Delta U_H^F \geq 0$, federalism is individually rational for H. The graph of (15) can be viewed as a function of c, where $\Delta U_H^F(\rho - 1) = 0$ forall β because of (5). Furthermore, $\Delta U_H^F(0) \geq 0$ if $\beta \geq \frac{\rho+1}{2}$ because of (4). Thus $\Delta U_H^F(0) > 0$ for $\beta \geq \rho$. $\Delta U_H^F(c)$ is a quasiconcave function of c, if $-\Delta U_H^F(c)$ is a quasiconvex function of c. $-\Delta U_H^F(c)$ is quasiconvex, if $-\Delta U_H^F(\rho - 1) \geq -\Delta U_H^F(0)$ implies $\frac{\partial - \Delta U_H^F(\rho-1)}{\partial c}(\rho - 1) \geq 0$. Using

$$\frac{\partial n(\rho - 1)}{\partial c} = -\frac{1}{\rho+1}, \tag{16}$$

the first derivative of $\Delta U_H^F(c)$ with respect to c at $c = \rho - 1$ is given by

$$\frac{\partial - \Delta U_H^F(\rho - 1)}{\partial c} = \frac{\beta - \rho}{\rho+1}, \tag{17}$$

which is greater than or equal to zero, if $\beta \geq \rho$. Thus, $\Delta U_H^F(c)$ is a quasiconcave function of c, and $\Delta U_H^F(c) \geq 0$ for $0 < c < \rho - 1$.

Consider case ii) of the proposition now. For $\frac{\rho+1}{2} < \beta < \rho$, we have $\Delta U_H^F(c) = 0$ at $c = \bar{c} = \beta\frac{\rho+1-2\beta}{\rho-2\beta}$. $\Delta U_H^F(c)$ is a quasiconcave function of c, if $-\Delta U_H^F(c)$ is a quasiconvex function of c. $-\Delta U_H^F(c)$ is quasiconvex, if $-\Delta U_H^F(\bar{c}) \geq -\Delta U_H^F(0)$ implies $\frac{\partial - \Delta U_H^F(\bar{c})}{\partial c}\bar{c} \geq 0$. The first derivative of

$-\Delta U_H^F(c)$ with respect to c at $\bar{c}$ is given by

$$\frac{\partial - \Delta U_H^F(\bar{c})}{\partial c} = \frac{\partial n(\bar{c})}{\partial c}\left(\frac{\rho}{(1+n(\bar{c}))^2} - \beta\right), \tag{18}$$

Using

$$n(\bar{c}) = \frac{\rho}{\beta} - 1 \tag{19}$$

yields

$$\frac{\partial - \Delta U_H^F(\bar{c})}{\partial c} = \frac{\partial n(\bar{c})}{\partial c}\frac{\beta}{\rho}(\beta - \rho) . \tag{20}$$

Since $\beta < \rho$ we have $-\Delta U_H^F(\bar{c}) > 0$. Thus, $\Delta U_H^F(c)$ is a (strictly) quasicon-cave function of c, and $\Delta U_H^F(c) > 0$ for $0 < c < \bar{c}$.

Finally, for $\beta \leq \frac{\rho+1}{2}$, the only real zero of $\Delta U_H^F(c)$ is at $c = \rho - 1$ and (17) is smaller than zero. Hence, $\Delta U_H^F(c) < 0$ forall c, $0 < c < \rho - 1$, which completes the proof. ∎

Proof of Proposition 2. The necessary conditions for fiscal equalization to be Pareto improving are given by $U_H^E \geq U_H^F$ and $U_L^E \geq U_L^F$, where one of the two inequalities must hold strictly. The former condition implies $\rho - T^\star \geq \frac{\rho}{1+n}$. Defining $\Delta U_H = U_H^E - U_H^F$ and using (14), we obtain

$$\Delta U_H = \frac{\rho + 1 + c}{2} - \frac{\rho}{1+n}, \tag{21}$$

the graph of which can be viewed as a function of c. Due to (4) and (5), we have $\Delta U_H(0) = 0$ and $\Delta U_H(\rho - 1) = 0$. If (21) is a strictly quasiconvave function of c, then $\Delta U_H(c) > 0$ for $0 < c < \rho - 1$. $\Delta U_H(c)$ is strictly quasiconcave if $\Delta U_H(0)(\rho - 1) > 0$. Using

$$\lim_{c \to 0}\frac{\partial n(c)}{\partial c} = -4\frac{\rho}{(\rho + 1)^3}, \tag{22}$$

the first derivative of (21) with respect to c at $c = 0$ is given by

$$\frac{\partial \Delta U_H(0)}{\partial c} = \frac{1}{2}\frac{\rho - 1}{\rho + 1}, \tag{23}$$

which is strictly positive since $\rho > 1$. Thus, $\Delta U_H(c)$ is a strictly quasicon-cave function of c. The second condition for fiscal equalization to be Pareto improving implies $1 + T^\star \geq \frac{1}{1-n}$. Defining $\Delta U_L = U_L^E - U_L^F$ and using (14), we obtain

$$\Delta U_L = \frac{\rho + 1 - c}{2} - \frac{1}{1-n}, \tag{24}$$

the graph of which again can be viewed as a function of c. Due to (4) and (5), we have $\Delta U_L(0) = 0$ and $\Delta U_L(\rho - 1) = 0$. Analogously, if (24) is a strictly concave function of c, then $\Delta U_H(c) > 0$ for $0 < c < \rho - 1$. Using (22), the first derivative of (24) with respect to c at $c = 0$ is given by

$$\frac{\partial \Delta U_L(0)}{\partial c} = \frac{1}{2}\frac{\rho - 1}{\rho + 1}, \tag{25}$$

which is strictly positive. Thus, $\Delta U_L(c)$ is a strictly quasiconcave function of c, which completes the proof. ∎

Proof of Proposition 3. Consider case i) first. Individual rationality of federalism with fiscal equalization requires $U_H^E \geq U_H^S$, or $\rho - T^\star \geq \rho - \beta n$. Using (14), we define

$$\Delta U_H^E = U_H^E - U_H^S = \beta n - \frac{\rho - 1 - c}{2}. \tag{26}$$

Obviously, for $\Delta U_H^E \geq 0$, federalism is individually rational for H. The graph of (26) can be viewed as a function of c, where $\Delta U_H^E(\rho - 1) = 0$ forall β because of (5). Furthermore, $\Delta U_H^E(0) \geq 0$ if $\beta \geq \frac{\rho+1}{2}$ because of (4). $\Delta U_H^E(c)$ is a quasiconcave function of c, if $-\Delta U_H(c)$ is a quasiconvex function of c. $-\Delta U_H^E(c)$ is quasiconvex, if $-\Delta U_H^E(\rho - 1) \geq -\Delta U_H^E(0)$ implies $\frac{\partial -\Delta U_H^E(\rho-1)}{\partial c}(\rho - 1) \geq 0$. Using

$$\frac{\partial n(\rho - 1)}{\partial c} = -\frac{1}{\rho + 1} \tag{27}$$

the first derivative of $\Delta U_H^E(c)$ with respect to c at $c = \rho - 1$ is given by

$$\frac{\partial - \Delta U_H(\rho - 1)}{\partial c} = -\left(\frac{1}{2} - \beta\frac{1}{\rho + 1}\right), \tag{28}$$

which is greater than or equal to zero, if $\beta \geq \frac{\rho+1}{2}$. Thus, $\Delta U_H^E(c)$ is a quasiconcave function of c, and $\Delta U_H^E(c) \geq 0$ for $0 < c < \rho - 1$.

Consider case ii) now. If $\beta < \frac{\rho+1}{2}$, solving $\Delta U_H^E(c) = 0$ for c, $0 < c < \rho - 1$ yields

$$\bar{c} = \frac{\rho - 1 + \sqrt{(\rho-1)^2 - 8\beta(\rho+1) + 16\beta^2}}{2} \quad \text{and} \tag{29}$$

$$\underline{c} = \frac{\rho - 1 - \sqrt{(\rho-1)^2 - 8\beta(\rho+1) + 16\beta^2}}{2}. \tag{30}$$

If $\beta = \frac{\rho+1+2\sqrt{\rho}}{4}$ then $\bar{c} = \underline{c} = \frac{\rho-1}{2}$, $n = \frac{\rho+1-2\sqrt{\rho}}{\rho-1}$, and $\Delta U_H^E(\frac{\rho-1}{2}) = 0$. If $\frac{\rho+1+2\sqrt{\rho}}{4} < \beta < \frac{\rho+1}{2}$, obviously $\bar{c} > \underline{c}$ and hence we must show that $\Delta U_H^E(c)$ is a quasiconcave function of c between $\underline{c}$ and $\bar{c}$ which is the case if $\frac{\partial \Delta U_H^E(\underline{c})}{\partial c}(\bar{c} - \underline{c}) \geq 0$. Since

$$\frac{\partial n(\underline{c})}{\partial c} = -\frac{1}{\rho+1} \tag{31}$$

we have

$$\frac{\partial \Delta U_H^E(\underline{c})}{\partial c} = -\frac{\beta}{\rho+1} + \frac{1}{2} \tag{32}$$

which is greater than or equal to zero if $\beta \leq \frac{\rho+1}{2}$.

Finally, for $\beta < \frac{\rho+1+\sqrt{\rho}}{4}$, the only real zero of $\Delta U_H^E(c)$ is at $c = \rho - 1$ and (28) is smaller than zero since $\frac{\rho+1+\sqrt{\rho}}{4} < \frac{\rho+1}{2}$. Hence $\Delta U_H^E(c) < 0$ forall c, $0 < c < \rho - 1$, which completes the proof. ∎
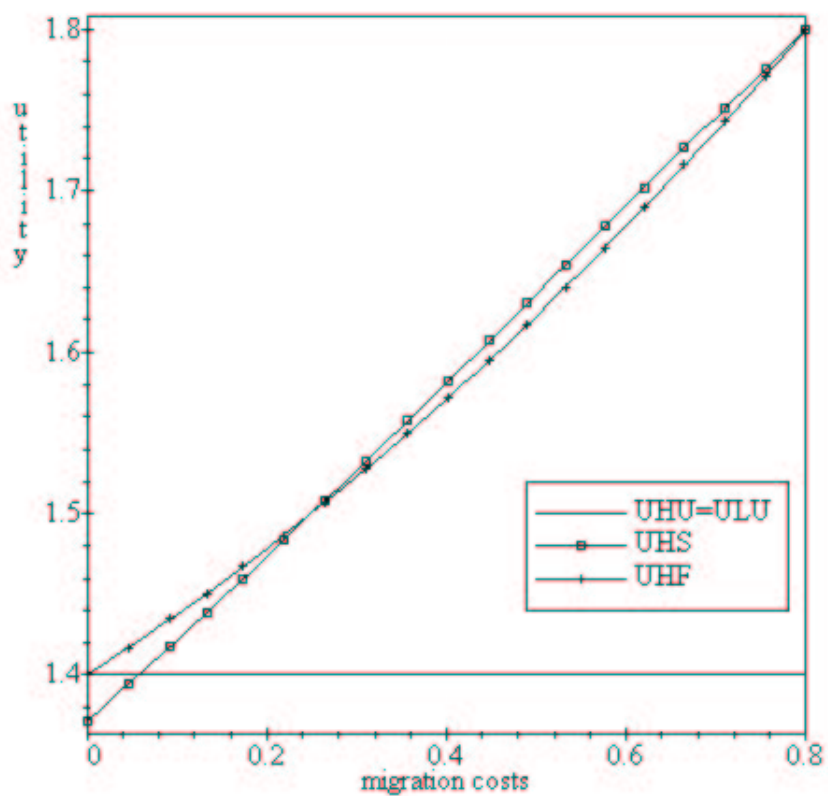
Figures

Figure 1 Utility of the high–income region under different fiscal arrangements with $\rho = 1.8$, $\beta = 1.5$
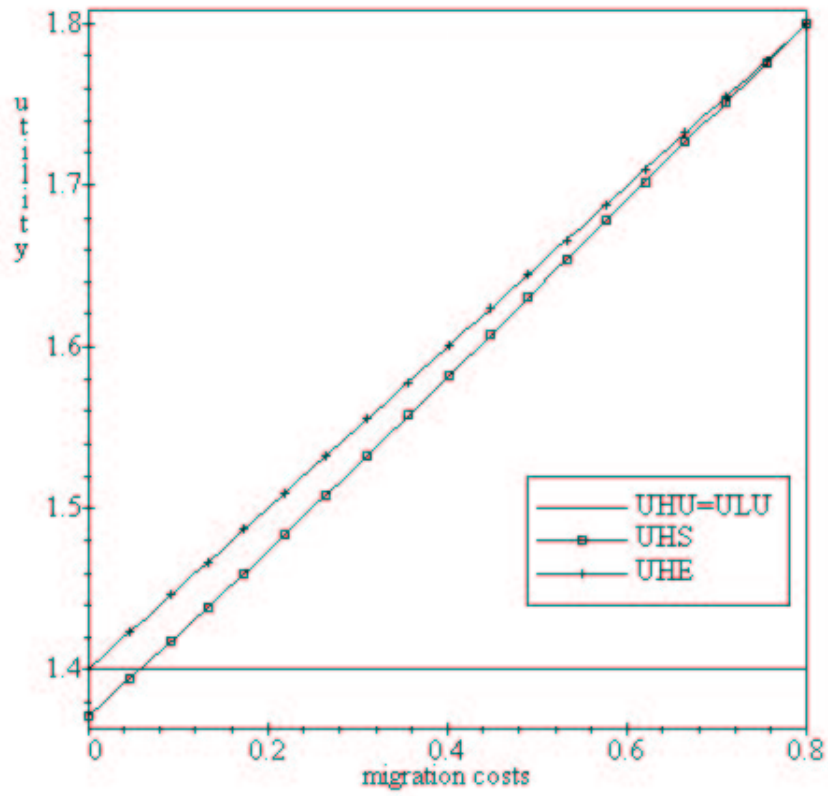
Figure 2 Utility of the high–income region under different fiscal arrangements with $\rho = 1.8$, $\beta = 1.5$, when fiscal equalization is possible.
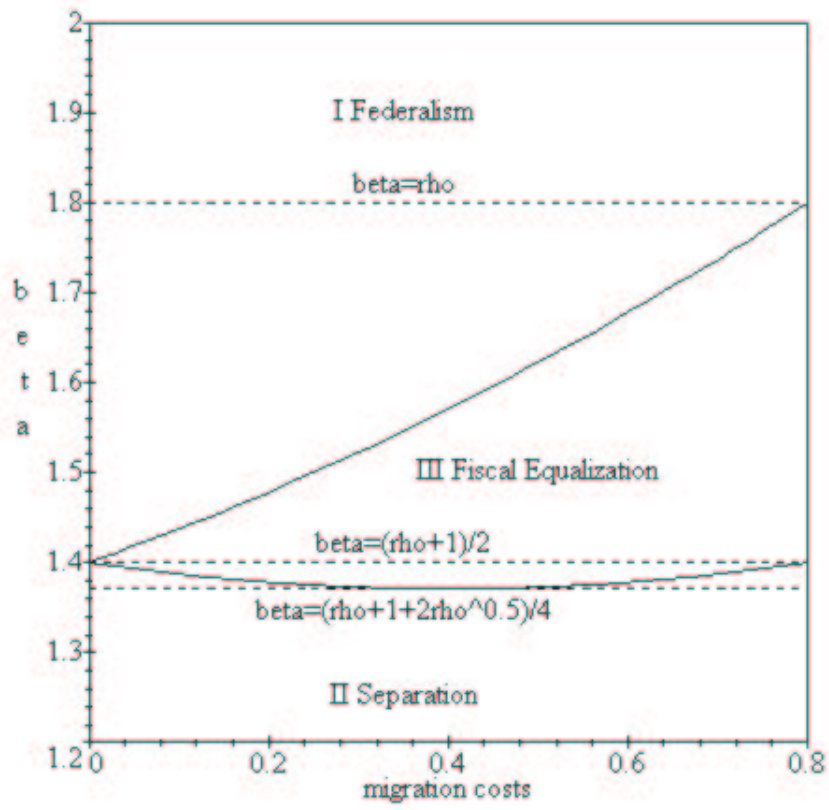
Figure 3 Parameter space for c and β.