Margani, Patrizia; Ricciuti, Roberto

Conference Paper

Further Evidence on Convergence across Italian Regions

41st Congress of the European Regional Science Association: "European Regional Development Issues in the New Millennium and their Impact on Economic Policy", 29 August - 1 September 2001, Zagreb, Croatia

Provided in Cooperation with:
European Regional Science Association (ERSA)

Suggested Citation: Margani, Patrizia; Ricciuti, Roberto (2001) : Further Evidence on Convergence across Italian Regions, 41st Congress of the European Regional Science Association: "European Regional Development Issues in the New Millennium and their Impact on Economic Policy", 29 August - 1 September 2001, Zagreb, Croatia, European Regional Science Association (ERSA), Louvain-la-Neuve

This Version is available at:
https://hdl.handle.net/10419/115208

41ST CONGRESS OF THE EUROPEAN REGIONAL SCIENCE ASSOCIATION

FURTHER EVIDENCE ON CONVERGENCE ACROSS ITALIAN REGIONS

Patrizia MARGANI[1] e Roberto RICCIUTI[2]

1 ICE, Ufficio Studi, Statistica e Documentazione, Via Liszt 21, 00144 Roma.

2 Dipartimento di Economia Politica, Università di Siena, Piazza S. Francesco 7, 53100 Siena.

E-mail:ricciuti@econ-pol.unisi.it

ABSTRACT

In the last decade the issue of convergence across states and regions has received a great deal of attention both on the theoretical and empirical ground. It is often argued that exogenous growth theory would predict convergence, while new growth theory would predict divergence. These consequences are misleading since we need some more specifications on the characteristics of the convergence process. On the empirical ground, different estimated specifications lead to different results and the robustness of the results is also questioned.

Convergence across Italian regions has been mainly studied using regression tools. In this paper we use a methodology that enhances the power of the estimates, based on common trends and Monte Carlo simulations. Data cover the period 1951-1998 and we also split the database in two subperiods, 1951-1973 and 1974-1998. We find evidence of overall conditional convergence and absolute convergence for the first subperiod and divergence for the second subperiod.

1 Introduction

Why do growth rates differ across countries and across regions? During the last ten years, there has been an explosion of research on economic growth and on the forces that lead to economic convergence. Indeed, the convergence issue has become one of the most relevant battlefield in which "old" and "new" theories of growth contrast each other.

The convergence debate has taken place at different scale: most studies have analysed this issue at the world level, taking into considerations some collections of countries, other works have studied the convergence process at the regional level of a sample of connected countries. Finally, other studies have considered the theme at the national level. In this paper we follow the former approach. We start from the consideration that cross-sectional studies do not take advantage of all the variance of the data, this results in a waste of information that may be useful for a deeper understanding of the growth pattern of a collection of countries/regions. Furthermore, an increasing literature has pointed out that cross-sectional studies do not take into account correlated individual effects and endogenous explanatory variables, and rely on the rather unrealistic assumption that the economies have identical first-order auto-regressive dynamic structures and all permanent cross-economy differences are completed controlled for. Apart from a considerable gain in power, the econometric approach used here encompasses in a single framework all the possible process that can take place (absolute and conditional convergence, and divergence).

We analyse convergence across Italian regions for the period 1951-1998, using the largest database used up to now. There is an overall consensus that convergence has taken place in this period, and that if we split this span in two subperiods (divided by the oil crisis in the early '70s) absolute convergence occurred in the first one. The second subperiod is often seen as a span of time in which an increase in the divide between the North and the South has occurred. However, the results are inconclusive, since much conditional convergence has been detected and substantial manipulation of the data and the inclusion of new and *ad hoc* variables are needed to obtain divergence. In contrast, in this paper we use a general framework that is able to discriminate between absolute and conditional convergence on the one hand, and divergence on the other hand.

The paper is organised as follows: in the sections 2 and 3 the theoretical issues concerning convergence in both old and new growth theories are analysed. In section 4 the empirical evidence on international convergence is surveyed. The criticism to the conventional method applied to detect convergence and the results obtained under panel data and time series estimations are discussed in Section 5. Section 6 reviews the evidence on the Italian case. The econometric methodology and data are presented in section 7. In section 8 the results are discussed, and section 9 concludes.

2 Decreasing Returns In Capital And Convergence: The Neoclassical Growth Model

The neo-classical growth theory suggests that in the long run the poorer regions converge to the richer ones and that, consequently, the growth rate of a region is inversely correlated to its starting level of per capita income (Solow, 1956). This would arise if differences in steady-state income paths are swamped by country transitions to their steady-state. In other words, this result, known as absolute convergence, appears whether regions converge to the same steady state, that is, when the different determinants of this state (preferences, technology, population growth) are the same for both kinds of regions. Convergence property is a consequence of the neo-classical assumption of the decreasing return to capital: economies more endowed in the reproducible factor will increase to lower rate than economies with lower levels of capital stock.

The theoretical apparatus of the model is characterised by a linear homogeneous production function which displays constant returns to scale and diminishing marginal productivity to each input taken separately. Let s be the constant saving rate, which is a fixed fraction of output. In a closed economy, savings are equal to gross investment, and gross investment, in turn, is equal to the net increase in the capital stock plus depreciation.

Defining k as the stock of capital per person, its evolution is governed by:

$$\dot{k} = sAf(k) - (d + n)\,k \qquad (1)$$

where $Af(k)$ is the production function in per capita terms, d is the depreciation rate and n is the exogenous rate of population growth. The parameter A reflects the level of technology.

For the moment, we assume that A, d and n are exogenous constants. Eq. (1) is the fundamental differential equation of the Solow model which, given k_0, describes the dynamic behaviour of capital at all futures times. If we divide both sides of (1) by k, we get an expression for the growth rate of the capital stock, k:

$$g_k = sAf(k)/k - (d + n) \qquad (2)$$

Eq. (2) implies that k converges to a steady-state value k^* defined by $sk^* = (d + n)k^*$. Given k_0, the behaviour of the economy can be analysed using Fig. 1. The figure displays two functions: a horizontal line at $d + n$, the *depreciation curve,* and a downward line, $sAf(k)/k$, which we will call the *savings curve.* Eq. (2) indicates that the growth rate is the difference between the two lines. The neo-classical assumption of diminishing returns to capital ensures that the savings curve is downward sloping. The Inada conditions impose that the savings curve is vertical at $k = 0$ and it approaches the horizontal axis as k tends to infinity. Since the savings curve takes all values between zero and infinity, we are sure that it crosses the depreciation line at least once, and since it is downward sloping, this intersection is unique. The crossing point is called the *steady-state capital stock*.

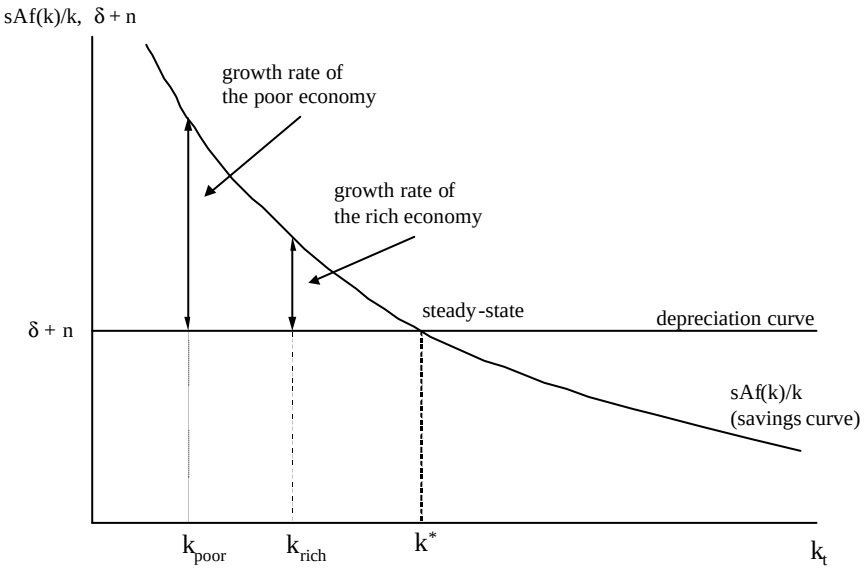

Fig. 1 Solow's neoclassical model: absolute convergence

Suppose all the same value for each parameter), so differences in initial capital stock path represent different

positions relative to the common steady-state path. Fig. 1 shows that the growth rate corresponding to the poor economy (k_{poor}) is larger than the growth rate of the rich one (k_{rich}), so they will converge to the single steady state (k^*). So if the only difference across economies is the initial level in the reproducible factor, the neo-classical model predicts absolute convergence in the sense that poor regions will grow faster than the rich ones.

The optimising version of Solow model (Cass, 1965; Koopmans, 1965) suggests that the neo-classical growth paradigm generates "conditional" convergence and not necessarily absolute convergence. The specification of the model is given by the assumption that agents maximise their utility over an infinite horizon. Indeed, when the saving rate is not fixed, the possibility of a non monotonic relationship between growth rate and starting level of per-capita income, stems from the fact that saving depends on the capital stock.

Conditional convergence defines the idea that countries tend to grow faster the lower their income conditioning on their steady-state. Suppose that countries differences in their steady-state income paths are permanent, convergence in this sense takes place only after controlling the impact for each region of the determinants of the steady state. Fig. 3 illustrates this result. We consider two economies that differ in two aspects: they have different initial stocks of capital per person ($k_{poor} < k_{rich}$) and different saving rates ($s_{poor} < s_{rich}$). The difference in saving rates generates difference in the same direction in the steady-state values of the reproducible factor ($k^*_{poor} < k^*_{rich}$). The model does not predict absolute convergence: the rich economy would grow faster than the poor one.

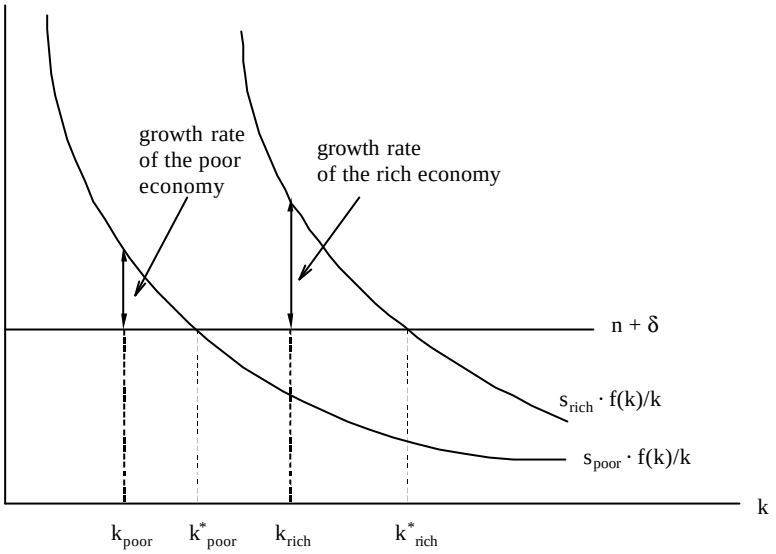

Fig. 2 Conditional Convergence

3 Increasing Returns In Capital And Divergence: The Endogenous Growth Models

The first attempt to overcome the neo-classical conclusions is given by the one-sector AK model (Jones and Manuelli, 1990; Rebelo, 1991), which predicts that all the economies follow long-run growth parallel paths (Fig. 3). In these models there is no steady-state level of income: differences among regions in per capita income can persist indefinitely, even if they have the same saving and population growth rates. The fundamental difference with the Solow model is the presence of nonconvexities in production.

The linear AK technology violates two key neo-classical assumptions: diminishing returns and the Inada conditions. If we substitute the neo-classical technology $Af(k)$ by the linear technology Ak, then the growth equation (2) becomes:

$$g_k = sA - (d + n) \qquad (3)$$

The dynamic behaviour of this model is illustrated in Fig. 2. The depreciation curve is still a horizontal line at $d + n$. The savings curve is no longer downward sloping but is a horizontal line at sA.

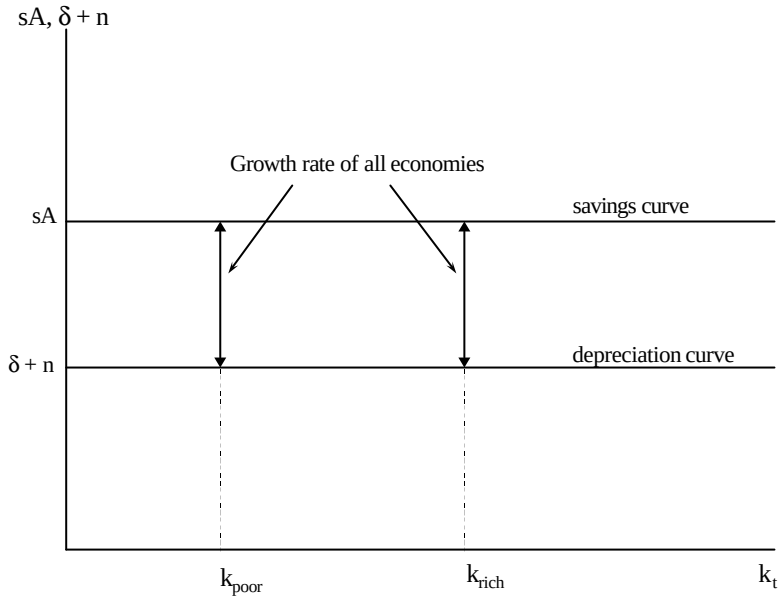

Fig. 3 The one-sector AK growth model

Fig. 2 is drawn under the assumption that $sA > d + n$, which implies a positive and constant distance between the saving and depreciation line and, as a result, a positive and constant rate. If we consider two economies which differ in the initial capital stocks (k_{poor} and k_{rich}) then, the model predicts that the growth rate of the two economies is the same (poor countries will always be poorer and rich countries will be richer). So they will not converge.

A second approach along the new theories of endogenous growth gives to external economies a prominent role in the growth process. The discovery of new ideas, since they are nonrivalrous in their use, is the engine of growth. Romer (1990) models an economy in which there are three sectors: a perfectly competitive one for output, a monopolistic competitive one for the intermediate input, and a free-entry R&D one. Investing in R&D gives new intermediate output, there is no obsolescence, innovations last forever. The R&D sector is relatively intensive in human capital, and the cost of inventing a new product is constant over time. In this framework the amount of research undertaken in a decentralised economy is non-efficient. On the one hand, monopolistic competition induces a level of research activity that is less than the optimal one. On the other hand, the spillover effect of new research is not taken into account. However, it must be pointed out that if the intermediate input market was

competitive, there will be no innovations at all, since the total cost would be higher than the revenue.

The set-up of the Aghion and Howitt (1992) model is similar to the previous one in terms of market structure, but the discovery of new products makes the previous obsolete, and then they disappear from the market. In this sense the model is based on the Schumpeterian creative destruction. When the amount n is used in research, innovations arrive randomly according to a Poisson process at an arrival rate ln. There are some spillover effects: as in Romer, the monopoly rents that the innovator can capture are generally less than the consumer surplus created by the intermediate good, and the invention makes it possible for other researchers to begin working on the next innovation. However, in contrast to Romer, there is some reward on the margin for the innovator. In addition, there is a negative spillover due to the "business-stealing effect" whereby the successful monopolist destroys the surplus attributable to the previous generation of intermediate good by making it obsolete. As a consequence there are too many innovations.

An important problem that affects endogenous growth models is the scale effect. That is, the rate of growth is proportional to the size of population, because the more people, the more researchers, *ceteris paribus*. To overcome this effect, which is strongly rejected by empirical evidence (Jones, 1995), a new stream of literature (Jones, 1999) has attempted to confine this scale effect to income levels and not growth rates. In these non-scale growth models policies implemented by the government are usually ineffective in the long-run, and that exponential growth cannot be sustained without population growth. The consequences of these models in terms of convergence have been analysed by Eicher and Turnovsky (1999). It turns out that capital and technology differ in their convergence paths and speeds. This is in contrast to the neo-classical model, and it can account for conditional convergence, in contrast to endogenous growth models.

Another strand of research in the endogenous fashion involves an emphasis on human capital. Lucas (1988) introduces a model in which the production of human capital involves no physical capital. The growth rate tends to rise with the amount of the imbalance between human and physical capital if human capital is abundant relative to the physical one, and tend to fall with amount of the imbalance if human capital is relatively scarce. The underlying source of this result is the assumption that the education sector is relatively intensive in human capital.

4 International Empirical Evidence

Baumol (1986) found, on the basis of Maddison's data over the past century (1870-1980), that the sample of 16 major industrialised countries have converged in output. The correlation between growth and initial income was negative and the convergence coefficient 0.9 per cent. However, when the sample was increased to 72 countries, no overall pattern of convergence over the period 1950-1980 emerged. Only when this broader sample was disaggregated in different groups, a tendency to convergence emerged within each group, except for that of the very poorest economies. This finding has been interpreted by Baumol as the possibility of different convergence dynamics that can be generated within groups of countries that share some common characteristics.

Two measures have been proposed to test for convergence. The first one concerns the cross-section dispersion of per capita income levels: there is convergence if the dispersion decreases over time, indicating a tendency to equalisation of per capita income levels across economies. This is called s-convergence. The second is linked to cross-section regression of time averaged growth rates on initial levels of per capita income: a negative regression coefficient on initial income level is interpreted as evidence of absolute convergence. A negative coefficient of the initial income level in cross-section regressions of time averaged growth rates on initial income and a set of additional explanatory variables is interpreted as evidence of conditional convergence. This statistical technique is known as b-convergence.

Tests of the neo-classical growth model exploit the second one of these concepts and take the form (Barro and Sala-i-Martin, 1991, 1992):

$$\frac{1}{T}\ln\left[\frac{y_{i,t0+T}}{y_{ito}}\right] = g + \ln\left[\frac{y_i^*}{y_{i,t0}}\right]\left[\frac{1-e^{-bT}}{T}\right] + u_{it} \qquad (4)$$

where i is the country, t is time, the left-hand side is the averaged growth rate defined in terms of per capita output, T is the length of the period of observation, g is the exogenous growth rate. The coefficient of the initial level of income is given by $(1\text{-}e^{-bt})/T$ where b is the rate of convergence of $y_{i,t0+T}$ to its steady-state value y^*. This equation implies conditional convergence because the negative correlation between the growth rate and the initial income

level is conditioned by the steady-state value y^*. For given values of the steady-state, the growth rate is higher the lower is $y_{i,t0}$, and this will support the convergence hypothesis. Using regional data, Barro and Sala-i-Martin (1991) examine b-convergence and s-convergence of income per capita across the USA since 1880 and for the regions of seven European countries since 1950. The hypothesis of absolute convergence seems confirmed within the US states only if diminishing returns to capital set in very slowly and in European countries if a set of variables that proxy for differences in steady-state characteristics are held constant. The estimated b for the states of USA was found around 2 per cent per year which is much lower than that implied by the neo-classical model under standard assumptions. The value of b for the European countries is only slightly smaller than that estimated for the USA (1.8 per cent a year). Also a process of s-convergence can be observed for these countries.

This view has been rejected by Mankiw *et al.* (1992). The thesis of their study demonstrates that the Solow model is fully consistent with the international disparities in per-capita income. They argue that it is possible to explain cross country variations in income per-capita in the Solow model without appealing to differences in technologies but allowing for differences in saving rates and population growth. The novelty in their analysis data is the inclusion of variables that proxy for differences in steady state positions. The basic equation they estimate with OLS is:

$$\ln y_i(t) = \ln A_i + gt + \frac{a}{1-a}\ln(s_i) - \frac{a}{1-a}\ln(n_i + g + d) \qquad (5)$$

where $\ln y_i(t)$ is the steady-state income per-capita at a given time, s_i is the fraction of GDP devoted to investment in physical capital, subscripts indicate the variables that are considered country-specific, all the others are considered the same in all countries. $A(t)$, the multiplicative factor of the production function, may differ across countries because it reflects technology, resources endowments, climate and institutions. Without controlling for human capital, the results of their regression for 98 countries produce the right signs on the coefficients of saving and population growth (positive and negative, respectively).

The unconditional test fits the value of a, the capital income share only if they introduce directly investment in human capital on the right-hand side of the equation. They conclude that differences in the investment rate in physical and human capital and in population growth rate explain almost 80 per cent of the cross country variation in per-capita income. Finally, they explore for convergence, estimating the coefficient of ln $y(60)$. The coefficient of initial income is negative for all groups of countries, whereas for the group of OECD countries also absolute convergence is displayed. The speed of convergence is different for the three groups of countries examined in their sample, but in general it is slower than in the standard Solow model (it varies from 1.4 to 2 per cent). Hence, an augmented Solow model, in the form $Y = K^{1/3} H^{1/3} L^{1/3}$ shows that economies are converging[1].

5 Estimation Problems

The results of cross section regression tests have been criticised for different reasons. All the empirical tests on convergence rest on the assumption of an identical production function and also of an identical rate of technological progress across countries and over time. There is evidence that this is an unrealistic assumption. Countries with low level of income operate normally along a lower production function. Other critiques are very general, stressing the vulnerability of results to different types of biases deriving from omitted variables, from the sensitivity of the convergence process to the choice of years included in the regressions as well as from the quality of data used in international comparison. Because of such errors in the measurement of initial income, and of their subsequent elimination over time, least square techniques tend to overestimate the convergence rate. Another criticism concerns the *ex-ante* and *ex-post* selection biases of the sample countries. In the first case the inclusion, after 1961, in the sample of OECD countries of some latecomers with exceptional growth rates such as Japan, Finland, Australia and New Zealand, can bias the result toward acceptance of convergence. *Ex-post* selection comes out from the inclusion of countries that *ex-post* were successful, and from the exclusion of those that were successful at the beginning of the period of observation but not at the end. Levine and Renelt (1986) criticise the literature that uses cross-country regressions to search for empirical linkages between growth rate and a variety of economic and political factors suggested by the theory. A large empirical literature has

estimated regression equations and more than 50 variables have been found to be significantly correlated with growth. Using the "extreme bound analysis", Levine and Renelt find that only few results of these studies are robust.

Quah (1993) argues that the concept of convergence used in Barro's type regressions is uninformative for the dynamics of distribution. Invoking Galton's observation that heights in a family tend to regress toward the mean does not imply that heights across the population tend to decline over time, he concludes that the cross sectional distribution can diverge even when the initial conditions regression shows a negative correlation. Thus, the real test for convergence should be based on a decline over time of the cross section dispersion of income per-capita across economies. The alternative model proposed by the author is a Markov chain model with probability transitions to estimate the evolution of cross-country income distribution relative to the world average. It emerges an extreme immobility over time in the transition probabilities either for rich or poor countries.

These problems are discussed at length in the literature (Capolupo (1998) for a detailed review). We want to stress two other sources of inconsistency in cross-section convergence regressions that are usually less considered in the literature: the failure to take into account correlated individual effects and endogenous explanatory variables. The standard cross-section estimator (OLS or another that take into account nonspherical disturbances) is consistent only if individual effects are uncorrelated with the other right-side variables. Omission of individual effects biases downward the convergence coefficient. The endogeneity is a problem arising from the inclusion of some elements determined at the same time of the growth rate. This is the case of the rate of investment in physical and human capital, and the rate of government expenditures.

The issue of endogeneity has been taken into account by Barro and Lee (1994) that split the time-span in two subperiods and dates stock variables at the starting date of each subperiods. Hence, they stack the two cross-section for the two subperiods and apply GLS estimator to correct for serial correlation and consider as instruments lagged values of endogenous variables. However this procedure is contradictory. The solution is consistent only if individual effects are random, but the introduction of lagged variables makes this assumption invalid.

Individual effects problems are analysed by Knight *et al*. (1993) and Islam (1995) without taking into account endogeneity, using the Π-*matrix* approach. They end up estimating, for

each period, a cross-section of income levels regressed on all the explanatory variables in all periods. The structural parameters are then estimated via minimum distance. This method is valid only under the assumption that all conditioning variables are exogenous.

Lee *et al.* (1997) argue that individual country effects in growth rates are also needed to accurately model world-wide economic performance. With this effect in place, they find evidence of conditional convergence with idiosyncratic technologies, where each country approaches its own unique growth path. Caselli *et al.* (1996) perform a GMM estimation that is able to overcome both problems, and obtain a per-capita convergence rate at 10 percent, a much higher rate than that found in previous studies. In addition, they are able to reject the Solow model both in the textbook and in its augmented versions.

The use of the Dickey-Fuller unit root test to detect convergence is suggested by Bernard and Durlauf (1995). Using this procedure implies a modification in the definition of convergence, since output innovations in one economy should be transmitted internationally. The absence of transmission implies that per-capita output differences between countries contains a unit root, since output shocks infinitely persist causing divergence. Catching-up is therefore defined as the absence of a unit root in the difference between the per-capita real output of a pair of countries y_i - y_j so that this difference narrow over time. A sufficient condition for catching-up is stochastic cointegration between y_i and y_j. Long-run convergence, in turn, implies the absence of a unit root in y_i - y_j and a time trend in the deterministic process, i.e., the absence of both a stochastic and a deterministic trend. A sufficient condition for long-run convergence is stochastic and deterministic cointegration between y_i and y_j.[2] Their results maintain the existence of pairs of converging countries across OECD economies, but not overall convergence. However, it should be clear the difference between testing for convergence in a time-series and in a cross-section framework. Time series requires that the difference must be stationary with no statistical association with initial values, while cross-sectional studies require a negative association between output differences and initial output levels.

6 Italian Empirical Evidence

Most of the empirical work on convergence across Italian regions assumes as benchmark the article by Barro and Sala-i-Martin (1991). Using data for some annual observations for the

period 1950-1985 taken from different datasets, they find that b-convergence occurred at about 1.2 percent a year, a rate that they claim not to be significantly different from the joint estimate of the more important European countries (about 1.8 percent, a result not so different from the standard 2 percent). Northern regions have grown at a 0.71 percent per year below the national average rate, while Southern ones have grown at a 0.51 percent above the average. In addition, the dispersion of GDP regional levels has decreased over time. The fact that this rate is rather low, and that the starting level of Southern regions lagged quite behind the Northern ones have prevented convergence, but Southern regions will eventually catch-up Northern ones. These results are at odds with most of the empirical discussions on regional development in Italy. Indeed during the sixties and the first half of the seventies, poorer regions showed better performances than richer ones, but this evidence is strongly reversed in the following decades. The fact that Barro and Sala-i-Martin's database mainly covers that years, explains the tendency that they find toward convergence. Subsequent works have unambiguously shown the lack of convergence across Italian regions.

Di Liberto (1994) showed that both b and s-convergence occurred in the period 1960-1991, but with a decreasing intensity over time. According to Mauro and Podrecca (1994), convergence in both sense did not take place in the time-span 1963-1989 because the previous result is mainly due to breaks in the different series used for estimation. Paci and Pigliaru (1995) replicate the analysis undertaken by Levine and Renelt (1992) for international data for the period 1971-1989. Through an "extreme bounds analysis", they find that the correlation between growth rate and its explanatory variables (such as initial GDP per capita, initial secondary school enrolment, investment share on GDP, and population growth) are very low and then their explanatory power is quite limited. Instead they find that the initial endowment of infrastructure, persistence of development, and, in particular, the rate of variation of relative specialisation in manufacturing explain quite well the behaviour of growth rates across Italian regions.

Cellini and Scorcu (1997) consider the period 1970-1991 and use both cross-sectional and time-series methods. The former is noteworthy. Firstly, they regress pairs of labour productivity per person and test for the stationarity of the residuals in a deterministic environment. Then, in a stochastic environment, they test for an error-correction model and then again for the stationarity of the residuals. They show that regions converge toward their

respective stochastic equilibrium paths and not toward a national one. These equilibrium paths are different for among regions and change over time. In a similar way, D'Amato and Pistoresi (1997) study the degree of homogeneity across regions is analysed computing pairwise coherence at zero frequency as a measure of long-run comovements, and pairwise correlation as a measure of short-run comovements. The degree of homogeneity within macro-areas is analysed by computing an index based on dynamic principal components analysis. They consider data for the period 1970-1992 and find that there are strong long-run links among group of regions based on geographical proximity.

Among the control variables that are usually used regression analysis there are mixed results. Investments are not significant in explaining Italian regional growth (Mauro and Podrecca, 1994; Paci and Pigliaru, 1995; Acconcia, 1997), while infrastructures have a positive and highly significant effect on growth (Paci and Pigliaru, 1995; Ferri and Mattesini, 1997). Ambiguous results are obtained for human capital (Di Liberto, 1994; Mauro and Podrecca, 1994; Paci and Pigliaru, 1995; Cosci and Mattesini, 1997). A closer look at government intervention and regional growth is taken by Acconcia (1997). He estimates a positive relationship between average growth rate of GDP per unit of labour and level of infrastructure. In contrast, a negative relationship has been estimated between growth rate and collective consumption. A further negative, although non significant, effect has been found in the seventies between growth and investments in machinery and transports. It is explained by the fact that at that time a large proportion of these investments was driven by government intervention.

In some studies (e.g., Mauro and Podrecca, 1994; Di Liberto, 1994, Paci and Saba, 1998) dualism and the existence of convergence club are tested using a dummy variable to indicate homogeneous group of region according to their geographical position. They find that this coefficient is significant and then support the idea of perpetuating dualism across Italian regions. However, D'Amato and Pistoresi (1997) do not find strong evidence in favour of a dualistic divide across Italian regions. A more refined analysis is provided by Cellini and Scorcu (1997) who tackle the issue of convergence clubs across Italy. They find that there are some clubs made up by few regions (e.g., Umbria-Sicilia, Val d'Aosta-Sicilia) that are formed not because of geographical proximity (as North-Eastern and Adriatic regions), but because of their structural composition. However, these clubs appear rather counterintuitive. Although the use of geographical dummies appears to be consistent with observation, divergence found in

this way is not linked to an overall economic and econometric procedure, and it is vulnerable to the preferences of the researchers.

An analysis based on a transition matrix is given by Fabiani and Pellegrini (1997). They find that provinces exhibit a rather high dynamism in the period 1952-1992. The probabilities to remain in the same class are never higher than those of moving to other classes. Many provinces starting from the two lowest classes gain two classes at the end of the period, and there is an high probability of moving to intermediate classes from provinces that belong to extreme ones. From the geographical point of view, these more dynamic provinces are found in the North-East, Marche, some Southern provinces close to the Centre and other Southern ones in Puglia, Campania and Sicilia.

In a recent contribution, Notarstefano and Vassallo (1999) apply a 3-way analysis on 10 variables indicating social and economic issues relevant for growth (migration, schooling, labour market, productive structure, public intervention, infrastructure, innovation, agglomeration, crime, and credit). They find that there exist structural differences across Italian regions that prevent convergence. Fabiani and Pellegrini (1997) and Cosci and Mattesini (1998) analyse convergence at the provincial level with several different methodologies. The results closely follow that of the previous studies.

7 Methodology And Data

In this study we apply the methodology developed by Evans and Karras (1996). They consider set of 1, 2, …, N economies that use the same productive techniques. In a stochastic environment, these economies converges if and only if a common trend a_t and finite parameters m_1, m_2, …, m_N exist such that:

$$\lim_{i \to \infty} E_t (y_{n,t+1} - a_{t+i}) = m_n , \qquad (6)$$

where y_{nt} is the logarithm of per capita output for economy n at period t valued at constant prices. The parameter m_n determines the level of economy n's parallel balanced growth path. Because a_t is unobservable, averaging over the N economies we can rewrite eq. 6 as:

$$\lim_{i\to\infty} E(\bar{y}_{t+i} - a_{t+i}) = \frac{1}{N}\sum_{n=1}^{N} m_n \,,$$

(7)

where $\bar{y}_t \equiv \sum_{n=1}^{N} y_{nt} / N$. We measure the level of the common trend a_t so that the left-hand member of eq. 7 is zero. Subtracting eq. 7 from eq. 6:

$$\lim_{i\to\infty} E_t(y_{n,t+i} - \bar{y}_{t+i}) = m_n \,. \qquad (8)$$

According to eq. 8, the deviations of $y_{1,t+i}$, $y_{2,t+i}$, …, $y_{N,t+i}$ from their cross-economy average $\bar{y}_t$ can be expected, conditional to current information, to approach constant values, as i approaches infinity. Eq. 8 holds if and only if $y_{nt} - \bar{y}_t$ is stationary with an unconditional mean vector m_n for n = 1, 2, …, N. Therefore, economies 1, 2, …, N converge if and only if every y_{nt} is non-stationary, but every $y_{nt} - \bar{y}_t$ is stationary. Convergence is absolute or conditional whether $m_n = 0$ for all n or $m_n \neq 0$ for some n. The economies diverge if and only if $y_{nt} - \bar{y}_t$ is non-stationary for all n.

Evans and Karras show that previous studies on convergence based on cross-sectional relationship between the growth rate of per-capita output over some time period and the initial level of GDP rely on the assumption that the economies have identical first-order auto-regressive dynamic structures and all permanent cross-economy differences are completed controlled for. These conditions are easily violated. The authors provide an alternative approach that avoids unrealistic assumptions and enhances the efficiency of the estimates because it completely uses the time-series variations in *y*s[3]. The data generating process is:

$$\Delta(y_{nt} - \bar{y}_t) = d_n + r_n(y_{n,t-1} - \bar{y}_{t-1}) + \sum_{i=1}^{p} j_{ni}\Delta(y_{n,t-i} - \bar{y}_{t-i}) + u_{nt} \,, \qquad (9)$$

where r_n is negative if the economies converge and zero if they diverge, d_n is a parameter, and the js are parameters such that all roots of $\Sigma_i j_{ni} L^i$ lie outside the unit circle. The us are supposed uncorrelated as N approaches infinity.

The null hypothesis is that $r_n = 0$ for all n and that $d_n \neq 0$ for all n, the former since in endogenous growth models differences in technology, preferences, government policy, and market structures generate differences in trend growth rates. The procedure to test for the null hypothesis is the following:

1) Apply OLS to eq. (9) to obtain $\hat{s}_n$, the standard error of estimate. Then calculate the normalised series $\hat{z}_{nt} \equiv (y_{nt} - \bar{y}_t)/\hat{s}_n$ for each n.

2) Using OLS, obtain the parameter estimate $\hat{r}$ and its t-ratio $t(\hat{r})$ by estimating:

$$\Delta\hat{z}_{nt} = \hat{d}_n + r\hat{z}_{n,t-1} + \sum_{i=1}^{p} j_{ni}\Delta\hat{z}_{n,t-i} + \hat{u}_{nt} \qquad (10)$$

as a panel for $n = 1, 2, \ldots, N$ and $t = 1, 2, \ldots, T$, where $\hat{d}_n \equiv d_n/\hat{s}_n$ and $\hat{u}_{nt} \equiv u_{nt}/\hat{s}_n$.

3) If $t(\hat{r})$ exceeds an appropriately chosen critical value, reject H_0: $\forall_n r_n = 0$ in favour of H_1: $\forall_n r_n < 0$. If not, H_0 may hold.

4) If H_0 can be rejected, calculate the F-ratio:

$$\Phi(\hat{d}) = \frac{1}{N-1}\sum_{i=1}^{p}\left[t(\hat{d}_n)\right]^2, \qquad (11)$$

where $t(\hat{d}_n)$ is the t-ratio of the estimator of d_n obtained by applying OLS to eq. 9 for economy n. If $\Phi(\hat{d})$ exceeds an appropriately chosen critical value, infer that convergence is conditional. If not, convergence may be absolute.

Under the null hypothesis, $t(d)$ converges to standard normal as T and N approach infinity, N/T approaches zero. As T approaches infinity while p remain fixed, the F-ratio $\Phi(\hat{d})$ converges in distribution to $F\left[N-1,(N-1)(T-p-2)\right]$. However, the asymptotic distributions of $t(\hat{r})$ and $\Phi(\hat{d})$ do not closely approximate the distribution of the sample. For this reason we employ Monte Carlo simulations to provide approximate distributions for inference.

Our data concern the period 1951-1998: their main source, which covers the time-span 1951-1993, is the dataset used by Paci and Saba (1998); data for the remaining period are taken from Svimez (2000). With respect to previous studies about convergence across Italian regions, we share some features of Cellini and Scorcu (1997) and D'Amato and Pistoresi (1997) with some differences. Firstly, we use a much longer dataset that enables us to overcome small samples biases and to have a more clear idea of the long-run growth behaviour. In addition, we focus on per-capita income rather than per-worker productivity because the former is a better approximation of well-being than the latter, and we believe that convergence is a desirable target only if well-being is concerned. With respect to D'Amato and Pistoresi (1997) our work focuses on common trends and unit root. In addition we do have in mind a theoretical paradigm, rather than focusing on blind statistical results.

8 Discussion of the results

To test for convergence, we firstly analyse the overall sample 1951-1998, then we split it in two subperiods: 1951-1973 and 1974-1998. We consider these two subperiods because according to previous evidence, they show very different patterns: in the first one convergence occurred, while in the second one the distance between North and South has increased again. The reason for choosing 1973-1974 as the breaking point is twofold: firstly, previous literature places somewhere in the first half of the seventies this switch. Secondly, by inspection of our dataset, growth rates dramatically change in those years, corresponding with the oil crisis.

According to the Akaike Information Criterion, we have used two lags in all the estimations. For the overall period the convergence rate is quite high, higher than those found in previous studies indeed, and according to the t-statistic (also supported by the marginal significance level) we can reject divergence. When we test conditional convergence against absolute one, we notice that the value of both $\Phi(\hat{d})$ and its marginal significance level enable us to accept conditional convergence. As we will see below, this is a kind of "in-between" result, since when we split the dataset in two subperiods, we find absolute convergence in 1951-1973 and divergence in 1974-1998.

Table 1 Main results

	$\hat{r}$	$t(\hat{r})$	$\Phi(\hat{d})$
All sample	-0.0860	-4.9957	2.8903
	(0.0366)	[0.0001]	[0.0003]
1951-1973	-0.0992	-4.0191	1.8828
	(0.0548)	[0.0006]	[0.0474]
1974-1998	0.3457E-02	-5.0506	2.4377
	(0.0500)	[0.5720]	[0.0050]

The figures in parentheses are standard errors, those in brackets are marginal significance levels obtained from Monte Carlo simulations.

For the first subperiod, the convergence rate is high, and based on the t-statistic and the marginal significance level, we can reject divergence. Absolute convergence is also accepted because even if the t-statistic suggests to accept conditional convergence at the 10%, the marginal significance level is rather high, therefore conditional convergence is not accepted in favour of the alternative hypothesis. This result confirm many of the previous studies that find absolute convergence in the period before the oil crisis. Moreover, the economies converge at about 10% per year a level higher than the one found for the overall period.

For the second subperiod the value of $\hat{r}$ is positive but negligible. The t-statistic is high, but is not confirmed by the marginal significance level, therefore we cannot reject divergence. This result is rather important since pervious studies have found a resurgence of dualism in this period, but they were usually unable to clearly detect divergence unless manipulating the variables and adding new hypothesis. Panel data methods are often said to bias upward the results. We think that as long as the methodology used here is based on a more careful consideration of the data generating process, this result is cast new light on the issue.

The analysis of the regional intercepts is consistent with the above discussed results. From an economic point of view, these coefficients represent differences in tastes, technology, skills, infrastructure, market structure and economic policy that determine differences in trend growth rates. According to the neoclassical model, they are simultaneously equal to zero, while in the endogenous model they are all different from zero. Therefore, on the one hand we can interpret these coefficients as another test for convergence and growth theories, and on the other hand as an indicator of club convergence.

Table 2 Regional intercepts

Regions	All sample	p-values	1951-1973	p-values	1974-1998	p-values
Piemonte	0.5475	0.007	1.0669	0.010	1.6411	0.000
Valle d'Aosta	0.5338	0.027	1.6167	0.007	1.7777	0.000
Lombardia	0.9575	0.000	1.4605	0.004	3.6727	0.000
Trentino A. A.	0.7605	0.000	0.9780	0.008	2.1438	0.000
Veneto	0.6265	0.000	0.4364	0.059	2.7041	0.000
Friuli V.G.	0.5648	0.004	0.1528	0.558	2.1645	0.000
Liguria	0.4747	0.006	0.8636	0.011	1.3435	0.000
Emilia R.	1.0022	0.000	1.0074	0.000	2.8620	0.000
Toscana	0.5540	0.002	0.8026	0.002	1.1889	0.000
Umbria	-0.0922	0.552	-0.4509	0.083	-0.2250	0.324
Marche	0.2703	0.063	0.7730	0.722	0.9453	0.000
Lazio	0.4578	0.028	0.9565	0.034	1.0283	0.000
Abruzzo	-0.2814	0.081	-0.6491	0.042	-1.2936	0.001
Molise	-0.6142	0.004	-1.3731	0.001	-1.7908	0.000
Campania	-1.0340	0.000	-1.7965	0.000	-2.2099	0.000
Puglia	-0.6129	0.001	-0.7185	0.015	-2.3646	0.000
Basilicata	-0.4642	0.007	-0.5507	0.038	-1.7559	0.000
Calabria	-0.9860	0.000	-1.1384	0.002	-3.2883	0.000
Sicilia	-0.7381	0.000	0.9863	0.006	-2.0796	0.000
Sardegna	-0.6751	0.001	-0.7830	0.023	-1.9274	0.000

For the overall period, most of the coefficients (18 out of 20) are significantly different from zero at the 5 percent confidence level. For the 1951-1973 subperiod only 4 coefficients are not significantly different from zero, adding more support to the neoclassical convergence model found on the previous test. For the 1974-1998 subperiod all the coefficients but one are significant, giving support to the endogenous growth model and the correlated divergence.

These coefficients give also some insight on the issues of club convergence, and in particular the debate on dualism between the North and the South in Italy. Central and Northern regions have overall positive coefficients, a somewhat confirmation that a growth process has occurred for those regions. Umbria is an exception, but all its coefficients are not significant. All Southern regions show negative coefficients, even Abruzzo, which is commonly believed as the "success story" of the Italian Mezzogiorno, but in this case the results are not very significant, in particular for the first and the second estimations.

9 Conclusions

In this study we have applied a powerful procedure to detect convergence across Italian regions. The results are quite consistent, since find conditional convergence for the overall period 1951-1998 and absolute convergence and divergence respectively for the two subperiods in which we have divided our dataset, 1951-1973 and 1974-1998.

As a further test we think that it may be useful to see if the divergence result in the second subperiod is the outcome of the structural break occurred in 1992, when a financial crisis caused a real crisis and a new management of both the Italian public finance and the development policy.

Footnotes

[1] An attempt to reconcile empirical evidence on convergence with the endogenous growth approach is made by Howitt (2000). He extends the Shumpeterian model with technology transfer in a multicountry framework. Countries with positive R&D levels converge to parallel growth paths, with the same growth rate, while other countries stagnate. A parameter change that would have raised a country's growth rate in the standard model, will permanently increase its productivity and per-capita income with respect to other countries.

[2] Catching-up differs from long-run convergence since the latter relates to some particular period T equated with long-run steady-state equilibrium. In this case the existence of a time trend in the non-stationary y_i - y_j implies a narrowing of the gap or that though catching-up had not yet converged. Conversely, the absence of a time trend in the stationary series implies that catching-up has been completed.

[3] With respect to other studies that use a time-series approach (e.g., Bernard and Durlauf, 1991), the gain in efficiency is considerable. When tested with N = 54, T = 37 and a size of 0.05, $\breve{H}_0 : \forall_n (r_n = 0) \cap (d_n = 0)$ is rejected in a fraction 0.8246 of the estimated sample.

Acknowledgements

We are indebted to Pierpaolo Pierani for excellent TSP programming. In addition, we would like to thank Paul Evans for having discussed some econometric issues, and seminar partecipants at the University of Bari for useful comments. The usual disclaimer applies.

References

Acconcia A. (1997) "Intervento pubblico e crescita delle regioni italiane nel periodo 1979-91", in Del Monte, A. and Giannola, A., *Istituzioni economiche e Mezzogiorno*, NIS, Roma.

Aghion P. and Howitt P. (1992) "A Model of Growth through Creative Destruction", *Econometrica*, 60, 323-351.

Barro R. and Lee W.A. (1994) "Sources of Economic Growth", *Carnegie Rochester Conference on Public Policy*, 40, 1-46.

Barro R. and Sala-i-Martin X. (1991) "Convergence across States and Regions", *Brookings Papers of Economic Activity*, 1, 107-158.

Barro R. and Sala-i-Martin X. (1992) "Convergence", *Journal of Political Economy*, 100, 223-251.

Baumol W. (1986) "Productivity Growth, Convergence and Welfare: What the Long-run Show", *American Economic Review*, 76, 1072-1085.

Bernard A.W. and Durlauf S.N. (1995) "Convergence in International Output", *Journal of Applied Econometrics*, 10, 97-108.

Capolupo R. (1998) Convergence in Recent Growth Theories: A Survey", *Journal of Economic Studies*, 25, 496-537.

Caselli F., Esquivel G. and Lafort F. (1996) "Reopening the Convergence Debate: A New Look at Cross-Country Growth Empirics", *Journal of Economic Growth*, 1, 363-389.

Cass D. (1965) "Optimum Growth in an Aggregate Model of Capital Accumulation", *Review of Economic Studies*, 32, 223-240.

Cellini R. and Scorcu A. (1997) "How Many Italies? What Data Show about Growth and Convergence across Italian Regions, 1970-91", *Rassegna di lavori dell'ISCO*, 14, 93-124.

Cosci S. and Mattesini F. (1995) "Convergenza e crescita in Italia: un'analisi su dati provinciali", *Rivista di politica economica*, 85, 35-68.

D'Amato M. and Pistoresi B. (1997) "Statistical Evidence on Regional Cohesion in Italy", *Giornale degli economisti e annali di economia*, 56, 211-234.

Di Liberto A. (1994) "Convergence across Italian Regions", *Nota di lavoro 68.94*, Fondazione Eni Enrico Mattei.

Eicher T.S. and Turnovsky, S.J. (1999) "Convergence in a Two-Sector Nonscale Growth Model", *Journal of Economic Growth*, 4, 413-428.

Evans P. and Karras G. (1996) "Convergence Revisited", *Journal of Monetary Economics*, 37, 249-265.

Fabiani S. and Pellegrini G. (1997) "Convergenza e divergenza nella crescita delle provincie italiane", in Santini (eds.), *Ricerche quantitative per la politica economica*, Banca d'Italia, Roma.

Howitt P. (2000) "Endogenous Growth and Cross-Country Income Differences", *American Economic Review*, 90, 829-846.

Islam N. (1995) "Growth Empirics: A Panel Data Approach", *Quarterly Journal of Economics*, 110, 1127-1170.

Jones C.I. (1995) "Time Series Tests of Endogenous Growth Models", *Quarterly Journal of Economics*, 110, 520-525.

Jones C.I. (1999) "Growth: With or Without Scale Effects?", *American Economic Review*, 89, 139-144.

Jones L.E. and Manuelli R.E. (1993) "A Convex Model of Economic Growth: Theory and Policy Implications", *Journal of Political Economy*, 98, 1008-1038.

Koopmans T.C. (1965) "On the Concept of Optimal Economic Growth", *The Econometric Approach to Development Planning*, North-Holland, Amsterdam.

Knight M., Loayza N., and Villanueva D. (1993) "Testing the Neoclassical Growth Model", *IMF Staff Papers*, 40, 512-541.

Lee K., Pesaran H. and Smith R. (1997) "Growth and Convergence in a Multi-country Empirical Stochastic Solow Model", *Journal of Applied Econometrics*, 12, 357-392.

Levine R. and Renelt D. (1992) "A Sensitivity Analysis of Cross-Country Growth Regressions", *American Economic Review*, 82, 942-963.

Lucas R.E. (1988) "On the Mechanics of Economic Development", *Journal of Monetary Economics*, 22, 3-42.

Mankiw N.G., Romer D. and Weil D.N. (1992) "A Contribution to the Empirics of Economic Growth", *Quarterly Journal of Economics*, 107, 407-437.

Mauro L. and Podrecca E. (1994) "The Case of Italian Regions: Convergence or Dualism", *Economic Notes*, 23, 447-472.

Notarstefano G. and Vassallo E. (1999) "Convergenza economica nelle regioni italiane nel periodo 1980-95", *Rivista economica del Mezzogiorno*, 13, 175-197.

Paci R. and Pigliaru F. (1995) "Differenziali di crescita tra le regioni italiane: un'analisi cross-section", *Rivista di politica economica*, 85, 3-34.

Paci R. and Saba A. (1998) "The Empirics of Regional Economic Growth in Italy. 1951-1993", *Rivista internazionale di scienze economiche e sociali*, 45, 515-542.

Quah D. (1993) "Galton's Fallacy and Tests of the Convergence Hypothesis", *Scandinavian Journal of Economics*, 95, 427-44.

Rebelo S. (1991) "Long-Run Policy Analysis and Long-Run Growth", *Journal of Political Economy*, 99, 500-521.

Romer P.M. (1990) "Endogenous Technological Change", *Journal of Political Economy*, 98, S71-S102.

Solow R.M. (1956) "A Contribution to the Theory of Economic Growth", *Quarterly Journal of Economics*, 70, 65-94.

Swan T.W. (1956) "Economic Growth and Capital Accumulation", *Economic Record*, 32, 334-361.

Svimez (2000), *I conti economici delle regioni italiane, 1970-1998*, Il Mulino, Bologna.