Income Distribution and Redistribution within Federations

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ABSTRACT. – In a federation, workers are generally legally entitled to seek employment in any locality or region. On the other hand, not all factors of production are equally mobile and some workers or other factors may not be able to relocate in order to take advantage of higher returns in other jurisdictions. Furthermore, the higher degree of factor mobility within a federation may constrain the ability of individual jurisdictions to undertake redistributive policies. The paper analyzes the efficiency and distributional consequences of the formation of federations and of decentralized redistributive policies within federations.

Distribution et redistribution de revenus à l'intérieur d'un état fédéral

RÉSUMÉ. – Les travailleurs sont légalement autorisés à chercher du travail dans n'importe quelle région ou état fédéral. Par ailleurs, tous les facteurs de production n'étant pas mobiles de la même façon, certains travailleurs ou certains facteurs de production ne peuvent pas déménager pour tirer profit d'une délocalisation. En outre, un haut degré de mobilité à l'intérieur d'une fédération peut contraindre le type de politique redistributive au sein des juridictions locales. Ce papier analyse l'efficacité et les conséquences en matière de distribution de la formation d'états fédéraux, des politiques redistributives à l'intérieur des fédérations.

1 Introduction

Fiscal policies at all levels of government can affect the distribution of income. This is obvious in the case of explicitly redistributive policies such as income-tax financed transfers to the poor. It is only slightly less obvious in the case of public provision of public goods and services. Public intervention in the provision of health care, education, housing, transportation, and other goods and services certainly have important allocative effects, and in some cases may help to correct market failures. However, these activities can be financed in a variety of ways with different distributional consequences and, commonly, there are many ways in which the benefits of these interventions can be distributed.

Since redistributive activities figure so prominently in public policy, they deserve close attention in the analysis of fiscal decentralization and of vertical and horizontal fiscal interactions. Indeed, fiscal and economic decentralization is a topic of active concern in many countries today, and distributional issues are invariably important elements in the normative evaluation and political success of initiatives for reform. Perhaps most obviously, the move toward more market-oriented economic systems, associated with the collapse or erosion of central planning mechanisms in the formerly socialist/communist countries, has been accompanied in many case by devolution of fiscal responsibility from central to lower-level authorities. Such devolution is an almost inevitable consequence of a step back from central planning as an organizing principle for a society. Furthermore, the end of the Cold War has relaxed constraints on the revision of political boundaries that had been frozen, somewhat artificially, for a long period of time. In some cases, such as the breakup of the Soviet Union or Czechoslovakia, this has brought about greater fiscal decentralization, at least in the short run, while in other cases, exemplified by Germany (the two Koreas may be an impending example), previously-separated entities have become united. In the European Union, there is extensive debate about the desirable extent of policy coordination, including fiscal and "social" (*i.e.*, redistributive) policy. It is arguable that the recent expansion of the EU to include Finland, Sweden, and Austria, the decision to exclude Turkey, and the reluctance to admit countries from Eastern Europe into the EU is based at least in part on fiscal and distributional considerations. Within countries like South Africa and China, strong central government controls (*apartheid*, the pass laws, and the establishment of "native areas" in South Africa, the household registration system in China) have until recently prevented the full economic integration of different regions and populations. Actual or prospective economic and political liberalization within these countries has crucial fiscal and distributional implications, and in both cases it is probable that distributional issues, including those associated with the assignment of redistributive power to central or lower-level governments, have played an important role in political developments. In the US, the new Republican majorities in Congress are promoting devolution of responsibility for redistributive activities from the Federal to the state governments, a

reform which could overturn the basic fiscal organization of the "Great Society" programs launched 30 years ago.

These profound developments raise a host of important questions for public economics. The ultimate issue facing policymakers and citizens, perhaps, is to determine the consequences for economic welfare, including of course both allocative and distributional effects, of revisions of political structure such as the formation of federations either through the unification of previously-independent jurisdictions or through the decentralization of political power from a previously-centralized authority. Resolution of this issue requires an understanding of both the economic and political functioning of centralized and decentralized systems. For instance, a common theme in the literature of fiscal federalism is that lower-level governments cannot effectively redistribute income because they face highly-elastic factor supplies. This view is an assertion about the functioning of markets and their response to decentralized redistributive policy, an economic question with both theoretical and empirical dimensions [1].

At the same time, it is also crucial to understand the political economy of centralized and decentralized governments in order to assess what types of redistributive and other policies they actually carry out. Is it in fact the case that fiscal decentralization reduces redistributive activity? It is certainly plausible that factor mobility limits the feasibility or raises the costs of certain types of redistribution, and it may follow from this that there is less redistribution by decentralized governments (BRENNAN and BUCHANAN [1980] see this as one important potential benefit of a federal structure of government). This conclusion is not completely self-evident, however. First, rather than not engaging in income redistribution at all, it is possible that decentralized juridisctions might engage in a different *kind* of redistribution than central governments, perhaps because they can exploit informational or organizational advantages relative to central governments (see RAFF and WILSON [1995]). Furthermore, lower-level governments may have incentives to capture local rents that disappear in a more centralized setting (WILDASIN and WILSON [1996]). The establishment of new countries resulting from the division of an existing country may result in fiscal decentralization accompanied by an increase in regulatory constraints (immigration, capital controls, quotas) that facilitate redistributive policies by new, smaller governments; by contrast, liberalization of markets and elimination of regulatory constraints may result when regions group together to form larger political units, as in the formation of the United States, the European Union, unified Germany, and indeed in the formation of most countries, within which household and capital mobility tends to be relatively free. In short, the exact institutional form of decentralized

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1. This idea has been articulated by STIGLER, OATES, and other writers for four decades, and appears in numerous recent contributions. The relevant literature is growing quickly and a comprehensive survey is beyond the scope of the present paper; see e.g., FRENKEL *et al.* [1991], WILDASIN [1992], and CREMER *et al.* [1995] for recent discussions of factor mobility and many references. There is a significant empirical literature on the effects of welfare benefits on migration among US states; see MOFFITT [1992], for a review of this literature and SHRODER [1995] for a recent contribution.

political units and the types of policy instruments at their disposal, not to mention the organization of the political process itself, can be important determinants of the extent to which they pursue redistributive policies [2].

The present paper aims to shed additional light on one aspect of these very complicated questions by focusing on the set of *attainable* income distributions within a system of two ore more jurisdictions before and after the formation of a federation. The basic spirit of the exercise is to explore a potential efficiency-equity tradeoff that can arise when two or more jurisdictions enter into a federation or other political arrangements within which they relinquish certain policy instruments. Specifically, the defining charasteristics of a "federation", for the purposes of the present analysis, are that federation members cannot directly restrict the movement of factors or production across their boundaries with other federation members and that they must apply their fiscal policies on a non-discriminatory basis to all federation citizens [3]. These constraints on policy may limit the ability of individual jurisdictions within the federation to affect the distribution of income. On the other hand, freedom of movement for labor (and other factors) should have some economic benefits. Many people may not happen to be born in precisely those locations where they can be most productively employed throughout their lives, and the freedom to change locations facilitates more efficient (productive) allocations of labor (and other factors). Thus, while liberalization of factor markers through federation may impose constraints on the effectiveness of public policy, it offers potential benefits as well. What is the nature of this tradeoff?

Section 2 presents a simple model which can be used to study this question. Section 3 first analyzes the way that the formation of a federation affects the level and distribution of income when no governments undertake any redistributive policies. Using these results as benchmarks, it is possible to describe how decentralized tax/transfer policies can be used to change the distribution of income in a federation, taking into account the constraints that factor mobility places on the effectiveness of these instruments. The analysis in Section 3 uses the concept of an "income distribution frontier" previously discussed in WILDASIN [1994] to describe the distributions of income that are *attainable* via government redistributive instruments with and without factor mobility [4].

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2. EPPLE and ROMER [1991] present a majority-voting model of local income redistributions. Their results suggest that mobile local voters may undertake redistributive policies at the expense of local landowners. See also GOODSPEED [1995 a, b] and CUKIERMAN *et al.* [1994] for voting models with housefold mobility.

3. The principles of free movement and equal treatment are very commonly observed within most countries and are also embodied in some international agreements, notably the Treaty and Rome (the founding document of the European Union). As mentioned, China's *hukou* (household registration) system and the South African pass laws in the *apartheid* era are important examples where these principles have not been applied within a country.

4. While relying on analytical tools similar to those in WILDASIN [1994], the present study is concerned with fundamentally different issues. It is perhaps useful to explain the major differences between the two. First, the present paper emphasizes the productivity-enhancing effects of factor mobility as a potential economic benefit from forming a federation, an issue not analyzed in the previous paper. Furthermore, WILDASIN [1994] is concerned with one-way

The paper is primarily concerned with the "positive economics" of federation, in that it focuses on the description of feasible income distributions in the presence of factor mobility. Analysis of the set of feasible outcomes can, however, help to build a foundation for normative or public choice models of redistributive policy. Section 4 discusses several implications the formal analysis and, in particular, takes a step toward a model of equilibrium choice of redistributive policies. Although the treatment in Section 4 is far from comprehensive, it does present a simple example with the perhaps surprising property that greater factor mobility results in an *increase* in the extent of government redistributive activities, *even though* factor mobility does indeed impose constraints on these activities. In addition to exploring the implications of the analysis in Sections 2 and 3, Section 4 also identifies important issues that warrant further research.

2 A Model

In order to highlight basic issues and to avoid many technical complexities, the analysis is based on a highly stylized model. To develop a model within which the potential efficiency gains and redistributive constraints of federation issue can be examined formally, three elements seem essential. First, the model should be one in which the liberalization of factor markets through federation provides some potential "gains from trade". Second, there must be sufficient heterogeneity among households to produce non-trivial income distributions. Third, income redistribution policies undertaken by individual jurisdictions within the federation should affect factor markets and factor prices in "plausible" ways; in particular, it is important to avoid knife-edge cases in which the slightest redistributive interventions cause massive factor reallocations that cause employment and output levels in individual jurisdictions to go to zero. The present section describes a framework for analysis that, while admittedly very simple and stylized, does contain these essential features. It is helpful to begin by describing the framework in general terms; special assumptions will be imposed at various points in order to derive certain specific results.

Suppose, then, an initial situation in which each of a group of two or more jurisdictions contains two or more industries. The output of each industry is a function of only two inputs, called "high-skilled labor" and "low-skilled labor". The focus of the discussion of distributional issues will be on the distribution of income between these two broad catagories of workers. Let

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(net) migration between jurisdictions and the implications that this has for the destination jurisdiction, an approach that is perhaps most helpful when considering potential population flows between less- and more-developed regions. By contrast, the present paper focusses on productivity-enhancing two-way factor flows and the potential efficiency gains from federation. This approach is more helpful in thinking about federation formation from a long-run constitutional perspective in which asymmetries in levels of economic development among regions are seen as relatively tempory in nature.

n_{is} and N_{is} denote, resp., the exogenously-given initial number of high- and low-skilled workers in industry s of jurisdiction i, and assume that each worker provides one unit of industry-specific services. Thus, low-skilled workers in industry s provide a different type of labor than low-skilled workers in industry t, each uniquely suited to its specific industry, and similarly for high-skilled workers. Output in industry s, jurisdiction i is given by a well-behaved production function $F_{is}(n_{is}, N_{is})$ exhibiting constant returns to scale in the two types of labor input [5]. Initially, both types of labor are assumed to be interjurisdictionally-immobile.

In order to focus attention on factor markets, all goods are assumed to be tradeable on world markets at exogenously-fixed prices, *i.e.*, all jurisdictions are small and open in output markets. Without loss of generality, the world price of each good is normalized to unity so that $F_{is}(\cdot)$ is the value of production in industry i, sector s. Labor markets are assumed to be competitive so that wages and thus the distribution of *gross* income is governed by labor productivity, which in turn depends on technology and factor endowments. The distribution of *net* income can be affected by tax/transfer policies undertaken by individual jurisdictions. The simplest form of redistribution that captures the essential issues is one in which each locality imposes a fixed per-capita tax, denoted τ_i for jurisdiction i, on all high-skill workers employed there, while using the proceeds to pay a per-capita subsidy, denoted σ_i for jurisdiction i, to all low-skill workers within the jurisdiction [6].

Now suppose that two or more jurisdictions join together to establish a federation with a liberalized labor market, such that any worker can move without legal restraint from one jurisdiction to another. To reflect the fact that workers are differentially mobile, it is assumed that high-skilled workers can migrate *costlessly* from one locality to another whereas migration costs for low-skilled workers are sufficiently high that they do not migrate at all [7]. Given these assumptions, the equilibrium net incomes of all high-skilled workers in each industry must be equalized across jurisdictions, as initial income differentials induce movements from low- to high-wage locations. The presence of low-skilled labor as a specific factor in each industry and jurisdiction insures diminishing returns to skilled labor. Letting l_{is} denote

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5. Some generalizations of the production technology to allow for more factors of production would change none of the qualitative insights in the following analysis. Specifically, one can allow for any number of other factors of production that are tradeable at fixed prices on external (world) markets; capital might exemplify such a factor of production. Allowing for other factors whose returns are determined on markets internal to the group of jurisdictions, on the other hand, would introduce general-equilibrium considerations that would complicate the analysis and could affect some of the conclusions.

6. Under the strong simplifying assumptions imposed, there is no behavioral margin (such as the tradeoff between labor and leisure) that can be distorted by such policies. For this reason, the assumption of fixed per capita taxes and subsidies is convenient but inessential; the following analysis would be unchanged in all important respects, for instance, if one were to suppose that each locality redistributes income through a linear income tax.

7. Highly-educated workers are relatively mobile compared to the less-educated, and the assumptions made here are consistent with that stylizaton. (See, e.g., EHRENBERG and SMITH [1988, p. 360], who cite US Census data showing high migration rates for young and highly educated people; they write, "[while] age is ... the best predictor of who will move, education is the single best indicator of who will more *within* an age group. ... [I]t is *college* education

the number of high-skilled workers employed in industry s in jurisdiction i, and defining $f_{is}(l_{is}) \equiv F_{is}(n_{is}, N_{is})$, the gross wage of skilled workers there will be $f'_{is}(l_{is})$ and the total wages of low-skilled workers will be $f_{is}(l_{is}) - l_{is} f'_{is}(l_{is})$, or $[f_{is}(l_{is}) - l_{is} f'_{is}(l_{is})]/N_{is}$ per capita. Of course, $l_{is} - n_{is}$ represents the amount of migration of high-skilled workers in industry s into jurisdiction i from other localities.

In general, bringing together a set of jurisdictions with arbitrarily-specified technologies and initial factor endownents can result in a wide variety of possible effects on employment, output levels, and the distribution of income. In many cases, asymmetries in technologies and endownents would lead one to expect significant net factor flows from one jurisdiction to another. For example, the establishment of a common labor market in unified Germany resulted in predictable net flows of labor from the low-wage East to the high-wage West. There is substantial net migration from Latin America to the US and from Eastern Europe and North Africa to the affluent countries of Western Europe. The immediate impact of a net flow of workers from one jurisdiction to another is to depress the incomes of workers in the destination jurisdiction who compete with immigrants and to raise the incomes of competing workers in the origin jurisdiction, while returns to complementary factors move in the opposite direction in each jurisdiction. The implications of this sort of net migration for income redistribution policy have been discussed, e.g., in WILDASIN [1994], WELLISCH and WILDASIN (1996), RAZIN and SADKA [1995], and references therein.

However, in other important contexts, net migration flows between localities may be rather small, while gross migration flows are still of great importance. Many recent college graduates in the US and other countries are likely to seek and find employment in a metropolitan area, state, or region of the country different from the locality where they were born or where they attended college. Gross interjurisdictional flows for such individuals are likely to exceed by far the net flows. BOADWAY and GREEN [1981] discuss Canadian internal migration and emphasize the importance of "matching migration" in which workers from one province find better employment opportunities in another, and vice versa, again resulting in gross flows in excess of net flows. Such "matching" migration presumably indicates that workers in each locality typically possess specialized skills and talents that cannot be most effectively exploited in their initial locations. Jurisdictions containing heterogeneous households possessing specialized skills can realize efficiency gains from the formation of a common labor market, even when such a market results in no net migration at all.

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that raises the probability of migrating the most"; emphasis in original.) Of course, it is unnecessary to assume that *all* of the potentially-mobile group be able to relocate; rather, there must be "sufficiently many" mobile workers so that there is in equilibrium a "marginal" worker who is indifferent between different locations. For the purposes of the present analysis, the assumption that migration costs are zero for high-skilled workers is a fairly harmless idealization. In other contexts, costly migration can raise interesting new issues. See, e.g., CUKIERMAN *et al.* [1993], HERCOWITZ and PINES [1991, forthcoming], MANSOORIAN and MYERS [1993], MYERS and PAPAGEORGIOU [1994], WILDASIN and WILSON (1996), WILDASIN (1995), and references therein.

In order to focus on the implications of such *gross* factor mobility while suppressing the issues that arise on account of *net* factor mobility, let us specialize the model by imposing several strong symmetry conditions. First, suppose that each industry in each jurisdiction contains an identical number of unskilled workers, *i.e.*, $N_{is} = \overline{N} \; \forall i, s$. Second, suppose that the production functions in all industries and localities are identical. This assumption does not mean that different industries produce identical goods, not does it contradict the assumption that workers possess skills that are specialized to particular industries. Rather, it means only that given quantities of industry-specific labor of each skill level produce outpout of identical *value* in all localities and industries. For the sake of technical simplicity, assume that there are only two industries s, t and only two juridictions, i, j and that $n_{is} + n_{js} = n_{it} + n_{jt} = n$ and $n_{is} + n_{it} = n_{js} + n_{jt} = n$; that is, the total number of skilled workers in each industry is identical, and the jurisdisctions start out with equal total numbers of skilled workers. Finally, in order to obviate minor technical complications, it is assumed that corner solutions do not occur in equilibrium. This can be guaranteed by assuming that $f'_{is}(l_{is}) \to \infty$ as $l_{is} \to 0$, but this assumption is stronger than necessary. Without further loss of generality, assume that $n_{is} \geq n_{js}$. Note that these assumptions imply that $n_{it} \leq n_{jt}$, $n_{is} = n_{jt}$, and $n_{it} = n_{js}$.

Under these assumptions, initial *gross* factor returns for skilled and unskilled workers, resp., satisfy [8]

(1.1)
$$f'_{is}(n_{is}) = f'_{jt}(n_{jt}) \leq f'_{it}(n_{it}) = f'_{js}(n_{js})$$

and

(1.2)
$$f_{is}(n_{is}) - n_{is} f'_{is}(n_{is})$$
$$= f_{jt}(n_{jt}) - n_{jt} f'_{jt}(n_{jt}) \geq f_{it}(n_{it}) - n_{it} f'_{it}(n_{it})$$
$$= f_{js}(n_{js}) - n_{js} f'_{js}(n_{js}),$$

with strict inequalities if $n_{is} > n_{js}$. Of course, nothing in this model dictates *a priori* that "high-skill" workers have higher gross earnings that "low-skill" workers, and indeed the formal analysis does not require this to be the case. However, the restriction of policy instruments to taxes and transfers between high- and low-skill workers is most natural if one assumes that the configuration of technologies and endowments is such that members of the former group (whatever intra-group interindustry wage differentials may exist) earn more than those in the latter group (whatever intra-group interindustry wage differentials may exist for them).

Now consider what happens when jurisdictions i and j form a common labor market, as for instance through participation in a federation. In

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8. As a matter of notation, the subscripts on the production fucntions have been retained for clarity although the *form* of the production function in each case is identical.

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equilibrium, high-skill workers in each industry must have identical net incomes, *i.e.*, the allocation of labor in each industry must satisfy

$$(2.1) \qquad f'_{is}(l_{is}) - \tau_i = f'_{js}(l_{js}) - \tau_j$$

$$(2.2) \qquad f'_{it}(l_{it}) - \tau_i = f'_{jt}(l_{jt}) - \tau_j,$$

a system of two equations which can be used, along with the full-employment conditions

$$(3.1) \qquad l_{is} + l_{js} = n_{is} + n_{js} = n$$

$$(3.2) \qquad l_{it} + l_{jt} = n_{it} + n_{jt} = n$$

to solve for the equilibrium allocation high-skill labor in each jurisdiction as a function of underlying technological parameters and the fiscal policy variables (τ_i, τ_j); specifically, it is apparent from (2) that the equilibrium allocation of labor depends only on the *differential* in fiscal treatment of mobile workers in each locality, $\tau_i - \tau_j$.

Since net incomes for mobile workers in each industry are equalized across jurisdictions, we may define the aggregate net income accruing to the workers *originally* located in industry s in jurisdiction i by

$$(4) \qquad x_{is} = n_{is}(f'_{is}(l_{is}) - \tau_i)$$

and similarly for x_{js}, x_{it}, and x_{jt}. The aggregate net income of high-skill workers originally located in jurisdiction i can then be defined as

$$(5) \qquad X_i = x_{is} + x_{it};$$

the net income of the original high-skill inhabitants of jurisdiction j, X_j, is defined similarly.

From the budget constraint for jurisdiction i, the transfer paid to each low-skill worker is given by

$$(6) \qquad \sigma_i = \frac{\tau_i(l_{is} + l_{it})}{\overline{N}}$$

Thus, the total net income of low-skill workers in industry s in jurisdiction i is

$$(7) \qquad y_{is} = f_{is}(l_{is}) - l_{is}f'_{ls}(l_{is}) + \sigma_i\overline{N}$$

and the net incomes of low-skill workers in the other industry and jurisdiction, y_{it}, y_{js}, and y_{jt}, may be defined similarly. The total net income accruing to low-skill workers in jurisdiction i is

$$(8) \qquad Y_i = y_{is} + y_{it}$$

and Y_j is defined similarly. The government budget constraints can be used to eliminate the variable σ_i. Thus, the incomes of the low-skill workers in each jurisdiction depend directly on that jurisdiction's tax rate; moreover, they depend indirectly on the tax differential $\tau_i - \tau_j$ through its impact on the allocation of high-skill labor. We can now study the effect of local redistributive policies, parameterized by the tax rate (τ_i, τ_j), on the distribution of income among worker types and on aggregate income.

3 Decentralized Income Redistribution within a Federation

3.1. The Distribution of Income under Laissez-Faire

Consider first the special case where each locality pursues a laissez-faire regime by setting $\tau_i = \tau_j = 0$. In this case, the allocation of labor will be perfectly symmetric between localities and industries, with $l_{is} = l_{it} = l_{js} = l_{jt} = n$. This allocation is first-best efficient, and results in complete equalization of (gross and net) earning among all high-skill workers.

To compare incomes before and after federation for different groups, define $x_{is}^0 \equiv n_{is} f_{is}'(n_{is})$ and $y_{is}^0 = f_{is}(n_{is}) - n_{is} f_{is}'(n_{is})$, resp., to be the pre-federation gross earnings of high- and low-skill workers in industry s, jurisdiction i, and define x_{it}^0, y_{it}^0, etc. similarly. Let $X_i^0 \equiv x_{is}^0 + x_{it}^0$ and $Y_i^0 \equiv y_{is}^0 + y_{it}^0$ denote, resp., the pre-federation levels of total income for high- and low-skill workers in jurisdiction i, and define X_j^0 and Y_j^0 similarly. Furthermore, define $X^* \equiv nf'(n/2)$ and $Y^* \equiv f(n/2) - nf'(n/2)$; these represent the gross earnings of each type of worker in each jurisdiction in the post-federation *laissez-faire* equilibrium.

The precise effect of federation on the returns to each type of labor depends on their degree of substitutability or complementarity. One simple case that yields clear results is that of the *quadratic production function*, i.e., $f(l) = al - bl^2/2$, $a > 0$, $b > 0$. Another case of interest is that of the *Cobb-Douglas production fucntion*, $f(l) = Al^\alpha$, where $\alpha \in (0, 1)$ and $A = N^{(1-\alpha)}$. The Cobb-Douglas case has the property that the elasticity of demand for high-skill labor is constant and greater than one in absolute value, $\varepsilon = -1/(1 - \alpha)$. More generally, the elasticity of demand, defined as $\varepsilon(l) = (d \ln f'(l)/d \ln(l))^{-1}$, depends on the level of employment. It can vary between 0 and $-\infty$. (For example, if the underlying technology exhibits a constant elasticity of substitution between the two labor types, $\varepsilon = 0$ in the case of a Leontief production technology while $\varepsilon = -\infty$ when the production function is linear in both labor types, corresponding to an infinite elasticity of substitution.)

PROPOSITION 1 : Suppose that both jurisdictions i and j follow *laissez-faire* policies both before and after forming a federation, *i.e.*, $\tau_i = \tau_j = 0$.
(a) In the post-federation equilibrium, the total earnings of the high-skill workers initially located in each jurisdiction, and of the high-skill workers in each industry, are equal to X^*. If either the production function is Cobb-Douglas or $f'''(\cdot) \leq 0$, including in particular the case o a quadratic production function, these earnings are *higher* than in the pre-federation equilibrium, *i.e.*,

$$(\text{P.1}) \qquad X^* \geq x_{is}^0 + x_{js}^0 = x_{it}^0 + x_{jt}^0 = X_i^0 = X_j^0.$$

(b) In the post-federation equilibrium, the total earnings of the low-skill workers initially located in each jurisdiction, and of the low-skill workers in each industry, are equal to Y^*. If the production function is Cobb-Douglas, then these earnings are *higher* than in the pre-federation equilibrium, *i.e.*,

$$(\text{P.2.1}) \qquad Y^* \geq y_{is}^0 + y_{js}^0 = y_{it}^0 + y_{jt}^0 = Y_i^0 = Y_j^0.$$

If instead $f'''(\cdot) \leq 0$, including in particular the case of a quadratic production function, then these earnings are *lower* than in the pre-federation equilibrium. *i.e.*,

$$(\text{P.2.2}) \qquad Y^* \leq y_{is}^0 = y_{js}^0 = y_{it}^0 + y_{jt}^0 = Y_i^0 = Y_j^0.$$

(c) In the post-federation equilibrium, total earnings in each industry and the total earnings of all workers in each jurisdiction are equal to $X^* + Y^*$. These earnings are *higher* than in the pre-federation equilibrium, *i.e.*,

$$(\text{P.3}) \quad X^* + Y^* \geq x_{is}^0 + x_{js}^0 + y_{is}^0 + y_{js}^0 = x_{it}^0 + x_{jt}^0 + y_{it}^0 + y_{jt}^0$$
$$= X_i^0 + Y_i^0 = X_j^0 + Y_j^0.$$

Proof: See Appendix.

The results in Proposition 1 are obviously not very general; only (c) holds without restrictions on the form of the production fucntion. In fact, it is not difficult to construct examples in which the earnings of high-skill workers are *lower* in the post-federation equilibrium. Still, (a) suggests that earnings for these workers increase as a result of federation in many economically-interesting cases, whereas (b) shows that there are very simple cases where the earnings of low-skill workers could either go up or down after the establishment of a common labor market.

Figure 1 illustrates some of these results. Measuring the earnings of high-skill workers on the horizontal axis and those of low-skill workers on the vertical axis, point A shows the *laissez-faire* distribution of income in the pre-federation equilibrium, with $A = X_i^0 + Y_i^0$ the total income of

workers in jurisdiction i. After federation, X_i rises in the cases identified in part (a) of Proposition 1, whereas Y_i may fall or rise, resulting in a new distribution of income such as A_q (corresponding to the quadratic case where $Y^* < Y_i^0$) or A_{CD} (corresponding to the Cobb-Douglas case where $Y^* < Y_i^0$). In any case, as long as the initial allocation of labor does not already correspond to the first-best efficient *laissez-faire* equilibrium, total income rises, so the points A_q and A_{CD} must both lie above the 45-degree line PQ through the pre-federation income distribution of A. In the special case where $n_{is} = n/2$, the formation of a federation has no impact on the allocation of labor between industries and jurisdictions and there is thus no effect on factor prices, total come, or the distribution of income. In this special case, the points A, A_q, and A_{CD} all coincide.

3.2. **Federation and the Impact of Redistributive Policy**

Now let us consider the use of redistributive instruments before and after federation. In the pre-federation case, tax/transfer policy has no effect on the allocation of resources within each locality, so total income is invariant to
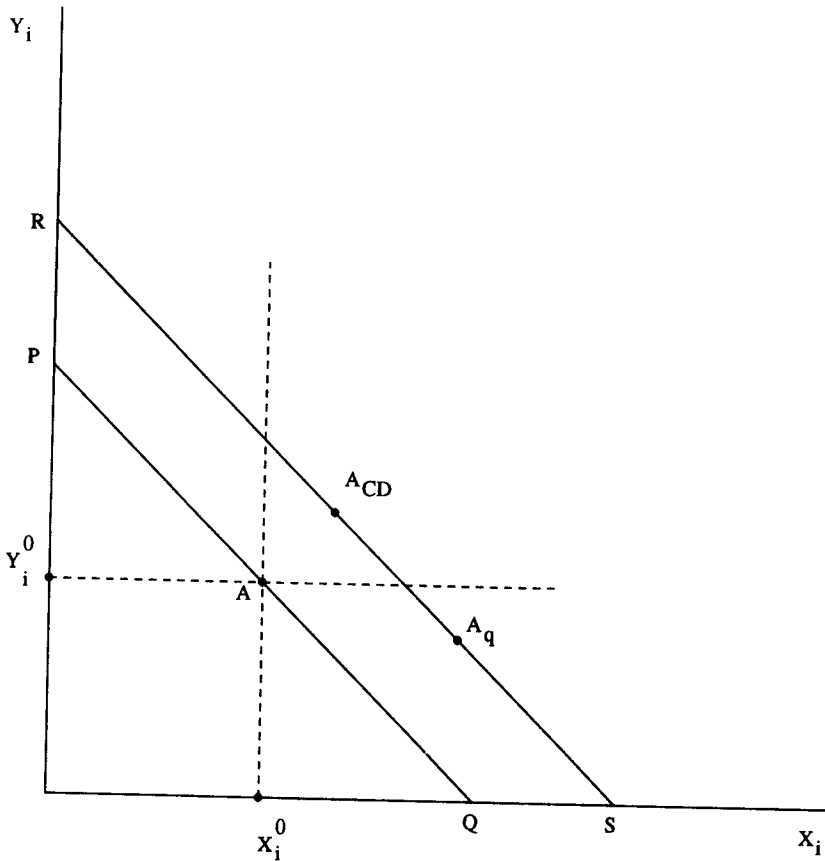

FIGURE 1

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the extend of redistribution. In terms of Figure 1, an increase in τ_i starting from $\tau_i = 0$ moves the *net* pre-federation income distribution along the line PQ from A toward P. A tax on low-skill workers used to subsidize high-skill workers ($\tau_i < 0$) would move the net distribution of income from A toward Q. Thus, the line PQ traces out the pre-federation *income distribution frontier*, that is, the locus of attainable income distributions [9].

After federation occurs, total potential income for each jurisdiction increases. As noted above, the post-federation *laissez-faire* equilibrium level of income in each jurisdiction is higher than in the pre-federation situation. Moreover, the allocation of labor will also be first-best efficient, and of course perfectly symmetric between firms and industries, whenever τ_i and τ_j are equal, even if they are non-zero. The 45-degree line RS shows the income distribution frontier when both jurisdictions simultaneously vary their tax/transfer policies, keeping $\tau_i = \tau_j = \tau$. The points on this frontier to the left of the *laissez-faire* distribution of income (points A_q and A_{CD}) correspond to positive values of τ, while points to the right correspond to net transfers from immobile low-skill workers to mobile high-skill workers. This frontier can be viewed as the income-distribution frontier attainable by a centralized redistributive authority in the post-federation economy.

For any individual locality within the federation pursuing a redistributive policy alone, however, RS does not represent the menu of attainable income distributions. To determine the effects of tax/transfer policies undertaken by a single jurisdiction within a federation, note first that since these policies apply uniformly across industries, the marginal product of high-skill labor in each jurisdiction will be equalized across industries; thus, we may define

$$f_i(l_i) \equiv \max_{l_{is}} f_{is}(l_{is}) + f_{jt}(l_i - l_{is})$$

and define the earnings of high- and low-skill workers in jurisdiction i in terms of this aggregate production function as

(5') $$X_i = n\left(f_i'(l_i) - \tau_i\right)$$

and, using the government budget constraint,

(8') $$Y_i = f_i(l_i) - l_i f_i'(l_i) + l_i \tau_i.$$

Similarly, the labor-market equilibrium conditions reduce to

(2') $$f_i' - \tau_i = f_j' - \tau_j$$

and

(3') $$l_i + l_j = 2n$$

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9. See Baumol and Fishcer [1979] and Baumol [1989] for earlier uses of the concept of an income distribution frontier. A more closely-related analysis appears in Wildasin [1994]; that study, however, does not analyze the interactions between the tax/transfer policies of different jurisdictions, nor does it compare income distributions before and after the formation of a federation.

which can be used to solve for (l_i, l_j) implicitly in terms of $(\tau_i - \tau_j)$. Differentiating (5′) and (8′) with respect to τ_i yields

(9.1)
$$\frac{\partial X_i}{\partial \tau_i} = \frac{-n\, f_j''\,(l_j)}{f_i'' + f_j''} < 0$$

(9.2)
$$\frac{\partial Y_i}{\partial \tau_i} = \frac{l_i\, f_j''\,(l_j) + \tau_i}{f_i'' + f_j''}$$

Combining these results, one obtains

(10)
$$\frac{\partial\,(X_i + Y_i)}{\partial \tau_i} = \frac{(l_i - n)\, f_j''\,(l_j) + \tau_i}{f_i'' + f_j''}.$$

These results can be used to characterize the post-federation income distribution frontier facing jurisdiction i.

First, note from (9.2) that Y_i is generally not monotonic in τ_i. Starting from $\tau_i = 0$, taxes on high-skill workers can raise the net incomes of low-skill workers, but sufficiently high taxes drive away so many high-skill workers that low-skill workers can be made worse off. The tax rate that maximizes Y_i satisfies.

(11)
$$\hat{\tau}_i = -l_i\, f_j''\,(l_j)$$

which, roughly speaking, is an inverse-elasticity formula; in particular, as the demand elasticity for labor in jurisdiction j becomes sufficiently high, $\hat{\tau}_i \to 0$ [10]. The following discussion restricts attention to values of $\tau_i < \hat{\tau}_i$, since only in this range is there a tradeoff between the incomes of the two types of workers.

Next, consider the income distribution frontier for jurisdiction i assuming that τ_j is fixed at a positive value $\overline{\tau}_j$. In Figure 2, let A' represent the *laissez-faire* distribution of income corresponding to $\tau_i = \tau_j = 0$ (thus, A' could be a point like A_q or A_{CD} in Figure 1). Then the income distribution frontier when $\tau_i = \overline{\tau}_j$ will be at a point like B lying on RS to the left of A'. At this point, the income distribution frontier cuts RS from below [11]. Furthermore, when $\tau_i = 0$, $X_i < X^*$ but total income in i,

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10. Expressing the tax in *ad valorem* terms,
$$\frac{\hat{\tau}_i}{f_i'(l_i) - \hat{\tau}_i} = -\frac{l_i}{l_j}\, \frac{f_j'(l_j)}{f_j'(l_j) - \tau_j}\, \frac{1}{\varepsilon_j}$$
where $\varepsilon_j = l_j\, f_j''(l_j)/f_j'(l_j)$ is the elasticity of demand for high-skill labor in j. When $\tau_j = 0$, this is just an inverse-elasticity rule modified for the comparative populations of the jurisdictions. Obviously, there may be no maximum or multiple (global or local) maxima depending on the behavior f'''. For the purposes of the folowing diagrams, a unique maximum is assumed; no other results depend on this assumption.

11. B lies on RS because $l_i = n$ where $\tau_i = \overline{\tau}_j$. The slope of the frontier is (algebraically) greater than -1 at this point, by (10).
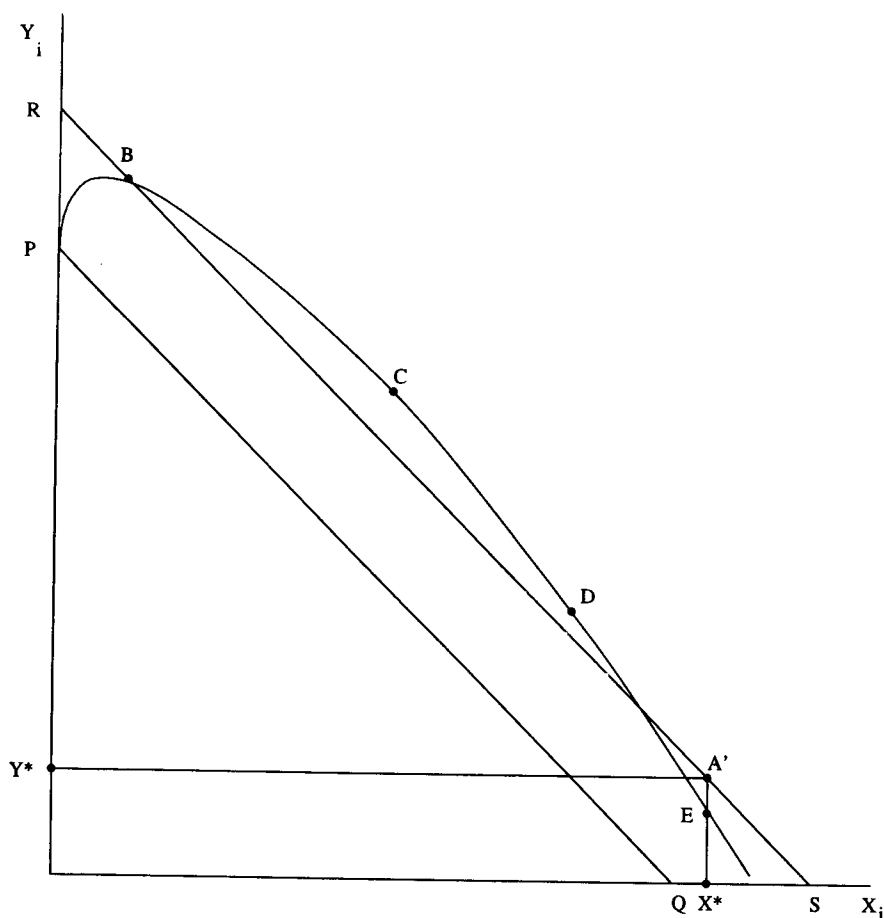
FIGURE 2

$X_i + Y_i$, exceeds the *laissez-faire* level; the distribution of income in this case thus corresponds to a point like D [12]. Total income is maximized at a positive value of τ_i, resulting in an income distribution like C; at this point, $\tau_i \in (0, \overline{\tau}_j)$ [13]. Finally, the income distribution frontier cuts below RS to the right of D and to the left of A' and remains below it thereafter [14].

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12. When $\tau_i = 0 < \overline{\tau}_j$, $l_i > n$ and so $n f_i'(l_i) < n f_i'(n)$. However, $X_i + Y_i = f_i(l_i) - l_i f'(l_i) + n f_i'(l_i)$. The derivative of this expression with respect to l_i is $(n - l_i) f_i''$ which is positive for $l_i > n$.

13. This follows directly from (10).

14. The point E at which $X_i = X^*$ corresponds to a subsidy $\tau_i < 0$ such that $f'(l_i) - \tau_i = f'(n)$. At this point, $Y_i = f_i(l_i) - l_i (f_i'(l_i) - \tau_i) = f_i(l_i) - l_i f'(n)$. This expression is decreasing in l_i for $l_i > n$, hence $Y_i < Y^*$. The slope of the income distribution frontier is smaller (algebraically) than -1 for $\tau_i < 0$ by (10), using the fact that $l_i > n$ in this range. Thus the income distribution frontier cuts RS from above only once to the right of D.
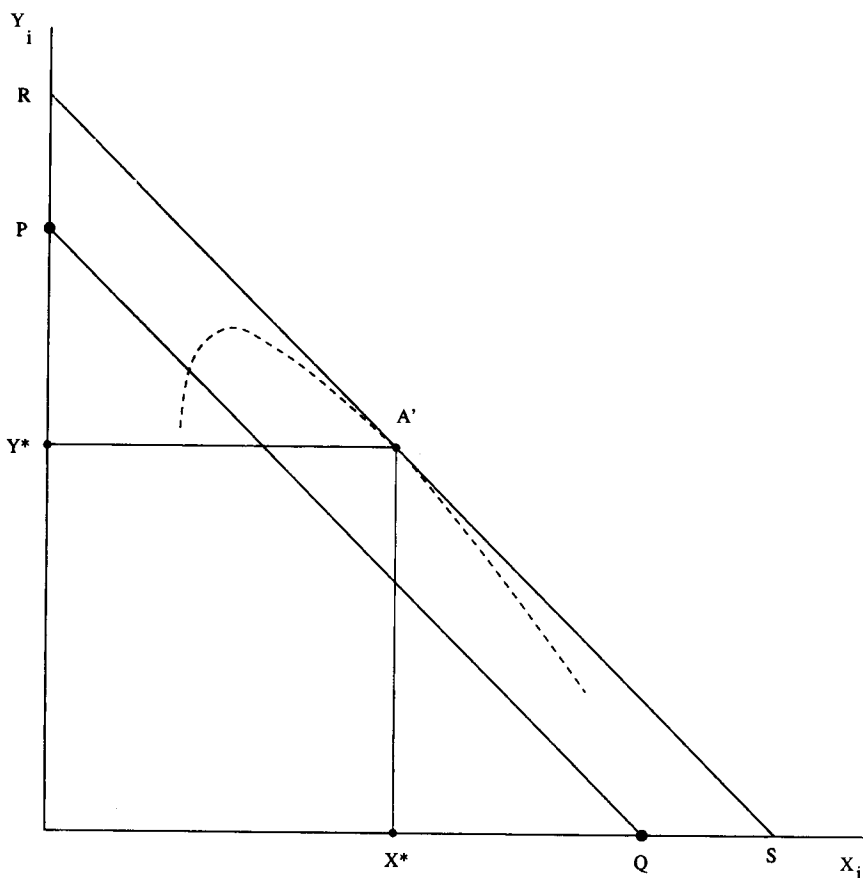
FIGURE 3

Suppose now that the tax rate in jurisdiction j is fixed at $\tau_j = 0$. In this case, as shown by the dashed line in Figure 3, the income distribution frontier lies below RS except at A'. The general shape of the curve is the same as for the case where $\tau_j > 0$ [15]. Finally, when $\tau_j < 0$, the income distribution frontier (not drawn for brevity) will form roughly a reflection arounds the 45-degree line of that shown in Figure 2. It will cut the line RS from below, and with a slope less than -1, at a point to the right of the *laissez-faire* equilibrium point A'; at this point, the tax rate on high-skill workers τ_i is positive. As τ_i falls, the frontier eventually crosses RS from above and then remains below RS for all higher values of τ_i.

Let us now compare the pre-federation income distribution frontier with the post-federation frontier(s). First, as is clear from the diagrams, there are always some points on the latter that lie above some points on the former,

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15. Note from (10) that $X_i + Y_i$ is maximized at $\tau_j = 0$, using the fact that $l_i - n \gtrless 0$ as $\tau_j - \tau_i \gtrless 0$.

provided that $n_{is} > n$. On the other hand, some of the distributions of income that can be reached in the pre-federation situation may no longer be attainable after federation occurs. To see this, note that the pre- and post-federation *laissez-faire* distributions of income, and thus the lines PQ and RS, can be arbitrarily close together; in fact they coincide when $n_{is} = n/2$. Thus, for example, as $n_{is} \rightarrow n/2$, the pre-federation frontier PQ in Figure 3 lies *above* the post-federation frontier shown by the dashed line everywhere except at point A'. These basic observations show that there is no unambiguous welfare ranking of the attainable income distributions before and after federation. However, the greater the potential efficiency gains from federation, as represented by the difference between n_{is} and $n/2$, the larger the set of post-federation income distributions that lie outside the pre-federation frontier.

4 Implications and Extensions

This section discusses some of the implications of the preceding analysis and some issues for futher research.

Large vs. Small Federations. The analysis so far has assumed that there are only two jurisdictions that form a federation. A simple replication argument, however, can be used to see what happens with many identical jurisdictions. Suppose that there are m jurisdictions each of type i and type j. For each value of $m = 1, 2, \ldots$, the comparisons of the *laissez-faire* distributions of income before and after formation of a federation are unchanged. However, the shape of the income distribution frontier for any one jurisdiction is significantly affected by increases in the size of a federation. The existence of many jurisdictions employing high-skill labor restricts the ability of any one jurisdiction either to increase or to decrease the net income of these workers. For example, if all other jurisdictions pursue a *laissez-faire* policy, the income distribution frontier for a single jurisdiction collapses to the line segment $A'X^*$ shown in Figures 2 and 3. Essentially, the supply of high-skill labor becomes perfectly elastic for any one locality when the number of jurisdictions becomes large. As shown earlier, the tax rate on high-skill workers that maximizes the income of low-skill workers approaches zero as the elasticity of demand for labor becomes infinite, so that the point on the income distribution frontier at which Y_i reaches its maximum approaches the *laissez-faire* point A'. In this case, local redistributive policies can no longer change the net income accruing to local high-skill workers and can only serve to reduce the net income accruing to low-skill workers. On the other hand, adding *heterogeneous* jurisdictions to a federation can increase the efficiency gains from factor mobility. This presents an interesting question for empirical research. The integration of labor markets between jurisdictions at very different levels of economic development can result in net fiscal burdens or benefit for one jurisdiction or another; in particular, it is possible that allowing freer migration between

rich and poor countries might result in fiscal losses for the former (though this is a hotly debated issue; see BORJAS [1994] for recent discussion of the fiscal impact of immigration in the US). Nevertheless, one might expect to find the largest potential efficiency gains from freer labor markets in such cases. What are the comparative magnitudes of these effects?

Redistributive Federations. While the discussion of large federations suggests that the formation of a federation may limit the amount of redistribution undertaken by individual jurisdictions, it is actually possible for there to be more rather than less redistribution in a small federation. Consider the case where each jurisdiction's redistributive policy is chosen to maximize a welfare function $W(X_i, Y_i)$, and suppose, for the sake of a simple comparison, that it is optimal for each jurisdiction to choose a zero tax rate in the pre-federation situation, that is, W is maximized at point A along the frontier PQ. Suppose further that the maximum of W along RS occurs to the left of the *laissez-faire* distribution A'; this will occur, for example, in the case of a quadratic production function portrayed in Figure 1, if the welfare function exhibits "normality" in each type of income. (For instance, suppose that $W = \ln X_i + \ln Y_i$ and that A lies at the midpoint of PQ.) Then, in a symmetric Nash equilibrium, each jurisdiction will choose a positive tax rate on high-skill workers and the resulting distribution of income will lie to the left of the *laissez-faire* dstribution A' [16]. It is also possible, though not necessary, that welfare in each jurisdiction may be higher in the post-federation Nash equilibrium.

This example (which could obviously be generalized) is of interest because it shows that redistributive policies may become more rather than less attractive after the formation of a federation, and that welfare in both jurisdictions may increase as a result of the formation of a federation coupled with the introduction of decentralized redistribution. The intuition behind the finding of increased redistribution is that the mobility of high-skill labor may depress the earnings of low-skill workers, raise the earnings of high-skill workers, or both, making redistribution toward low-skill workers more attractive by increasing economic inequality; furthermore, since there are efficiency gains from factor mobility, "income effects" in the social preference structure favor increases in the net incomes of both worker types as well. An inequality-averse social welfare function results in policies that cause some of the "gains from trade" in the market for high-skill to be shared with low-skill immobile workers through the mechanism of redistributive transfers. Social welfare in each jurisdiction may be increased as a result of the formation of a federation; note that this may occur even at the cost of a reduction in the equilibrium incomes of immobile workers, if the gains to the mobile workers are sufficiently great.

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16. To see this, observe that the level of curve of W through the *laissez-faire* point A' must be flatter than RS at that point. If $\tau_j = 0$, it is clear from Figure 3 that $\tau_i \leq 0$ cannot be a best reply for jurisdiction i. Furthermore if $\tau_j < 0$, the income distribution frontier for jurisdiction i lies below RS for all values of $\tau_i \leq 0$. Since any Nash equilibrium in a symmetric world must lie on RS and since $\tau_i = \tau_j \leq 0$ is not an equilibrium, the taxes imposed on high-skilled workers in both jurisdictions must be positive in equilibrium.

Between- and Within-Group Inequality. Economic models of migration are fundamentally models of labor market arbitrage. As such, they predict equalization of real incomes among workers with comparable skills and tastes [17]. In the present model, the formation of a federation leads to equalization of net returns among high-skill workers both across industies and across locations. From the viewpoint of risk-averse high-skill workers or inequality-averse welfare functions, this within-group equalization is beneficial (WILDASIN [1995]). In the special model used here, the formation of a federation also results in the equalization of incomes among low-skill workers; unlike the corresponding results for high-skill workers, however, this is a consequence of the strong symmetry assumptions that have been imposed on technologies and endowments, and it is easily possible that increased mobility of high-skill workers could result in greater *inequality* of incomes among low-skill workers in different jurisdictions. The analysis in Section 3 has focussed on the distribution of income between high- and low-skill workers, and has made clear that formation of a federation may either increase or decrease between-group inequality. Simultaneous changes in both within- and between-group inequality can obviously raise some measures of inequality while reducing others, depending on the weights attached to inequality at different points in the income distribution. In public finance terms, the foregoing analysis suggests that the formation of a federation may improve horizontal equity for at least some groups in the population while having ambiguous effects on vertical equity. Note that the equalization of within-group incomes is the result of *gross* migration, and, indeed, the empirical importance of gross migration for horizontal equity is likely to be quite important.

Which Factors Are Immobile? The labeling of immobile factors as "low-skill" labor and of mobile factors as "high-skill" labor obviously has no effect on the formal analysis. There are other interpretations of the model that might be more appropriate depending on the intended application. For instance, depending on the time horizon of the analysis, it might be appropriate to regard land and other natural resources, public infrastructure, and possibly private capital as immobile, and to think of labor as a whole as the mobile factor of production. The issue of "between group" inequality in this case becomes one of inequality in the functional distribution of income. Since ownership claims on non-human resources are generally tradeable in economies with well-developed asset markets, inequalities in the distribution of returns to non-human immobile resources do not carry any particular normative implications. The formation of a federation in this case equalizes the distribution of earnings among workers and, under the special symmetry assumptions used in the formal analysis, also equalizes the returns to land and capital across industries and (at least in the *laissez-faire case*) across jurisdictions. Assuming that the owners of immobile assets are able to trade owernship claims, and assuming that the realization of industry-

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17. See HATTON and WILLIAMSON [1994] and references therein for discussion of the role of international migration and capital flows for the convergence of factor prices in the nineteenth century.

specific technologies is *ex ante* uncertain, the formation of a federation would imply less need for asset-market transactions to achieve risk-pooling through diversified portfolios. On the other hand, as noted above, it is quite possible to construct a model in which labor mobility would result in divergence of returns to immobile resources, in which case risk-averse owners of these resources might wish to hold more diversified portfolios of claims on assets in different jurisdictions. Although it is unclear *a priori* whether the formation of a federation would increase or decrease the inter-industry and inter-jurisdictional variability of asset returns, in either case it could have significant impacts on the volume and types of asset-market transactions that risk-averse investors would wish to undertake.

Endogenous Human Capital and Localization Economies. The analysis in this paper has treated as exogenous the skill distribution within the labor force. In reality, of course, the level and distribution of human capital is endogenously determined, and wage risk is likely to be one important determinant of attractiveness of human capital investments. To the extent that an integrated labor market reduces wage risk, it is plausible that it may encourage more human capital accumulation. KRUGMAN [1991] has stressed the role of urban agglomerations as dense labor markets within which workers can easily switch employers in order to escape randomly-unproductive jobs, suggesting that human capital investment could be greater within a highly-urbanized economy. Similarly, a federation within which workers are freely mobile would offer greater opportunities to diversify the risks of skill acquisition and might lead to more human capital accumulation. One would conjecture, then, that the equilibrium expected return to human capital investment would be lower as a result of the formation of a larger federation, and the equilibrium earnings of lower-skilled workers would be higher. This possible impact impact on the distribution of income between low- and high-skill workers deserves further study. In addition, these considerations suggest that there could be interesting interactions between the geographical scope of a federation and the equilibrium size of metropolitan areas.

APPENDIX

Proof of Proposition 1: The basic idea of the proof is to compare the perfectly symmetric and efficient post-federation equilibrium with a pre-federation equilibrium in which the allocation of high-skill labor differs from the efficient allocation by a "mean-preserving spread."

(*a*) Define

$$X(\lambda) \equiv \left(\frac{n}{2} + \lambda\right) f'\left(\frac{n}{2} + \lambda\right) + \left(\frac{n}{2} - \lambda\right) f'\left(\frac{n}{2} - \lambda\right).$$

Note that

(A.1) $$X^* = X(0)$$

and that

(A.2) $$x_{is}^0 + x_{js}^0 = x_{it}^0 + x_{jt}^0 = X_i^0 = X_j^0 = X\left(n_{is} - \frac{n}{2}\right).$$

Differentiating,

(A.3) $$X'(\lambda) = f'\left(\frac{n}{2} + \lambda\right) - f'\left(\frac{n}{2} - \lambda\right) + \left(\frac{n}{2} + \lambda\right) f''\left(\frac{n}{2} + \lambda\right)$$
$$- \left(\frac{n}{2} - \lambda\right) f''\left(\frac{n}{2} - \lambda\right).$$

For $\lambda > 0$, the first two terms of (A.3) are negative by concavity of $f(\cdot)$. If $f'''(\cdot) \leq 0$, the next two terms are also negative; note in particular that this is true when f'' is constant, *i.e.*, in the quadratic case. In the Cobb-Douglas case, where $f(l) = Al^\alpha$, note that $lf''(l) = \alpha(\alpha - 1) l^{\alpha-1} = (\alpha - 1) f'(l)$. Thus, (A.3) can be written as $X'(\lambda) = \alpha(f'[\frac{n}{2} + \lambda] - f'[\frac{n}{2} + \lambda])$, which is negative by the concavity of f. Whenever $X'(\lambda) < 0$, (A.1) and (A.2) implies that the earnings of high-skill workers are higher at the post-federation equilibrium, establishing (P.1).

(*b*) Define

$$Y(\lambda) \equiv f\left(\frac{n}{2} + \lambda\right) - \left(\frac{n}{2} + \lambda\right) f'\left(\frac{n}{2} + \lambda\right) + f\left(\frac{n}{2} - \lambda\right)$$
$$- \left(\frac{n}{2} - \lambda\right) f'\left(\frac{n}{2} - \lambda\right).$$

Note that

(A.4) $$Y^* = Y(0)$$

and that

(A.5) $$y_{is}^0 + y_{js}^0 = y_{it}^0 + y_{it}^0 = Y_i^0 = Y_j^0 = Y\left(n_{is} - \frac{n}{2}\right).$$

Differentiating,

(A.6) $$Y'(\lambda) = -\left(\frac{n}{2} + \lambda\right) f''\left(\frac{n}{2} + \lambda\right) + \left(\frac{n}{2} - \lambda\right) f''\left(\frac{n}{2} - \lambda\right).$$

If $f''' \leq 0$, including in particular the quadratic case where f'' is constant, $Y' > 0$. (P.21) follows from (A.4) and (A.5). On the other hand, in the Cobb-Douglas case, (A.6) becomes $Y'(\lambda) = -(\alpha - 1)(f'[\frac{n}{2} + \lambda]) - f'([\frac{n}{2} - \lambda])$, which is negative by concavity of $f(\cdot)$. (P.2.2) now follows from (A.4) and (A.5).

(c) Summing (A.3) and (A.6),

$$(A.7) \qquad X'(\lambda) + Y'(\lambda) = f'\left(\frac{n}{2} + \lambda\right) - f'\left(\frac{n}{2} - \lambda\right)$$

which is negative by concavity of $f(\cdot)$. (P.3) follows from (A.1), (A.2), (A.4), and (A.5).

$\square$

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