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DECENTRALIZED INCOME REDISTRIBUTION AND IMMIGRATION*

by

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Abstract

We analyze the welfare and other effects of immigration on a system of jurisdictions with a common labor market, mobile capital, and redistributive tax/transfer policies. Comparative-statics analysis of a model of Nash non-cooperative equilibria in tax/transfer policies shows that the welfare effect of immigration depends on whether immigrants are net fiscal contributors or burdens. Any one jurisdiction's redistribution and immigration policies generate fiscal externalities for others in the system, which a central government can internalize by appropriate taxes and subsidies.

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I. Introduction

Immigration policy has proven to be a contentious issue in developed countries. It often raises questions of race, culture, language, and religion, but intertwined with all of these, and no less important, is the economic dimension of migration. Immigration is alleged to have significant effects, favorable or unfavorable, on labor markets, housing markets, and industry output, either in particular regions or throughout entire economies. Aside from these market impacts, it is also frequently claimed that immigration may have important fiscal effects. Some argue that immigrants impose fiscal burdens on host economies while others claim that immigrants are net fiscal contributors. Certainly, by comparison with the migrations of earlier eras, there is good reason to pay closer attention to the fiscal aspects of present-day migration. In modern advanced economies, governments play much larger roles than was true a half-century or more ago, as evidenced (crudely) by government expenditure levels that now commonly amount to 1/3 to 1/2 of national income. Much of the growth of the public sector in the present century can be attributed to expansion of programs in which transfers of income in cash or in kind figures prominently. A case could be made that the benefits and costs of migration in earlier times tended to accrue predominantly to migrants themselves, but the expansion of the public sector could well attenuate the connection between the private and social benefits and costs of migration in modern economies.

The current quantitative importance of immigration for the EU and the US is readily apparent. Germany, France, and many other EU countries are confronted with rising numbers of immigrants from Eastern Europe, the former Soviet Union, and North Africa. Immigration rates in the US are also very high, having reached levels not seen since the early years of the present century. High rates of immigration into the EU and the US are quite likely to persist well into the next century. EU countries have always taken the view that issues of immigration policy (i.e., immigration from outside the EU) are matters of national legal jurisdiction, an approach that is confirmed in the Maastricht Treaty (Art. K 1). However, citizens of member states have always had the right to move freely within the EU. For instance, no citizen of a member state may be prohibited from employment in any other member state. The EU countries therefore form a "common labor market." In such a common labor market, wages and employment levels are interdependent, and the effects of immigration policy in one country can be transmitted to other member states. It is true that the Treaty of Rome (Art. 48) only allows EU citizens to move freely among member states, but the easing of border controls within the EU makes it difficult to prevent immigrants from moving to other member states. Furthermore, even if EU authorities could prevent immigrants from moving between EU countries, [1] the induced migration of EU workers competing with immigrants in the destination country would have the same or similar effects, as we will demonstrate. Thus, international transmission of the effects of

[1] Heaton (1992) discusses several ways that EU countries can prevent immigrants from moving between member states.

immigration policy can take place by a direct movement of immigrants from one EU country to another or indirectly, by an induced movement of EU citizens. Constitutional guarantees of freedom of movement provide the US with a common labor market as well. In the US case, the central government assumes responsibility for immigration policy, so there is no possibility of state-specific controls on immigration.

A starting point for any analysis of the fiscal effects of immigration is first of all to develop a framework within which fiscal policy involves redistribution, so that it is meaningful to discuss the possibility that immigrants may be net beneficiaries of or net contributors to the fiscal systems of their destination jurisdictions (countries or states). Secondly, however, it is apparent that there is little reason to examine the effects of immigration when fiscal policies are set in a completely arbitrary way. We therefore follow a line of studies in the literature on decentralized income redistribution in supposing that there is a system of jurisdictions (two, for simplicity) in which each jurisdiction chooses its tax and transfer policies optimally from its own viewpoint. Each takes into account the effects of its policies on the system-wide labor market equilibrium and recognizes, as well, that capital is internationally mobile. Whereas previous studies have assumed that the population of the system of jurisdictions is fixed, however, our interest is in studying what happens when the equilibrium of this system is disturbed by increases in population from outside the system. [2]

The main objective of the analysis presented below is to study the impact of immigration policies on the destination country (or state) and on its neighbors. Section II presents a model of decentralized fiscal policy with mobile labor and capital and characterizes some of the properties of the tax and transfer policies that emerge in a Nash non-cooperative equilibrium. Section III studies the effect of immigration on this non-cooperative equilibrium. The analysis in these sections shows, first of all, that immigration of workers into one jurisdiction creates external effects for other jurisdictions that are transmitted through migration of mobile workers *within* the system of jurisdictions. Secondly, we find that when each jurisdiction chooses optimal redistributive policies, the external effect is purely fiscal in nature: immigrants who make net fiscal contributions create external benefits, and those who impose net fiscal burdens create external costs. Third, we show that jurisdictions refrain from taxing mobile capital at source. Section IV discusses the implications of these basic findings for issues of decentralization vs. coordination of immigration policy within a system of jurisdictions and for the evaluation of the welfare consequences of possible expansion in the membership of the EU. Section IV also shows how a central government can use a program of intergovernmental fiscal transfers to internalize the external effects of any one jurisdiction's income redistribution and immigration policies on its neighbors.

Section V summarizes some of the principle findings, discusses further policy questions,

[2] See, e.g., Pauly (1973), Wildasin (1991), and references therein. Modern analysis of income redistribution with factor mobility can be traced to authors such as Stigler (1957) and Oates (1968). For further references and related discussion, see Wellisch (1992, 1995) and Wildasin (1992).

and suggests directions for further research.

II. Decentralized Tax-Transfer Policy with Labor and Capital Mobility

A. Factor Market Equilibrium. A major goal of the analysis is to explore the interactions between factor mobility and fiscal policy, particularly redistributive fiscal policy, within a system of jurisdictions. In the EU or the US, labor mobility among jurisdictions (EU member countries, states of the US) is greater than between these jurisdictions and the rest of the world. Thus, the model presented in this section assumes that citizens in any "member state" of the system of jurisdictions may migrate to other member states and become employed in them without legal restraint, while obtaining fiscal treatment on the same terms as native citizens (i.e., there is a "common labor market" within the system of jurisdictions), but that legal constraints are used to control the entry of workers from outside of the system. One purpose of the analysis is to explore the impact on this system of increases in the amount of immigration from outside through changes in these legal constraints. For simplicity, it will be assumed that there are only two countries in the system (e.g., Germany and all other EC member states), denoted by i, $j = 1, 2$.

In order to focus attention on factor markets and redistributive policies, we abstract from issues of trade and assume that each jurisdiction within the system produces a single homogeneous output which is taken as numeraire throughout the analysis. (The products produced in each jurisdiction need not literally be identical; for the purposes of the present analysis, there may be any number of goods produced in each jurisdiction, as long as they are traded at exogenously-fixed prices on world markets and thus treated as a homogeneous aggregate.) The output in each jurisdiction is produced using three (types of) inputs.

The first input is called the "fixed factor," assumed to be immobile and inelastically supplied within each jurisdiction. It may represent land or other natural resources, but should be interpreted to include any other immobile factors of production as well. The precise definition of these other factors depends on the intended application, but could include immobile labor (e.g., the old, or workers in particular skill or occupational categories), public infrastructure (highways networks, harbors), or possibly private fixed capital.

The second input is "mobile labor," and it refers to a class of identical workers who are *potentially* mobile among jurisdictions. For simplicity, we ignore labor/leisure tradeoffs, assuming that each worker provides a fixed amount of labor. The variable l_i represents the size of the mobile labor force in jurisdiction i, consisting of the exogenously-given original residents n_i, plus any workers that enter from another jurisdiction, plus any immigrants from outside the system, denoted by m_i. Native (and possibly immigrant) workers are assumed to be able to migrate from one jurisdiction to another within the common labor market, though perhaps at a cost. [3] The variable γ_{ij} denotes the cost that a worker incurs in moving

[3] According to the Treaty of Rome (Article 48), only EU citizens are guaranteed the right to migrate freely among the member countries. It is not crucial for our analysis to specify

from jurisdiction i to jurisdiction j; the special case where labor is perfectly mobile among jurisdictions corresponds to the case where $\gamma_{ij} = 0$ for all i, j. As mentioned above, some types of labor may be completely *immobile*; in the case of the EU or the US, where substantial numbers of (mobile) immigrants are unskilled relative to the initial populations, we might interpret l_i to represent unskilled labor while skilled labor is included in the aggregate fixed factor. Thus, although we refer to l_i as "mobile labor," or just "labor," for short, it should be borne in mind that l_i may designate just one component of the labor force.

The third factor of production, "capital," is freely mobile among jurisdictions and traded on world markets at fixed prices. The amount of capital employed in jurisdiction i is denoted by k_i, and r denotes the price of this input on the world market. The formal analysis and results of the paper would be completely unchanged if k_i and r were vectors, so k_i should be interpreted to represent not only mobile capital but any other factors of production obtained from the world market at fixed terms of trade. The initial endowment of capital held by the owners of the immobile factors in jurisdiction i is denoted by $\bar{k}_i \geq 0$, while each mobile worker is endowed with $\bar{k}_l \geq 0$ units of capital. These endowments earn the world rate of return r for their owners.

The production function in jurisdiction i is denoted by $f^i(l_i, k_i)$, where the dependence of f^i on immobile factors of production is suppressed in the notation and it is assumed, accordingly, that f^i is strictly concave in l_i, k_i. (Note that production functions may differ among jurisdictions, thus allowing not only for differing endowments of immobile factors but for differences in technology as well.) Denoting derivatives of the production function with subscripts, it is assumed that $f^i_l > 0$ and $f^i_k > 0$; strict concavity means that the matrix of second-order derivatives of f^i is negative definite. In order to simplify the notation, the formal analysis will be carried through for the case where k_i is a scalar, so that concavity of f^i means that $f^i_{ll} < 0$, $f^i_{kk} < 0$, and

$$F^i \equiv f^i_{ll} f^i_{kk} - (f^i_{kl})^2 > 0. \tag{1}$$

We assume competitive factor markets, so that the gross wage per worker is f^i_l, the gross return to capital is f^i_k, and the gross return to the fixed factor, a pure rent, is $f^i - l_i f^i_l - k_i f^i_k$. Gross and net factor returns may diverge because of public interventions through tax and transfer policies. In particular, the government in jurisdiction i may engage in redistributive transfers which pay a lump sum of z_i per worker, financed by a tax at rate t_i on capital and by taxes on the immobile factor. [4] Tax and transfer policies may vary from one jurisdiction to another and thus represent *decentralized* tax and transfer policies from the perspective

whether or not immigrants can migrate between jurisdictions. Furthermore, the assumption that immigrants can migrate among jurisdictions at the same cost as native residents is made for convenience only. The costs borne by immigrants in initially entering either jurisdiction may be arbitrarily specified.

[4] The tax on capital is a tax on the *use* of capital in production, i.e., a tax on capital at source. Any residence-based taxes on capital, such as personal income taxes, must fall either on the owners of immobile factors or on the workers who reside in each jurisdiction,

of the system of jurisdictions. (In the EU context, the policies of the national or "central" governments of individual countries are "decentralized" or "local" from the viewpoint of the EU as a whole.) Net income per worker in jurisdiction i (exclusive of any migration costs) is given by $c_i \equiv f_l^i + z_i + r\bar{k}_l$, that is, gross wage income plus fiscal transfers plus the return to any initial endowments of capital. To balance the budget of the government in jurisdiction i, immobile factor owners must pay $l_i z_i - t_i k_i$ in taxes, and hence they receive, in aggregate, a net income of $y_i \equiv f^i - l_i f_l^i - k_i f_k^i + r\bar{k}_i - l_i z_i + t_i k_i$.

It should be noted that fiscal variables are not at this stage restricted as to sign, and they should be interpreted very broadly. The formal treatment of taxes and transfers as cash or cash equivalents simplifies the analysis considerably but should not be taken literally. The variable z_i represents, to a first approximation, the net fiscal benefit, per mobile worker, of the totality of government tax, transfer, and expenditure policies. Public expenditures for the provision of rival (congested) public services to mobile workers should also be included in z_i. Pure cash transfers are the most obvious and easily-measured examples of government provision of rival goods to households but any public goods or services for which it makes sense to construct cash equivalents fit the model equally well. [5] Similarly, the tax rate on capital, t_i, should not be viewed simply as a measure of a statutory tax rate on capital. Rather, it represents the fiscal contribution or burden on capital net of any subsidies paid to capital and net of the monetized value of the benefits of public provision of infrastructure or other public services that benefit capital on a per-unit basis. Either or both z_i and t_i may be negative or zero, corresponding to a transfers from labor to immobile factor owners, from immobile factor owners to capital, or to no redistributive policy at all.

It is also important to note that the tax/transfer policy in each jurisdiction is assumed to treat all workers equally, regardless of their origin, an assumption which requires some justification. As mentioned, there are legal constraints within the EU and the US, derived mainly but not entirely from the Treaty of Rome and the US constitution, that impose substantial *de jure* uniformity of fiscal treatment for all residents who are citizens of other

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and are included along with other taxes on immobile factor owners or are netted out from the fiscal transfer z_i to workers in jurisdiction i.

[5] Numerous empirical studies in the literature of local public finance find evidence of congestion effects for many urban public services; see Wildasin (1986) for references. In the international migration context, Usher (1977) examines how immigrants may partake of public (and therefore common-property) resources such as government-owned natural resources, revenue streams from the corporation income tax, or public infrastructure as well as absorb some share of the national debt and other public-sector liabilities. Other studies in this vein are cited in Simon (1989). The comprehensive measurement of the empirical magnitude of the variable z_i for any particular worker type is a very complex exercise. A typical household will pay income or consumption taxes, make contributions to social insurance programs, and receive cash and in-kind benefits from a variety of government expenditure programs. A household's fiscal benefits and contributions can be expected to change markedly over the life cycle due to changing employment, health, family, and other circumstances. In our static model, the variable z_i is properly interpreted as a comprehensive measure of the net value of all of these fiscal factors, expressed in present-value terms. Measurement issues are discussed further in the conclusion.

jurisdictions within the system. The fiscal treatment of immigrants is not subject to the same fundamental legal constraints, but even here fiscal differentiation is limited by statute, policy discretion, or basic administrative constraints. For instance, legal immigration often carries with it taxpaying responsibilities and public service access that are very similar to those of native residents. The fiscal status of illegal immigrants is more complex. Illegals commonly pay certain taxes, such as VAT or other consumption taxes, in the same way as native citizens. Their employers may withhold social insurance contributions or income taxes just as for legal immigrants or native residents. In principle, it may be possible for a jurisdiction to deny illegals access to health, education, welfare, and other social benefits, but, as illustrated by recent controversies surrounding Proposition 187 in California, exclusion is often not practiced even though it might be legally and administratively feasible. Furthermore, in many cases, exclusion from benefits is infeasible or would be very costly. For instance, tax incentives or subsidies to increase the supply of low-income housing result in lower housing costs for all poor people, whether immigrant or non-immigrant; job-training programs may reduce the supply of low-skilled workers and thus improve wages for remaining low-skilled workers both in the formal sector and in the informal or underground economy. It would be difficult or impossible to exclude illegals from subsidized public transportation, police and fire protection, and some forms of health care. Finally, more complete access to public services is usually obtainable with a lag for those immigrants who manage to establish themselves in the country for a sufficiently long time. Hence, although linguistic, legal, and other difficulties may result in some *de facto* inequality of fiscal treatment between native and non-native populations, and although no simple assumption can capture all of the complexities of fiscal treatment of these populations, the equal-treatment assumption at least warrants analysis.

Market equilibrium with mobile or potentially mobile factors requires that spatial arbitrage conditions be satisfied, such that factor owners have no incentive to relocate themselves or the resources that they own, taking fiscal policies and mobility costs into account. Capital market equilibrium requires that

$$f_k^i - t_i = r, \qquad i = 1, 2, \tag{2}$$

that is, the net rate of return on capital in each jurisdiction must be equal to the rate of return prevailing in world markets. Labor market equilibrium requires that no worker has an incentive to move from one jurisdiction to another. The total amount of migration from jurisdiction i to j is given by the difference between the native population plus immigration minus employment, i.e., $n_i + m_i - l_i$. In equilibrium, if workers migrate from jurisdiction i to jurisdiction j, the return to mobile labor in jurisdiction j net of migration costs must be equated to the return to labor in jurisdiction i, while migration must be zero if the differences in the return to labor are smaller than migration costs, i.e.,

$$n_i + m_i - l_i > 0 \rightarrow c_i = c_j - \gamma_{ij}\,, \qquad i = 1, 2, j \neq i \tag{3.1}$$

$$c_i > c_j - \gamma_{ij} \rightarrow n_i + m_i - l_i \leq 0 \tag{3.2}$$

As a special case, if migration costs are zero so that labor is freely mobile, $c_1 = c_2$ must hold in equilibrium. Whether immigration occurs or not, total employment in the two jurisdictions must be equal to the total supply of labor:

$$l_1 + l_2 = n_1 + n_2 + m_1 + m_2. \tag{4}$$

Substituting $c_i = f_l^i + z_i + r\bar{k}_l$ into (3), the factor market equilibrium conditions (2), (3), and (4) can be used to determine the equilibrium employment of capital and labor (k_i, l_i) in each jurisdiction for any specification of the level of immigration (m_1, m_2) into each jurisdiction, transfers to mobile workers (z_1, z_2), and tax rates on capital (t_1, t_2). If interjurisdictional migration costs are non-zero, there are three possible equilibrium regimes: one with no migration at all between jurisdictions 1 and 2 ($n_i + m_i = l_i$, $i = 1, 2$) and two with migration in one direction or the other. The no-migration equilibrium is "most likely" to occur when migration costs are very high. Since our main interest is in the case where migration does occur, we assume that migration costs are not "prohibitive" so that the level of migration is non-zero in equilibrium. [6]

Conditions (2), (3), and (4) constitute a simple general equilibrium system whose detailed comparative statics properties, presented in the Appendix, are important for subsequent derivations. Several general properties of this system that should be noted here, however. First, changes in the fiscal treatment of either factor in one jurisdiction affect the equilibrium allocation of both labor and capital in both jurisdiction. For example, more favorable fiscal treatment of mobile workers in jurisdiction 1 (an increase in z_1) increases employment in jurisdiction 1 and reduces it in jurisdiction 2 and affects the level of capital employment in each jurisdiction in a way that depends on whether capital and labor are complement or substitute inputs (the model imposes no restrictions dictating one or the other). Similarly, changes in the tax treatment of capital by one jurisdiction affect the equilibrium levels of capital and labor employed in both jurisdictions. Welfare evaluation of fiscal policy must therefore take complex general-equilibrium interrelationships into account. Second, operative linkages between the markets for mobile labor in the two jurisdictions imply that only the *total* amount of immigration in the system $m_1 + m_2$ matters for equilibrium allocations, factor prices, or welfare, not the level of immigration in either jurisdiction taken by itself. As discussed further below, this fact calls into question the extent to which either jurisdiction can meaningfully implement an "independent" immigration policy. Third, the equilibrium allocation of labor depends only on the *differential* in the level of transfers to mobile workers, $z_1 - z_2$, not upon each of these policy variables separately.

[6] Whether or not migration occurs in equilibrium depends not only on migration costs but on endogenous variables, including the level of transfers to workers. The assumption that labor markets in the two jurisdictions are linked by active (or incipient) migration is therefore non-primitive. It is certainly satisfied, however, in the special case where migration costs are zero. See Myers and Papageorgiou (1994) for more detailed discussion of fiscal policy with different migration "regimes" in a model with costly migration.

B. Nash Equilibria in Tax-Transfer Policy. Having described how a market equilibrium is established for any given specification of tax, transfer, and immigration policies, it remains to explain how those policies themselves are determined. Our basic approach is to allow tax and transfer policies to be determined endogenously for arbitrarily-specified levels of immigration; we then analyze the effects of immigration on these policies and on the overall equilibrium of the system. One may think of this analysis in the context of a stage game in which immigration policy is determined in the first stage and fiscal variables (tax and transfer policies) are determined in the second stage. Section IV presents further discussion of this stage-game approach.

A model of endogenous decentralized government tax and transfer policy is necessary in order study the way that factor mobility affects the extent and nature of redistributive policies. One common modelling approach is to assume that redistribution results from altruism, in the form of interdependent utilities, between donors and recipients. Thus, one might assume that immobile factor owners derive utility both from their own consumption and from that of workers, as reflected in a utility function $u_i(y_i, c_i)$, and that they choose the level of transfer payments to workers, z_i, to maximize this function. This function is assumed to be strictly quasi-concave and continuously differentiable, with partial derivatives denoted by u_{ic}, u_{iy}, u_{icc}, etc. Alternatively, resident or native workers might set the level of transfers, limiting the size of transfers due to altruism toward the immobile factor owners, again captured by a utility function $u_i(y_i, c_i)$. As still another possibility, redistributive policy might be chosen so as to maximize a social welfare function defined over the net incomes of immobile factor owners and workers—again representable by a function $u_i(y_i, c_i)$. As just one special case, $u_i(y_i, c_i)$ could be a utilitarian social welfare function with population weights given by the numbers of households in each factor-ownership category. [7]

In all of these cases, the determination of tax and transfer policy in jurisdiction i amounts to choosing a level of per capita redistributive transfers z_i and a level of capital taxation t_i to

$$max$$

where

$$y_i = f^i - l_i f^i_l - k_i f^i_k + r\bar{k}_i - l_i z_i + t_i k_i \tag{5.1}$$

$$c_i = f^i_l + z_i + r\bar{k}_l. \tag{5.2}$$

The constraints on this optimization include the general-equilibrium impact of tax/transfer policy on equilibrium factor allocations and factor prices. This implies that the optimization takes place in a strategic setting, since the values of the variables (l_i, k_i) that appear in (5) depend not only on the policies chosen by jurisdiction i but on (z_j, t_j), policies chosen by the other jurisdiction. We assume that the jurisdictions act non-cooperatively to achieve a Nash equilibrium in which each jurisdiction i solves problem (P) taking the transfers to mobile workers and the tax on capital (z_j, t_j) of jurisdiction j as fixed at their equilibrium values (z^*_j, t^*_j).

C. Characterization of Nash Equilibria. What can one say about the fiscal policies (z^*_i, t^*_i) chosen by the two jurisdictions in a Nash equilibrium? These can be characterized formally using the first-order conditions for the optimal policy problem (P), which imply (after dividing by the marginal social utility of income of the immobile factor owners u_{iy} and using the capital-market equilibrium conditions (2)) that

$$MRS_i - l_i + \left([MRS_i - l_i]\, f^i_{ll} - z_i\right) \frac{\partial l_i}{\partial z_i} + \left([MRS_i - l_i]\, f^i_{lk} + f^i_k - r\right) \frac{\partial k_i}{\partial z_i} = 0 \tag{6.1}$$

$$\left([MRS_i - l_i]\, f^i_{ll} - z_i\right) \frac{\partial l_i}{\partial t_i} + \left([MRS_i - l_i]\, f^i_{lk} + f^i_k - r\right) \frac{\partial k_i}{\partial t_i} = 0 \tag{6.2}$$

where $MRS_i \equiv u_{ic}/u_{iy}$ is the marginal rate of substitution between the consumption of workers and immobile factor owners in jurisdiction i.

Our first result concerns the taxation of capital. Standard optimal tariff principles would suggest that such taxes could only be welfare-improving if they altered the world terms of trade. Since both jurisdictions are small relative to the world capital market, one might expect to find that $t^*_i = 0$. However, the theory of second best suggests that first-best rules of optimal policy generally do not hold at a second-best optimum, and optimal tax principles generally imply that many tax distortions are better than one. In the present model, both capital taxes and transfers to workers affect the distribution of income between immobile factor owners and mobile workers. Starting from $t_i = 0$, one might expect that an increase in the capital tax rate would reduce the amount of capital employed in jurisdiction i and thus the productivity of labor, lowering the net incomes of workers, causing a labor outflow, and thus reducing the return to the immobile factor owners in the taxing jurisdiction. The interjurisdictional labor flow to the other jurisdiction would presumably depress wages there, attract additional capital, and increase the return to the immobile factors. The story is even more complicated when the fiscal contributions or burdens of mobile workers are taken into account. Depending *inter alia* on the relative social valuation of the incomes of mobile workers and immobile factor owners, one might expect the optimal capital tax rate could

be either positive or negative but probably not zero. Despite this ambiguity of intuitive arguments, one can show:

Proposition 1: In a Nash equilibrium, neither jurisdiction taxes or subsidizes capital: $t_i^* = 0$ for $i = 1, 2$.

Proof: See Appendix.

The proof of this result depends crucially on the fact that each jurisdiction is optimizing its fiscal treatment of both capital *and* mobile labor, utilizing both of the first-order conditions (6.1) and (6.2). It is therefore not simply a repetition of the standard small-country first-best result. One might surmise that it is therefore a "targets and instruments" result

III. Distributional and Welfare Consequences of Immigration

The preceding section has analyzed the determination of equilibrium tax and transfer policies for a pair of strategically-interacting jurisdictions, taking as given the level of immigration permitted by each. If the level of immigration changes, the equilibrium of this system is affected in several ways. First, additional immigrants will compete for employment in the labor market of the receiving jurisdiction, affecting wages there; in turn, this will affect the equilibrium utilization of capital and the return to immobile factor owners. Because labor markets are linked, similar effects are transmitted to the other jurisdiction. In addition, immigrants have a direct fiscal impact, positive or negative, depending on the sign of their net fiscal transfer z_i. Finally, changes in the number of workers through migration changes the benefit-cost tradeoffs in the tax/transfer policies of both jurisdictions by changing the number of transfer recipients (or fiscal contributors, if $z_i < 0$), l_i. In short, a change in the level of immigration changes the entire general equilibrium of the system, including not only the market equilibrium but the Nash equilibrium policies chosen by the two jurisdictions.

A comparative-statics analysis of this system makes it possible to examine the impact of these simultaneous reactions to a change in the level of immigration. Assuming that the Nash equilibrium of this system is locally stable, the first-order conditions (7) provide a system of two equations which determine (z_1^*, z_2^*) as functions of the parameters of the system. As noted earlier, given a common labor market, changes in immigration in either jurisdiction affect the equilibrium of the system only through their effects on the total supply of labor $l \equiv n_1 + n_2 + m_1 + m_2$. To see how changes in immigration policy affect the system, then, amounts to performing a comparative-statics analysis of the effect of l on (z_1^*, z_2^*) and thus on the other endogenous variables of the system.

To carry out this analysis, define the matrix $A = (a_{ij})$ with elements

$$a_{ii} = \frac{\partial \left(MRS_i - l_i + z_i \frac{f^j_{kk}}{F^j} \right)}{\partial z_i} \quad \text{and} \quad a_{ij} = \frac{\partial \left(MRS_i - l_i + z_i \frac{f^j_{kk}}{F^j} \right)}{\partial z_j}$$

for $i = 1, 2$, and $j \neq i$. Differentiating (7) then yields

$$A \begin{bmatrix} dz_1 \\ dz_2 \end{bmatrix} = - \begin{bmatrix} a_{12} \frac{F^2}{f^2_{kk}} \\ a_{21} \frac{F^1}{f^1_{kk}} \end{bmatrix} dl. \tag{8}$$

The assumption of local stability of the Nash equilibrium implies that $a_{ii} < 0$ and $|A| > 0$. We can solve from (8) for

$$\frac{\partial z_i}{\partial l} = -\frac{a_{ij}}{|A|} \left(a_{jj} \frac{F^j}{f^j_{kk}} - a_{ji} \frac{F^i}{f^i_{kk}} \right). \tag{9}$$

The terms a_{ij} may be positive or negative, and it is therefore not possible to sign $\partial z_i / \partial l$. As shown in the Appendix, however,

$$a_{jj} \frac{F^j}{f^j_{kk}} - a_{ji} \frac{F^i}{f^i_{kk}} > 0, \tag{10}$$

holds if the third derivatives of the production function are sufficiently small (or of the "correct" sign) and if weak restrictions on preferences are satisfied (e.g., for the case where $z_j \geq 0$, it is sufficient for c_i not to be inferior in the utility or welfare functions u_i). This condition is used to derive our main results.

It is now possible to use (9) to calculate the effect of changes in immigration on the net incomes of mobile workers c_i and immobile factor owners, y_i. Under one interpretation, the function $u_i(y_i, c_i)$ represents the utility of immobile factor owners, assuming that their welfare depends not only on their own net incomes but on that of mobile workers. Whether u_i is interpreted in this way or as a social welfare function, it is useful to express the effect of immigration on this function in units of income; letting $d\mu_i = u_{iy}^{-1} du_i = \frac{u_{ic}}{u_{iy}} dc + dy_i$, one can show

Proposition 3: (i) An increase in the level of immigration in either jurisdiction lowers the equilibrium net income of mobile workers in both jurisdictions, i.e.,

$$\frac{dc_i}{dl} < 0. \tag{11.1}$$

(ii) The effect of an increase in immigration on the net incomes of immobile factor owners is given by

$$\frac{dy_i}{dl} = -l_i \frac{dc_i}{dl} - z_i \frac{dl_i}{dl}. \tag{11.2}$$

While generally ambiguous in sign, this effect is positive in the special case of symmetric jurisdictions if mobile workers are net fiscal contributors ($z_i \leq 0$).

(iii) The direction of the effect of an increase in the level of immigration in either jurisdiction on the equilibrium welfare of immobile factor owners (or social welfare) in jurisdiction i is given by

$$sgn\left\{\frac{d\mu_i}{dl}\right\} = -sgn\left\{z_i\right\}, \tag{11.3}$$

that is, immigration raises welfare in jurisdictions where immigrants (and other mobile workers) are net fiscal contributors ($z_i < 0$) and that it lowers welfare in jurisdictions where they are net fiscal beneficiaries ($z_i > 0$).

Proof: See Appendix.

Part (i) of this proposition states, in effect, that additions to the mobile work force will harm the existing members of that work force, both in the jurisdiction that admits immigrants and in the other jurisdiction, and this is true even taking into account any possible endogenous increases the level of transfer payments to workers (or reductions in the level of taxes that they pay) that occur when immigration increases. The effect of immigration on the net incomes of immobile factor owners is ambiguous (see Appendix). Ordinarily, an increase in immigration results in an increase in the number of mobile workers in both jurisdictions ($dl_i/dl > 0$), although this might not be true if immigration gives rise to highly asymmetric changes in redistributive policies. Since the first term in (11.2) is

definitely positive, it follows that immigration raises the net incomes of immobile factors if mobile workers are net taxpayers. If instead they are recipients of transfers ($z_i > 0$), it is possible that the net incomes of immobile factor owners fall as immigration increases. With the net incomes of mobile factor owners and the net incomes of immobile factor owners either rising or falling, it is perhaps surprising that the impact of immigration on welfare can be clearly ascertained merely by determining whether workers are net fiscal contributors or beneficiaries. In the end, all of the other effects of immigration on factor prices and the distribution of income can be ignored and only the tax or transfer "wedge" on the migration margin needs to be taken into account to see whether a jurisdiction gains or loses from additional immigration.

IV. Implications of the Analysis

A. Immigration Policy: Local or Global? The analysis summarized in Proposition 3 identifies the distributional and welfare effects of immigration for workers and immobile factor owners in both jurisdictions. One important feature of those results is that the effects of immigration do not depend on the "port of entry" of the immigrants. This is a consequence of the assumption of a common labor market, even one characterized by costly and imperfect mobility between jurisdictions, as in our model. Under these conditions, the ability of any one jurisdiction to execute an independent immigration policy is obviously somewhat questionable. To explore this issue further, one might consider how each jurisdiction would set its immigration limit m_i if acting independently and in a self-interested fashion. In the context of our model, it is natural to examine a Nash non-cooperative game in which each jurisdiction chooses its own immigration quota, m_i, taking the level of immigration in the other jurisdiction as given, so as to maximize u_i. Let (m_1^*, m_2^*) denote the equilibrium strategies of this game.

To analyze such a game in full detail would be quite complicated. However, the results of Proposition 3 provide sufficient information to describe the most important features of this game since they show how each jurisdiction's payoff u_i depends, locally, on the level of immigration. In particular, it follows from Proposition 3 that if immigrants are net burdens in *both* jurisdictions, then both would have an incentive to limit immigration further. If immigrants are net fiscal contributors in both jurisdictions, then both have an incentive to relax immigration quotas. A more complicated situation arises when $z_i > 0 > z_j$; in this case, one jurisdiction would benefit from more immigration while the other would be harmed.

It follows that if immigrants are net fiscal burdens in both jurisdictions, no matter what the level of immigration, the Nash equilibrium is given by no immigration in either jurisdiction, i.e., $(m_i^*, m_2^*) = (0, 0)$. If immigrants are net fiscal contributors no matter what the level of immigration, then each jurisdiction has an incentive to maximize the level of immigration, presumably by setting immigration quotas so high that they become non-binding. If immigrants are net contributors in one jurisdiction and net burdens in the

other for all levels of immigration, the jurisdiction whose welfare is raised by immigration has an incentive to remove all quotas. The other jurisdiction would prefer to prevent all immigration but any attempt it might make to limit immigration would be irrelevant, given that the other jurisdiction imposes no restrictions on immigration at all. [8]

It is interesting to evaluate EU immigration policies in the light of these remarks. Since high-income EU countries tend to have large public sectors that offer substantial protection to low-income households, it is plausible to conjecture that low-wage immigrants impose fiscal burdens on them. If so, then these countries would have incentives to limit immigration and would have an interest in seeing that that other EU countries do the same. One might suppose, on the other hand, that low-wage workers impose smaller fiscal burdens, or provide net fiscal benefits, in poorer EU countries. [9] One could imagine some conflict, therefore, between rich and poor member states, in which the former attempt to exert influence on the latter to impose (or enforce) stricter immigration limits. This, of course, is precisely what has happened in recent years, resulting in delays in the relaxation of border controls, with implications not only for the free movement of labor within the EU but also for the free movement of goods and services.

Our analysis also sheds light on the incentives for changes in EU membership. Suppose that the EU is evaluating the application for membership of a rich country with a highly-developed program of income support for the poor. Such a country is unlikely to be a source of net migration to the rest of the EU of low-income households that would impose fiscal burdens on other member states. Indeed, admission of such a country into the EU might on the contrary result in a flow of high-income net fiscal contributors into other EU countries. From the EU viewpoint, then, the membership application of a high-income country might be quite attractive. An application from a low-income country, on the other hand, might be quite unattractive. It is noteworthy that the applications for EU membership by the Nordic countries and of Austria were accepted relatively quickly. That of Turkey, on the other hand, has been delayed more or less indefinitely. It seems unlikely that applications from other nearby poor countries would be solicited by existing EU members. [10] Of course,

[8] It is possible that the net fiscal contributions of immigrants may change sign as the level of immigration varies; in this case, the analysis becomes more involved. As already noted, it is not possible to sign (9) in general.

[9] The total size of the public sector (as measured, for instance, by government spending as a share of GDP) is smaller in the poorer EU countries, suggesting less redistributive activity in general in those countries. Furthermore, a low-wage worker will occupy a higher location in the income distribution of a poor country than in a rich one. If transfer policies are pro-poor in general, the low-wage worker may be a fiscal burden in a rich country but a fiscal contributor in a poor country. Detailed empirical analysis of fiscal benefits and burdens is required to confirm or reject these speculations, however.

[10] Various forms of associate membership that would allow freer trade between the EU and the coutries of northern Africa and eastern and southeastern Europe might prove more attractive since they need not include free movement of labor. Indeed, the North American Free Trade Agreement does *not* entail the freedom of movement that characterizes the EU. One of the arguments made in favor of NAFTA in the US debate on ratification of the agreement, in fact, was that it might reduce the pressure of illegal immigration into the US

many factors are important for decisions about EU membership. Our model is deliberately structured to emphasize the factor market and fiscal dimensions of economic integration and omits other considerations. Nevertheless, these developments do appear to be generally consistent with the findings of the present analysis.

B. Fiscal Impacts of Immigration with Corrective Grants. When two jurisdictions share a common labor market, their redistributive policies create fiscal externalities for one another. An increase in fiscal transfers to workers in country i will attract additional workers, thus reducing the fiscal burden in country j of any transfers that it may offer to workers. It will also raise the equilibrium net income of workers throughout the system, which also benefits region j. The classical remedy for such externalities is to develop a system of intergovernmental grants, in the spirit of Pigovian corrective subsidies.

There are many practical examples of such fiscal arrangements, such as the assistance offered by the U.S. Federal government to the states through the AFDC (Aid to Families with Dependent Children) program, or the extensive system of fiscal assistance offered by the Canadian Federal government to the provinces. In Western Europe, the EC supports redistribution in member states through such programs as the European Regional Development Fund (ERDF), the European Social Fund (ESF), and the Common Agricultural Policy (CAP) (which is certainly redistributive in its effects, even if it is not often characterized as a redistribution policy). EC efforts to coordinate various aspects of the social and labor policies of member states do not entail explicit intergovernmental transfers but may in some cases have analogous effects.

In the context of our analysis, it is of interest to consider the effects of immigration policy when countries are linked by a system of intergovernmental transfers. In particular, imagine a system of two countries, as in Section III, which now also contains a central government – such as the EU, in the European context, or the US Federal government, in the US case. Suppose that this central government collects taxes from each of the two countries and uses the proceeds to implement matching grants that finance some fraction s_i of country i's expenditures on redistributive transfers to workers. [11]

Let T_i denote the lump-sum tax imposed by the center on jurisdiction i. Without loss of generality it may be assumed that this tax falls entirely on the incomes of immobile factor

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by facilitating more rapid economic development in Mexico.

[11] Alternatively, the center could offer a lump-sum grant h_i to country i for every worker that is employed there. This is equivalent in its effects to a matching grant at the rate s_i such that $s_i z_i = h_i$, however. It is also equivalent to a direct subsidy from the center to the workers, or to direct central government expenditures on their behalf. The following framework can therefore encompass many types of cen

owners. [12] The policies of the central government must satisfy the constraint

$$\sum_i s_i z_i l_i = \sum_i T_i, \tag{12}$$

while the net income accruing to the immobile factor owners in country i is given by

$$y_i = f_i(l_i) - l_i f_i'(l_i) - (1 - s_i) l_i z_i + r\bar{k}_I - T_i; \tag{5.1'}$$

this condition reflects the fiscal contribution of immobile factor owners to the central government as well as the fiscal relief that they obtain from grants received by their regional governments.

How do central government grants and taxes affect the levels of redistribution chosen by each country? There are several possible modelling approaches, but it is traditional to assume that individual jurisdictions take central government policies as parametrically given. Thus, matching grants lower the relative price of redistributive expenditures, as well as easing the fiscal burdens of recipient governments, while taxes paid to the center lower each country's net income. Following this traditional approach, each country i chooses z_i subject to (5.1') and (5.2) to maximize utility, taking the other country's redistributive transfer level as given. This yields a first-order condition

$$MRS_i = l_i - \frac{(1 - s_i) z_i}{f_j''} - \frac{N s_i l_i}{f_j''}, \tag{7'}$$

which is clearly a generalization of (7). Although this condition characterizes the choice of z_i for arbitrary central government policies, it must hold in particular when (s_1, s_2) are chosen in such a way as to internalize the external effects of redistribution. The following conditions hold in such a *corrected Nash equilibrium* (Wildasin, 1991):

$$MRS_1 + MRS_2 = l \tag{13.1}$$

$$z_1 = z_2 = z; \tag{13.2}$$

intuitively, (13.1) is the Samuelson condition for efficient expenditures while (13.2) implies that redistributive transfers do not create fiscal incentives for inefficient locational choices.

We can now examine how the effects of immigration differ when a central government uses intergovernmental transfers to internalize the externalities associated with redistributive

[12] Suppose that the central government imposes taxes on both mobile and immobile factor owners in both jurisdictions and uses the proceeds to support redistributive transfers to mobile workers by each jurisdiction. This possibility is exemplified by VAT-financed contributions by EU member states to the ESF, ERDF, and CAP and by US Federal government grants to states for AFDC, Medicaid, and employment programs financed by personal income taxes. As just noted, the center's matching grants to each jurisdiction are equivalent to per capita grants, and these in turn are equivalent to direct payments to workers in each region. Thus, interpreting the per-capita subsidies h_i of the preceding footnote as subsidies *net* of any taxes paid to the center, T_i is simply the net fiscal burden on immobile factor owners.

transfers. As before, this requires a comparative-statics analysis of the effect of a change in total population, l, on the equilibrium levels of redistributive transfers in each jurisdiction and on equilibrium factor allocations and factor prices. Although not strictly necessary for the purposes of the analysis, suppose that the matching rates s_i are held fixed when additional immigration occurs, so that the expenditures of the central government only change due to changes in redistributive transfer payments by the two countries. This means that T_1, T_2, or both must change as immigration occurs. Recalling the definition of real income change for each jurisdiction, $d\mu_i$, one can show

Proposition 4: Assuming that the central government provides corrective intergovernmental grants to both jurisdictions, the effect of immigration on the real income of both jurisdictions taken together is equal to the size of the net fiscal contribution of the immigrants, i.e.,

$$\frac{d\mu_1}{dl} + \frac{d\mu_2}{dl} = -z. \tag{14}$$

Proof: See Appendix.

This result describes the impact of immigration on the *system* of destination countries but does not describe the distribution of gains and losses among them. The distributional impact is however of considerable interest. In the EU context, when member countries do not have coordinated immigration policies, the redistributive and immigration policies of any one country will ordinarily produce spillover effects on the well-being of other countries.

It follows from Proposition 4, however, that central government control of matching grant rates, s_i, and of the distribution of tax burdens among immobile factor owners in each jurisdction, T_i, provide adequate policy instruments to internalize both types of externalities and to achieve any desired distribution of income between the jurisdictions. In particular, it is possible to link central government taxes to the immigration policies of individual countries so as to insulate other countries, in welfare terms, from immigration-related spillover effects. For instance, if country j relaxes its immigration policy, it is possible to choose dT_i/dl so that $d\mu_i/dl = 0$, that is, *central government taxes can be used to compensate country i for the effects on its welfare of changes in the immigration policy of country j, in which case the entire welfare impact of immigration, falls on country j, the country undertaking the change in immigration policy*, i.e., $d\mu_i/dl = -z$.

The center might or might not choose its tax policy in this compensatory fashion, but such a policy has some appeal as a normative principle since it implies that each country would then bear the full burden of any immigratio

j and in country i, and gross wages will fall in both. Compensatory reductions in country i's taxes do not insulate it from the labor market effects of $j's$ immigration policy, they simply offset the real income loss that immigration policy would otherwise entail.

V. Conclusion

The preceding sections have investigated the effects of immigration on factor incomes and welfare in a system of jurisdictions, taking into account not only general equilibrium market interactions but also the endogenous response of redistributive fiscal policies as determined through the strategic interactions of these jurisdictions.

In brief summary, we have found that if *either* jurisdiction liberalizes its immigration policy, the equilibrium real incomes of workers who compete with immigrants must fall in *both* jurisdictions. Social welfare rises or falls depending on whether immigrants are net fiscal contributors or net fiscal beneficiaries. It is worth emphasizing here that the net incomes of "workers," i.e., of those who compete with immigrants in the labor market, may be reduced even if these workers are net fiscal contributors; in this case, immigration raises "social welfare," but this welfare gain is not a Pareto-improvement; instead, the gains to one group more than offset the losses to the other. In general, the effects of a more liberal immigration policy in either jurisdiction will be felt by both because the two are linked through a common labor market. However, we have shown that a central government can, in principle, internalize these fiscal externalities through a system of suitably-designed taxes and subsidies.

Since immigration policy is such a contentious issue, it is important to discuss ways in which this analysis might contribute some insight into real policy problems and ways in which it is too limited to do so. First, the general conclusion that the fiscal impact of immigration is important for welfare in each of the countries that share a common labor market is certainly robust to relaxation of many of the simplifying assumptions. Second, the analysis clearly indicates that measuring the size of the net fiscal contribution of immigrants (the z_i's) is crucial for quantitative policy evaluation. This is a complex empirical problem that deserves much more attention than it has received so far. The fiscal status of an individual immigrant changes over the life cycle due to variations in consumption, savings, and labor market behavior, the extent of remittances, the frequency and duration of return migration, health, and other factors. Furthermore, immigrants are often joined (though perhaps with a lag) by family members, and the demographic composition of immigrant families changes over time, causing complex changes in the fiscal relationship between the immigrant worker family and the host jurisdiction. Since the immigrant family may remain in the country for a long time, the flow of fiscal contributions and benefits may extend far into the future—perhaps over several generations. In this dynamic setting, the variables z_i should be interpreted as the present value, over the entire horizon of the "immigration event," of the monetized equivalent of the fiscal benefits enjoyed by an immigrant minus the present value of the immigrant's fiscal contributions. That is, the variables z_i should

be interpreted as the annualized flow of fiscal benefits less fiscal contributions for the entire period that the immigrant resides in the host country. The issues involved in measuring these variables seem to us to be sufficiently complex that it would be unwise to leap to a judgment about the net fiscal contribution of any particular group of workers – North Africans in France, Poles in Germany, East Germans in unified Germany, Latin Americans in the US – on the basis of more-or-less casual empiricism.

The assumption that two or more countries or states share a common labor market is more robust than might appear at first sight. Our analysis explicitly allows for migration costs; these costs may be large or small but it is essential for the analysis that they not be prohibitively high, i.e., so high that workers cannot move from one jurisdiction to another. As a simplifying assumption, we have assumed that the cost of migration from one jurisdiction to another is the same for all (potentially) mobile workers. In practice, however, we know that migration costs are not zero, nor are they necessarily the same for all workers (see, e.g., Topel (1986)).

It is not actually essential for our results, however, that the cost of migration be the same for all workers, or that migration costs be less than prohibitively high for all potentially mobile workers. All that is required is that migration costs not be prohibitive for *sufficiently many* workers that changes in net incomes in one jurisdiction give rise to labor reallocations that work to change net incomes in the other jurisdiction in the same direction. As is generally true with such arbitrage arguments, there need only be "enough" workers capable of moving among jurisdictions to limit the extent of net wage differentials. Comparatively small reallocations of labor might suffice for this purpose, and common labor market linkages can certainly exist when many workers are completely immobile. Whether the labor markets of EU member countries, the EU and potential member countries, US states, or the US and neighboring countries are sufficiently closely linked for this to be the case is an empirical question that goes beyond the scope of the present analysis. Certainly much of the migration that occurs within the EU, within the US, between the EU and the rest of the world, and between the US and the rest of the world, does seem to move in the expected directions, with workers generally moving toward labor markets where they can obtain higher incomes. There are, however, many specific and detailed aspects of this issue which we cannot explore here.

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APPENDIX

This appendix presents derivations of a number of results needed to establish the findings reported in the main text. A more detailed appendix is available from the authors on request.

Comparative Statics of General Equilibrium Factor Allocations. Equations (2), (3), and (4) in the text can be used to determine (l_i, k_i) as functions of (z_i, t_i, m_i). For concreteness, suppose that migration flows from jurisdiction 1 to jurisdiction 2 in equilibrium, so that $c_1 = c_2 - \gamma_{12}$. [13] Let $l \equiv n_1 + n_2 + m_1 + m_2$ denote the total supply of labor, from both native and immigrant workers, in the two jurisdictions. Then, substituting from the definition of the c_i's and using the labor market-clearing condition (4) to eliminate $l_2 = l - l_1$, the system (2), (3), and (4) reduces to

$$f_l^1(l_1, k_1) + z_1 - f_l^2(l - l_1, k_2) - z_2 + \gamma_{12} = 0 \qquad (A.1.1)$$

$$f_k^1(l_1, k_1) - t_1 - r = 0 \qquad (A.1.2)$$

$$f_k^2(l - l_1, k_2) - t_2 - r = 0 \qquad (A.1.3)$$

noting that the (gross) capital income accruing to workers from the returns to their capital endowments, if any, have been netted out in (A.1.1).

The system (A.1) can be differentiated to yield

$$\begin{bmatrix} f_{ll}^1 + f_{ll}^2 & f_{lk}^1 & -f_{lk}^2 \\ f_{kl}^1 & f_{kk}^1 & 0 \\ -f_{kl}^2 & 0 & f_{kk}^2 \end{bmatrix} \begin{bmatrix} dl_1 \\ dk_1 \\ dk_2 \end{bmatrix} = \begin{bmatrix} -1 & 1 & 0 & 0 & f_{ll}^2 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & -f_{kl}^2 \end{bmatrix} \begin{bmatrix} dz_1 \\ dz_2 \\ dt_1 \\ dt_2 \\ dl \end{bmatrix}. \qquad (A.2)$$

The determinant of the matrix on the left, denoted by D, can be written as

$$D = f_{kk}^1 F^2 + f_{kk}^2 F^1 < 0 \qquad (A.3)$$

where, using (1) of the text, the sign of D follows from strict concavity of the production function.

It is now possible to solve for the endogenous variables of the system in terms of its parameters:

$$\frac{\partial l_i}{\partial z_i} = -\frac{\partial l_i}{\partial z_j} = \frac{-f_{kk}^1 f_{kk}^2}{D} > 0 \qquad (A.4.1)$$

[13] If migration flows in the opposite direction, then this condition is replaced by $c_1 - \gamma_{21} = c_2$. If migration costs are zero, then these two conditions are equivalent and $c_1 = c_2 = c$. Our results depend only on the assumption that the labor markets of the two jurisdictions are linked by active (or incipient) migration in equilibrium, which is necessarily the case if migration costs are zero but which is also the case if migration costs are not "prohibitive." The direction of labor flow is not important to the analysis.

$$\frac{\partial l_i}{\partial t_i} = \frac{-f^i_{lk} f^j_{kk}}{D} \tag{A.4.2}$$

$$\frac{\partial l_i}{\partial t_j} = \frac{f^i_{kk} f^j_{lk}}{D} \tag{A.4.3}$$

$$\frac{\partial l_i}{\partial l} = \frac{f^i_{kk} F^j}{D} > 0 \tag{A.4.4}$$

$$\frac{\partial k_i}{\partial z_i} = -\frac{\partial k_i}{\partial z_j} = \frac{f^i_{kl} f^j_{kk}}{D} \tag{A.4.5}$$

$$\frac{\partial k_i}{\partial t_i} = \frac{(f^1_{ll} + f^2_{ll}) f^j_{kk} - f^j_{kl} f^j_{lk}}{D} < 0 \tag{A.4.6}$$

$$\frac{\partial k_i}{\partial t_j} = \frac{-f^i_{kl} f^j_{lk}}{D} \tag{A.4.7}$$

$$\frac{\partial k_i}{\partial l} = \frac{-f^i_{kl} F^j}{D}. \tag{A.4.8}$$

The signs of (A.4.1) and (A.4.4) are algebraically clear and economically intuitive: higher subsidies (or lower taxes) for mobile workers in one jurisdiction increases the equilibrium number of residents, while an increase in the total population in the system of jurisdictions, for example as a result of an increase in the level of immigration allowed by any one jurisdiction, increases the equilibrium number of residents of every jurisdiction. According to (A.4.6), an increase in capital taxation in jurisdiction i necessarily reduces the level of capital utilized there, which is intuitively plausible. To confirm the result algebraically, note that the numerator can be written as $\left(\left[f^1_{ll} + f^2_{ll} \right] f^j_{kk} - f^j_{ll} f^j_{kk} \right) + \left(f^j_{ll} f^j_{kk} - f^j_{kl} f^j_{lk} \right) = f^j_{kk} f^i_{ll} + F^j$, which is positive due to the concavity of the production technology. The signs of the other derivatives in (A.4) depend on the cross-partials of the production function. Since it is not necessary for our purposes to impose restrictions on the substitutability between capital and mobile labor, these derivatives are of uncertain sign. It is of course plausible that mobile labor and capital might be complementary inputs, in which case all of the comparative statics results have determinate and economically-plausible signs; in summary, when the mobile factors are complements, "fiscal inducements," in the form of more favorable fiscal treatment of *either* mobile factor of production, attract additional units of *both* factors of production.

Proof of Proposition 1:

To prove Proposition 1, let

$$\alpha_i \equiv (MRS_i - l_i) f^i_{ll} - z_i \tag{A.5.1}$$

$$\beta_i \equiv (MRS_i - l_i) f^i_{lk} + f^i_k - r, \tag{A.5.2}$$

so that the first-order conditions (6) can be written

$$MRS_i - l_i + \alpha_i \frac{\partial l_i}{\partial z_i} + \beta_i \frac{\partial k_i}{\partial z_i} = 0 \tag{A.6.1}$$

$$\alpha_i \frac{\partial l_i}{\partial t_i} + \beta_i \frac{\partial k_i}{\partial t_i} = 0 \tag{A.6.2}$$

From (A.4), it follows that

$$\frac{\partial l_i}{\partial t_i} = \frac{f^i_{lk}}{f^i_{kk}} \frac{\partial l_i}{\partial z_i} \qquad (A.7.1)$$

$$\frac{\partial k_i}{\partial t_i} = \frac{1}{f^i_{kk}} + \frac{f^i_{lk}}{f^i_{kk}} \frac{\partial k_i}{\partial z_i}. \qquad (A.7.2)$$

Substituting from (A.7) into (A.6.2) and multiplying through by f^i_{kk}/f^i_{lk} implies that

$$\alpha_i \frac{dl_i}{dz_i} + \beta_i \frac{dk_i}{dz_i} + \frac{\beta_i}{f^i_{lk}} = 0. \qquad (A.8))$$

Substituting into (A.6.1) and using (A.5.2) yields

$$f^i_k - r = 0 \qquad (A.9)$$

which, by (2) in the text, proves the proposition.

Sufficient conditions for (10).

Somewhat involved calculations show that

$$a_{jj} \frac{F^j}{f^j_{kk}} - a_{ji} \frac{F^i}{f^i_{kk}} = \frac{\partial MRS_j}{\partial y_j} z_j + 1 + \frac{f^i_{kk}}{F^i} \frac{F^j}{f^j_{kk}} + z_j \frac{\partial \left(\frac{f^j_{kk}}{F^j} \right)}{\partial z_j} \left(\frac{F^j}{f^j_{kk}} + \frac{F^i}{f^i_{kk}} \right). \qquad (A.10)$$

If c_j is a normal (or not inferior) good in the preference structure u_j, $\partial MRS_j/\partial y_j \geq 0$. If $z_j > 0$ as well, the first term in (A.10) is positive. If $z_j < 0$, this term will be non-positive unless c_j is inferior; however, assuming normality, the first term, though negative, will be dominated by other positive terms if the income elasticity of demand for c_j is sufficiently small. The last term in (A.10) involves third-order derivatives of the production function f^j. If f^j is quadratic in (l_j, k_j), these derivatives will all be zero and the entire term drops out. Thus, unless, third-order derivatives are sufficiently large and of the "wrong" signs, the last term in (A.10) will either be positive or dominated by other positive terms. It is therefore economically reasonable to assume that (10) holds in many cases of interest.

Proof of Proposition 3:

One can use (A.4.1), (A.4.4), (A.4.5), and (A.4.8) to express derivatives of l_i and k_i with respect to l in terms of derivatives with respect to z_i, and then to express derivatives of k_i in terms of derivatives of l_i, to show that

$$\frac{dc_i}{dl} = \frac{f^i_{kk} f^j_{kk} \left(a_{ii} \frac{F^i}{f^i_{kk}} - a_{ij} \frac{F^j}{f^j_{kk}} \right) \left(a_{jj} \frac{F^j}{f^j_{kk}} - a_{ji} \frac{F^i}{f^i_{kk}} \right)}{D|A|} < 0, \qquad (A.11)$$

where the inequality follows from (10), (A.3), and local stability of the Nash equilibrium. This establishes part (i) of the proposition.

Next, note from (5.1), (5.2) and Proposition 1 that

$$\frac{dy_i}{dl} = -l_i \frac{d\left(f_l^i + z_i\right)}{dl} - z_i \frac{dl_i}{dl} = -l_i \frac{dc_i}{dl} - z_i \frac{dl_i}{dl}. \qquad (A.12)$$

By (A.11), the first term on the right-hand side of (A.12) is positive. However, the sign of the second term depends both on the sign of z_i and on the effect of l on l_i, which, though likely positive, could conceivably be negative. In the special case of symmetric jurisdictions, $\partial z_i/\partial l = \partial z_j/\partial l$ and hence

$$\frac{dl_i}{dl} = \frac{\partial l_i}{\partial l} > 0 \qquad (A.13)$$

where the inequality follows from (A.4.4). Combining (A.11) and (A.12) confirms part (ii) of the proposition.

Finally, one can show that

$$\frac{d\mu_i}{dl} = -\frac{z_i a_{ii} f_{kk}^j \left(a_{jj} \frac{F^j}{f_{kk}^j} - a_{ji} \frac{F^i}{f_{kk}^i}\right)}{F^j |A|}. \qquad (A.14)$$

Statement (iii) of the proposition follows from local stability of the Nash equilibrium, concavity of the production technologies, and (10).

Proof of Proposition 4:

The change in an individual jurisdiction's welfare is equal to

$$\frac{d\mu_i}{dl} = MRS_i \frac{dc_i}{dl} + \frac{d(f^i - l_i f_l^i - rk_i)}{dl} - \frac{d(1-s_i) z_i l_i}{dl} - \frac{dT_i}{dl}. \qquad (A.15)$$

According to (12),

$$\frac{d(\sum_i s_i z_i l_i)}{dl} = \frac{d(\sum_i T_i)}{dl}, \qquad (A.16)$$

and hence

$$\begin{aligned}
\frac{d\mu_1}{dl} + \frac{d\mu_2}{dl} &= \sum_i MRS_i \frac{dc_i}{dl} + \frac{d\left(\sum_i [f^i - l_i f_l^i - rk_i]\right)}{dl} - \frac{d\left(\sum_i z_i l_i\right)}{dl} \\
&= \sum_i (MRS_i - l_i) \frac{dc_i}{dl} + \sum_i l_i \frac{df_l^i}{dl} + \sum_i l_i \frac{\partial z_i}{\partial l} + \frac{d\left(\sum_i [f^i - l_i f_l^i - rk_i]\right)}{dl} \\
&\quad - \sum_i l_i \frac{\partial z_i}{\partial l} - \sum_i z_i \frac{dl_i}{dl} \\
&= \sum_i (MRS_i - l_i) \frac{dc_i}{dl} - \sum_i z_i \frac{dl_i}{dl}. \qquad (A.17)
\end{aligned}$$

Notice that $dc_1/dl = dc_2/dl$ whenever migration occurs between both jurisdictions. In the special case where matching grant rates are set so that (13) is satisfied, (A.17) reduces to

$$\frac{d\mu_1}{dl} + \frac{d\mu_2}{dl} = -z, \qquad (A.18)$$

as was to be demonstrated.