4. A Model of Inter-Regional Redistribution and Income Convergence

Introduction

At a normative level, the whole purpose of redistributing resources across jurisdictions is to reduce or eliminate their differences in living standards, development and, with some simplification, to equalize average income levels. Whatever the probability, discussed in the previous chapter, that the democratically chosen measures for redistributing resources across jurisdictions promote, if not reach, this normative goal, fiscal policy is by no means the only way to reach it. There are market forces that tend to reduce differences across jurisdictions that compose an integrated economy. The theory of economic growth shows that, under certain circumstances, productive inputs move to jurisdictions where they are relatively scarce, so their availability and their rates of return are equalized across jurisdictions. The determinants of this process of “income convergence” have been thoroughly analyzed. With a few exceptions, there is considerable evidence showing that this process takes place across jurisdictions within a country and, with a few more exceptions, between the countries of the world (Barro and Sala-i-Martin, 1995).

The presence of two mechanisms to reduce income differences across jurisdictions – fiscal policy and factor relocation – raises the following question: are these two mechanisms substitutes or complements? Do they obstruct or reinforce each other? How do they interact?

Surprisingly, this question has received little attention in the literature so far. A possible reason is that data on the migration of tax bases across jurisdictions and countries are scarce, especially for income from capital. Economists have therefore sidestepped the effects on factor relocation and focused their attention directly on the impact of fiscal policy on the rate of economic growth (Barro, 1990). The underlying reasoning is that, since
convergence is a by-product of output growth, whatever policy measure fosters growth should also accelerate the speed of the convergence process. This is actually a non sequitur because, as the endogenous models of growth with locational externalities have shown, income levels may converge in the long run while factors relocate so to temporarily increase the differences in their endowments across jurisdictions and countries. In the context of secular processes such as these, temporary or “local” equilibria may actually last a long time, quite long enough for the political processes that drive interjurisdictional redistribution to be activated. The interaction between interjurisdictional income redistribution and the market forces that drive the process of convergence thus deserves closer attention.

Another possible reason why this interaction has not been thoroughly studied before is related to the fairly recent paradigm shift in growth theory (Romer, 1986). Only with the development of endogenous growth models in the late 1980s, has a suitable theoretical framework for this type of inquiry become available. Neoclassical growth models explain convergence starting from a generalized assumption of diminishing marginal returns to the mobile factors, which push them to relocate so to balance rates of return (Barro and Sala-i-Martin, 1992, 1995). This equalizing role leaves little room for any other phenomenon to explain the dynamics of the converging economies. Jurisdictional specialization in the basket of goods produced, locational externalities, increasing returns, interjurisdictional differences in institutions, or even in fiscal policies, are all irrelevant, at least in the long run, in a Solow world. Although the main prediction of the neoclassical model – convergence – generally receives a strong empirical support, at the beginning of the 1990s the renewed interest in regional economics (Krugman, 1991a, b; Blanchard and Katz, 1992) brought about evidence that other phenomena, beyond convergence, characterize the dynamics of regional incomes. Blanchard (1991) observed that, because of the lack of suitable data on factor mobility, especially capital, we may often just presume that factor relocation drives convergence. Eventually, the application of endogenous growth models to the dynamics of jurisdictional and country incomes has underscored, at the country level, the importance of institutional and policy differences and knowledge spillovers (Barro and Sala-i-Martin, 1997; Lucas, 1988, 1990). At the jurisdictional level, endogenous growth models have pointed out the relevance of specialization, increasing returns to scale and locational externalities (Krugman, 1991b; Blanchard and Katz, 1992). To sum up, factor relocation is an important determinant of the dynamics of jurisdictional incomes in their movement towards (or even away from) the steady state, but it is by no means the only one.

The convergence model introduced in this chapter has three main characteristics. First, it fits into the paradigm of endogenous growth, as it allows for a variety of types of returns to mobile factors and for jurisdictional specialization in production. Second, it is a model of jurisdictional (or country) income convergence, rather than simply income growth, which
includes the standard corollary of the negative correlation between the initial income levels and the average growth rate. Third, it explicitly accounts for interjurisdictional redistribution through taxation and public expenditures. The idea that drives the model is quite simple. Taxes and expenditures open a wedge between factor prices and factor returns, which makes differences in fiscal policies a potentially relevant determinant of factor migration and, under certain hypotheses about factor returns, of income convergence too. Interestingly, the analysis of this chapter shows that interjurisdictional redistribution can impede or promote income convergence across jurisdictions independently of the assumptions about the returns to scale of mobile factors. Incomes may converge even when growth is subject to locational economies of scale, provided that interjurisdictional redistribution is sufficiently regressive with respect to relative factor prices across jurisdictions. At the other end of the spectrum, when mobile factors experience diminishing marginal returns, incomes may diverge under a sufficiently progressive scheme of redistribution. Furthermore, the identification of the channels through which interjurisdictional redistribution affects the determinants of income convergence suggests an appropriate regression equation to test for convergence and to characterize an indicator of the effects of fiscal policy on the convergence process, called the “Index of Geographical Redistribution”. The IGR index provides the basis for the empirical analyses and cross country comparisons of chapter 5.

In a strict sense, the analyses of the models of chapter 3 and 4 are not equivalent, because of the differences in the assumptions. The static model addresses two “steady state” situations, while the convergence model is concerned with the transition to the steady state. Furthermore, the theoretical structure of this chapter does not feature distortions in the labor market, asymmetries in the provisions of spending programs, and centralization or decentralization of fiscal policy decisions. Nevertheless, in both models the effects of fiscal policy on output are analyzed under different conditions of factor mobility (the case where both factors are immobile is devoid of interest here). Also the instruments of fiscal policy and the dependent variables are similar. The analysis of this chapter can therefore be seen as an extension of the study conducted in the previous one, in the sense that it shows how the fiscal policies, determined in the ways examined in chapter 3, affect the process of income convergence

The rest of the chapter is organized in a similar fashion to chapter 3. Section 2 presents a standard endogenous model of jurisdictional income convergence, based on Blanchard (1991). The advantage of adopting a standard baseline theory of convergence is that it makes it easier to appreciate the role of interjurisdictional redistribution. Sections 3 and 4 explore the relationship between interjurisdictional redistribution and income convergence for the case of capital and labor mobility, respectively. Sections 5, 6 and 7 describe the effects of interjurisdictional redistribution for the case of labor mobility, capital mobility and full factor mobility. Section 8
discusses how the model can be tested and introduces the Index of Geographical Redistribution. Section 9 reviews the main conclusions of the analysis.

The model

Contrary to neoclassical models of jurisdictional income convergence, which treat jurisdictions as closed “Solow economies” producing identical goods, this model characterizes each jurisdiction as a small open economy, each producing a different good under conditions of high factor mobility. This framework of analysis is especially suited to the analysis of the impact of interjurisdictional redistribution on income convergence: boundaries between jurisdictions act as barriers to trade and factor mobility only to the extent that fiscal and regulatory policies alter factor costs and returns (Krugman, 1991a)\(^2\).

In the model there are \( n \) jurisdictions, denoted by \( i = 1, \ldots, n \), each assumed to produce a different good. As in chapter 3, the production function for good \( i \) is of the Cobb-Douglas form:

\[
(q_i - q) = \alpha(l_i - l) + (1 - \alpha)(k_i - k) + \theta_i \quad (4.1)
\]

Let \( q_i \), \( l_i \) and \( k_i \) stand for the log of jurisdiction \( i \)'s output, employment, and capital in year \( t \). The same variables without the \( i \) subscript refer to national (geometric) averages. Equation (4.1) is obtained by subtracting the aggregate production function from the jurisdiction’s production function. Jurisdictions are assumed to have the same production function but different technological shocks; \( \theta_i \) represents the jurisdiction-specific technological shock.

Equation (4.2) specifies the demand for jurisdiction \( i \)'s output relative to the national average

\[
(p_i - p) = -\delta(q_i - q) + \epsilon_i \quad (4.2)
\]

The relative indirect demand function for the jurisdiction’s output is decreasing in its relative price. \( \epsilon_i \) stands for the shock to relative demand. To the extent that jurisdictional economies are specialized, shifts in relative productivity and in relative demand are likely to contain a permanent component. \( \theta_i \) and \( \epsilon_i \) are therefore assumed to be both nonstationary.

The assumption that each jurisdiction produces a single good, or even a basket of goods, different from that of other jurisdictions seems very strong. While it is true that, at any point in time, there is substantial specialization across jurisdictions in the production of goods\(^3\), in the long run increasing returns may play a homogenizing role. The question is whether this complex situation is better approximated by the above assumption, or by the
opposite assumption that $\theta_i$ and $\varepsilon_i$ are stationary. Stationarity of the error terms implies that, by changing the basket of goods they produce, jurisdictions can avoid the permanent effects of changes in relative demand and technological progress. Economic reality suggests that countries are better at changing their basket of goods over time than regions or jurisdictions (Blanchard and Katz, 1992). Nations that grow fast do not experience steady decreases in their terms of trade, as it would likely be the case if they sold an unchanging basket of outputs (Krugman, 1989). Conversely, the failure to industrialize the South of Italy between the 1950s and the 1970s and the permanence of productive traditions in Italian provinces support the assumption of nonstationarity in $\theta_i$ and $\varepsilon_i$. Similarly, the struggle of the economy of Michigan to reconvert its output during the crisis of the automobile industry is another example of the plausibility of this assumption. As we shall see, the empirical tests of chapter 5 indirectly confirm that the assumption of nonstationarity is in fact the most realistic one.

In the model, labor and capital mobility are given by:

\[
(l_{i,t+1} - l_{i,t}) = (l_{i,t} - l_{i,t}) + \lambda[(w_{it} - w_{it}) - \eta(\theta_{it} - \theta_{it-1})] \
(4.3)
\]

\[
(k_{i,t+1} - k_{i,t}) = (k_{i,t} - k_{i,t}) + \gamma[(r_{it} - r_{it}) - \phi(\theta_{it} - \theta_{it-1})] \
(4.4)
\]

where $w$ and $r$ stand for the logarithms of wages and rates of return on investments. $w$ and $r$ are assumed to be equal to the value the marginal products of labor and capital; both labor and capital markets are competitive in all jurisdictions. Again, allowing for market power in the labor market would have increased the similarities with the model of chapter 3, but at the cost of much greater complexity.

In this model, factors are fixed within the period. Short-run (one period) elasticities of labor and capital with respect to wage and rate of return differentials are given by $\gamma$ and $\lambda$, respectively. An implicit assumption is that people have the same consumption across states. Relaxing this assumption or allowing for state specific amenities to enter the labor mobility equation is straightforward but outside the scope of the present analysis.

The parameter $\eta \geq 0$ in equation (4.3) is a factor that measures the elasticity of labor with respect to relative tax rates on wages $\theta$; similarly, $\phi \geq 0$ in equation (4.4) weights the elasticity of capital with respect to relative tax rates on rates of return on investments, $r$. The $(\theta_{it} - \theta_{it-1})$ and $(\sigma_{it} - \sigma_{it-1})$ terms measure jurisdiction $i$'s relative tax rates on wages and rates of return on investments. If relative tax rates are exactly proportional to relative wages and rates of return, both $(\theta_{it} - \theta_{it-1})$ and $(\sigma_{it} - \sigma_{it})$ are equal to zero. After-tax differences in wages and rates of return are identical to their pre-tax
differences, the case illustrated in Graph 1a for taxation on labor incomes (taxation on capital would yield the same diagram). Interjurisdictional (or “geographic”) proportionality in the tax structure is thus neutral with respect to labor and capital migration and, as we shall see more precisely later on, to jurisdictional income convergence. If, instead, the interjurisdictional tax structure is geographically progressive, relative tax rates increase more than proportionately with respect to relative wages and rates of return. In this case \((\vartheta w_u - \vartheta w_l) > 0\) and \((\pi_u - \pi_l) > 0\). A geographically progressive tax regime means that relative after-tax wages and rates of return are less than their pre-tax values (Graph 1b). Finally, under a regressive inter-jurisdictional tax regime, \((\vartheta w_u - \vartheta w_l) < 0\), and \((\pi_u - \pi_l) < 0\), and interjurisdictional tax regressivity amplifies the differences between pre- and after-tax wages and rates of return (Graph 1c).

Graph 1a. Geographically proportional redistribution

\[
(\vartheta w_u - \vartheta w_l)
\]
In this framework, taxes on wages and returns on investments are used to finance interjurisdictional income redistribution. Here we can equivalently assume the presence of a central fiscal authority that orchestrates interjurisdictional redistribution, or a decentralized process such as the one described in chapter 3. Whatever the case, the budget of the interjurisdictional taxation and spending programs is balanced in every period:

\[ (\partial w_g - \partial w_j) \]

[Graph 1b. Geographically progressive redistribution]
Graph 1c. Geographically regressive redistribution

\[
(s_i - s_j) = (\partial w_i - \partial w_j) + (\sigma_i - \sigma_j)
\]

In equation (4.5) \(s_i\) denotes the log of central government’s expenditures (income transfers and public investments) in jurisdiction \(i\) and \(s_j\) again indicates the national geometric average of the \(n\) spending programs \(s_i\).

To better illustrate the effects of inter-jurisdictional income redistribution on the dynamics of relative jurisdictional income levels, we begin by examining two polar cases: the first, when labor is immobile; the second, when capital is immobile. We then move to the case of full factor mobility.
Effects of interjurisdictional redistribution on capital mobility - KMLI

The first case assumes that labor is immobile ($\lambda = 0$) and identically distributed across jurisdictions ($l_a - l_i = 0$). As such, and with the proviso discussed in the introduction, it resembles the KMLI case of section 4 in chapter 3. Here the nominal values of jurisdictional and national per capita incomes are represented by:

\[ x_a + s_a = q_a + p_a - l_a \]  \hspace{1cm} (4.6)
\[ s_i + s_t = q_i + p_i - l_i \]  \hspace{1cm} (4.7)

where $x_a$ and $x_t$ are, respectively, jurisdictional and national incomes net of government transfers, $s_a$ and $s_t$. Let: $y_a = x_a + s_a$ and $y_t = x_t + s_t$ be the jurisdictional and national incomes after government redistribution. The behavior of relative jurisdictional income from period $t-1$ to period $t$ is obtained by subtracting equation (4.7) from equation (4.6) and substituting the relationships from equations (4.1) through (4.5) for recursive periods. The resulting expression (equation (4.8)) shows the increase (or decrease) in jurisdiction $i$’s relative income:

\[ (y_a - y_t) = (1 - \beta)(y_{a,t-1} - y_{t-1,t}) + \xi_a \]  \hspace{1cm} (4.8)

The $(y_a - y_t)$ term is negatively related to the $(y_{a,t-1} - y_{t-1,t})$ term and decreases for $|\beta| > 0$. Jurisdictional incomes converge to a common value more rapidly the larger the (positive) value of $|\beta|$. A positive $\beta$ indicates the negative correlation between income levels and rates of growth that Barro and Sala-i-Martin (1995) term "$\beta$ convergence".

The convergence coefficient $\beta$ can be expressed in terms of the value marginal product, the elasticity of capital and the inter-jurisdictional capital tax structure:

\[ \beta = \gamma(1 - (1 - \alpha)(1 - \delta)[1 - \phi(s_{a,t-1} - s_{t-1,t})]) \]  \hspace{1cm} (4.9)

Equation (4.8) shows that relative output follows a first order process with forcing term $\xi_a$:

\[ \xi_a = [(1 - \delta)\theta_a + \epsilon_a] - (1 - \gamma)[(1 - \delta)\theta_a + \epsilon_a] \]  \hspace{1cm} (4.10)

To capture the effects of inter-jurisdictional redistribution on jurisdictional income convergence, consider equation (4.9) and suppose, as a benchmark,
that taxes on rates of return from capital are geographically proportional: 
\((\pi_n - \pi_r) = 0\). In this case, the expression in equation \((4.9)\) reduces to

\[
\beta = \gamma(1 - (1 - \alpha)(1 - \delta))
\]

This indicates that the process of income convergence is driven solely by the equilibration of differences in returns on capital, the standard neoclassical tenet. The same reduced form expression for equation \((4.9)\) holds if investors are indifferent to taxes, or perhaps uninformed about the relative tax structure \((\phi = 0)\).

If relative tax rates are not proportional, the convergence process is augmented by the expression \(\phi(\pi_n - \pi_r)\). Positive values of \(\phi(\pi_n - \pi_r)\) mean that relative after-tax earnings between rich and poor jurisdictions are smaller in value than relative pre-tax rates of return; consequently, productivity differences exceed relative after-tax earnings. Increasing inter-jurisdictional tax progressivity further widens the spread between relative productivities and relative after-tax rates of return and this impedes the process of income convergence. In terms of the model, \(\phi(\pi_{n-1} - \pi_{r-1}) > 0\) reduces the value of \(\beta\) in equation \((4.8)\) and results in slower income convergence than in the case of a geographically proportional capital tax structure. Intuitively, progressive capital taxation impedes the flow of capital in the direction of poor jurisdictions, because relative after-tax rates of return are less than relative productivity differences.

The central government can also use \((s_n - s_r)\), relative public expenditures, to alter differences between pre-tax and after-tax rates of return. If the legislated inter-jurisdictional tax rates on capital are proportional and levied on investments returns net of government transfers or subsidies \(r_n\), spending programs that make \(\frac{\partial (s_n - s_r)}{\partial (r_n - r_r)} < 0\), namely relatively more transfers directed to jurisdictions with lower than average rates of return on capital, produces the same effects on capital mobility and convergence as a progressive inter-jurisdictional tax structure; the process is slowed down and may be even reversed for large enough values of \(\frac{\partial (s_n - s_r)}{\partial (r_n - r_r)} < 0\).

Note that this case is actually similar to the equilibrium configurations of the \(KMLI\) case in section 3 of chapter 3. Although voters there decide for an equal tax rate in both jurisdictions - thereby making the interjurisdictional tax structure proportional - the asymmetry in the provisions of the spending programs are such that more is spent in region \(S\), where capital has a lower rate of return. This is precisely the case described by the condition \(\frac{\partial (s_n - s_r)}{\partial (r_n - r_r)} < 0\) above. In the model of chapter 3 the \(KMLI\)
configurations were characterized by the creation of an income differential between $S$ and $N$ in favor of the latter. Likewise, in the present context \( \frac{\partial (s_a - s_i)}{\partial (r_a - r_i)} < 0 \) slows down, if not reverse, the convergence of jurisdictions’ income.

A geographically regressive tax structure, in contrast, means that relative after-tax rates of return are larger in value than pre-tax rates of return and that differences in after-tax rates of return exceed differences in productivity. If relative tax rates are regressive \( \phi(\tau_a - \tau_i) < 0 \), then capital migration from low to high income jurisdictions is encouraged. \( \phi(\tau_a - \tau_i) < 0 \) thereby amplifies the effects of differences in the pre-tax rate of return. \( \beta \) is higher under a regressive capital tax structure compared to a proportional structure, which means that relative income differences decline between the two periods. The intuition is straightforward. Relative rates of return on capital are high in high wage, high income jurisdictions. A geographically regressive tax structure is analytically equivalent to a subsidy for investments in relatively poor jurisdictions, which then become even more attractive to investors than rich jurisdictions. The same results of inter-jurisdictional tax regressivity are obtained by a geographically proportional tax structure on pre-subsidy returns on capital and a government expenditure scheme that makes \( \frac{\partial (s_a - s_i)}{\partial (r_a - r_i)} > 0 \). Such a scheme involves transfers mainly directed at jurisdictions with rates of return to capital above the national average.

Interestingly, the case of geographically regressive tax structures or spending programs do not emerge as a voting equilibrium, a fact broadly consistent with economic reality. This circumstance further reinforces the plausibility of the results from the static model of chapter 3.

Larger values of \( \phi \) reflect an increasing disutility from tax payments, speeding up convergence in a regressive tax regime and slowing down convergence in a progressive regime.

Effects of inter-jurisdictional redistribution on labor mobility – KILM

Assume now that capital is immobile \( (\gamma = 0) \) and identically distributed across jurisdictions \( (k_a - k_i) = 0 \). This configuration matches that of KILM discussed in section 5 of chapter 3. Following the same procedure and solving for the effect of labor mobility on changes in relative jurisdictional incomes, we obtain:
where, in this case:

$$\beta = \lambda[1 - \alpha(1 - \delta)(1 - \eta)(\varpi_{\nu_{a-1}} - \varpi_{\nu_{a-1}})]$$

(4.12)

and

$$\zeta_a = [(1 - \delta)\theta_a + \epsilon_a] - [(1 - \delta)\theta_{a-1} + \epsilon_{a-1}]$$

(4.13)

In the case when taxes are geographically proportional, the expression in equation (4.12) reduces to

$$\beta = \lambda[1 - \alpha(1 - \delta)]$$

and the income convergence process is driven solely by the equilibration of wage differences. The same reduced form expression for equation (4.12) holds if workers are indifferent to taxes, or perhaps uninformed of the relative tax structure ($\eta$ is zero).

If relative tax rates are not proportional, the convergence process is augmented by the expression $\eta(\varpi_{\nu_{a}} - \varpi_{\nu_{a}})$. If $\eta(\varpi_{\nu_{a}} - \varpi_{\nu_{a}}) > 0$ relative after-tax earnings between rich and poor jurisdictions are narrower than relative pre-tax earnings and, more importantly, productivity differences exceed relative after-tax earnings. Increasing interjurisdictional tax progressivity thus further widens the spread between relative productivities and relative after-tax earnings, and this again impedes the process of income convergence. Again a government policy of subsidization of relatively low wage jurisdictions, such that $\frac{\partial}{\partial (w - w)} < 0$, produces results equivalent to inter-jurisdictional tax progressivity on wages.

This is the case that most closely resembles the KILM equilibrium configurations of chapter 3. The conclusion of a widening gap between jurisdictions described here is consistent with the negative impact of interjurisdictional redistribution on the output of region $S$ described in section 5 of chapter 3.

A regressive tax structure, instead, means that relative after-tax earnings are wider than pre-tax earnings and that after-tax wage differences exceed productivity differences. In this case labor migration from low to high income jurisdictions is encouraged and convergence accelerated. This may occur also if $\frac{\partial}{\partial (w - w)} > 0$, i.e., if subsidies are directed towards jurisdictions whose wages are lower than the national average.
Larger values of $\eta$ reflect an increasing disutility from tax payments, speeding up convergence in a regressive tax regime and slowing down convergence in a progressive regime.

**Convergence under capital mobility**

The analysis conducted so far shows that the dynamics of jurisdictional income dispersion is conditional on the values of the factor return parameters, as well as on the alternative tax structure and redistributive regimes. We now consider the connection between factor returns and interjurisdictional redistribution more in detail.

Equations (4.8) and (4.12) can be rearranged to give the growth rate of jurisdiction $i$ for a given $t$:

$$ (y_i - y_{i-1}) = (y_t - y_{t-1}) - \beta(y_{i-1} - y_{t-1}) + \zeta_t $$

(4.14)

The growth rate of income in jurisdiction $i$ depends on the national income growth rate, on the difference between the lagged jurisdictional and national income levels, and on an error term.

The average growth rate of income in jurisdiction $i$ at time $t$ is derived by rearranging equation (4.14) and solving recursively from time 0 to time $T$, the end year of the time series:

$$ \left(\frac{1}{T}\right)(y_{it} - y_{it-1}) = \left(\frac{1}{T}\right)(y_t - y_0) - \left(\frac{1}{T}\right)[1 - (1 - \beta)^T](y_0 - y_t) + \psi_{it} $$

(4.15)

where:

$$ \psi_{it} = \left(\frac{1}{T}\right)[\zeta_{it} + (1 - \beta)\zeta_{it-1} + \ldots + (1 - \beta)^{T-1}\zeta_{0}] $$

(4.16)

The average growth rate in jurisdiction $i$ over $T$ periods depends on the national average growth rate, on the initial difference between the jurisdiction’s and the nation’s income level and on an error term. This, in turn, depends on the value of the shocks between time 0 and $T$, as shown in equation (4.16).

In order to see under what conditions convergence occurs, suppose again first that labor is immobile ($\lambda = 0$) and the tax structure neutral with respect to jurisdictional income dynamics ($\phi = 0$ or $(\tau_d - \tau_i) = 0$). As equation (4.9) shows, the economy will exhibit “$\beta$ convergence” ($|\beta| > 0$) as long as either $\alpha$, the rate of return parameter, or $\delta$, the slope of the demand...
curve for the good produced in jurisdiction \( i \), are positive. Thus, even if jurisdictions exhibit constant returns to capital, (\( \alpha = 0 \)), \( \beta \) convergence will hold as long as they do not face a perfectly elastic demand for their product. As in Blanchard (1991), this implies that \( \beta \) convergence does not reveal much about the characterization of the crucial technological parameter in endogenous growth models, namely, the returns to scale to adjustable factors.

The analysis of this chapter also shows that, even when \( |\beta| > 0 \), if the jurisdiction-specific shocks to technology \( \theta_i \) and relative demand \( \varepsilon_i \) are nonstationary, the outputs per capita of the various jurisdictions will eventually diverge far from each other. In this case, \( \sigma \) (or “true”) convergence does not occur even if \( \beta \) convergence does. Technically, this is caused by the fact that in equation (4.8) the error term is the sum of nonstationary processes and is itself nonstationary, as equation (4.10) shows. Consequently, jurisdictional output per capita is also nonstationary. The intuition behind this result is straightforward: in a world of jurisdiction-specific shocks and no labor mobility, the movement of capital will amplify the effects of the shocks on output per capita, by flowing to the jurisdictions that are experiencing positive shocks. Such an outflow of capital will increase the gap between low income and high income jurisdictions.

Relaxing the tax structure neutrality hypothesis changes this conclusion. Even if \( \gamma[1-(1-\alpha)(1-\delta)] > 0 \), \( \beta \) can be positive for a sufficiently large \( \phi > 0 \) and \( (\sigma_i - \sigma_j) < 0 \) or \( \frac{\partial(s_i - s_j)}{\partial(r_i - r_j)} > 0 \) values; in other words, a sufficiently regressive inter-jurisdictional capital tax structure or expenditure program results in income convergence even if capital is subject to constant or increasing returns to scale. Conversely, a sufficiently progressive inter-jurisdictional tax regime or expenditure program (\( \phi > 0 \) and \( (\sigma_i - \sigma_j) > 0 \) or \( \frac{\partial(s_i - s_j)}{\partial(r_i - r_j)} < 0 \) ) can result in income divergence (or simply non convergence) even though \( \gamma[1-(1-\alpha)(1-\delta)] < 0 \), namely, even when capital is subject to diminishing returns to scale. This is precisely what the equilibrium condition of the KML configuration in chapter 3 predicts.

Convergence under labor mobility

In this case, period-by-period and average jurisdictional income convergence are defined as in equations (4.14) and (4.15), the disturbance term as in equation (4.13) and the convergence coefficient as in equation (4.12). Aside from state intervention, this economy will exhibit convergence as long as either \( \alpha < 1 \) or \( \delta > 0 \). Once more, convergence may hold even if the
technology exhibits constant returns to the adjustable factor, in this case labor.

Yet, differently from the case of capital mobility, this economy will exhibit convergence even when the shocks to technology and demand have a permanent component. Because of the stochastic nature of the shocks, the jurisdictions do not converge to the same value of income per capita; the economy, instead, eventually settles onto a stochastic steady state with a stable distribution of output per capita across jurisdictions. Technically, this happens because in equation (4.13) the shocks $\theta$ and $\epsilon$ enter as first differences, so that, even when they are not stationary, the error $\zeta_{it}$ in equation (4.13) and, by implication, relative jurisdictional income per capita are stationary. In other words, just like the movement of capital in paragraph 5, labor relocation amplifies the effects of the shocks on total output by moving to the jurisdictions that are experiencing positive shocks. Yet, because of decreasing returns to labor, the movement of labor into those jurisdictions decreases the effects of the shocks on output per capita. In response to a shock, labor moves in until wages are again equalized. At that point, outputs per capita are also equalized.

Should the tax structure be non-neutral, a sufficiently regressive interjurisdictional tax regime or expenditure program ($\eta > 0$ and $(\sigma_n - \sigma_l) < 0$ or $\frac{\partial (s_n - s_l)}{\partial (w_n - w_l)} > 0$) can force convergence even when the marginal productivity of labor is constant or increasing, namely, when $\lambda[(1 - \alpha)(1 - \delta)] > 0$. Conversely, income levels may diverge (or simply remain stable) when the value marginal product of labor is diminishing ($\lambda[(1 - \alpha)(1 - \delta)] < 0$) but the inter-jurisdictional tax structure or the expenditure program is sufficiently progressive ($\eta > 0$ and $(\sigma_n - \sigma_l) > 0$ or $\frac{\partial (s_n - s_l)}{\partial (w_n - w_l)} < 0$).

Again, this is the prediction of the KILM configurations in chapter 3. Interestingly, that result was obtained under the assumption of diminishing marginal returns to labor, the situation that this convergence model provides as an endogenous result.

Convergence under full factor mobility - KMLM

The solution for the case when both labor and capital are mobile and unevenly distributed is much more complicated, as the equation for motion of output and the associated process followed by the disturbance term depend on the relative size of the parameters $\lambda$ and $\gamma$, that is, on the relative sensitivity of labor and capital to differences in the wages and rates of return. The size of $\lambda$
and $\gamma$, of course, includes also the sensitivity parameters of labor and capital to tax differentials across jurisdictions, $\eta$ and $\phi$, respectively. This, in turn, further increases the complexity of the analysis.

To characterize the equation of motion in a tractable form we must introduce the hypothesis that the factors of production have the same sensitivity to interjurisdictional differences in net wages and rates of return, i.e., they are equally mobile. Suppose, without loss of generality, that $\lambda = \gamma = 1$; the equation of motion then is

$$
(y_i - y_j) = (\eta_i - \eta_j) + (1 - \beta)(y_{i-1} - y_{j-1}) + \xi_i
$$

where

$$
\xi_i = [\xi_i + (1 - \beta)\xi_{i-1} + \ldots + (1 - \beta)^{i-1} \xi_{i-1}]
$$

The disturbance term $\xi_i$ in (4.18) is the sum, for recursive periods, of the $\xi_i$ specified in (4.10) and (4.13), i.e., for the special cases of capital mobility and labor mobility only. This implies that, in the cases of full factor mobility, an economy is likely to exhibit $\beta$ convergence. Again, the evidence of $\beta$ convergence does not reveal the characteristics of the underlying technology; factors of production may exhibit non-decreasing returns to scale and still produce convergence. The dynamic effects of shocks on each jurisdiction’s output per capita will be amplified by capital mobility and dampened by labor mobility. The presence of labor mobility, however, eventually leads to convergence and to a stable distribution of jurisdiction output per capita.

Yet convergence comes to an halt or may be reversed to divergence if the interjurisdictional tax structure is sufficiently regressive and

$$
\frac{\partial (s_{u} - s_{l})}{\partial (w_{u} - w_{l})} \text{ and } \frac{\partial (s_{u} - s_{l})}{\partial (r_{u} - r_{l})}
$$

negative enough to upset the effects of diminishing returns to labor, as shown in sections 5 and 6. Likewise, an interjurisdictional regressive tax structure and public transfer schemes that make

$$
\frac{\partial (s_{u} - s_{l})}{\partial (w_{u} - w_{l})} \text{ and } \frac{\partial (s_{u} - s_{l})}{\partial (r_{u} - r_{l})}
$$

positive accelerate the convergence process.

The voting equilibria of the KMLM case in chapter 3, however, show that there is no incentive to depart from a fiscal policy that is proportional across jurisdictions. This is in turn consistent with the widespread evidence that jurisdictions’ incomes converge when factors are mobile.
How to test for convergence

The analysis of the relative economic performances of a set of jurisdictions belonging to the same economy shows that, once we relax the tight assumptions of the neoclassical model about homogeneity of production across jurisdictions and diminishing returns to mobile factors of production, a rich set of phenomena appears to determine the evolution of such performances. In this respect, the model leads to two sets of conclusions. A first set consists of implications related to the structure of the economy. A second set includes predictions stemming from the structure of interjurisdictional redistribution.

As for the structure of the economy, the model shows that factor mobility per se does not necessarily produce the convergence of jurisdiction incomes to a unique value. At any point in time, even though $|\beta| > 0$, jurisdiction-specific demand or technology shocks may thwart the convergence process. Especially in the case where capital is more mobile than labor, shocks may prevent the dispersion across jurisdictions’ incomes from going below a strictly positive value. Hence, $\beta$ convergence, a negative correlation between initial income levels and average growth rates, does not necessarily imply $\sigma$ convergence, an actual reduction of the dispersion of jurisdictions’ incomes per capita.

As for the effects of fiscal policy, this model shows that interjurisdictional income redistribution plays a potentially important role. Convergence can be forced in an otherwise nonconvex economy if the interregional tax structure is sufficiently regressive and/or the spending programs target relatively high income jurisdictions. Conversely, the dispersion of incomes across jurisdictions may increase if the tax structure is geographically progressive enough or spending programs target relatively low-income jurisdictions.

Both sets of conclusions must be taken into account in testing for interjurisdictional income convergence. Beginning with the conclusions related to the structure of the economy, it is necessary to control for the dynamics of regional income dispersion at every period of the sampled time series and not just regress the regional income average growth rates on initial income levels, as it is generally done to find $\sigma$ convergence. Moreover, the analysis of $\sigma$ convergence must be related to the equations that characterize the structure of the economy described in the previous sections; a temporal diagram of the evolution of the variances of jurisdictional incomes simply will not do. The point is that the test of $\sigma$ convergence must convey information about the returns to scale of the adjustable factors, which the tests of $\beta$ convergence do not provide.

The model suggests a simple means to do so. If there is really $\sigma$ convergence, then, controlling for initial levels, average rates of growth of regional incomes should become more similar as they are computed over
longer periods of time. To implement this idea, consider the cross-section version of equation (4.15):

\[
\left(\frac{1}{T}\right)(y_{iT} - y_{0}) = \left(\frac{1}{T}\right)(y_{T} - y_{0}) + \left(\frac{1}{T}\right)[1-(1-\beta)^{T}] \lambda(y_{0} - y_{0}) + \psi_{T}
\]

The T-period regional growth rate depends on a constant and on their initial levels. The disturbance term, as shown in equation (4.16), is a weighted sum, with decreasing weights, of current and past \( \zeta_{it} \). These are, in turn, linear combinations of the underlying demand and production shocks. For the economy to exhibit convergence, the \( \zeta_{it} \) must be stationary; this was the case in section 7 under the assumption of labor mobility and a neutral or regressive inter-jurisdictional tax structure. But, if the \( \zeta_{it} \) are indeed stationary, the estimated standard error of the regression, \( \sigma(T) \), should go to zero as we increase \( T \). In other words, controlling for initial conditions, the average annual regional output growth rates over \( T \) periods should converge to the same value. If, instead, the \( \zeta_{it} \) are nonstationary, \( \sigma(T) \) should instead converge to a strictly positive value. This was the case of when only capital was allowed to relocate and the fiscal policy was neutral or progressive with respect to jurisdictions' incomes.

It appears therefore crucial to control for the effects of the structure of fiscal policy – its proportionality, progressivity or regressivity across jurisdictions - on the process of convergence. That allows us to: a) identify the relationship between the evolution of the relative economic performances of jurisdictions incomes and changes in the interjurisdictional differences of tax structures and spending programs; b) set a ceteris paribus condition necessary to detect the characteristics of the returns to scale to the mobile factor.

To this end, we introduce the “Index of Geographical Redistribution” (IGR). The IGR is the estimated coefficient of the following cross-section regression:

\[
\left(\frac{Y_{i} - Y_{disp}}{Y_{i}}\right) = C + IGR(Y_{i}) + \mu_{i}
\]

where \( Y_{i} \) is real per capita income in region \( i \) and \( Y_{disp} \) is real per capita disposable income in jurisdiction \( i \). The dependent variable is a proxy for jurisdiction \( i \)'s average effective tax rate, because the difference between total and disposable income approximates tax revenues. The IGR coefficient then measures the change of the average tax rate across jurisdictions due to a change in per capita income – the tax base - across jurisdictions. As such, it represents the effective marginal geographical tax rate. A geographically proportional tax regime, one in which tax rates are constant with respect to income, would yield an IGR coefficient equal to zero. That would be the case
illustrated in Graph 1a. The average geographical tax rate, short of measurement errors captured by $\mu$, would then be equal to $C$, the intercept in equation (4.20). Positive values of IGR reflect a geographically progressive tax regime (Graph 1b), with larger values indicating increasing degrees of progressivity. Moving from low to high income jurisdictions (tax bases) increases the tax pressure more than proportionally. Finally, negative values for IGR indicate a geographically regressive tax regime (Graph 1c).

The expressions representing interjurisdictional redistribution in the model distinguish tax rates on labor and capital, as well as taxation from public spending. The IGR presented in equation (4.20), instead, is a highly aggregated measure. The lack of data on rates of return on investments disaggregated by jurisdictions, as well as problems in the imputation of mobile tax bases to different jurisdictions, to be discussed in chapter 5, make it generally impossible to calculate an IGR for capital and labor separately, as the model of this chapter would have required. There are both disadvantages and advantages in this situation. The disadvantage of aggregating the incidence of taxes on capital and on labor is that the structure of taxes on labor might be progressive, while taxes on capital might be regressive. In that case the predicted effects on factor mobility and income convergence run in opposite directions. The IGR on overall income (wages plus investment returns) measures the net effect of various degrees of proportionality across types of taxation and spending programs and, consequently, the net effect on capital and labor. On the other hand, the high aggregation of the IGR metric has the desirable property of combining the expenditure and the taxation side of public intervention. While the $(Y_i - Y_{disp})$ term measures regional fiscal levy, the $Y_i$ variable includes state spending in the jurisdiction (both transfers and capital expenditures) and interest payments on public debt. The $Y_{disp}$ term takes into account changes in the effective tax base due to tax deductions.

Concluding remarks

The analysis developed in this chapter shows that interjurisdictional redistribution and, in particular, the interjurisdictional proportionality of both taxation and spending programs influence the evolution of jurisdictional incomes by driving a wedge between the relative rates of return on capital and labor before and after redistribution. An interjurisdictional regressive fiscal policy favors income convergence, while an interjurisdictional progressive redistribution retards it. These results hold independently of decreasing or increasing returns to scale of the mobile factors and of locational externalities that may also affect the process of income convergence. Such a conclusion undermines the explanation of interjurisdictional income convergence offered by the neoclassical growth theory, which relied solely on the equalizing role
of diminishing returns to the adjustable factors. As the interjurisdictional redistribution of incomes becomes more progressive and the differences between relative wages and rates of return on capital before and after redistribution narrow, the incentives for factor relocation decrease to the point of vanishing, however diminishing the returns of scale of the mobile factors are. Conversely, under a sufficiently regressive redistribution process, the divergence path on which increasing returns to scale may set the relative incomes of the jurisdiction may be reversed. Fiscal policy plays an important role in shaping the evolution of the relative incomes of jurisdictions.

Once we account for the differences in the assumptions between this model and the static one of chapter 3, we find that the conclusion reached in chapter 3 in the context of a comparison of steady state equilibria can be generalized to the transitional dynamics towards the steady state equilibrium considered in the present chapter. Both models offer similar characterizations of factor mobility and fiscal policy instruments, and reach broadly similar results. If anything, the analysis of the chapter 3 allows us to restrict the set of policy measures considered in the present chapter that are compatible with a voting equilibrium.

Finally, the identification of the channels through which interjurisdictional redistribution affects the determinants of income convergence allows us to specify a more appropriate regression equation to test for convergence and to characterize an indicator of the effects of fiscal policy on the convergence process, called the “Index of Geographical Redistribution”. This conceptual structure will be put to use to obtain empirical estimates in chapter 5.
Table 3.1. List and explanation of the variables

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$q$</td>
<td>Quantity of good produced in each jurisdiction (log)</td>
</tr>
<tr>
<td>$i$</td>
<td>Index of jurisdictions</td>
</tr>
<tr>
<td>$n$</td>
<td>Number of jurisdictions</td>
</tr>
<tr>
<td>$t$</td>
<td>Time index (year)</td>
</tr>
<tr>
<td>$T$</td>
<td>Total time in sample period</td>
</tr>
<tr>
<td>$l$</td>
<td>Labor (log)</td>
</tr>
<tr>
<td>$k$</td>
<td>Capital (log)</td>
</tr>
<tr>
<td>$l\alpha$</td>
<td>Labor share</td>
</tr>
<tr>
<td>$1-\alpha$</td>
<td>Capital share</td>
</tr>
<tr>
<td>$\theta$</td>
<td>(Relative) technological shock</td>
</tr>
<tr>
<td>$p$</td>
<td>Price of good produced in each jurisdiction (log)</td>
</tr>
<tr>
<td>$\delta$</td>
<td>Demand slope parameter</td>
</tr>
<tr>
<td>$e$</td>
<td>(Relative) demand shock</td>
</tr>
<tr>
<td>$w$</td>
<td>Wage (log)</td>
</tr>
<tr>
<td>$r$</td>
<td>Rate of return on capital (log)</td>
</tr>
<tr>
<td>$\theta$</td>
<td>Tax rate on labor</td>
</tr>
<tr>
<td>$\tau$</td>
<td>Tax rate on capital</td>
</tr>
<tr>
<td>$\lambda$</td>
<td>Labor’s one period elasticity to wage differentials</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>Capital’s one period elasticity to rate of return differentials</td>
</tr>
<tr>
<td>$\eta$</td>
<td>Labor’s one period elasticity to relative taxes on wages</td>
</tr>
<tr>
<td>$\phi$</td>
<td>Capital’s one period elasticity to relative tax rates on rates of return</td>
</tr>
<tr>
<td>$x$</td>
<td>Income net of government transfers</td>
</tr>
<tr>
<td>$y$</td>
<td>Income gross of government transfers</td>
</tr>
<tr>
<td>$\beta$</td>
<td>$\beta$ convergence parameter</td>
</tr>
<tr>
<td>$\zeta$</td>
<td>Shock to the process of $\beta$ convergence</td>
</tr>
<tr>
<td>$\xi$</td>
<td>Shock to the growth rate of income</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>$\sigma$ or “true” convergence parameter</td>
</tr>
<tr>
<td>$\psi$</td>
<td>Shock to the process of $\sigma$ convergence</td>
</tr>
<tr>
<td>$Y$</td>
<td>Total income in each jurisdiction (gross of public spending)</td>
</tr>
<tr>
<td>$Y_{disp}$</td>
<td>Disposable income (net of tax revenues)</td>
</tr>
<tr>
<td>$C$</td>
<td>Intercept</td>
</tr>
<tr>
<td>$IGR$</td>
<td>Index of Geographical Redistribution</td>
</tr>
<tr>
<td>$\mu$</td>
<td>Error in estimates of $IGR$</td>
</tr>
</tbody>
</table>
1 Admittedly, a unified theory that endogenizes the selection of the redistributive programs and their effects on the determinants of the convergence of jurisdictional incomes towards their long run equilibrium would be a more elegant theoretical structure, but this is as far as we can go.

2 Whether assuming specialized jurisdictional economies is realistic is an empirical issue whose theoretical implications will be discussed later on.

3 Krugman (1991) estimates the Gini coefficients of sectorial dispersion for the 50 U.S. states and shows that they differ considerably in their composition of production.

4 See Blanchard and Katz (1992) for such an exercise.

5 Allowing jurisdictions to borrow and the budget to be balanced in the long run would only complicate the analysis without providing new insights.

6 See Blanchard (1991) on this point.