How many Italies?

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What Data Show about Growth and Convergence across Italian Regions, 1970-91.*

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Abstract -- The paper analyses the evidence about the growth of the Italian regions over the period 1970-91; in particular it studies the beta-convergence across regions, the convergence of each region towards its possible steady-state equilibrium path and the existence of groups of regions sharing the same stochastic trend. Besides the specific results on Italian regions, the paper provides and analyses some applications of different econometric methods for the investigation of the growth process.

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1. INTRODUCTION

While there exists a large set of different econometric studies analysing the national growth process, the set of studies focusing on the growth of regions is more restricted. Among the latter, Barro and Sala-i-Martin (1991, 1992 and 1995) advocate the use of available regional accounting data, and implement cross-sectional studies. They find a robust evidence of regional convergence; in particular, the convergence across the States of the USA and across regions of Europe appears to occur slowly but steadily, at a rate equal to 2% per year.

Our purpose is to investigate some features of the growth process of Italian regions in three different but related aspects: we study the convergence across the regions, the convergence of each region towards a possible steady-state equilibrium path, and the possible existence of different clubs of converging regions.

We are aware of the fact that inequality and convergence have many facets, but we limit ourselves to the analysis of some of them. In particular, we do not investigate the economics of Italy's "dualism" which is a major issue in Italian regional economics; moreover, we do not investigate the issue of structural changes within a region and across regions. To this respect, our paper follows the recent econometric literature about growth and convergence, and shows the features of the different econometric methods employed by this literature.

Three different methods are proposed to deal with the issue of convergence. First, we consider cross-sectional studies to assess the importance of different factors on the growth in different territories over a given period of time. This method is perhaps the most commonly used in the econometrics of growth: Levine and Renelt (1992) and Fischer (1993) list about fifty studies of this kind published between 1980 and 1990. The explanatory variables considered are generally suggested by exogenous as well as endogenous growth models. In our sample, we find a different performance in growth through the Eighties, compared to the Seventies; in particular the catching-up effect appears to be more significant in the first period rather than in the second.

In the following section, we test the hypothesis of convergence of each region towards a steady-state equilibrium path, which is assumed to be determined by stochastic variables, and evaluate how current labour productivity moves with respect to its steady state equilibrium level. To this purpose, we pool the annual data of each region to form a panel. Obviously, the annual frequency of data requires particular caution and we have to separate the high-frequency (i.e. short-run) movements in data from the low-frequency (long-run) components; moreover, we have to take into account the presence of individual regional effects in the panel. The result about the convergence towards specific regional steady state paths is rather strong: this kind of convergence emerges as a robust outcome.

Finally, different convergence criteria for couples of regions are proposed and assessed. The first one relies upon the concept of "stochastic convergence" suggested by Bernard and Durlauf (1991 and 1993). The second one entails short-run deterministic transition to the same level of labour productivity, and the third one allows for a stochastic formulation of short-run dynamics. All these approaches make use of the tools provided by unit-root and cointegration literature. In particular, cointegration between the labour productivity time series of different regions is necessary although not sufficient condition for stochastic convergence to occur.

A peculiar result is the presence of different sub-groups of Italian regions sharing the same unit root in labour productivity time series; pairs of regions belonging to the same sub-group show stationary and zero-mean differences. Transitional dynamics helps to select groups of regions where stochastic convergence does occur.

Our conclusion is that the "(stochastic) local convergence" appears more convincing than "(stochastic) global convergence", even for regions within one country.

The results of our paper are not at variance with the usual picture that shows persistent differences in the economic performance of Italian regions. However, our evidence suggests that the framework is more complex than the traditional one, based on the bipartition North-Centre and South of Italy. As a matter of fact, the convergence of the labour productivity levels across regions appears to operate only for limited periods and for restricted groups of regions.

The structure of the paper is the following: section 2 illustrates the data; section 3 presents evidence from cross-sectional regressions; section 4 presents panel data estimations on the convergence of regions towards their equilibrium paths; section 5 deals with the time-series analysis and stochstic convergence; the conclusions are drawn in section 6.

2. THE DATA

National or regional convergence, if it occurs, appears as a slow process. Because of the very nature of the phenomenon, a careful investigation of convergence should cover a rather long time span; this requirement puts an obvious limit on the significance of the empirical investigations[1].

For Italy, the Central Statistical Office, ISTAT, has recently released newly improved regional income accounts for the period 1980-1991; SVIMEZ, an agency for the economic development of the southern regions, extended the accounts back to 1970, following similar methodologies, so that an analysis on reliable and homogeneous data is possible over the period 1970-91. The twenty regions of Italy are listed and shown in fig. 2.1.

fig. 2.1

Convergence of the Italian regions is analyzed using labour productivity - real GDP divided by standard units of labour[2]. Both GDP and standard unit of labour series represent the only homogeneous sources currently available at the regional level.

We decide to use a labour productivity variable rather than per capita income or per capita GDP, for several reasons. First, and most importantly, labour productivity is the variable upon which technological progress convergence is better assessed; secondly, the administrative figures for regional population are scarcely reliable[3]; finally, the series of standard units of labour take into account important aspects of labour market (part-time and irregular work) that differ across regions[4]. Thus, the variable we

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[1]For country's convergence, the conventional wisdom supports the use of the data set of Summers and Heston (1991) or Maddison (1991), while for regional analysis the situation is less clearcut. Barro and Sala-i-Martin (1991, 1992) use data from 1840 to 1988 for personal income, and from 1963 to 1986 for GDP. A recent attempt to look at the regional convergence in Italy over the period 1963-1989 is the work of Mauro and Podrecca (1994), who consider data from three different sources, which are not homogeneous. Paci and Pigliaru (1993) use the same sources as ours, but limited to 1989.

[2] Standard units of labour take into account part-time and some forms of irregular jobs; for a description see ISTAT (1990).

[3]An upward bias of the figures on population emerge in inter-census years for almost all regions. This outcome might be due to the fact that a significant share of the government expenditures and transfers is granted on per capita basis; it is not surprising, therefore, that the regions usually do not update administrative figures, especially when a cancellation is required. In some cases the differences are particularly striking by all standards; in Basilicata, for example, in 1971 and 1991 the population drops, with respect to the previous years, by 2.8%.

[4] The underground economy is important in Italy (from 6% to 24% of the GNP, a figure comparable with Germany and USA), and in this respect there is no uniformity between the different regions: our measure of productivity should reduce this potential source of bias in the empirical analysis.

mainly consider is the log of output per total units of labour: in what follows, we use the expression "labour productivity", referring to "GDP per standard units of labour".

In sections 3 and 4 we use also data on gross fixed investment and household and collective consumption, provided by the same sources. Data construction follows the traditional accounting practices and is described in ISTAT (1990) and SVIMEZ (1994). Investment comprises residential and non-residential construction, public expenditure on infrastructure, equipment and vehicles. Households consumption comprises expenditures on durables, non-durables and services. Collective consumption refers to public and private non-profit organization expenditure on non-durables. The data on education are from ISTAT (1963, 1973). If not otherwise specified, all variables are in log.

3. REGIONAL CONVERGENCE: EVIDENCE AND LIMITS OF THE BARRO-TYPE REGRESSIONS.

A large amount of literature is devoted to the cross-section analysis of convergence across countries. Generally this kind of convergence is regarded as a major element for accepting or rejecting the neoclassical growth model. We do not agree with this interpretation. In fact, neoclassical growth models, such as Solow's, predict convergence towards a steady state path, determined by a set of parameters, and economies sharing the same parameters converge to the same steady state path. However, convergence among economies could occur for reasons different from those taken into account by neoclassical models. On the other hand, even when a Solow-type model is assumed, we do not expect convergence among economies, if parameters differ across economies. Therefore, our purpose is not to test the neoclassical model by looking at the convergence across regions; more simply, we aim at assessing the convergence process, and we do not draw any conclusions on neoclassical models.

The first concept of "convergence" that we consider is concerned with the reduction in dispersion indices over time; Barro and Sala-i-Martin (1990) label this kind of convergence as sigma-convergence. In the case of Italian regions the standard deviation (equal to 0.156 in 1970) decreased over the Seventies; it reached the minimum value (0.123) in 1980 and since then it has been increasing (0.147 in 1990). This fact could indicate that the process of convergence occurring through the Seventies has been stopped at the beginning of the Eighties.

A second concept of convergence (beta-convergence in the Barro and Sala-i-Martin terminology) is concerned with the catching-up effect. Beta convergence is said to occur if a negative relation between the growth rate (of labour productivity) during a given period of time and the (labour productivity) level at the beginning of the period is found in a set of economies.

We consider *conditional* beta convergence, i.e. we consider additional variables determining the growth rate, besides the initial productivity level and a constant.[5] The question we have to address is: What are the additional variables to be considered?.

We begin with the variables suggested by the neoclassical growth theory and then we take into account further variables suggested by endogenous growth models. According to the standard neoclassical growth theory, the steady state level of labour productivity and the labour productivity growth rate during the transition towards equilibrium are determined by the propensity to accumulate physical capital, human capital (when it appears among the inputs in production function), and by the growth rate of employment. As a first exercise, we regress the growth rate of labour productivity on variables that are proxies of the three mentioned factors; then we consider also the effect of public spending. We run two separate regressions for the periods 1970-80 and 1980-90. The results are summarized in Table 3.1.

[5] It is quite surprising that a large amount of literature looks at the unconditional beta convergence with interest, while it is well known that such regressions provide biased estimation, since relevant variables are omitted. For the sake of curiosity, unconditional beta convergence emerges across Italian regions during 1970-80 (β=-0.028, t=-3,67), but not during 1980-90 (β=0.014, t=1.78); the regression over 1970-90 would provide β=0.009, t=-1.64.

TABLE 3.1 - CONDITIONAL CONVERGENCE UNDER ALTERNATIVE SPECIFICATIONS

Dependent variable: annual average growth rate of labour productivity over the decade 1970-80.
Number of observations: 20.

	(1)	(2)	(3)	(4)	(5)
C	0.16	0.17	0.14	0.21	0.21
	(6.27)	(5.96)	(5.84)	(7.96)	(8.86)
Y0	-0.04	-0.03	-0.03	-0.07	-0.07
	(-5.58)	(-4.33)	(-4.52)	(-6.62)	(-7.27)
LSEC60	0.01	0.01	0.02	0.01	0.01
	(1.61)	(1.70)	(3.02)	(2.43)	(2.87)
DLLAVD	-0.006	-0.003	-0.01	-0.005	
	(-0.34)	(-0.19)	(-0.74)	(-0.37)	
ALSKD	-0.013			-0.004	
	(-2.53)			(-0.80)	
ALIWD		-0.011			
		(-1.99)			
DLINVD			0.014		
			(2.89)		
ALGDPD				-0.02	-0.02
				(-2.99)	(-4.49)
R^2	0.68	0.63	0.70	0.80	0.79
SER	0.004	0.004	0.004	0.003	0.003

Dependent variable: annual average growth rate of labour productivity over the decade 1980-90.
Number of observations: 20.

	(1)	(2)	(3)	(4)	(5)
C	-0.003	-0.1	0.02	0.11	0.12
	(-0.10)	(-0.29)	(0.39)	(1.95)	(2.21)
Y0	0.004	0.009	0.001	-0.04	-0.04
	(0.38)	(0.95)	(0.13)	(-1.90)	(-2.18)
LSEC60	0.003	0.005	0.006	0.009	0.01
	(0.35)	(0.61)	(0.82)	(1.25)	(1.70)
DLLAVD	-0.03	-0.03	-0.05	-0.02	
	(-1.38)	(-1.42)	(-1.89)	(-0.94)	
ALSKD	-0.004			-0.001	
	(-0.70)			(-0.19)	
ALIWD		0.002			
		(0.03)			
DLINVD			0.011		
			(1.19)		
ALGDPD				-0.02	-0.02
				(-2.51)	(-3.08)
R^2	0.30	0.28	0.34	0.52	0.48
SER	0.004	0.004	0.004	0.004	0.005

Notes: C is the constant, Y0 the log of labour productivity at the beginning of the period, LSEC60 the log level of the secondary school enrollment rate in 1960, DLLAVD the growth rate of standard units of labour over the period; ALSKD is the share of investment in GDP (in log, average value over the decade), ALIWD the investment per standard unit of labour (in log, average value over the decade), DLINVD the growth rate of investment during the decade, ALGDPD the share of public consumption in GDP (in log, average value over the decade).

Based on our regional data, there is robust evidence of conditional beta convergence for the period 1970-80, while no similar tendency emerges in the subsequent period - when the situations is less clearcut. Even in the specification where convergence appears to be statistically significant, its importance is lower during the Eighties than during the Seventies.

The log of secondary school enrollment rate in 1960, (LSEC60), is the proxy for the human capital accumulation variable; we chose to consider its value in 1960, because the effects of such investments are of the long-run type. School enrollment rates are common proxies for human capital accumulation propensity (see Mankiw, Romer and Weil (1992)), although other choices are possible as well (see Barro and Lee (1993)): for instance, we considered the literacy rates and measures about the "quality" of human capital (even if it is not easy to count on meaningful data), but did not find any robust regressor. The level of secondary school enrollment rate appears to have a positive -- although not particularly strong -- effect on the growth rate of labour productivity.

The coefficient of the employment growth is almost always negative, as the theories predict, but it is not highly significant.

Regarding physical capital accumulation, we consider different variables alternatively; however, we should avoid the mistake of interpreting these variables as proxies for the saving rate: remember that the neoclassical model about a closed economy under conditions of perfect competition assumes aggregate savings equal to investments and consequentely the ratio of investment/GDP is also the average propensity to save[6]. A worrisome aspect is the variability of the coefficient of the physical capital accumulation variables. Neither investment per standard unit of labour, nor the investment share in GDP presents a significant, positive coefficient, contrarily to what emerges regularly from previous empirical analysis on cross-country growth (see Levine and Renelt, 1992). For Italy this is a well-known result, obtained also by Paci and Pigliaru (1994) and Mauro and Podrecca (1994). Public subsidies based on questionable schemes and misallocation in investment partly help to explain this outcome.

Finally, an important aspect deserving attention is public spending. Theoretical and empirical work about the effects of public spending on long-run economic growth is not unanimous. Neoclassical models with exogenous technological progress predict that public spending does not affect the growth rate, but simply causes crowding-out effects. In the endogenous growth framework, the argument is not so simple and the effects depend on the types of public spending: Barro (1990) argues that public spending devoted to making property rights more certain (such as investment in defence or police) is a

[6]In our regional data a negative effect of the regressor ALSKD -- as it appears in column (1) of table 3.1 -- does not necessarily mean a negative effect of the saving rate, mainly because we are dealing with open economies and because of all the reasons that force a departure from the equality between investments and savings.

source of greater economic growth, as well as spending for public infrastructures. By contrast, public consumption expenditures, as long as they determine a reduction in investment by the private sector, causes lower economic growth. The results by recent econometric works actually depend on how public consumption data are calculated; without public investment, they generally support the evidence that collective consumption determines a reduction of private investment and (consequently?) a reduction of the economic long-run growth rate[7]. As we noted in section 2, our series on collective consumption includes all kinds of collective consumption. The result is very clear and striking: public spending level always appears harmful to growth.

Note that in column (4) of Table 3.1 the inclusion of public spending determines a reduction in significance of the private investment variable. It is worthwhile to note that a test on Granger-causality (both with one and with two lags), on all the pooled annual observations, accepts that public spending is not Granger-caused by investment, while rejects the non-Granger causality of LG on LINV, at the 95% level of confidence[8]. If we delete the variable of private investment (as well as the faintly significant employment growth rate) from regressions, we derive the results printed in columns (5) of Table 3.1, that we consider as the final outcome of cross-section regressions.

Cross-section estimations are "inefficient", since they use only one datapoint for each contry. In fact, it is possible to study the same problem by considering five-year period data, i.e. by using quinquennial panel data. However, the evidence from this kind of data[9] confirms the results of the more usual cross section regressions.

In the following estimation, the growth rate over a quinquiennium (1970-75, 75-80, 80-85, 85-90) is regressed upon the level of labour productivity at the beginning of the quinquennium, and other explanatory variables: (i) the average value of investment per standard unit of labour over the quinquennium; (ii) the secondary school enrollment rate in 1960, which varies among regions but not over the quinquennia for a given region (it is a sort of individual, observable effect); (iii) the employment growth rate: since we are using log, to avoid negative values we consider the log of

[7]See Easterly and Rebelo (1993) for a review on theoretical and empirical relations between growth and fiscal variables.

[8]The correlation (on all the pooled annual observation) between LINV and LG is equal to 0.977, the correlation between the investment over GDP and the collective consumption over GDP is 0.594, while the correlation between investment per standard unit of labour and collective consumption per standard unit of labour is 0.300. The F-test for the null hypothesis "LINV is not Granger-caused by LG, one (two) lags" gives F=17.85 p-value=0.0000 (F=12.83, p-value=0.0000), while "LG is not Granger-caused by LINV" gives F=0.22, p-value=0.64 and F=0.27, p-value 0.76 (one or two lags, respectively).

[9]Brander and Dowrick (1992), Easterly, Kremer et al. (1993), and Knight et al. (1994) among many others use quinquennial panel data.

employment growth rate plus 0.25;[10] (iv) the collective consumption.

The results of panel data regression are in Table 3.2 - column (1); all tests on individual effects allow for the consideration of total OLS regression: no individual effects appear in regressions.[11] Moreover, no problem of endogeneity arises: TSLS give estimates very similar to those obtained by OLS.[12] Thus, our comments will be on total-OLS estimates.

Note that the catching-up effect is highly significant, the public spending has a negative, highly significant effect on growth, while investment ratios are not significant.

As further exercises on longitudinal data, we split the sample according temporal or geographical criteria. If we split the sample into two parts, 1970-80 and 1980-90, each of them with 40 quinquennial observations, the results would be substantially similar in the subsamples and similar to the total regression. For the sake of brevity, we do not report these results (availabe from the authors). The results deriving from the split according to the geographical criterion are reported in Table 3.2: we split the sample into three subsamples, constituted by the Northern, Central and Southern regions. In none of the three regressions are individual effects significant, and total OLS estimation has been run.

[10] Also in Mankiw, Romer and Weil (1992) or Durlauf and Johnson (1992), 0.05 is added in each annual observation of the employment growth rate: they do that, not only for mathematical convenience, but mainly because their purpose is to test the implications of Solow's model that consider (n+g+d) as a variable, where n is the employment growth rate and (g+d) is the sum of exogenous technological progress rate and capital depreciation rate; such sum is assumed equal to 0.05.

[11] The main problem in panel data regression is the control for heterogeneity across the individual units (regions, in the present case) considered. Depending on the existence and nature of "individual effects", it is possible to run: (1) total OLS regression, when no individual effects exist; (2) OLSD or within-estimation, which allows for a different intercept term for every individual unit, and this different constant captures an effect that is unobservable but correlated with other regressors; (3) "random-effects estimation", when the individual effects are assumed to be uncorrelated with the regressors and constituting a part of the error; (4) between-estimators that remove individual effects, by considering only the individual means for each variable. A comprehensive reference can be Hsiao (1986).

[12] The problem of endogeneity could arise especially for investments; other variables are assumed exogenous. Anyway, TSLS estimations give results very similar to those obtained by OLS.

TABLE 3.2 - EVIDENCE FROM QUINQUENNIAL LONGITUDINAL DATA

Dependent variable: quinquennial growth rate of labour productivity.
(Total OLS regression)

	ITALY	NORTH	CENTRE	SOUTH
Num. of regions	20	7	5	8
Num. of observ.	80	28	20	32
C	0.75	0.44	0.35	0.28
	(3.90)	(1.42)	(0.60)	(0.67)
Y0Q	-0.23	-0.01	-0.21	-0.23
	(-3.30)	(-0.13)	(-1.23)	(-4.07)
ALIWQ	-0.02	-0.04	0.08	-0.02
	(-0.99)	(-0.69)	(0.69)	(-0.49)
LSEC60	0.05	0.08	-0.05	-0.0009
	(1.89)	(1.42)	(-0.21)	(-0.005)
LNGDQ	-0.04	0.11	0.03	-0.15
	(-0.91)	(1.33)	(0.25)	(-2.65)
ALGWQ	-0.10	-0.01	-0.13	-0.24
	(-2.96)	(-0.20)	(-0.95)	(-2.36)
R^2	0.61	0.18	0.21	0.59
SER	0.014	0.05	0.06	0.04
Tests for individual effects				
Test F	$F_{19,55}$=0.262	$F_{6,16}$=0.652	$F_{4,10}$=0.018	$F_{7,19}$=0.122
(P-value)	(0.998)	(0,688)	(0.999)	(0.996)
θ stat.	0.734	0.505	0.972	0.847

Note: Y0Q is the (log) level of labour productivity at the beginning of quinquennium; ALINVQ is the average (log) level of investment over the quinquennium; LSEC60 is the (log) of secondary school enrollment rate in 1960; LNGDQ the log of the growth rate of labour in standard units plus 0.25; ALGWQ the average value of (log) of public consumption per standard unit of labour over a five-year period. Stat. F for individual effects tests [Ai,B]=[A,B]; θ stat.: 0=ind.eff., 1=OLS total.

Comments must focus on the fact that important differences emerge. In particular, conditional convergence is much more significant within Southern Italy than in the other parts. Moreover, in Northern and Central Italy the performance of the regression is worse than in Southern Italy; this fact could be a signal of actual *local* convergence within the regions groups. Note that neither Northern Italy nor Central Italy constitutes a club of converging regions, while the South could be a converging regions group (although further splits could reverse this result). In section 5 the issue of local convergence will be analysed again, using a different method, but the suspicion that local --rather than global-- convergence across regions occurs will be confirmed.

4. DO REGIONS CONVERGE TOWARDS THEIR OWN STEADY STATE PATH?

If we aim at assessing convergence, using all annual observations, a new problem arises: we must take into account that the annual data contains high-frequency movements that could hinder the study of the determinants of long-run growth; hence, we have to consider further regressors for describing such short-run movements. Thus, two groups of variables are present in the regression specification: those capturing the long-run determinants and those related to short-run movements.

Long-run movements are captured by adjustment dynamics toward an equilibrium steady state path, of neoclassical type. Such an equilibrium path for labour productivity is determined by the propensity to accumulate capital, by the sum of growth rate of employment, plus the exogenous technical progress and the capital depreciation rate; moreover a linear time trend, with slope equal to the exogenous technical progress rate, is present. Denoting the (log)level of the steady-state equilibrium of labour productivity (at time t) by y^*_t, we can write:

(4.1) $$y^*_t=y^*(c,\ T_t,\ s^K_t,\ s^H_t,\ (n_t+g+d)),$$

where c is a constant, T a linear time trend, s^K and s^H the propensities to accumulate physical and human capital, (n+g+d) is the sum of employment growth rate with technical progress rate and capital depreciation, which is assumed to be the same for physical and human capital. Standard neoclassical models consider s^K, s^H and n as constant parameters, while we consider them as variables: in fact, they vary greatly not only across regions, but also over time in a given region;[13] as a consequence, also the equilibrium level of labour productivity varies over time and across regions. In the neighbourhood of its equilibrium paths, the labour productivity moves according to the following[14]:

(4.2) $$\Delta y_{t+1} = (y_{t+1}- y_t) = g + b\ (\ y_t\ -\ y^*(a,\ T_t,\ s^K_t,\ s^H_t,\ (n_t+g+d))$$

Notice that equation (4.2) describes an error correction mechanism and b has to be a negative parameter for stability: if the current labour productivity at time t is greater than its equilibrium value, the current labour productivity will decrease in the next period and it will increase if the

[13]In particular s^K and n vary over time; since we do not possess annual data for the secondary school enrollment rate and this variable is rather stable over time within each region, we will consider s^H_t constant over time in the following regressions.

[14]See Mankiw-Romer-Weil (1992) or Barro-Sala i Martin (1995) for the analitical derivation.

current value is less than the equilibrium value. As it is usual in models with an error correction mechanism, a short-term part of dynamics can be considered for capturing the short-run components of Δy. The simplest choice is to use the annual first-differences of regressors included in the long-term part, and the first difference of public spending (ΔG), as responsible for the short-run movements of Δy_t . Thus our complete error correction model, (ECM), in linear form, can be written as follows:

$$(4.3) \qquad \Delta y_{it} = \alpha_1 + \alpha_2 T_{t-1} + \alpha_3 s^K_{it-1} + \alpha_4 s^H_{it-1} + \alpha_5(n_{it-1}+g+d) + \alpha_6 y_{it-1} + \\ + \gamma_1 \Delta s^K_{it} + \gamma_2 \Delta(n_{it}+g+d) + \gamma_3 \Delta G_{it} + u_{it}$$

A negative value of coefficient α_6 is a necessary condition for convergence: $-1<\alpha_6<0$ is the necessary and sufficient condition for convergence towards steady-state to occur.[15] Moreover, according to neoclassical theory, we expect $\alpha_2>0$, $\alpha_3>0$, $\alpha_4>0$, $\alpha_5<0$. Growth theory does not make predictions about the signs of short-run components' coefficients; however, the short-run regressors (whose coefficients are denoted by γ in (4.3)) have to be considered in order to wash out the high frequency components in y_t, so that annual data can be used to study the long-run growth.

We should expect that the error term u_{it} entails an individual effect, so that $u_{it}=e_i+v_{it}$ (v_{it}=zero mean white noise); we will show below that this is actually the case. Remember that such an effect, e_i, can be "fixed" or "random" (see footnote 11), but -- given the nature of the data sample we are dealing with -- we have no doubt in considering individual effect as fixed.

Let us now consider the estimation of the ECM, in Table 4.1. We present the result of regression with log(INV/GDP)=LSK (PLSK denotes its lagged value) as a regressor for the physical capital accumulation propensity; if we considered different variables (the level of investment or investment per unit of labour), no substantially different result would be obtained.

Consider the tests on individual effects reported in Table 4.1: they show that such effects are present, so that only the within-estimator gives reliable results. The vector of individual dummy coefficients is printed in Table 4.1.bis. As it is well known, the individual effect captures an unobservable effect, so that we cannot offer a structural interpretation; in any case, note that in Northern Italy the dummy coefficients are generally larger than in the South; the highest value is in Lombardia, while the lowest is in Basilicata.

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[15]Recently, economic models tend to overlap ECM with the issues of unit-root and cointegration, in the line of Granger's representation theorem. The interpretation of the neoclassical growth model we are proposing here is also consistent with cointegration theory: note that y, the current labour productivity, possesses a unit root, as well as its equilibrium paths' determinants and the equilibrium level itself, y*. If y and y* are cointegrated, the coefficient α_6 in (4.3) is such that $-1<\alpha_6<0$ and the first difference of current labour productivity is a stationary process. See Cellini (1994) for further details about this stochastic interpretation of Solow's model; see also Quah (1993) and Easterly, Kremer et al. (1993).

TABLE 4.1 - REGRESSION ON ECM WITH ANNUAL DATA, 1972-1991.

Dependent variable: annual growth rate of labour productivity.
(Fixed effects estimation.)

Num. of regions	20	
Num. of observ.	400	
T	0.004	(6.94)
PLSK	0.03	(3.12)
LSEC60	---	
PLNGD	-0.02	(-4.41)
Y0	-0.25	(-8.25)
DLINV	0.14	(8.72)
DLNGD	-0.02	(-6.12)
DLG	0.03	(0.38)
R^2	0.35	
SER	0.022	

test for [a,b]=[ai,bi]: F (171,220)=1.61, p-value=0.0005
test for [a,b]=[ai,b]: F (19,372)=3.92, p-value=0.0000
test for [ai,b]=[ai,bi]:F (152,220)=1.27, p-value=0.0542
Θ-stat (0=ind.eff;1=total) : Θ=0.269.

Note: with respect to the equation (4.3): T denotes the linear trend; PLSK=s^K_{it-1}; LSEC60 is the empirical counterpart of s^H_i, assumed constant over time in each region; PLNGD=(n_{it-1}+0.06); Y0=y_{it-1}; DLINV is the annual first difference of investment; DLNGD is the annual first difference of LNGD, and DLG is the first difference of public expenditure.

TABLE 4.1.bis - FIXED EFFECT COEFFICIENTS IN WITHIN-ESTIMATION OF TABLE 4.1

(1)	PIEMONTE	0.558	(11)	MARCHE	0.532
(2)	VAL D'AOSTA	0.523	(12)	LAZIO	0.568
(3)	LOMBARDIA	0.581	(13)	ABRUZZO	0.508
(4)	TRENTINO A.A.	0.526	(14)	MOLISE	0.454
(5)	VENETO	0.547	(15)	CAMPANIA	0.499
(6)	FRIULI V.G.	0.548	(16)	PUGLIA	0.503
(7)	LIGURIA	0.570	(17)	BASILICATA	0.441
(8)	EMILIA R.	0.566	(18)	CALABRIA	0.462
(9)	TOSCANA	0.550	(19)	SICILIA	0.512
(10)	UMBRIA	0.516	(20)	SARDEGNA	0.505

We consider the regression in Table 4.1 as an interesting and satisfactory result. The signs of coefficients are in accordance with the theory. Note that the equilibrium is not the same across the regions and therefore we allow for the equilibrium level differing through time as well as across regions. As a consequence convergence *across regions* cannot be inferred from this regression. By contrast, as a matter of fact, this piece of evidence indicates that the error correction mechanism is operative, i.e. the convergence of each region towards its (stochastic) steady state path actually occurs.

The last exercises of this section are panel-data regressions on split samples. We split the sample into two sub-samples (1972-81 and 1982-91), each of them with all 20 regions, and the results are reported in Table 4.2 (only fixed-effects estimations are printed, since all tests support this choice).

TABLE 4.2 - REGRESSION ON ECM IN THE SEVENTIES AND IN THE EIGHTIES.

Dependent variable: annual growth rate of labour productivity.
(Fixed effects estimation)

	1972-1981		1982-1991	
Num. of regions	20		20	
Num. of observ.	200		200	
C	---		---	
T	0.01	(5.76)	0.01	(9.36)
PLSK	0.05	(2.74)	0.06	(3.02)
LSEC60	---		---	
PLNGD	-0.03	(-3.94)	-0.01	(-3.37)
Y0	-0.43	(-7.23)	-0.46	(-8.51)
DLINV	0.14	(7.37)	0.06	(2.92)
DLNGD	-0.02	(-3.43)	-0.02	(-6.14)
DLG	0.18	(1.61)	-0.09	(-0.54)
R^2	0.45		0.49	
SER	0.023		0.017	

Note: regressors as in Table 4.1.

No marked differences emerge between the two regressions; in particular, the speed of convergence toward the equilibrium also appears quite similar during the Seventies and the Eighties.

Now, we split the sample according to geographical criteria. The results are in Table 4.3. Also in this case, no appreciable differences appear across subsamples; in particular, the coefficient of error correction is very similar across the three subsamples. Thus, we will refer to the unified regression of Table 4.1 as a reliable regression.

TABLE 4.3 - REGRESSIONS ON ECM IN THE NORTH, CENTRE AND SOUTH OF ITALY, 1972-1991.

Dependent variable: annual growth rate of labour productivity.
(Fixed effects estimation)

	NORTH	CENTRE	SOUTH
N. of regions	7	5	8
N. of observ.	140	100	160
C	---	---	---
T	0.004 (3.60)	0.005 (3.97)	0.004 (4.33)
PLSK	0.01 (0.71)	0.02 (1.19)	0.05 (2.77)
LSEC60	---	---	---
PLNGD	-0.04 (-3.31)	-0.01 (-1.08)	-0.01 (-2.43)
Y0	-0.26 (-4.66)	-0.31 (-4.84)	-0.23 (-4.97)
DLINV	0.18 (7.03)	0.11 (4.90)	0.09 (3.90)
DLNGD	-0.02 (-2.48)	0.007 (0.73)	-0.02 (-4.99)
DLG	-0.006(-0.10)	-0.08 (-1.20)	0.08 (0.50)
R^2	0.45	0.43	0.32
SER	0.021	0.018	0.024

Note: with respect to Table 4.1.bis, the North is constituted by regions (1) to (7), the Centre (8) to (12) and the South (13) to (20). Regressors as in Table 4.1.

Let us sum up the evidence collected. The convergence towards equilibrium path appears to occur, following an error correction mechanism; the speed of convergence does not vary dramatically across groups of regions or periods of time. By contrast, section 3 pointed out that beta-convergence across regions appears, with significance and strength actually depending on the group of regions and on the time-period under consideration. How is it possible to put together these pieces of evidence? It seems correct to argue that the (conditional) convergence towards the long-run equilibrium path is a rather stable process, but general convergence across regions is absent *because of the changes of the determinants of the equilibrum paths*, so that equilibrium paths of different regions follow different stochastic processes.

This fact could be consistent with the presence of convergence within resticted gropus of regions. To investigate this point we employ an alternative method in the next section, where the time series of labour productivities will be seen as realizations of univariate stochastic processes.

5. COMMON TRENDS AND CONVERGENCE IN REGIONAL PRODUCTIVITY

In the previous sections we pursue a rather aggregate view of regional convergence. This section follows a different research strategy, that consider a more disaggregate geographical level: using a time series approach, we analyze the pattern of the productivity of each region and look for similarities. We therefore analyze convergence across regions in a particular perspective -- that of the long-run equality of the productivity level.

The first question to be answered is whether regional growth is deterministic or stochastic. Even if with a 22-year time span it is difficult to discriminate between these two hypotheses, we shall assume the latter as a useful working hypothesis.

TABLE 5.1. - STATIONARITY OF THE LOG OF THE PRODUCTIVITY OF THE ITALIAN REGIONS, 1970-1991.

	DF	ADF(1)		DF	ADF(1)
PIEMONTE	-3.14	-3.13	MARCHE	-1.64	-2.63
VALDAOSTA	-2.09	-2.28	LAZIO	-2.19	-1.97
LOMBARDIA	-2.81	-2.80	ABRUZZO	-3.79*	-3.72*
TRENTINOAA	-2.68	-2.92	MOLISE	-1.43	-1.86
VENETO	-2.61	-3.20	CAMPANIA	-2.10	-2.33
FRIULI VG	-2.24	-2.74	PUGLIA	-2.64	-3.70*
LIGURIA	-2.39	-1.95	BASILICATA	-2.41	-2.68
EMILIA ROM	-1.96	-2.78	CALABRIA	-2.29	-2.29
TOSCANA	-1.61	-1.30	SICILIA	-2.41	-2.39
UMBRIA	-1.97	-2.19	SARDEGNA	-3.02	-2.52
ITALY	-2.45	-2.98			

Note: Productivity = Real GDP/Labour. Real GDP is in 1985 values and labour is measured in standard units. For trended variables, critical values at 5% confidence level with 22 observations are -3.65 for the test DF and -3.66 for the test ADF(1). An asterisk indicates a significant value of the statistics at 5% critical level.

In fact, on the basis of the tests DF and ADF summarized in Table 5.1 we cannot reject the hypothesis that the labour productivity time series in all regions (except Abruzzo) follow a random walk with a drift and a linear deterministic trend

$$(1-B)LY_{it}=C+\delta T+\rho(B)LY_{it}+U_t \qquad i=1,2,...,20;$$

with LY_{it} the (log) productivity of region i at time t, B the lag operator, C a constant, T a linear time trend and U a white noise zero mean process. We have the same result -- the acceptance of the unit-root hypothesis -- for the level of the national productivity too. The results for the stationarity of the rate of growth, not reported for the sake of brevity, are univocal and clearly support the hypothesis of an integration of order one of the regional productivities. Therefore, in the following we use the non stationarity of the level of regional and national productivity as a maintained hypothesis.

An obvious question that arises is whether a common stochastic trend drives each regional series. The obvious candidate for the common trend is the national value of GDP per standard unit of labour. If the differences between regional and national series ($LY_{it}-LY_{ITALYt}$), turned out to be stationary, we could say that there is a national model with persistent shocks that explain the (common) non stationarity of the regional series, while regional shocks in the productivity are temporary and disappear in the long run.

From a test on the stationarity of the difference between the level of the productivity on each region and the level of the productivity of Italy, this definitely does not appear to be the case. The results in Table 5.2 suggest that regional productivities do not follow a national model: regional specific shocks are persistent, since the presence of a unit root cannot be rejected for the series ($LY_{it}-LY_{ITALYt}$), except for Abruzzo. Therefore, if a region reaches a given relative position with respect to the whole country, it is expected to maintain it in the long run.

TABLE 5.2. - STATIONARITY OF THE DIFFERENCES BETWEEN THE PRODUCTIVITIES OF THE ITALIAN REGIONS AND ITALY, 1970-1991.

	DF	ADF(1)		DF	ADF(1)
PIEMONTE	-1.39	-1.30	MARCHE	-1.45	-1.63
V. D'AOSTA	-1.56	-1.77	LAZIO	-2.77	-2.45
LOMBARDIA	-0.98	-1.17	ABRUZZO	-4.33*	-4.47*
TRENTINOAA	-2.19	-1.39	MOLISE	-1.19	-1.44
VENETO	-1.93	-2.57	CAMPANIA	-2.85	-2.90
FRIULI VG	-1.00	-1.04	PUGLIA	-2.04	-1.17
LIGURIA	-1.70	-1.94	BASILICATA	-1.67	-1.30
EMILIA ROM	-1.68	-3.30*	CALABRIA	-2.62	-1.21
TOSCANA	-0.79	-1.02	SICILIA	-1.35	-0.48
UMBRIA	-2.32	-1.66	SARDEGNA	-0.98	-1.50

Notes: Productivity as in Tab 5.1. For non-trended variables, critical values at 5% confidence level are -3.02 for the test DF and -3.03 for the test ADF(1) (22 obs.). An asterisk indicates a significant value at 5% critical level. A constant is included in the regression.

Similar results hold also if we divide the Italian regions into the North-Centre and the South, and specify the mean model for each group; the mean trend of growth of the productivity of the northern regions, as well as of the southern regions, is permanently different from that of each region of the group. The time-series approach therefore suggests the presence of diverging dynamics of productivity even at the geographical level most often used in the analysis of the Italian economic dualism.

Note that this evidence of the absence of a "national model" in time-series analysis is a result close in spirit to the evidence of the absence of the national model reached in the previous section based on cross-section regression.

A more fruitful time-series approach seems to be the analysis at the most disaggregate level, considering regions two by two, and then looking for couples of "similar" (i.e. cointegrated) regions.

We performed the following regression for each of the 190 possible couples of regions:

$$LY_{it}=\alpha+\psi LY_{jt}+U_{ijt}, \qquad i<j,\ i=1,2,...19; \tag{5.1}$$

and then we tested for the stationarity of the residuals U_{ijt}. Roughly speaking, if two regions have the same (non-stationary) dynamics, they are cointegrated and cannot diverge too much.

The results of Table 5.3 indicate that a significant number of regions cointegrate each other. Within a total of 190 regressions between the productivity levels of the 20 Italian regions, 29 show stationary residuals at the 5% critical value. Only three regions do not enter in any of the 29 cointegration cases: Valdaosta, Liguria and Basilicata. Two of them (Valdaosta and Basilicata) are among the smallest Italian regions, respectively with 115,000 and 610,000 inhabitants in 1991, and it is possible that the data of these regions are very noisy. Of the remanining 17 regions Piemonte, Lombardia, Marche, Umbria, Campania and Sardegna enter in only one cointegration relation; Sicilia and Molise are cointegrated with two other regions; Friuli V.G. with three, Emilia R. and Lazio with four; Veneto, and Toscana and Calabria with five; Trentino A.A. and Puglia with six and Abruzzo with eight other regions.

The regions of the North-West and the South are more likely to be not cointegrated, while the reverse occurs for the often cited "third emerging group" of the North-East and Adriatic regions.

At this initial stage of the analysis, only an impressionistic explanation can be offered for this result. Each of the traditional industrial regions (Piemonte, Lombardia and Liguria) has a specific pattern of economic structure and shocks might have an idiosyncratic effect. Also for the less developed Southern regions the result is the same: with a disproportionate weight towards a few subsidized sectors, or even without a shaped economic structure, "local" shocks might be more important than "aggregate" shocks. Common stochastic trends are more frequent in the third group, characterized by a more rapid growth, often due to the emergence of a small and medium-size industrial sector with low capital intensity.

Geographical contiguity between cointegrated regions is not particularly important: there are only 5 cases of contiguity out of 29.

TABLE 5.3 - COINTEGRATION BETWEEN THE PRODUCTIVITIES OF THE ITALIAN REGIONS, 1970-1991.

Dependent variable: logarithm of regional labour productivity, vertical axis.

	PIE	VAA	LOM	TAA	VEN	FVG	LIG	EMR	TOS	UMB
PIE		-1.83	-1.93	-2.30	-1.83	-1.81	-2.65[a]	-1.45	-2.86	-1.69
VAA			-1.70	-1.92	-1.72	-1.94	-2.21	-1.47	-1.79	-1.67
LOM				-2.64	-3.28[a]	-1.59	-1.28	-2.47[a]	-2.38[a]	-1.68
TAA					**-4.08**	**-5.01**[a]	-1.96	-2.99	**-4.45**	-3.24
VEN						-3.35[a]	-1.91	**-3.88**[a]	**-5.42**[a]	-2.65
FVG							-2.17	-2.80[a]	-3.27	-2.83
LIG								-0.93	-1.88	-2.70
EMR									-3.20[a]	-3.19
TOS										-3.13
UMR										
MAR										
LAZ										
ABR										
MOL										
CAM										
PUG										
BAS										
CAL										
SIC										
SAR										

	MAR	LAZ	ABR	MOL	CAM	PUG	BAS	CAL	SIC	SAR
PIE	-1.35	-2.18	-2.84	-2.09	-2.65	**-3.66**	-2.29	-2.37	-2.22	-2.51
VAA	-1.41	-2.70	-1.70	-1.72	-2.50	-2.00	-2.29	-1.63	-1.67	-1.92
LOM	-1.48	-1.87	-3.40[a]	**-3.73**	-1.90	**-4.61**	-2.29	-2.91	-2.82	-2.41
TAA	-2.96	**-4.07**	**-4.12**[a]	-2.87	-2.70	**-3.72**	-3.14	-3.21	-3.50	-2.97
VEN	-1.75	-2.54	**-5.42**[a]	-2.73	-2.20	**-4.05**[a]	-2.82	-2.96	-2.79	-2.84
FVG	-1.34	**-3.85**	**-4.27**[a]	-2.09	-2.91	-2.78	-3.11	-2.76	-2.17	-2.46
LIG	-1.36	-3.26	-2.89	-1.64	-2.42	-2.19	-3.07	-2.54	-1.35	-1.95
EMR	-2.19	-2.05	**-6.37**[a]	-3.03	-1.79	-2.68	-2.55	**-4.46**	**-4.11**	2.93[a]
TOS	-1.87	**-3.72**	**-4.76**[a]	-2.90	-3.09	**-4.41**	-2.99	-3.42	-2.51	-2.50
UMB	-1.90	-2.91	-3.28[a]	-2.32	-2.29	-2.69	-3.14	**-3.93**	-3.38	-2.47
MAR		-1.65	-3.09[a]	-2.29	-2.95	-1.70	-2.56	**-4.57**	-3.52	-2.73
LAZ			-3.16	-1.67	**-4.52**[a]	-2.80	-3.14	-2.08	-1.72	-2.53
ABR				**-4.26**	-3.08	**-4.47**[a]	-2.53	**-3.90**	-3.06	-2.58
MOL					-1.68	-2.91	-2.08	**-4.06**	3.53	-2.48
CAM						-2.56	-2.65	-1.94	-1.76	2.79[a]
PUG							2.20	-2.68	-1.92	-2.27
BAS								-2.39	-2.36	-2.55
CAL									-4.57	-2.51
SIC										**3.65**[a]
SAR										

Note: DF test is used, unless otherwise indicated (with the letter a). In these latter cases, first-order autocorrelation in the residuals of the cointegration regression, suggests the use of ADF(1) test statistic. Critical values at 5% confidence level are, respectively, -3.64 and -3.66 (21 obs. for DF, 20 obs. for ADF(1). Boldface characters indicate a significant value at the 5% confidence level.

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If two regional productivities are cointegrated, these regions have experienced the same stochastic, non-stationary, shocks in the period 1970-1991. However, cointegration is a necessary but not sufficent condition for convergence in productivity levels, as Bernard and Durlauf (1991, 1993) point out. As a matter of fact, the tests in Table 5.3. give us a weak result: if cointegrated, regions *i* and *j* can have a common stochastic trend, but productivity levels can be persistently different (if α is significantly different from zero) and grow at different rates (if ψ is significantly different from 1). The results of Table 5.3 therefore give us little information about the (long-run) equalization of the level of GDP per unit of labour, an intuitive but strong convergence criterion; for convergence in the productivity levels, besides the stationarity of the residuals U_{ijt} in regressions (5.1), we require α=0 and ψ=1, so that

$$LY_{it}-LY_{jt}=U_{ijt} \qquad i<j \quad i=1,2,...19; \tag{5.2}$$

is a stationary stochastic process with mean zero and constant variance.[16]

This criterion, used by Bernard and Durlauf (1993), is stronger than others usually proposed in the literature on convergence, but it makes sense only if current labour productivity levels have the same distribution as their asymptotic values, so that there is no room for transitional dynamics.[17] For a while we maintain this assumption.

In this respect the results are striking: none of the 29 cointegration regressions in Table 5.4 satisfy these two restrictions. Dickey and Fuller's likelyhood ratio statistic Φ_1, that jointly tests the restrictions, far exceeds the standard critical values, except for the cointegrating regression for Veneto and Toscana. Only in this case is the test statistic between the 5% and the 2,5% critical values[18].

We must however be careful in the evaluation of these results. An estimate of α significantly different from zero and an estimate of ψ significantly different from 1 can be due not to the lack of convergence, but to the effects of a slow transition process towards the long-run equilibrium:

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[16]In fact, the results in Table 5.2 can be read, apart from the constant term, as a convergence analysis with respect to the national model.

[17]Note that this criterium is stronger than the one used in Section 3: convergence in level is not implied by beta-convergence.

[18]Two points are worth mentioning. Firstly, in the computation of Φ_1 there is only one restricted model ($LY_i=LY_j+U_{ij}$) but two different unrestricted models ($LY_i = \alpha + \psi LY_j + U_{ij}$ and $LY_j = \alpha + \psi LY_i + U_{ji}$). In small samples, although infrequent, different results are possible for the two unrestricted models. In fact, while in 28 cases both tests Φ_1 suggest the rejection of the convergence hypothesis, in the regression of LY_{VEN} on LY_{TOS} Φ_1 is 6.038, while in the regression of LY_{TOS} on LY_{VEN} Φ_1 is higher, equal to 8.24. Secondly, we perform a similar cointegration analysis setting α=0 as a maintained hypothesis in regression (5.1) and test for ψ=1 using Dickey and Fuller statistics τ. Even in this case, there are very few cases of "straight" convergence.

if region *j* is less developed than region *i*, it might be the case that *j* is slowly catching up with *i*, but a positive and significant difference between LY_i and LY_j remains in the period under scrutiny. Following Bernard-Durlauf (1991) we constrain the constant terms to zero in the estimation. If these constraints were invalid, the estimate of the elasticity ψ would be biased. For example, none of the three couples of regions portrayed in figure 5.1 passes the Bernard-Durlauf test of convergence; clearly, a more flexible approach in detecting convergence has to be preferred.

Fig.5.1/a,b,c. (available on request)

Bernard and Durlauf (1993) -- who perform a similar analysis at the international level and reject the convergence hypothesis -- are well aware of this problem, but they de-emphasize its importance on the basis of some simulation evidence. In the remainder of the section, we try a more constructive approach.

We stress once again that the validity of tests in Tables 5.2-5.3 implicitly relies on the assumption that current values have the same distribution as asymptotic values, so that these tests require the initial condition to be unimportant. This is a strong *a priori* assumption, requiring cautious treatment: transition periods are clearly important and cannot be ignored. Hence we must give up some further degrees of freedom and try to model transition dynamics.

To this purpose, we shall consider two simple hypotheses on transition dynamics, introducing τ, a deterministic time trend that progressively disappears or, alternatively, introducing a simple stochastic convergence process, in the form of an ECM.[19] Obviously, different and more complex deterministic and/or stochastic transitional dynamics could be proposed, but over a quite short period of time the transitional process must be simple and quite compressed in time.[20] It is apparent that the two patterns of transitional dynamics proposed represent therefore different approximations of the same simple process rather than mutually exclusive alternatives.

The first and somewhat extreme route suggests that the convergence process might be deterministic, even if productivity variables have a stochastic trend.

The analysis proceeds as follows: firstly, we regress the difference in

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[19]In practice, the small number of degrees of freedom in the estimation prevents us from modelling the more general hypothesis of compresence of both mechanisms. Hendry (1986) points out that the frequency of observations may not be crucial to the accuracy of the estimation of a long-run relation. In our case, however, the modelling of the short-run transitional dynamics is severely constrained by the use of yearly rather than quarterly data.

[20]This holds even in the case of stochastic convergence: all ECMs will have a very simple lag structure.

the (log) of the productivity levels for each couple of regions on a deterministic trend that progressively dies away:

$$LY_{it}-LY_{jt}=\theta\tau+W_{ijt} \qquad i<j,\ i=1,2,...19;$$

secondly, we test for the stationarity of the residuals W_{ijT} .

Clearly, while reasonable as a long-run approximation, the choice of a formulation of the deterministic transitional dynamics maintains some arbitrariness when a specific functional form is specified. As benchmark case, in Table 5.4 we present the results for the time trend given by τ=1/log(T+10)-0.2836, where T is a linear trend and the subtraction of 0.2836 assures that the value of this transitional deterministic component is 0 at the end of the period 1970-91 (when the long run "begins"): convergence should be therefore reached at the end of the period (rather than at the beginning).

The addition of a transitional dynamics seems to be important. We are able to identify 19 cases of convergence between couples of regions at the 95% confidence level and 30 cases of convergence at the 90% level of confidence. There are only 4 cases (out of 30) of convergence between countiguous regions. Nevertheless, and with due reserve imposed by the analysis of a quite short period, it is possible to guess the emergence of some convergence clubs. A group is that of the Centre and the North-East regions (Trentino A.A., Veneto, Toscana, Umbria); another that of the Centre and South Adriatic regions (again Umbria, Abruzzo, Molise and Puglia). A little more surprising is the convergence of Campania, Sicilia and Sardegna with some of the previouly cited regions of the second group. This result probably derives from the common (negative) shocks that affected the oil and chemical sectors (quite important, in particular, for Sicilia and Sardegna), and the consequent slow growth of these Southern regions, as suggested from figure 5.1.[21]

Even in this case the main result in Tables 5.2 and 5.3, that of a remarkable difference between cointegration and convergence, is confirmed, since only 7 cases on convergence are detected from the cointegration relations reported in Table 5.4: Trentino A.A. - Toscana, Trentino A. A. - Abruzzo, Veneto - Toscana, Abruzzo - Molise, Abruzzo - Puglia, Molise - Calabria and, finally, Sicilia-Sardegna.

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[21] In order to test for the robustness of our hypotheses and to get other insights about the effects of the choice of a given deterministic trend, we look for regional convergence along the previous line but using a different deterministic transitional trend (1/(1+log(T))-0.2394). Both trends smoothly fade away over time, but in the latter case convergence is relatively stronger in the first periods. Among the convergent couples of regions, 17 are common to both trends; at the 5% confidence level, the cases are reduced to 13. The results are available on request.

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TABLE 5.4. - CONVERGENCE BETWEEN THE ITALIAN REGIONS IN THE CASE OF DETERMINISTIC TRANSITIONAL DYNAMICS, 1970-1991

Dependent variable: log of regional labour productivity, vertical axis.

	PIE	VAA	LOM	TAA	VEN	FVG	LIG	EMR	TOS	UMB
PIE		-0.52	-0.32	-0.31	-0.62	-1.41	**-1.71**	-1.53	-0.37	-0.43
VAA			-0.08	**-2.31**	-1.39	-0.72	-0.00	-0.57	-1.50	**-1.65**
LOM				0.11	-0.15	-0.29	-1.17	0.15	-0.05	-1.33
TAA					-1.10	-0.21	0.85	-0.36	**-1.74**	**-2.18**
VEN						-0.62	0.62	-1.17	**-5.47**	-0.93
FVG							-0.39	-1.28	0.34	-0.36
LIG								-0.50	1.37	0.26
EMR									-0.19	-0.51
TOS										-1.41
UMB										
MAR										
LAZ										
ABR										
MOL										
CAM										
PUG										
BAS										
CAL										
SIC										
SAR										

	MAR	LAZ	ABR	MOL	CAM	PUG	BAS	CAL	SIC	SAR
PIE	-0.04	**-2.36**	0.08	-0.16	-0.07	-0.01	0.04	0.18	0.63	0.05
VAA	-1.35	-0.43	-0.90	-0.96	-0.82	-1.30	-0.21	-0.15	-0.76	-1.00
LOM	0.47	-0.87	-0.64	0.11	0.33	-0.19	0.15	0.38	0.99	0.52
TAA	**-2.92**	-0.20	**-1.70**	0.75	-0.67	-1.42	-0.21	-0.18	-0.99	-0.89
VEN	-0.39	-0.12	-0.42	-0.35	-0.31	-0.40	-0.10	0.15	0.52	0.05
FVG	0.50	-1.43	0.19	-0.11	0.01	0.21	0.14	0.39	1.20	0.26
LIG	-0.36	**-2.45**	0.78	0.36	0.54	0.73	0.45	0.60	1.68	0.94
EMR	0.09	**-2.82**	-1.10	-0.11	-0.39	-.59	-0.02	-0.23	0.79	0.03
TOS	-1.02	0.80	-0.61	-0.03	-0.70	-0.73	-0.30	-0.21	0.33	-0.28
UMB	**-1.83**	-0.14	**-2.81**	-0.43	-0.78	**-2.14**	-0.17	0.11	**-2.61**	**-1.71**
MAR		0.86	-1.44	-0.55	-0.92	-1.11	-0.27	-0.07	-0.82	-1.19
LAZ			0.44	0.14	0.15	0.60	0.27	0.59	1.69	0.40
ABR				**-1.82**	**-1.93**	**-3.19**	-0.50	-0.66	**-2.98**	**-2.21**
MOL					**-1.90**	-1.16	-0.95	**-1.73**	**-2.15**	**-2.58**
CAM						-1.36	-0.63	-0.76	**-1.97**	**-2.11**
PUG							-0.37	-0.22	-1.60	**-1.90**
BAS								**-1.66**	-0.87	-0.98
CAL									-1.02	-1.31
SIC										**-3.31**
SAR										

Notes: Critical values for the DF statistics (for a time series with no constant) are -1.60 at 10% and -1.95 at 5% confidence levels (for 25 observations) (Fuller, 1976, pg. 378). In each cell is reported the DF statistic when there is no sign of autocorrelation in the residuals W_{ij}, or the ADF(i) statistic of the lower order with white noise residuals. Boldface characters indicate a significant value at the 10% confidence level.

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In conclusion, the analysis of convergence with a deterministic transitional dynamics, even if not without drawbacks, offers a robust indication about a complex dynamic interaction between Italian regions, undetected by "straight" convergence methods.

The stochastic convergence offers an alternative modelization to the transitional dynamics. We analyze this hypothesis in three steps.

First, for each couple of regions j and i, two ECMs in the differences of the productivities with a long-run (1, -1) cointegrating vector are estimated:

$$\Delta LY_{ti} = \alpha_i + \beta_i \Delta LY_{tj} - \gamma_i (LY_{ti} - LY_{tj}) + a_i(B)\Delta LY_{ti} + b_i(B)\Delta LY_{tj} + U_{tij}$$

$$\Delta LY_{tj} = \alpha_j + \beta_j \Delta LY_{ti} - \gamma_j (LY_{tj} - LY_{ti}) + a_j(B)\Delta LY_{tj} + b_j(B)\Delta LY_{ti} + U_{tji}$$

Then we test for the stationarity of the residuals and, in the case of cointegration between LY_i and LY_j, we determine the causal link between variables.[22]

At this point a problem emerges: the constant term in the ECM can be explained by the deterministic trend in the productivity and/or by the presence of a constant in the cointegration relation. This latter case implies long-run divergence in the productivity levels, even with a unit elasticity (ψ=1, in regression 5.1). Since we want to rule out the second outcome, in the second stage of the analysis we determine the coefficient that expresses the deterministic trend of the exogenuos variable (its mean rate of growth) and constraint the constant term in the ECM for the endogenous variable to be equal to this value. Convergence implies the validity of this restriction.

If the constrained model is not rejected, in the third and last step of the analysis we subtract from the endogenous variable of the ECM its (theoretical) mean. Having re-estimated the ECM without a constant term, we test for the significance of the error correction term and the stationarity of the residuals. In the next step, we discard all ECMs that do not satisfy the restriction on the exogenuos productivity growth (at the 95% confidence level) or whose error correction parameter in the restricted model is not significant (at least at the 90% confidence level) or are unstable in the error correction term[23]. Finally we reject restricted ECMs if their residuals do not exhibit stationarity.

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[22]An ECM must have a (Granger) causal ordering in at least one direction; the exogenous variable is the one for which the error correction coefficient is not significant. In all cases of convergence we analyze, only one causal link always emerges; moreover, the ECMs often show insignificant coefficients for lagged proportional errors.

[23] γ>0 gives instability: there is only one case, Toscana and Emilia Rom.

In Table 5.5 we collect all cases of stochastic convergence derived from the ECM regressions and report the relevant test statistics. We are eventually left with 15 convergence cases, 9 of which are in common with the deterministic trend procedure summarized in Table 5.4.

TABLE 5.5 - CONVERGENCE IN PRODUCTIVITY BETWEEN THE ITALIAN REGIONS IN THE CASE OF STOCHASTIC TRANSITIONAL DYNAMICS, 1970-1991.

Exogenous variable	Endogenuos variable	Restrict. constant[a]	t statistic	DF statistic[b]	Adf(1) statistic[c]
PIEMONTE	MOLISE	2.34	-1.73	-4.21	-3.85
VALDAOSTA	SICILIA	3.66	-2.27	-4.46	-2.87
TRENTINOAA	MARCHE	2.09	-2.54	-4.62	-3.33
TRENTINOAA	ABRUZZO	3.09	-1.80	-4.52	-4.48
TRENTINOAA	MOLISE	1.46	-2.61	-4.44	-4.24
TOSCANA	VENETO	1.06	-1.83	-5.01	-3.89
LAZIO	LIGURIA	2.10	-2.32	-4.80	-3.81
LAZIO	EMILIA R.	0.76	-2.10	-4.46	-4.01
TOSCANA	MOLISE	1.80	-2.26	-4.33	-4.05
SICILIA	UMBRIA	0.02	-2.36	-3.65	-2.44
MARCHE	MOLISE	1.72	-1.87	-4.30	-4.03
CAMPANIA	MOLISE	1.67	-2.97	-4.59	-4.62
SICILIA	MOLISE	1.86	-2.52	-4.40	-4.20
BASILICATA	CALABRIA	1.64	-2.08	-5.12	-4.28
SARDEGNA	SICILIA	0.29	-3.37	-5.74	-3.68

Note: (a) the test statistic for the validity of the restriction on the constant is a $\chi^2(1)$; (b) the 5% critical value of the DF test is -3.66; (c) the 5% critical value of the ADF(1) test is -3.68.

It is worth noting that 7 of these 9 cases pass all tests in Tables 5.4 and 5.5 at the 95% confidence level; therefore these convergence relationships seem to be robust to different selection procedures. Once again, convergence across regions seems to be stronger for the southern regions, which lag behind the other regions of Italy. In particular, convergence emerges for the southern Adriatic regions, which in the period 1970-1991 experienced a more sustained growth process. The results in Table 5.5 provide further support that territorial contiguity is not particularly important in determining regional convergence.

In conclusion, time series analysis provides a clear support for the convergence in small groups of regions, even if some relations (e.g. Valle d'Aosta-Sicilia or Umbria-Sicilia) at first sight are not immediately obvious on *a priori* information. On the whole, the hypothesis of a significant degree of convergence (we need a strong and fast convergence process if it can be detected from a short time series) is confirmed for the North-East and Adriatic regions, which experienced (relatively) fast growth during the period 1970-91.

Our effort of description of regional convergence in the labour productivity levels has been limited to groupings of only two regions. Multivariate tests of cointegration and of convergence, such as Phillips and Ouliaris (1988), are likely to indicate a wide range for the number of potential common trends among regions. In our case these tests are of limited interest and therefore are not computed. Obviously, positing overall convergence is meaningless, according to our evidence.

6. CONCLUSIONS

Regional data can represent important sources for econometric works on growth: such data are not subject to different methods of collection, do not face the problems of conversion in a single currency, and are therefore immediately comparable. Thus, it is quite surprising that the recent macroeconomics of growth focused on convergence across nations, and the studies on regional convergence are a minor part in this literature.

Regional inequalities within a country are important, as shown --among many others-- by Barro and Sala-i-Martin (1991, 1992) and Blanchard and Katz (1991). In Italy, regional differences have been and are very significant and this has led to a large amount of literature, focusing on Italy's "dualism"; this literature often takes into account also historical, sociological and cultural factors[24].

Our perspective is narrower: the paper can be seen as an attempt to apply recent tools provided by the economics of growth to the Italian regional experience. In particular, we limit ourselves to the issue of convergence process in the labour productivity levels and we try to offer some general insights about the features of growth process across Italian regions and to provide evidence about the factors considered by different econometric approaches.

The present paper uses newly released annual data provided by ISTAT and SVIMEZ, which cover the period 1970-91. Obviously, a 22-year time period is quite short to detect the pattern of long-run growth, but some interesting conclusions can emerge.

The process of convergence among the regions' labour productivity levels does not appear over the whole time period: while in the Seventies convergence among regions is a matter of fact, in the Eighties there are clear signs of divergence between regions, a trend that seems to be common to the EC as a whole. For Italy, the periods of more sustained growth (the so called

[24]A incisive summary on the problem can be found in Zamagni (1993).

"Italian miracle" of the Fifties and Sixties) failed to permanently reduce the regional differences in productivity, while the growth of the Eighties even deepened the regional gaps; thus, the relationship between the GDP growth rate and the degree of regional disequality appears rather weak in the Italian experience.

With respect to the long run economic trends in Italy, the convergence process is an exception, rather than the rule. This is quite surprising and embarassing: the convergence has been one of the most emphasized and continuosly pursued purpose of economic policies for decades, and a lot of financial resources has been devoted to this goal. As a matter of fact, public interventions in the South did not stimulate the private enterpreneurship and raised only temporary regional incomes.

The lack of global (national) convergence arises also from a more disaggregated geographical level: the division of Italy into the North and the South is still important, but at a closer scrutiny, it appears too simplistic. Some "convergence clubs", each with a few Italian regions, might be posited. However, convergence clubs do not seem to depend on the geographical proximity of their constituents. Rather, the stuctural composition could be the main factor shaping each convergence group; such an issue is left for further investigations.

Our results show that regions converge toward their respective stochastic equilibrium paths. These equilibrium paths change over time and generally are different among regions. Nonetheless, common stochastic elements can be found for restricted groups of regions.

From a methodological perspective, our paper reviews different econometric procedures employed by the recent literature on growth, and it suggests that caution and improvements are necessary. Both the cross-section and the time series approaches show that the short-run dynamics are important in the identification of the patterns of long-run growth and in the identification of convergence clubs: some of our results strongly suggest that the evidence of overall beta-convergence, provided by several cross-section works, may be a statistical artefact, explained by the lack of an adequate dynamic specification for the short-run or transitional movements in data. Also the results based on time-series analysis are very sensitive to the consideration of short-run components of the data. Only 7 out of 190 possible two-by-two regional convergence cases, pass all the considered specifications.

We are aware that further developments have to rely on longer time series as well as on additional statistical tools (multivariate analysis, alternative specifications for transitional dynamics, etc.). Moreover, a fruitful analysis should take into account both the structural changes occurred across regions and additional elements about specific sectors and institutional environment.

However, we can draw a clearcut conclusion: altough the favourable conditions and the efforts for narrowing the regional gaps in Italy, convergence does not emerge as a constant process.

APPENDIX 1. - LIST OF VARIABLES

ALGDPD = average of ratio log (public consumption / GDP), over a 10-year period.
ALGWQ = average of log of public expenditure per standard unit of labour, over a 5-year period.
ALIWD = average of log level of investment per standard unit of labour, over a 10-year period.
ALIWQ = average of log level of investment per standard unit of labour, over a 5-year period.
ALSKD = average of LSK (log of investment / GDP), over a 10-year period.
C = constant term.
DLG = annual growth rate (log first difference) of public expenditure.
DLINV= annual growth rate (log difference) of investment.
DLINVD = growth rate (log difference) of investment, over a 10-year period.
DLLAVD = growth rate (log difference) of labour in standard unit, over a 10-year period.
DLNGD = first difference of LNGD.
LG = log level of public expenditure.
LINV = log lebel of investment.
LNGD = log of the sum of the annual growth rate of labour in standard units, plus 0.06.
LNGDQ = log of the sum of the growth rate of labour in standard units over a 5-year period, plus 0.25.
LSEC60 = log of the secondary school enrollment rate in 1960.
LSK = log of the ratio investment / GDP.
PLNGD = lagged value of LNGD.
PLSK = lagged value of LSK
T = linear trend.
Y0 = log of labour productivity at the beginning of the period considered.
Y0Q = log of labour productivity at the beginning of the 5-year period.

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FIGURE 2.1 - ITALIAN REGIONS

NORTH

1. PIEMONTE	2. VAL D'AOSTA	3. LOMBARDIA	4. TRENTINO A. A.
5. VENETO	6. FRIULI V. G.	7. LIGURIA	

CENTRE

8. EMILIA R.	9. TOSCANA	10. UMBRIA	11. MARCHE	12. LAZIO

SOUTH

13. ABRUZZO	14. MOLISE	15. CAMPANIA	16. PUGLIA
17. BASILICATA	18. CALABRIA	19. SICILIA	20. SARDEGNA

(chart available on request)