Giornale degli Economisti e Annali di Economia
Volume 63 - N. 2 (Novembre 2004) pp. 139-160

REGIONAL CONVERGENCE IN ITALY: 1951-2000

CLAUDIO MORANA
Università del Piemonte Orientale
International Centre for Economic Research (ICER, Turin)

Received: December 2003; accepted: May 2004

In the paper we assess the convergence hypothesis for the Italian economy over the period 1951-2000, using a new methodological approach. The approach is based on a two-step recursive principal components estimator, allowing to monitor the progress of the convergence process over time and to distinguish between steady-state and transitional dynamics. The overall conclusions of our work are in favour of a two-speed unconditional convergence process in per capita GDP across Italian regions, occurring at a slow pace and not monotonically.

J.E.L. classification: C32, O11.
Keywords: convergence, economic growth.

Address for correspondence: Claudio Morana, Università del Piemonte Orientale, Facoltà di Economia, Dipartimento di Scienze Economiche e Metodi Quantitativi, Via Perrone 18, 28100, Novara, Italy. E-mail: morana@eco.unipmn.it
The author is grateful to E. Giudice for assistance with the data, and to E. Baici, L. Spezia, G. Casalone, an anonymous referee and the editor C. Favero for constructive comments. The paper was written as a contribution to the Ricerca d'Eccellenza project no. 21302BAIPSE, financed by Piedmont Region.

1. INTRODUCTION

A key prediction of the neoclassical growth model (Solow, 1956; Cass, 1965; Koopmans, 1965) is an inverse relationship between the speed of growth and the level of development achieved by a country or region (the level of capital per worker or per capita income). This property is a consequence of the law of diminishing returns to capital, so that an economy with a low level of capital per worker should be characterised by a higher marginal productivity of capital, higher rates of return, and therefore grow

faster. Hence, if the structural parameters are the same, then different countries or regions should converge to the same per capita income level at decreasing rates. On the other hand, if the deep parameters of the economy differ across countries only conditional convergence should be observed, i.e. the inverse relationship between the initial level of per capita income and the rate of growth would hold empirically once it is accounted for the different features of the steady-states. This prediction of the neoclassical model has been initially employed in empirical analysis to test for the endogeneity of the growth process, being divergence in growth rates and per capita output levels an implicit general prediction of endogenous growth models. Among the reasons to study the convergence process across countries and regions there is then the issue of the role of economic policy to promote income equality and heaven growth. This latter issue is not independent of the economic model that is believed to explain the observed dynamics, since the appropriate policies to promote growth in the less developed regions may differ according to the characteristics of the growth process. In fact, according to standard neoclassical growth theory, public intervention would not be necessary, since the gap in per capita income levels between poor and rich regions would decrease at a given rate, explained by the capital share.[1] This would be the most favourable case of unconditional convergence. On the other hand, in the case of conditional convergence, i.e. each region converging towards its own steady-state, public interventions aiming to increase standards of living in low per capita income regions may be necessary. From a theoretical point a view, economic policy should aim to induce disequilibrium dynamics, since along an out of the steady-state growth path poorer regions could grow at a higher rate than richer ones. In fact, according to the model, steady-state growth is equal across regions and explained by the rate of technical progress. On the other hand, if the growth process is endogenous policy interventions could be employed to increase both per capita levels and growth rates in the poorer regions, since convergence in per capita income and growth rates would not be an asymptotic outcome, but rather a target, which economic policy may possibly achieve. Another important issue would then also be the determination of the characteristics of the engines of growth.

The above mentioned policy implications of the existence of a conver-

[1] The speed of adjustment parameter in the neoclassical model depends on the coefficient of relative risk aversion, the intertemporal rate of preference, the rate of growth of population, the depreciation rate, and the capital share of the economy. In particular, the lower is the capital share, i.e. the stronger are diminishing returns, and the faster is the convergence process to the steady-state.

gence process across Italian regions, rather than testing for exogenous growth process in Italy,[2] is what motivate this study. Previous studies which have assessed the convergence hypothesis across Italian regions are Paci-Pigliaru (1995, 1995b), Paci-Saba (1997), Di Liberto (1994), Goria-Ichino (1994), Cellini-Scorcu (1995, 1996), Mauro-Podrecca (1994), Piras (1992), Barro-Sala-i-Martin (1991), Ciriaci (2001), D'Amato-Pistoresi (1997). The evidence would point to conditional convergence rather than unconditional convergence. In fact apart from Barro-Sala-i-Martin (1991), who initially have provided evidence of unconditional β- and σ-convergence across Italian regions for the period 1950-1985, with β-convergence progressing at the 2% annual rate,[3] Di Liberto (1994) has found that proxy variables for human capital growth, public investment, investment in equipment and transport, and an area dummy capturing other uncontrolled featurers (i.e. social capability, difference in technology, crime), can account for the differences in regional steady-states. Moreover, Cellini-Scorcu (1995) have also shown that conditional β-convergence would have occurred in the 1970s, with convergence occurring across southern regions, but not across centre or northern regions. However, once the cross-sectional regression is augmented to control for institutional variables, such as administrative and demographic effects, evidence in favour of conditional β-convergence has been found for the period 1980-1991 as well.

Moreover, from the analysis of the evolution over time of the cross-sectional distribution of per capita GDP relative to national GDP, evidence of persistent dualism between the North and the South of the country has been found. For instance, Mauro-Podrecca (1994) and Ciriaci (2001) have not de-

[2] It should be added that testing for the exogeneity of the growth process should be preferably carried out, for instance, along the lines of Bernanke and Gurkainak (2001) or Binder and Pesaran (1999). In fact, the classical approach to convergence suffers from many drawbacks. We briefly discuss this latter issue later on in this section.

[3] Piras (1992) and Paci-Saba (1997) have pointed to a lower annual rate of convergence of about 0.7% and 1.13% per year, respectively. Di Liberto (1994) has also provided evidence of a slowdown of the unconditional convergence process over the period 1960-1991, given the progressive flattening of the negative relationship between the average rate of growth and the initial per capita GDP level. Moreover, Paci-Pigliaru (1995b) have pointed to structural change in the form of sectorial shifts of the labour force from agriculture to industry, which would have taken place in the 1970s in the southern regions, rather than diminishing returns to capital, as the causing factors of the convergence process. The industrialisation process would have in fact granted a rapid increase in productivity to regions characterised by per capita income levels below the Italian average, explaining the observed negative relationship between productivity growth and the initial productivity level. Finally, Goria-Ichino (1994) have pointed to migration flows as the explantion for the U-shaped σ-convergence dynamics of log per capita GDP.

tected any mobility from the low income class to the average and high income classes (apart from the case of Abruzzo), with some mobility characterising the average and high income classes only. Differently, Paci-Saba (1997) have detected some mobility across per capita GDP states, estimating a probability of about 0.4 for a region to shift from the low income state to the average income state over forty years (1951-1993), and a probability of about 0.6 to shift from the average income state to the high income state over the same horizon.[4]

Finally, the evidence provided by time series approaches yields a partially contrasting picture. Both Cellini-Scorcu (1995) and D'Amato-Pistoresi (1997) have found some evidence in favour of unconditional convergence, pointing to convergence clubs for the Centre and North East and the Centre and the South Adriatic regions. In particular, the Centre-East and the Nort-East macroregions would show the highest degree of comovement both in the short and in the long-run, with the Centre-West and the Nort-West macroregions following in the ranking. Finally, the South-East would appear to be well integrated with the Centre-East, while the highest degree of heterogeneity would seem to characterise the South-West of the country. Interestingly, while Cellini-Scorcu (1995) have concluded against a stable process of convergence across Italian regions, D'Amato-Pistoresi (1997) have concluded against a clear-cut dualistic structure for the Italian economy, particulary as far as trend dynamics are concerned.

Quah (1993b, 1996), Friedman (1992), Lee et al. (1995), Evans (1996), Bernard-Durlauf (1996), Islam (2003) have pointed to several drawbacks affecting the concepts of β-convergence, as usually assessed by means of cross-sectional regressions. The critics range from Galton's fallacy to various causes of inconsistent or distorted estimation of the convergence speed. Also the concept of σ-convergence has been criticised, since it would allow to asses only the evolution of the shape of the distribution. In the light of the above mentioned contributions, conclusions drawn using the tools of classical con-

[4] It should be noted that the decomposition of per capita GDP in productivity and participation rate, however, has provided a different picture, suggesting high mobility for southern regions, with five out of eight regions (Calabria, Puglia, Molise, Abruzzo, Basilicata) improving their position relative to the national productivity average over the period considered, and the remaining three (Campania, Sicilia and Sardegna) being stationary. Hence, the conclusion of Ciriaci (2001) would point to dynamics in the participation rate as the explanation of the divergence in per capita GDP levels across Italian regions: while for the Centre-North macroregions the participation rate would have increased from 108.4 to 112.4 over the time period considered, for the South macroregions it would have fallen from 87.4 to 79.3.

vergence analysis appear therefore to be unreliable. On the other hand, cointegration based time series approaches may be sensitive to the presence of unaccounted transitory dynamics, since the latter may bias the results against trend convergence. In the paper we have further assessed the convergence hypothesis, using a larger sample (1951-2000) than the one employed in previous studies and a new methodological approach. The approach followed draws on Carvalho-Harvey (2002) and Luginbuhl-Koopmans (2003), but differently from these latter works, can be implemented also when the cross-sectional dimension is large, as it is the case in this paper. By distinguishing between steady-state and transitional dynamics, the methodology employed should allow to draw reliable conclusions on trend convergence and on the so far unexplored issue of convergence in cyclical fluctuations. Moreover, differently from previous contributions in the literature, the suggested approach allows to monitor the dynamics of convergence over time and to identify different phases of the process. In fact, it should not be expected that the convergence process proceed monotonically over time, given the long-run impact that economic shocks may exercise on the macroeconomy. This is also in the light of the regional policies carried out in Italy over the period considered. Hence, the approach implemented should also allow to assess whether policy interventions have contributed to promote economic integration in Italy.

Using the proposed approach a set of new interesting findings emerges. Firstly, by analysing the evolution of the cross-sectional relative GDP per capita distribution over time we find evidence of unconditional convergence occurring across Italian regions. This outcome should be seen as a potentiality for the Italian economy, given that it is derived asymptotically. Convergence is however a very slow process, particularly the transition from the low per capita income state to the average or high income states, which requires at least twenty years. On the other hand, the transition to the high income state from the average income state is quicker, requiring about a decade. This finding seems to be in contrast with the prediction of convergence at a decreasing rate of the neoclassical growth model. Interestingly, the transitional dynamics appear to be one sided, i.e. once the transition to a higher per capita income state has occurred, regions are not likely to fall back over time. Secondly, by decomposing the log per capita income series in trend and cyclical components, we have been able to separate steady-state dynamics from transitional dynamics. We find that since the 1980s the North macroregions would have experienced a convergence phase in both trend and cyclical dynamics, while for the Centre and South macroregions convergence would be occurring in trend dynamics only (since the 1980s for the Centre, and since the 1960s for the South), albeit for the Centre the co-

ordination of cyclical fluctuations was strong already in the 1960s. Finally, given the potentiality for unconditional convergence detected in the data and the observed dynamics, our results point to a positive role for regional policies in promoting economic convergence.

After this introduction, the paper is organised as follows. In section two we discuss the results of a descriptive analysis of the convergence process; in section three we assess the evolution over time of the cross-sectional distribution dynamics of per capita GDP; in section four we discuss the results of the time series analysis of the convergence process using the new proposed approach. Finally, in section five we conclude.

2. Descriptive analysis

In Figure 1 log per capita GDP[5] for the twenty Italian regions is plotted over the period 1951-2000. The data have been collected in four geographical areas, corresponding to the standard classification: North-West (Piemonte, Lombardia, Valle d'Aosta, Liguria), North-East (Veneto, Trentino Alto Adige, Friuli Venezia Giulia, Emilia), Centre (Toscana, Umbria, Marche, Lazio), South (Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria, Sicilia, Sardegna). From the plots four findings can be noted. Firstly, a progressive convergence of log per capita GDP levels within each geographical area for the North-West, North-East and Centre macroregions. Secondly, for these latter regions convergence has occurred to some extent also across macroregions. Thirdly, since the mid 1970s some divergence seems to have occurred in the South macroregions, interrupting the process of convergence detected since the 1950s. Finally, a picture of dualism emerges, with a relatively well-off North-Centre macroregions separated by a relatively poor South macroregions.

This picture in confirmed by the descriptive analysis of regional per capita GDP relative to the national average. As is shown in Table 1, there is some evidence of catching-up across regions until the 1980s, with relative per capita income stabilising afterwards for most of the regions. Interestingly, the most noticeable dynamics concern the reduction in per capita GDP occurred in the most well-off regions over the time span considered (Valle d'Aosta, Piemonte, Lombardia, Trentino Alto Adige, Liguria), rather than the increase

[5] Per capita GDP figures have been computed by dividing regional GDP figures at constant 1995 prices for the number of residents. Annual figures have been obtained from CRENOS for the period 1951-1993 and from ISTAT for the period 1994-2000. The construction of the CRENOS data set is discussed in Paci-Saba (1997).

FIGURE 1 - *Log per capita GDP in four macroregions: North-West, North-Est, Centre, South.*

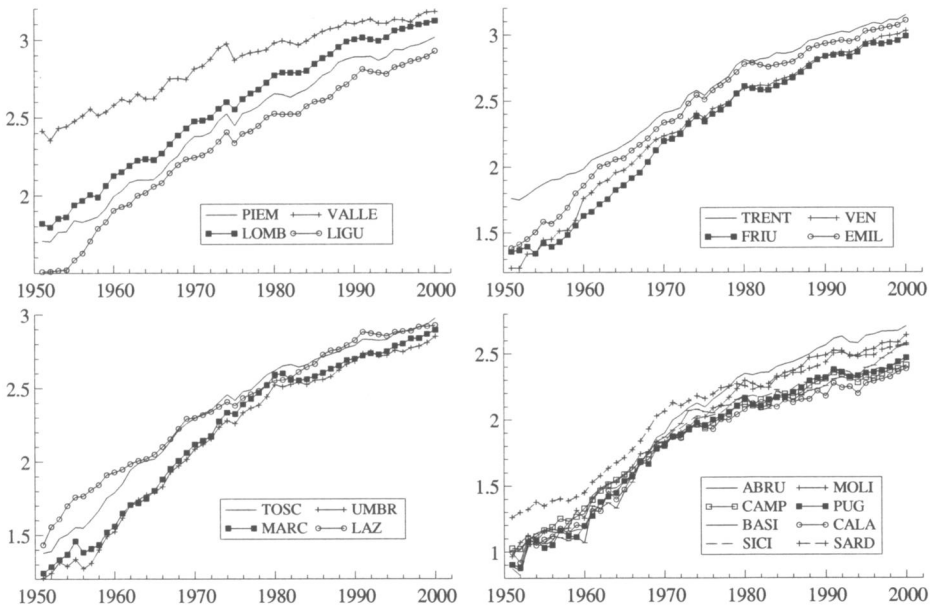


TABLE 1 - *Regional per capita GDP relative to national average.*

	1951	1960	1970	1980	1990	2000
PIEMONTE	1.36	1.33	1.22	1.15	1.21	1.18
V. D'AOSTA	2.76	2.39	1.89	1.59	1.50	1.39
LOMBARDIA	1.52	1.52	1.35	1.30	1.36	1.31
TRENTINO	1.44	1.32	1.26	1.35	1.34	1.35
VENETO	0.85	1.05	1.06	1.08	1.15	1.20
FRIULI	0.96	0.92	1.02	1.10	1.15	1.15
LIGURIA	1.11	1.21	1.07	1.01	1.07	1.08
EMILIA	0.98	1.16	1.17	1.30	1.27	1.29
TOSCANA	0.98	1.09	1.12	1.11	1.10	1.13
UMBRIA	0.82	0.83	0.91	1.01	0.99	1.00
MARCHE	0.85	0.86	0.94	1.08	1.00	1.05
LAZIO	1.03	1.25	1.13	1.04	1.14	1.08
ABRUZZO	0.67	0.66	0.76	0.85	0.87	0.86
MOLISE	0.65	0.64	0.71	0.81	0.81	0.81
CAMPANIA	0.69	0.68	0.69	0.67	0.68	0.64
PUGLIA	0.61	0.60	0.69	0.70	0.68	0.68
BASILICATA	0.60	0.53	0.73	0.72	0.64	0.75
CALABRIA	0.66	0.60	0.69	0.65	0.60	0.63
SICILIA	0.59	0.58	0.71	0.71	0.68	0.67
SARDEGNA	0.87	0.77	0.89	0.77	0.77	0.76

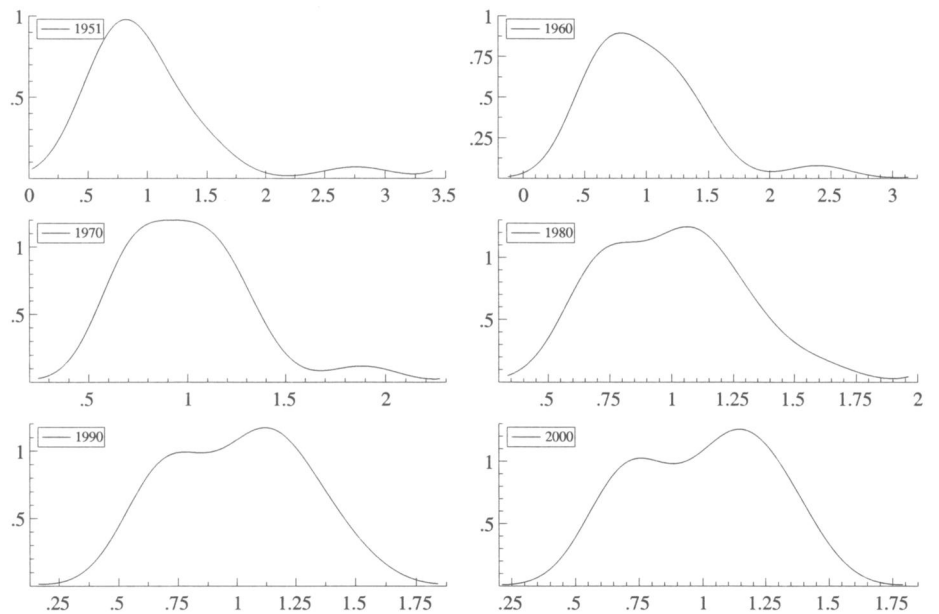
in relative per capita GDP in the less well-off regions (Sicilia, Calabria, Puglia, Campania). Abruzzo, Molise and Basilicata are the southern regions characterised by the strongest catching-up, while Sardegna is the only region with a below average initial per capita GDP level which has experienced a reduction over time, albeit not monotonic, in relative standards of living. On the other hand, Veneto, Friuli Venezia Giulia, Emilia Romagna, Toscana, Umbria and Marche have shown robust catching-up dynamics. From the table it is possible to draw a dualistic picture with the North and Centre macroregions being characterised by average or above average per capita GDP levels, and the South macroregions being characterised by below average per capita GDP levels. The dimension of the phenomenon is not negligible: in 2000 average relative per capita GDP was equal to 1.24 for the North-West, 1.25 for the North East, 1.06 for the Centre, and only 0.73 for the South.

3. Cross-sectional distribution dynamics

As shown by Quah (1993), comprehensive information concerning economic convergence can be gathered by investigating the evolution of the cross-sectional distribution of relative per capita GDP over time. In Figure 2 the relative (to national average) cross-sectional regional per capita GDP distribution is plotted for the years 1951, 1960, 1970, 1980, 1990 and 2000. As shown in the plot, there is clear evidence of evolving cross-sectional distributions. In all of the cases bimodality is evident, with the modes of the distributions becoming progressively closer to each other over time. This finding suggests a tendency towards equality in income distribution.[6] Following Quah (1993), we have tried to extrapolate the observed tendencies by assuming a first order Markov chain transition mechanism. The set of possible values of relative regional per capita GDP has been discretised into interval at 0.75, 1, 1.25, values which are close to the first, second and third quartile for the year 2000 cross-sectional distribution (0.75, 1.04, 1.18; the average values of the quartiles over the sample are 0.7, 0.96, 1.14). We denote these three states has the low, average and high income states. The estimated one step annual transition matrix is reported in Table 2, Panel A. This matrix is esti-

[6] The evolution of the cross-sectional dynamics also points to σ-convergence: the estimated standard deviations for 1950, 1960, 1970, 1980, 1990 and 2000 are 0.50, 0.44, 0.30, 0.26, 0.27, and 0.25, respectively. Dispersion seems to have stabilised since the 1980s. However, the evolution of the cross-sectional distributions is still in progress. Concluding against convergence on the basis of the observed dispersion dynamics would not be appropriate.

FIGURE 2 - *Regional per capita GDP relative to national average cross-sectional distribution dynamics: 1951, 1960, 1970, 1980, 1990, 2000.*



mated by averaging the observed one year transitions over every year from 1951 through 1999. As can be seen from the Table, across the twenty Italian regions and the 50 years of the sample, there have been 274 observations with relative income below 0.75, 206 observations with relative income between 0.75 and 1, 295 observations with relative income between 1 and 1.25. In addition, the states tend to be very persistent, with a negligible probability of moving across states at the one year horizon. In fact, the own diagonal elements are 0.98, 0.94 and 0.98, for the three states, respectively. In Table 2, Panel B the one 48 year step transition matrix is reported. According to the estimates only the high income state is persistent. Moreover, there is a high probability of moving from the low income state to the average income state (0.43), and from the average income state to the high income state (0.67), while the probability of a reduction in standards of living is null. The overall picture is therefore positive, pointing to the possibility of moving across income states over time through a gradual process, i.e. from the low income state to the high income state, passing through the average income state. Moving from the low income state to the average income state appears to be harder than moving from the average income state to the high income state. Moreover, the probability of falling in a lower income state is null. Looking at the ergodic probabilities, which can be interpreted as the unconditional

TABLE 2 - *Regional per capita GDP relative to national average.*

Panel A, First order, time stationary (1952 to 1999)
Grid (0, 0.75, 1, 1.25, ∞); States: 3

Number	0.75	1	1.25
274	0.98	0.02	0.0
206	0.01	0.94	0.05
295	0.00	0.02	0.98
Erg	0.13	0.24	0.63

Panel B, 48-year transition (1952-1999)

Number	0.75	1	1.25
7	0.57	0.43	0.0
6	0.00	0.33	0.67
2	0.00	0.00	1.00
Erg	0.00	0.00	1.00

Panel C, Stationary estimate, iterated 48 times

0.75	1	1.25	
0.75	0.47	0.23	0.30
1	0.12	0.25	0.63
1.25	0.06	0.24	0.70

The Table reports the estimated one step annual transition matrix (Panel A), the one 48 year step transition matrix (Panel B), the iterated one step annual transition matrix (Panel C). "*Number*" denotes the total number of transitions with starting point in a given income state. Element i, j denotes the probability of a move to state j at time $t + 1$, starting from state i at time t. "*Erg*" denote the ergodic probability of each state.

probability for each state, there appears to be a tendency towards unimodality, which is clear-cut when the one 48 year step transition matrix is employed. However, it should be noted that these dynamics are long-run ones, since at least twenty years are required to shift from the low income state to the average income state, while moving from the average income state to the high income state would require a decade.[7] Finally, the same predictions of convergence towards unimodality is attained by using a second order Markov chain mechanism: the ergodic probabilities from the one step annual transition matrix are 0.03, 0.16, and 0.81, for the low, average and high income state, respectively. It should be noted that the tendency towards unimodality

[7] The estimated one ten years step and one twenty years step transition matrices are available upon request from the author.

should be understood as a long-run tendency characterising the realized sample, rather than as a prediction on how the world will be in the future. The latter will obviously depend on extra sample information, as for instance the implementation of new regional policies, which is available as time goes on.

4. A NEW APPROACH TO CONVERGENCE ANALYSIS

The overall evidence collected so far is in favour of an ongoing process of unconditional convergence across Italian regions. This process has proceeded at a fairly slow pace, pointing to the relevance of transitional dynamics in a time series framework. Recently, Carvalho-Harvey (2002) and Luginbuhl-Koopmans (2003) have proposed two approaches for modelling convergence as an ongoing process. The approach followed is closely related to Luginbuhl-Koopmans (2003), since convergence is assessed by monitoring the progressive reduction in the rank of appropriate variance-covariance matrices over time. An important feature of the proposed methodology is that, by controlling for the presence of transitional dynamics, the conclusions about trend convergence should be reliable. Moreover, differently from the above mentioned papers, the proposed approach can be employed also when the cross-sectional dimension is large, as in the case at hand. In our framework the log of per capita GDP is decomposed in trend and cyclical components. This decomposition should allow to disentangle steady-state dynamics (trend component) from transitional movements in the series (cyclical component). Then, the convergence process can be assessed by monitoring the evolution over time of the rank of the variance-covariance matrices of the corresponding innovations. The approach allows therefore a complete assessment of the dynamics characterising the Italian regions: not only an assessment of the emergence of balanced growth across regions, i.e. the presence of just one common trend driving the log per capita GDP series, but also of the coordination over time of short-run fluctuations, possibly associated with the business cycle or regional shocks.

4.1 The econometric model

The econometric model can be written as follows

$$y_t = \mu_t + c_t, \tag{1}$$

where y_t is a $N \times 1$ vector of observations on the regional log per capita GDP series (N is the number of regions, $N = 20$), μ_t is a $N \times 1$ vector of obser-

vation on the trend components, following a multivariate random walk process with drift $\mu_t = \mu_{t-1}+\beta+\eta_t$, c_t is a $N \times 1$ vector of observations on the cyclical components, following a stationary VARMA(p, q) process $\Xi(L)c_t = \Psi(L)u_t$, where $\Xi(L)$ and $\Psi(L)$ are matrices in the polynomial operator, with roots all outside the unit circle. The i.i.d. innovation vectors η_t and u_t are assumed to be Gaussian, i.e. $\eta_t \sim NID(0, \Sigma_\eta)$, $u_t \sim NID(0, \Sigma_u)$, and pairwise orthogonal. The variance-covariance matrices Σ_i $i = \eta, u$ are all of dimension $N \times N$.

The presence of common trends or cyclical components implies a reduced rank in the corresponding variance-covariance matrices of the innovations. In particular, the restriction of balanced growth implies that just one common trend drives the regional per capita GDP series, implying that the matrix Σ_η has rank equal to one. The presence of a single common cyclical component, as it would be expected if the regional business cycles were not idiosyncratic, would also imply that the matrix Σ_u has rank equal to one. However, this latter component may capture also the effects of idiosyncratic regional shocks, with some commonalities at least for given macroregions. When convergence is an ongoing process it can be expected that the rank of the appropriate matrix will reduce over time, so that, as new observations are available, the singularity of the variance-covariance matrix would become more evident. The process of convergence can therefore be monitored by using principal components analysis to decompose the matrices Σ_η and Σ_u as

$$\Sigma_\eta = A\Lambda_\eta A'$$
$$\Sigma_u = B\Lambda_u B'$$

where Λ_i $i = \eta, u$ are the diagonal matrices of the eigenvalues of the corresponding variance-covariance matrices, and A, B are the matrices of the associated orthogonal eigenvectors. The principal components of the various components can then be computed as

$$c_t^+ = B'c_t$$
$$\mu_t^+ = A'\mu_t,$$

and the associated eigenvalues measure the variance of the innovation to each principal component. The proportion of total variance accounted by the s-th principal component is then $\Lambda_{\eta s}/\Sigma_j \Lambda_{\eta j}$ and $\Lambda_{vs}/\Sigma_j \Lambda_{vj}$, for common trends and common cycles, respectively, where Λ_{ts} $i = \eta, u$ is the s-th element on the main diagonal of the matrix Λ_t.[8]

[8] It is also possible to compute the proportion of variance of the i-th trend accounted by the j-th principal component (common trend) as $a_{ij}^2\Lambda_{\eta j} /(\Sigma_j a_{ij}^2\Lambda_{\eta j})$. Similarly, the propor-

The principal components can be standardised ($\Sigma_{c^{++}} = I_N$, $\Sigma_{\mu^{++}} = I_N$) yielding

$$c_t^{++} = \Lambda_u^{-1/2} B' c_t$$
$$\mu_t^{++} = \Lambda_\eta^{-1/2} A' \mu_t,$$

and the model rewritten in terms of the common trends - common cycles representation

$$y_t = \Theta \mu_t^{++} + \Phi c_t^{++}, \qquad (2)$$

where $\Theta = A\Lambda_\eta^{1/2}$ and $\Phi = B\Lambda_u^{-1/2}$ are $N \times N$ factor loading matrices.[9] As already mentioned, if there are common unobserved components, the corresponding variance-covariance matrices will be of reduced rank, and therefore not all the eigenvalues will be larger than zero. The number of common trends will be given by the number of non zero eigenvalues collected in the matrix Λ_η, say k, and the number of common cycles will be given by the number of non zero eigenvalues collected in the matrix Λ_u, say r. It follows that the factor loading matrices will be of reduced rank k and r, respectively, being of dimension $N \times k$ $k < N$, and $N \times r$ $r < N$.

The proposed approach can be implemented in two steps. In the first step the decomposition in trend and cyclical components is performed by means of the Hodrick-Prescott filter or other detrending methods, such as band pass filtering or model based filters (Harvey, 1989). This allows to achieve the permanent-transitory decomposition indicated in (1). In the second step the variance-covariance matrix of the corresponding innovations is computed and principal components analysis is performed. This allows to rewrite the permanent-transitory decomposition in terms of the common trends-common cycles model in (2). The two-step approach allows to easily handle large multivariate systems characterised by common dynamics.

4.2 Empirical results

The trend-cycle decomposition (first step) has been performed by means of the Hodrick-Prescott filter, since no satisfactory permanent-transitory de-

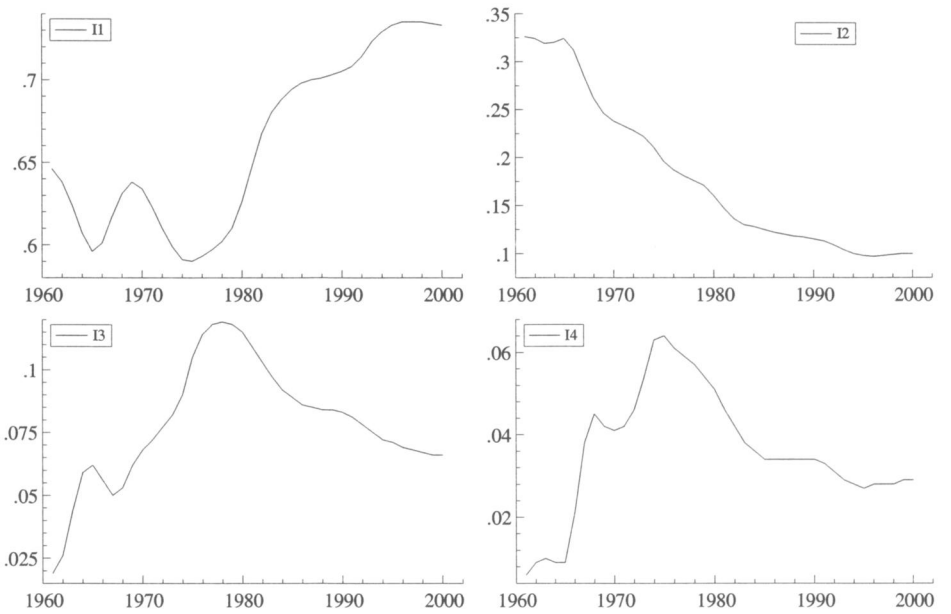
tion of variance of the i-th cycle accounted by the j-th principal component (common cycle) is $b_{ij}^2 \Lambda_{u_j} / (\Sigma_j b_{ij}^2 \Lambda_{u_j})$.

[9] Carvalho-Harvey (2002) have used this two-step approach to investigate commonalities occurring in the cyclical components only. We have used the approach also for the trends components.

compositions could be achieved by means of univariate structural time series models (Harvey, 1989). Coherent with the evidence of stochastic growth detected by standard ADF tests for the log per capita GDP series analysed,[10] the trend innovations have been computed by first differencing the estimated trend components. On the other hand, since no persistence seems to be left in the cyclical components according to the Box-Ljung test, these latter series have been directly employed to compute the variance-covariance matrix, which has then been decomposed by means of the eigenvalue-eigenvector decomposition (second step).

Trend dynamics For the trend innovations variance-covariance matrix, principal components analysis points to at most four significant factors, since the proportion of explained variance by these latter four factors ranges between 0.93 and 0.99 over the time span investigated. The proportion of explained variance associated with the four largest eigenvalues is plotted in Figure 3. The values have been obtained by recursive estimation, starting

FIGURE 3 - *Trend components, proportion of explained variance associated with the four largest eigenvalues (Italy, twenty regions).*



[10] The results are available upon request from the author.

from 1960. As is shown in the plot, both divergence and convergence dynamics can be detected. A first phase spanning from 1960 through 1980 is a phase of divergence. This phase is characterised by the progressive reduction in the proportion of explained variance associated with the two largest factors, which initially accounted for 98% of total variance. Since the 1970s there is in fact evidence of four significant factors. The divergence phase would seem to have peaked in 1975-1978. Afterwards the evidence points to a convergence phase, characterised by an increasing concentration of the proportion of explained variance in the first factor. In fact, the proportion of explained variance associated with the first factor has increased from a value of 65% to 73%, while the proportion of explained variance associated with the second factor has fallen from 33% to 10%. For the third and fourth factors the figures point to a reduction from 12% to 7%, and from 6% to 3%, respectively. Overall, the evidence points to the emergence of a single factor driving the per capita GDP trend dynamics, although the convergence process would be still in progress, with currently at most two factors accounting for the observed dynamics.

To get further insights into the divergence and convergence dynamics detected for the twenty Italian regions, the principal components analysis has been carried out also on each of the four macroregions. The results are reported in Figures 4 and 5. As shown in the Figures, the southern regions show different dynamics than the northern and centre regions. In fact, while the northern and centre regions would have experienced a divergence phase in the 1960s and 1970s, as is pointed out by the increasing importance of the second and third factors over these years, and a convergence phase afterwards, the southern regions would have experienced a protracted phase of convergence, with some divergence occurring in the 1970s and in the 1990s. A similar conclusion can be drawn when the North and the North-Centre macroregions are considered. Interestingly, the convergence dynamics across southern regions can be related to the effects of development regional policies undertaken since the 1950s. As pointed out in Felice (2002), the industrialisation phase of public interventions in the South (1958-1965) has been characterised by the creation of development poles, constituted of complementary industries of large dimension concentrated in specific areas, well endowed of infrastructures and a diversified labour market. The success of this top-down approach in leading to convergence across southern regions can be clearly seen in the dynamics of the percentage of total variance explained by the largest eigenvalue (Figure 5, first plot), as can also be noted the divergence phase that followed the first oil shock. The consequences of stagflation were particularly severe for the South, leading to the failure of the development plan successfully implemented in the previous

FIGURE 4 - *Trend components, proportion of explained variance associated with the four largest eigenvalues (North West (NW), North-East (NE), Centre (C)).*

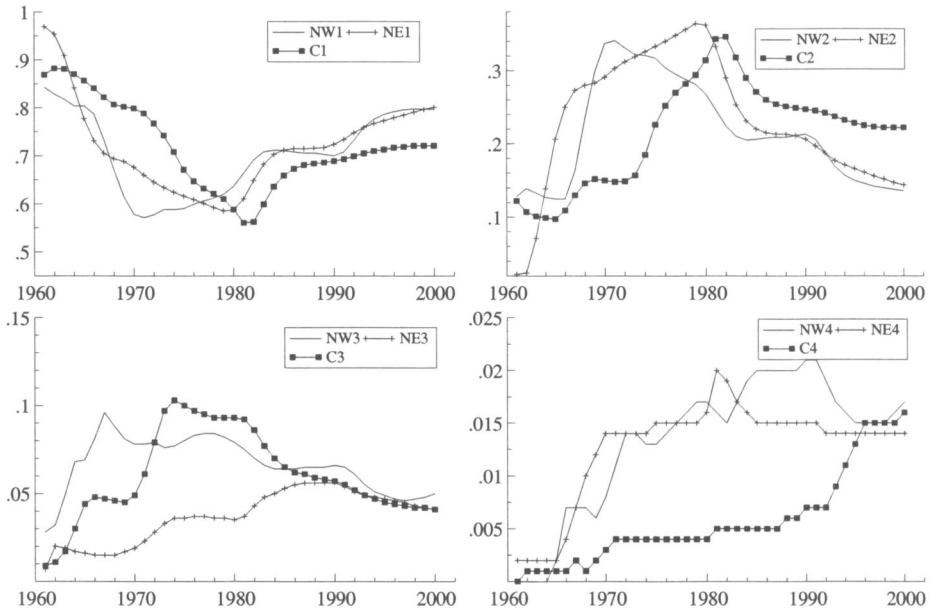
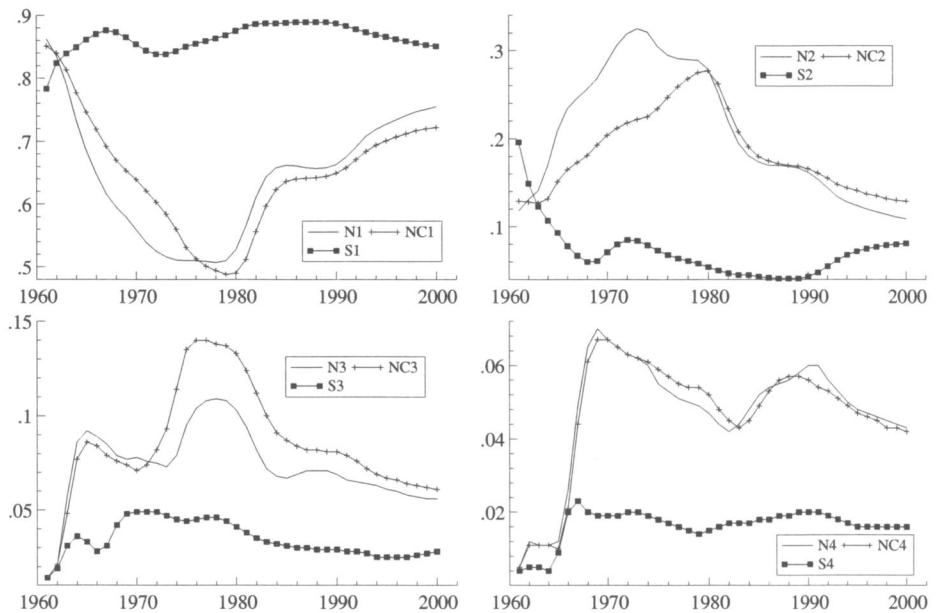


FIGURE 5 - *Trend components, proportion of explained variance associated with the four largest eigenvalues (North (N), North + Centre (NC), South (S)).*



decade. During the 1970s the percentage of public expenditure for development policies in the South increased from the average value of 0.7% of GDP of the 1950s and 1960s to 0.9% of GDP, with peaks above 1% of GDP over the period 1975-1977. The positive effects of these interventions can also be seen in Figure 5. From the plot it appears that the convergence process would have stabilised during the 1980s, possibly following the reduction in the level of public expenditure. Since the 1990s a new divergence phase across southern regions can be noted. This new divergence phase can be related to the fall in public investment occurred over this period, also as a consequence of the "tangentopoli" effect. The effects of the "Programma di Sviluppo del Mezzogiorno 2000-2006" launched by the current Government still have to be assessed, but in the light of the previous empirical evidence should lead to a new convergence phase. This would also be coherent with recent results of La Ferrara-Marcellino (2000), suggesting that the contribution of public capital to development has been positive for the Italian economy. In particular, the South and the Centre would be the areas where new investments would be more productive, and where the need of infrastructures is highest. The conclusion which can be drawn is therefore positive: public investment promoted convergence not only across southern regions, but also for the whole economy. The divergence phase occurred until the end of the 1970s should be related to divergence within and across North and Centre macroregions. Since the 1980s the process of convergence across Italian regions would seem to have continued without interruption, possibly stabilising at the end of the 1990s.

Cyclical dynamics In Figure 6 the estimated proportion of variance associated with the six largest eigenvalues is plotted for the whole sample of twenty regions. As is shown in the plots, over the sample considered cyclical fluctuations would not seem to have converged. In fact, the estimated proportions of variance are fairly constant, showing only minor adjustments. It seems possible to argue against a single common cycle, since at least three factors would seem to be necessary to explain the bulk of output fluctuations in Italy. The analysis of the various macroregions, however, points to interesting converging dynamics, masked by the nation wide analysis. In Figure 7 the proportion of variance associated with the four largest eigenvalues is plotted for the North-West, North-East and Centre macroregions. As is shown in the plot, the North-West and North-East macroregions show very similar dynamics. In particular, since the mid 1970s cyclical fluctuations would have increasingly moved together, as is pointed out by the increase in the proportion of variance associated with the first factor and the corresponding reduction in the proportion of variance associated with the other factors. On

FIGURE 6 - *Cyclical components, proportion of explained variance associated with the six largest eigenvalues (Italy, twenty regions).*

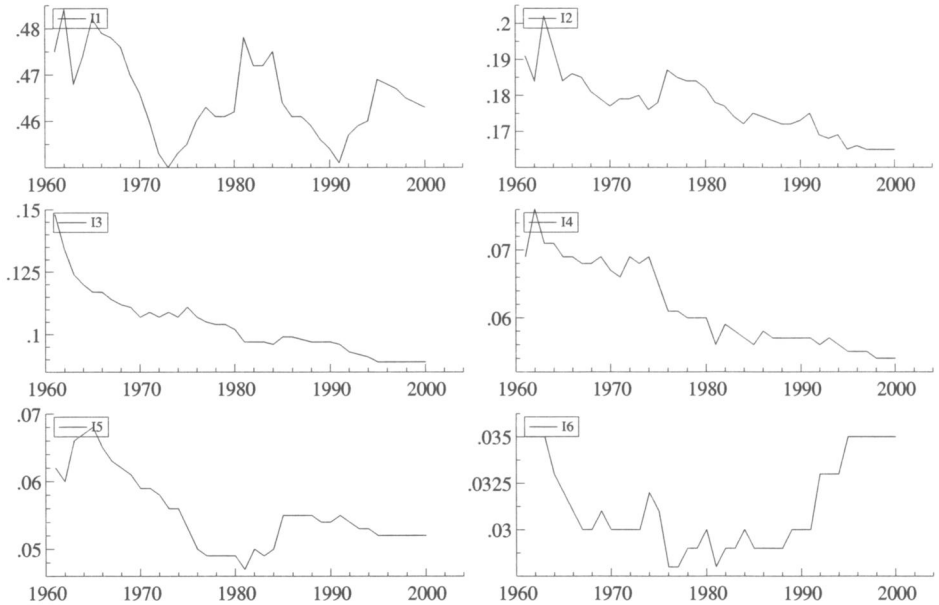
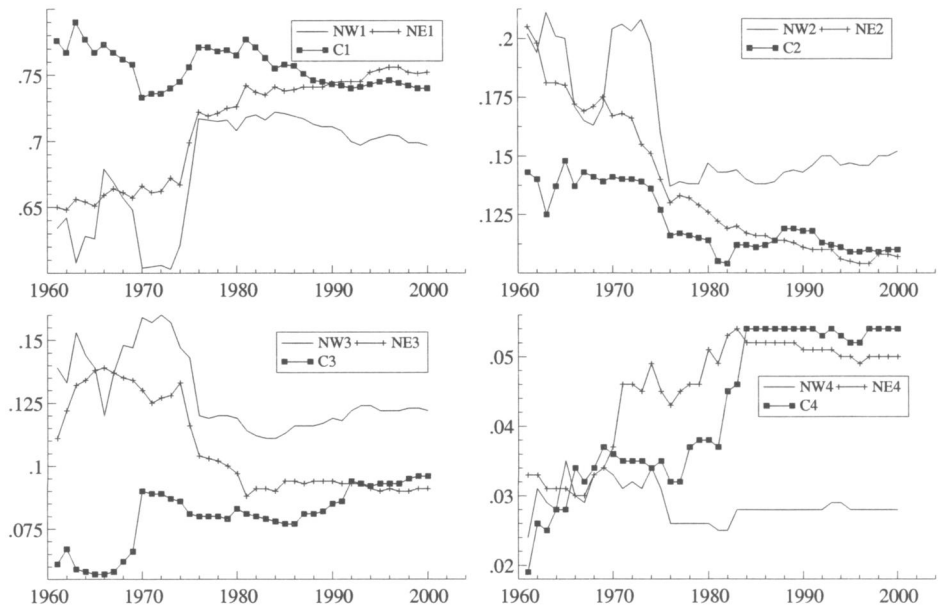


FIGURE 7 - *Cyclical components, proportion of explained variance associated with the four largest eigenvalues (North-West (NW), North-East (NE), Centre (C)).*

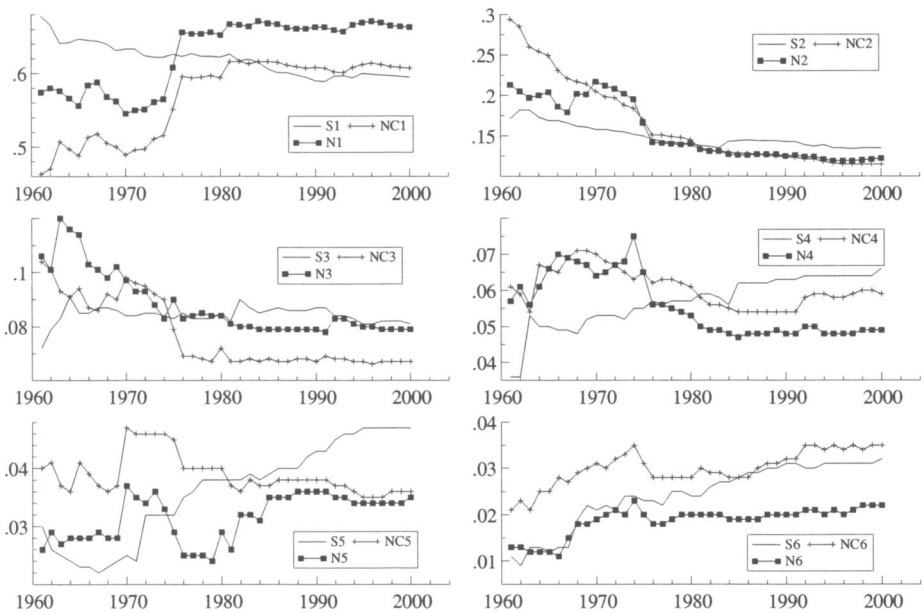


the contrary, the Centre macroregions does not seem to have experienced any significant change in the coordination of fluctuations, albeit the coordination of cyclical fluctuations was strong already in the 1960s. In all of the cases, albeit the bulk of fluctuations is associated with the first factor, also the second and third factor yield some contributions. Similar conclusions can be drawn for the South (Figure 8). In fact, also in this latter case the proportion of explained variance associated with each eigenvalue does not seem to have changed significantly over time and at least three factors would seem to be necessary to explain the bulk of fluctuations. Finally, the conclusion in favour of the progressive convergence of cyclical fluctuations for northern regions still holds when the North and Centre-North macroregions are considered.

5. Conclusions

In the paper we have assessed the convergence hypothesis for the Italian economy using a larger sample (1951-2000) than the one employed in previous studies, and a new methodological approach. The approach draws on Carvalho-Harvey (2002) and Luginbuhl-Koopmans (2003), but, differently from these latter works, can be implemented also when the cross-sec-

Figure 8 - *Cyclical components, proportion of explained variance associated with the six largest eigenvalues (North (N), North + Centre (NC), South (S)).*



tional dimension is large. The methodology is based on a two-step recursive principal components estimator, allowing to monitor the progress of the convergence process over time and to distinguish between steady-state and transitional dynamics. By controlling for transitional dynamics, the conclusions drawn on trend convergence should be therefore reliable. In the paper we have also investigated the evolution over time of the cross-sectional distribution of per capita GDP, as performed by Quah (1993b). The overall conclusion of our work is in favour of a two-speed convergence process. Since the 1980s the North macroregions would have experienced a convergence phase in both trend and cyclical dynamics, while for the Centre and South macroregions convergence is only occurring in trend dynamics (since the 1980s for the Centre, and since the 1960 for the South), albeit for the Centre the coordination of cyclical fluctuations was strong already in the 1960s. However, unconditional convergence towards the high per capita income state is a long-run process still in progress, requiring more time for the less well-off southern regions than for the other regions. Finally, given the potentiality for unconditional convergence detected in the data and the observed dynamics, our results point to a positive role for regional policies in promoting economic convergence.

References

BARRO, R. – SALA-I-MARTIN, X. (1992), "Convergence", *Journal of Political Economy*, vol. 100(2), pp. 223-51.

BARRO, R. – SALA-I-MARTIN, X. (1991), "Convergence across States and Regions", *Brookings Papers in Economic Activity*, vol. 1, pp. 107-82.

BINDER, M. – PESARAN, M.H. (1999), "Stochastic Growth Models and Their Econometric Implications", *Journal of Economic Growth*, vol. 4, pp. 139-83.

BERNARD, A.B. – DURLAUF, S.N. (1995), "Convergence in International Output", *Journal of Applied Econometrics*, vol. 10, pp. 97-108.

BERNANKE, B.S. – GURKAINAK, R.S. (2001), "Is Growth Exogenous? Taking Mankiw, Romer and Weil Seriously", manuscript, Princeton University.

CARVALHO, V.M. – HARVEY, A.C. (2002), "Growth, Cycles and Convergence in US Regional Time Series", manuscript, University of Cambridge.

CASS, D. (1965), "Optimum Growth in an Aggregative Model of Capital Accumulation", *Review of Economic Studies*, vol. 32, pp. 233-40.

CELLINI, R. – SCORCU, A.E. (1995), "How Many Italies? What Data Show about Growth and Convergence across Italian Regions, 1970-1991", Di-

partimento di Scienze Economiche, Università di Bologna, working paper no. 215.

CELLINI, R. – SCORCU, A.E. (1996), "Istituzioni, Stabilità e Crescita nelle Regioni italiane", manuscript, Università di Bologna.

CIRIACI, D. (2001), "Convergenza e Dualismo: Nord e Sud tra il 1970 e il 1999", *Rivista Economica del Mezzogiorno*, vol. 15(4), pp. 763-802.

D'AMATO, M. – PISTORESI, B. (1997), "Statistical Evidence on Regional Cohesion in Italy", *Giornale degli Economisti e Annali di Economia*, vol. 56(3-4), pp. 211-34.

DI LIBERTO, A. (1994), "Convergence Across Italian Regions", Nota di Lavoro della Fondazione ENI Enrico Mattei, no. 68.94.

EVANS, P. (1996), "Using Cross-Country Variances to Evaluate Growth Theories", *Journal of Economic Dynamics and Control*, vol. 20, pp. 1027- 49.

EVANS, P. – KERRAS, G. (1996), "Convergence Revisited", *Journal of Monetary Economics*, vol. 37, pp. 249-65.

FELICE, E. (2002), "Le Politiche Economiche Regionali in Italia e nel Regno Unito (1950-1989)", *Rivista Economica del Mezzogiorno*, vol. 1(2), pp. 1-20.

FRIEDMAN, M. (1992), "Do Old Fallacies Ever Die?", *Journal of Economic Literature*, vol. XXX(December), pp. 2129-2132.

GORIA, A. – ICHINO, A. (1994), "Migration and Convergence among Italian Regions?", Nota di Lavoro della Fondazione ENI Enrico Mattei, no. 51.94.

HARVEY, A.C. (1989), *Forecasting, Structural Time Series Models and the Kalman Filter*, Cambridge UK, Cambridge University Press.

HOBIJN, B. – FRANSES, P.H. (2000), "Asymptotically Perfect and Relative Convergence of Productivity", *Journal of Applied Econometrics*, 15, 59-81.

ISLAM, N. (2003), "What Have We Learnt From the Convergence Debate?", *Journal of Economic Surveys*, vol. 17(3), pp. 310-62.

KOOPMANS, T.C. (1965), "On the Concept of Optimal Economic Growth", *Scientific Papers of Tjialling C. Koopmans*, New York, Springer.

LA FERRARA, E. – MARCELLINO, M. (2000), "TFP, Costs and Public Infrastructure: An Equivocal Relationship", IGIER Working Paper Series, no. 176.

LEE, K. – PESARAN, M.H. – SMITH, R. (1995), "Growth and Convergence: A Multi-Country Empirical Analysis of the Solow Growth Model", DAE Working Papers, University of Cambridge, no. 9531.

LUGINBHUL, R. – KOOPMANS, S.J. (2003), "The Common Converging Trend-Cycle Model: Estimation and Application to European Convergence", mimeo, Free University, Amsterdam.

MAURO, L. – PODRECCA, E. (1994), "The Case of Italian Region: Convergence or Dualism?", *Economic Notes*, vol. 23(3), pp. 447-72.

PACI, R. – PIGLIARU, F. (1995), "Differenziali di crescita nelle regioni italia-

ne: un'analisi cross-section", *Rivista di Politica Economica*, vol. 10(2), pp. 3-34.

PACI, R. – PIGLIARU, F. (1995b), "β-convergence and/or Structural Change? Evidence from Italian Regions", Nota di Lavoro della Fondazione ENI Enrico Mattei, no. 72.95.

PACI, R. – SABA A. (1997), "The Empirics of Regional Economic Growth in Italy. 1951-1993", CRENOS, Contributi di Ricerca, no. 97/1.

PIRAS, G. (1992), "Convergenza Economica tra le Regioni Italiane", Working Paper n.10, Università di Cagliari, Dipartimento di Scienze Politiche.

QUAH, D. (1993b), "Galton's Fallacy and Tests of the Convergence Hypothesis", *The Scandinavian Journal of Economics*, vol. 95(4), pp. 427-43.

QUAH, D. (1993), "Empirical Cross-Section Dynamics in Economic Growth", *European Economic Review*, vol. 37(2), pp. 426-34.

QUAH, D. (1997), "Empirics for Growth and Distribution: Stratification, Polarization and Convergence Clubs", *Journal of Economic Growth*, vol. 2, pp. 27-59.

QUAH, D. (1996), "Empirics for Economic Growth and Convergence", *European Economic Review*, vol. 40, pp. 1353-1375.

SALA-I-MARTIN, X. (1996), "Regional Cohesion: Evidence and Theories of Regional Growth and Convergence", *European Economic Review*, vol. 40, pp. 1325-1352.

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