Convergence in TFP among Italian Regions: Panel Unit Roots with Heterogeneity and Cross Sectional Dependence

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Abstract

This paper performs a number of tests to estimate convergence in total factor productivity (TFP) among Italian regions during the period 1970-2001. We generate the regional TFP series using growth accounting methodologies, and then apply a range of panel unit root tests to analyse the process of convergence. We extend the existing literature by incorporating three main improvements. Firstly, we control for the heterogeneity arising from the different economic structure of each region. Secondly, we look for clubs of convergence using tests of poolability both on economic and statistical grounds. Finally, we account for the cross-sectional dependence due to common shocks or spillovers among different regions at the same time.

Keywords: Total Factor Productivity, Regional Convergence, Panel Data, Unit Root Tests, Heterogeneity.

JEL Codes: D24, R11, R12, C31, C33, O47

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1 Introduction

The income differential between the Northern and Southern regions is a well known and long standing issue in Italy. This gap still persists in spite of recent evidence of growth in some of the eastern regions of the peninsula, such as Abruzzo. Within Europe, Italy remains one of the countries with the widest regional growth differentials. This is clearly a matter of great concern for both national and local authorities. The main policy agenda of the past ("Intervento Straordinario per il Mezzogiorno") was oriented towards increasing the amount of industrial investment through financial assistance and/or direct investment in public firms. There is now a large consensus among researchers and policymakers, that this policy has not been effective at achieving long run convergence because it has not successfully targeted the structural differences (technological and financial, but also social and institutional) among the regions.

In the neoclassical framework, these structural differences affect Total Factor Productivity (TFP) and consequently have also an effect on long-run growth. Indeed, in the long-run steady state, it is possible to show that capital intensity (i.e. the ratio between capital and labour) grows at the same rate of labour productivity that in turn depends on TFP growth. Indeed, many recent papers[1] have asserted that the international cross-country variation in labour productivity depends more on TFP than on capital intensity. For Italian regions, a similar result was highlighted by Aiello and Scoppa (2000), Destefanis (2001), and Ascari and Di Cosmo (2004). Therefore, it seems particularly important to analyse the process of convergence among Italian regions with respect to their Total Factor Productivity over a long period of time.

In this analysis, we depart from the traditional approach to testing for beta and sigma convergence in a strictly cross-sectional regression, and rely

[1]See among the others, Klenow and Rodriguez-Clare (1997), Hall and Jones (1999), Parente and Prescott (2000), and Easterly and Levine (2001)

more closely on the strand of literature originating from the work of Evans and Karras (1996). However, we exploit some of the recent innovations in the literature on panel unit root tests in order to incorporate two main improvements with respect to the their methodology. Firstly, we account for the potential panel heterogeneity arising from the different economic structure of each region. Secondly, we consider the possibility that each region might be characterised by a different growth path. Finally, we incorporate the potential cross-sectional dependence due to common shocks hitting different sets of regions at the same time.

Bearing all this in mind, the remainder of the paper is organised as follows. The next section provides a further discussion on regional convergence in Italy. Section 3 presents the steps of the econometric methodology of the paper. Section 4 presents the empirical implementation and discusses the results. The final section concludes.

2 Regional Convergence in Italy

The literature on the empirical estimation of convergence in Italy developed after the work of Barro and Sala-i-Martin (BSiM, 1991). These authors estimated absolute convergence at a rate of 2 percent for the period 1950-1985. The stark contrast of this result with the dualistic nature of growth in Italy subsequently led many researchers to question the robustness of their analysis. Indeed, later studies have highlighted how this result depends on the particular time period taken under consideration. There is now a widespread agreement that during the 60s and the first part of the 70s the process of convergence reached its apex, whilst the later decades are characterised by a tendency for regional economies to diverge.[2]

However, these studies focus mostly on labour productivity and per capita

[2]See, among the others, Di Liberto (1994), Mauro and Podrecca (1994), Paci and Pigliaru (1995), Cellini and Scorcu (1997), Paci and Saba (1998), and Margani and Ricciuti (2001)

GDP. Very little attention, on the other hand, is dedicated on TFP.[3] We believe that this is an important limitation of the existing literature. TFP reflects a wide array of both tangible and non tangible factors that influence the efficiency of the economy, and production in particular. Since the persistence of the spatial differences in Italy can largely be rooted in the efficiency of the production system, TFP is a variable that requires the necessary attention.

The importance to look at TFP stems also from the need to look at the persistence (hence the structural nature) of the process of convergence . In comparison with previous papers, this study captures also the more recent evidence using data spanning from 1970 until 2001. We root our methodology in the work of Evans e Karras (1996), who try to analyse the process of convergence among US states through the identification of a common trend. Evans e Karras (1996) introduce a particular notion of convergence, claiming that the different economies converge if and only if there exists a common trend such that

$$E_t(y_{n,t+1} - a_{t+1}) = \mu_n \tag{1}$$

Moreover, if $\mu_n = 0$, convergence is absolute, and if $\mu \neq 0$, convergence is conditional. This methodology has been applied to Italian regions by Margani and Ricciuti (2001) to analyse the process of convergence in regional per capita GDPs during the period 1951-1998. These authors estimate a high rate of convergence for the entire period, but reject the hypothesis of absolute convergence and accepting that of conditional convergence. Moreover, they break the period into two sub-periods going from 1951 to 1973 and 1974 to 1998, and find evidence of absolute convergence for the first period and divergence for the second, a result already reached by other studies. However, with respect to the analysis of clubs of convergence their results are less conclusive. This is unfortunately a general feature of the literature on

[3] Only recently we can record some exceptions. See, for example, Di Liberto, Mura, Pigliaru (2003, 2004).

regional convergence.

At the international level, it has been noted that after the Second World War, only richer countries have shown a tendency to converge, whilst there seems to be a process of divergence between the richer and the poorer countries (Barro and Sala-i-Martin, 1992). With respect to the Italian regions, most of the literature seems to conclude that there is a dualistic process of growth between the Centre-North and the South. Some studies (Di Liberto (1994), Mauro and Podrecca (1994), and Paci and Saba (1998)) reach this conclusion using a set of dummy variables in the estimation of a convergence equation to account for the greater homogeneity between regions characterised by geographical proximity. A similar result emerges also from a strand of literature that uses data disaggregated at the Provincial level in order to measure the process of convergence in a more accurate way within geographical sub-units.[4] In particular, Arbia, Basile and Salvatore (2003) analyse convergence in per capita GDP of Italian Provinces during the period 1951-2000. They use models with spatial dependence, and show that two different spatial regimes characterise two different sub-periods. During the first period, between 1951 and 1970, only Provinces with relatively high income follow a process of convergence. During the second period after 1971 this result is completely inverted, and the incomes of poorer Provinces show a tendency to converge. It is interesting to note that, while during the first period the Provinces with lower income are located in the South, but also in the Centre (Lazio, Umbria, Marche and Toscana) and the North-East (Friuli Venezia Giulia and Veneto), during the second period only Southern Provinces still have low incomes. This result is particularly indicative of a tendency for the Southern regions in general to converge along a unique growth path that drives them fatally away from the National average. On the other hand, Centre-Northern regions seem to grow along different but virtuous paths. Hence, they show a tendency to diverge not only with the

[4] See, for example, Cosci and Mattesini (1995), and Fabiani and Pellegrini (1997).

Southern regions, but also among themselves.

3 Econometric Methodology

The traditional approach to testing for convergence consists of applying Ordinary Least Squares (OLS) to a regression of the average growth rate of per capita output over a specified period, Δy_n, on the initial level of per capita output, y_{n0}, after controlling for a number of cross-country permanent differences, x_n, i.e.

$$\Delta y_n = \alpha + \beta y_{n0} + \delta' x_n + \epsilon_n, \tag{2}$$

where ϵ_n is the usual country-specific random disturbance. Clearly, for convergence to have taken place over the period under consideration, a negative sign is expected on the coefficient of the initial level of per capita output, i.e. economies starting from a lower income grow more quickly than those starting from a higher income. This testing procedure is usually applied on a large number of cross-sections in order to get sufficient variation from the data.

However, Evans (1996) shows that OLS provides biased estimates of β and δ', if ϵ_n is correlated with y_{n0}, unless $y_{nt} - \bar{y}_t$ is a stationary process and the cross-country differences are permanent, i.e. they do not vary over time[5]. If these conditions are met, the N economies are said to converge, and inferences on the heteroskedastic-consistent t-ratio of β and F-ratio of δ of eq. (2) are valid. However, two further issues have to be considered. Firstly, technology differs widely across countries (or regions). Secondly, the assumption that all the economies have identical first-order autoregressive properties relies on the unlikely assumption that the set of variables x is able to control for all differences. These two assumptions imply that the traditional approach is valid only if the economies considered are homogeneous. Final criticism to the conventional approach is that it throws away all of the time series

[5]Hence, they are uncorrelated with ϵ_n.

variation of the ys. To solve these problems, Evans and Karras (EK, 1996) suggest testing for the stationarity of the demeaned series, i.e.:

$$\Delta(y_n - \bar{y})_t = \theta_n + \varphi_n(y_n - \bar{y})_{t-1} + \sum_{i=1}^{p} \lambda_{ni}\Delta(y_n - \bar{y})_{t-i} + \nu_{nt}, \qquad (3)$$

where, $\varphi = 0$ if the economies diverge, and $\varphi < 0$ if they converge. EK formulate a modified panel unit root test of eq. (3) that allows testing two implications of Endogenous Growth Models (EGM), namely that $\varphi = 0$, and $\theta \neq 0$. They employ Monte Carlo simulation to provide approximate distributions of $\tau(\hat{\varphi})$ and $\Phi(\hat{\theta})$.

Evans and Karras (1996), however, dispense from two critical facts. Firstly, they assume that ν_s are uncorrelated, an assumption that is likely to be invalid, especially for a finite cross-section of regional economies. Secondly, they do not exploit the fact that φ can be equal to zero even if only some of the economies diverge.

In this work, we intend to overcome some of these limitations exploiting some of the recent advances in Panel Unit Root (PUR) tests. These tests dramatically increase the power of univariate unit root tests by pooling cross sectional time series data. One of the first PUR tests was developed by Levin and Lin (1993) and then extended by Levin, Lin and Chu (LLC, 2002) This test can be essentially seen as a pooled Dickey-Fuller test, or a pooled Augmented Dickey-Fuller (ADF) test when lags of the dependent variable are included to account for serial correlation in the errors.

$$\Delta\tilde{y}_{it} = \alpha_1^*\tilde{y}_{it-1} + \beta t + \sum_{j=1}^{p+1} \alpha_j^*\Delta\tilde{y}_{it-j} + \tilde{\epsilon}_{it} \qquad (4)$$

where $\tilde{y}_{it} = y_{it} - \bar{y}_{it}$. As in the univariate ADF, the null hypothesis is that the series is non-stationary or integrated of order 1, I[1]. LLC derive a statistic (t^*), which is distributed as a standard normal under the null hypothesis of non-stationarity.

Although, the test accounts for individual effects, time effects and possibly a time trend, it assumes that each cross-section in the panel shares the same auto-regressive coefficient. This essentially means assuming that all series in the panel exhibit the same degree of mean-reversion. Although it is plausible to assume that all series may converge on average, the restriction that all converge at the same speed may be binding.

In this paper we are particularly interested in the issue of heterogeneity because differences in the economic structure across Italian regions are sizeable and this can have relevant implications for empirical modelling.

Firstly, we are interested in whether the rate of convergence across regions is of a similar magnitude. And consequently, whether we can group particular regions in terms of rates of convergence or all regions converge at the same pace. In addition, since the work of Robertson and Symons (1992) and Pesaran and Smith (1995), it has been noted in the literature that Fixed Effects (FE) estimation is potentially inconsistent when using dynamic equations under cross sectional heterogeneity. In contrast, an average panel estimator, such as the Mean Group (MG) estimator,[6] will provide consistent estimates of the average of the parameters from dynamic regressions although these estimates will be inefficient since we are not fully utilising all the potential advantages of poolability in the panel. We use the Hausman test statistic to explicitly examine panel poolability in what follows. The Hausman test can be used to compare the estimated coefficients from FE and RCM, hence whether bias is important for FE due to heterogeneity and therefore whether we can pool coefficients and groups in a single panel. As suggested by Pesaran, Smith and Im (1996) the test statistic, distributed as a $\chi^2(k)$, has a null hypothesis of homogeneity, when FE estimates are equal to RCM estimates, and an alternative of heterogeneity. Where $\hat{\theta}$ is a (k x 1) vector of FE estimates and $\tilde{\theta}$ is a (k x 1) vector of RCM estimates under the null of homogeneity. The test statistic is of the form

$$(\tilde{\theta} - \hat{\theta})'[V(\tilde{\theta}) - V(\hat{\theta})]^{-1}(\tilde{\theta} - \hat{\theta}) \sim \chi^2(k) \quad (5)$$

[6] See Pesaran and Smith (1995) or Swamy's Random Coefficient Model (RCM)

where $V(\theta)$ is the estimated variance of θ. In relationship to panel unit root tests, the test developed by Levin, Lin and Chu (2002) imposes homogeneity of no unit root under the alternative. This may be potentially restrictive and subject to the heterogeneity bias mentioned above.[7]

The test developed by Im, Pesaran, and Shin (IPS, 2003) tries to overcome this problem. IPS propose estimating individual-specific ADF tests and then pooling the t-statistic of each test, into a $\bar{t} - statistic$. They then compute the exact critical values of this statistic and show that after transformation by factors provided in the paper, the $W[\bar{t}]$ statistic is distributed standard normal under the null hypothesis of non-stationarity.

As in the LLC test, the test developed by IPS assumes that all series are non-stationary under the null hypothesis, after allowing for individual effects, time trends, and common time effects. As in LLC, lags of the dependent variable may be introduced to allow for serial correlation in the errors. Unlike the LLC test, however, the IPS test does not assume that all series are stationary under the alternative, but is consistent under the alternative that only a fraction of the series are stationary.

These two tests are the most common in the literature, but other equivalent are available. Maddala and Wu (MW, 1999), for example, have proposed a test known as Fisher's test, which is similar to that of IPS, in that it combines the p-values from N independent unit root tests.[8] Hadri (2000), on the other hand develops a Lagrange Multiplier (LM) test where the test statistic is distributed as standard normal under the null of stationarity.

Sarno and Taylor (ST, 1998) provide a test particularly useful for the purposes of our analysis. The Authors develop a multivariate augmented Dickey-Fuller test that can be considered similar to that of LLC, because

[7]The Hausman test will provide information on the similarity of cross sectional estimates. Therefore it will provide information on whether there is a similar speed of convergence across Italian regions or whether we should pool regions on the basis of convergence clubs.

[8]The major advantage of this test is that it does not require the panel to be balanced. This property, however, is not required in our case.

it similarly imposes a single autoregressive parameter over all units in the panel. However, this test employs the Zellner's seemingly unrelated regressions (SURE) estimator (one equation for each cross-section). Given that in standard SURE models T must exceed N, this test cannot be applied to panels where the cross-sectional dimension is greater than the time dimension. As such, it is maybe more suited to macro-econometric time series. The LLC test, on the other hand, does not have this "limitation", and is more suited, contrary to our case, for small-T, large-N panels.

The ST test involves the hypothesis, for each equation, that the sum of the coefficients of the autoregressive polynomial is unity. The null hypothesis consists of the joint test that this condition is satisfied over the N equations. Hence, under the null hypothesis, all of the series in the panel are non-stationary stochastic processes. The asymptotic properties of the statistic are unknown. Hence, Taylor and Sarno (1998) provide response surface estimates of the 5% critical values, derived from Monte Carlo simulation.[9] The main advantage of this procedure is that, unlike the previous ones, using SUR, it take into account the cross-sectional dependence of the errors. This is particularly important in our analysis, where it is very likely that shocks are connected across regions, and spillovers may have the effect of increasing the process of convergence among some regions and divergence among others.

An important caveat of this test is that the null hypothesis can be rejected even if one of the series in the panel is stationary. Hence, rejection of the null cannot be taken as conclusive indication that each of the series is stationary.

4 Empirical Implementation

4.1 Total Factor Productivity

The Italian Statistical Office (ISTAT) has recently provided the national time series for the period 1993-2003 of TFP. However, at regional level no official

[9]The response surface was estimated over sample sizes ranging from 25 to 500 observations per cross-sectional unit.

data is available. Hence, we have adapted the *growth accounting methodology* (Solow, 1957) in order to obtain the regional series for the period beginning 1970 and ending in 2001. This approach starts from a conventional Cobb-Douglas production function with constant returns of scale:

$$Y = K^{1-\alpha}(AL)^{\alpha}, \tag{6}$$

where Y is value added at constant prices, K is the stock of physical capital, L is labour measured in standard units, and A is the technical progress, which is assumed to be labour-augmenting (or Harrod neutral). Perfect competition is assumed in the inputs market. In this methodology, the main problem is to define a reasonable value for the labour income share (α). In many papers, this parameter is assumed to be a fixed value of 0.07 both over time and across units. Hence, the possibility of different regional economic structures is not taken into account. In order to overcome this criticism, particularly binding in our case, we have obtained an estimate of as the ratio between labour costs and added value:[10]

$$\alpha = \frac{wL}{Y},$$

where w is the per capita income of employed workers, L is the overall number of workers (employed and self-employed) measured in standard unit, and Y is the added value. This allows us to have labour income shares which vary both over time and across units. Figure 1 shows that each region had a different structural change over time. Indeed, while in 1970 the average α across units is 0.7, it becomes 0.6 in 2001. This result is coherent with the hypothesis of a change in the structure of the economy. From equation (6), we can obtain the value of the regional TFP:

$$A = TFP = \left[\left(\frac{Y}{L}\right) \Big/ \left(\frac{K}{Y}\right)^{\frac{1-\alpha}{\alpha}} \right]. \tag{7}$$

[10]Felli, Gerli and Piacentino (2004) used this measure of the income labour share parameter of Italian regions for the first time.

A, or Solow residual, measures the quantity of output that does not depend on the production factors. We have computed A for each year of the sample period and for each region, obtaining a panel-varying TFP. Reorganising equation (7), the decomposition of labour productivity becomes evident:

$$\left(\frac{Y}{L}\right) = TFP \cdot \left(\frac{K}{Y}\right)^{\gamma}, \tag{8}$$

where $\gamma = \frac{1-\alpha}{\alpha}$. Table 1 shows the average value for each region and for macro areas for each component of equation (8) in the period 1700-2001. From this table, we can see a decrease in labour productivity from the North-West (11% more than the national average) to the South (14% less than the national average) of the country. A similar gap is estimated for TFP. On the other hand, the distribution of capital per unit of output seems to be more homogenous among the macro-areas. Moreover, labour productivity is highly correlated with TFP (0.80) and little with the ratio K/Y (0.26). Hence, we believe that in order to explain the Y/L difference, it is more important to look at TFP rather than the ratio K/Y.

Figure 2 plots the regional time series for TFP, obtained using the growth accounting methodology. Based on the simple visual inspection of these series there seems to be a tendency for the series to convergence from 1970 to 1980 and a persistence of the regional gaps over the latter period.

4.2 Results

Tables 2 and 3 show the PUR tests of convergence for two possible measures of distance in TFP between regions. The first is the simple distance of each regional series from the cross sectional average, taken as the benchmark, i.e:

$$\tilde{y}_{it} = ln(y_{it}) - \frac{1}{N}\sum_{i=1}^{N} \ln(y_{it}). \tag{9}$$

The second is a measure of distance that does not make a distinction between regions below and above the benchmark, and uses the absolute (value of the) distance from the cross-sectional average[11], i.e.

$$\breve{y}_{it} = ln(1 + |y_{it} - \frac{1}{N}\sum_{i=1}^{N} y_{it}|). \quad (10)$$

The first step is the Levin-Lin-Chu (LLC) PUR test. As discussed in section 3 this test takes into account differences between regions that are constant over time, but does not consider differences in the speed of convergence. Still it provides useful inference of whether the data exhibits a process of convergence on average. Considering the full sample, for both measures of distance from the benchmark this test cannot reject the null of no stationarity in the series, leading us to conclude that there is no convergence in the Italian regional system as a whole. Interestingly, however, when we make a partition of the sample into two sub-groups (South and Centre-North), we observe a substantial difference in the results obtained from the two measures of distance. The test of convergence on $\tilde{y}$ concludes at the 5% critical level that there is no convergence among the Southern regions (Basilicata, Calabria, Campania, Molise, Puglia, Sardegna, Sicilia), and convergence among the regions of the Centre-North (Emilia Romagna, Friuli V.G., Liguria, Lombardia, Piemonte, Trentino A.A., Veneto, Lazio, Marche, Toscana, Umbria, Abruzzo). Interestingly, this result is overturned when we consider $\breve{y}$. As a further check, we have refined the disaggregation of the grouping of regions, dividing the Centre-North into Central (Lazio, Marche, Toscana, Umbria, Abruzzo), and Northern regions (Emilia Romagna, Friuli V.G., Liguria, Lombardia, Piemonte, Trentino A.A., Veneto). Now the test concludes for both measures that there is no convergence among Central regions (at the 5% critical level). The two measures, however, still yield different results for the Northern sub-group. The LLC test on $\tilde{y}$ shows that most of the convergence picked up in the Centre-North grouping was coming through the

[11] The rationale may be that distinguishing between regions above and below the average, as in the conventional measure, makes the two groups fall *a priori* on parts of the log function with different slopes, the second does away with this distinction and treats both groups of regions equally.

convergence among the Northern regions. The same test on the $\breve{y}$ reaches exactly the opposite conclusion of no convergence.

In order to investigate whether there is heterogeneity in the coefficients of our regressions, we have used the Hausman statistic discussed in section 3 to perform a test of poolability of the data. Table 4 shows that according to this test the slopes of the autoregressive parameters are homogeneous at any level of aggregation. This result is not surprising since our measures of TFP are bound to capture the more persistent part of growth dynamics. Hence this test simply concludes that the mean-reversion (or non-reversion) properties of each series are very similar.[12]

As a second step, we have used the test proposed by Im, Pesaran and Shin (IPS) in order to take into account not only of the fixed effects heterogeneity (as in LLC) , but also the possible presence of heterogeneity in the autoregressive parameter, a restriction that may be particularly binding in our case. Applied to the entire panel, this test cannot reject the null of no stationarity, using both measures of distance. This result basically mirrors the one obtained with the LLC test. However, this test concludes for no convergence even when we break down the sample into sub-groups of regions. Only in one instance, the test is able to reject the null, namely among the regions of the South and when we use $\breve{y}$.

IPS, however, does not consider fully the potential cross-sectional interdependence between the regions. A solution to this problem is the use of the SURE methodology. Therefore, we have performed the test proposed by Sarno and Taylor (1998) and Taylor and Sarno (1998), MADF. In this test, rejection of the null cannot be taken as conclusive evidence that all the series are stationary, but that at least one is. The interesting result, when we apply this test, is that the null hypothesis is often rejected in the case of $\tilde{y}$, leading us to conclude that some regions must be in a convergence process

[12] A corollary of this test could be that pooling the data as in the LLC test is not particularly damaging. It is however, important to note that the test may be affected by inconsistencies deriving from the dynamic nature of the data

and that there are convergence clubs present. We cannot reject the null of no stationarity only for the Northern regions and, consequently, we have to conclude that among these regions does not exist any process of convergence. When we look at $\breve{y}$, a tendency of club convergence is shown only for the first level of geographical disaggregation (South and Centre-North). Interestingly, when we consider the disaggregation into three groups of regions (South, Centre and North), we find that only the Southern regions seem to exhibit the tendency of club convergence. An odd result is that the test rejects the null hypothesis when we pool the Centre-Nothern regions, but fails to reject the null when we further disaggregate the sample into Central and Northern regions. In both cases, there seems to be no convergence. A plausible explanation for this result is that there must be some form of interdependence within the more general grouping and this causes some form of convergence between part of the regions. This is absent when we look at the two sub-groups. Ultimately, this seems to suggest that further analysis of the clubs of convergence may be important in order to get a richer picture.

5 Concluding Remarks

In this paper, we have intended to look for evidence of convergence in the long run structural determinants of growth using a measure of Total Factor Productivity derived from the growth accounting methodology. Past evidence on convergence in per capita income and labour productivity in Italy has underlined a substantial dualism between Northern and Southern regions. This is a well known result, but what happens within these two areas? Are the geographically near regions so similar in the economic structure and do they grow really along a same long run path? Taking into account the heterogeneity and the cross-sectional dependence, we have investigated more in depth on the presence of similarity in the TFP growth process of the Italian regions. Moreover, we have used two different measures of distance from the benchmark, $\tilde{y}$ and $\breve{y}$. For the full sample, the two measures lead to the same conclusion of no convergence for the tests of LLC and IPS, and of convergence using MADF. Hence, the first two tests show absence of convergence in Italy not only considering the heterogeneity in the fixed term but also in the autoregressive parameter. On the other hand, the test of MADF gives us information about the presence of some clubs of convergence. Consequently, we have made a partition of the sample, firstly, into two and, successively, into three sub-groups. In both of the cases, the results are quite different according to which measure we consider ($\tilde{y}$ or $\breve{y}$). In particular, we can frequently observe differences using LLC. Summing up, considering both the heterogeneity and the cross-sectional dependence, the North does not seem to show any convergence process. On the other hand, we can observe a tendency to converge of the Southern regions, especially when we take into account the cross-sectional dependence. In other words, whereas there is a long run convergence among Southern Italian regions (probably towards values below the national average), Northern regions seem to stand in different long run paths. These results still need a more robust assessment, however, they lead us towards some interesting issues for further researches. Firstly, structural investments are seriously necessary to stimulate the Southern regions to converge towards higher income paths. Secondly, the Northern regions seem to have different virtuous paths, probably characterized by different endogenous sources of growth.

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Table 1: **Regional and macro-area average value (1970-2001)**
Italy = 1.00

Region	**Y/L**	$(K/Y)^{\gamma}$	**TFP**
Piemonte	1.06	1.08	1.09
Lombardia	1.13	1.18	1.12
Liguria	1.09	0.89	0.95
North West	**1.11**	**1.05**	**1.02**
Trentino A.A.	1.06	0.83	1.03
Veneto	0.98	1.08	1.15
Friuli V.G.	0.93	0.89	1.02
Emila Romagna	1.02	1.05	1.05
North East	**1.00**	**0.96**	**1.06**
Toscana	0.99	1.01	1.04
Umbria	0.93	1.05	0.9
Marche	0.86	0.82	0.94
Lazio	1.14	0.79	1.2
Centre	**0.98**	**0.92**	**1.02**
Abruzzo	0.89	0.89	0.85
Molise	0.82	0.83	0.9
Puglia	0.82	1.02	0.82
Campania	0.86	0.78	0.92
Basilicata	0.79	0.98	0.76
Calabria	0.76	0.87	0.78
Sicilia	0.95	0.99	0.83
Sardegna	0.96	1.25	0.87
South	**0.86**	**0.95**	**0.84**

Table 2: **Panel Unit Root Tests of TFP** - $\ln(\tilde{y}_{it})$

All Regions (N=19)

Test	Statistic	P-value	Conclusion
LLC	-5.69	0.0804	*No Convergence*
IPS	-1.62	0.3140	*No Convergence*
MADF	258.98	26.38	*Convergence*

South (N=7)

Basilicata, Calabria, Campania, Molise, Puglia, Sardegna, Sicilia

Test	Statistic	P-value	Conclusion
LLC	-4.56	0.0888	*No Convergence*
IPS	-1.88	0.1430	*No Convergence*
MADF	29.26	26.38	*Convergence*

Centre-North (N=12)

Emilia Romagna, Friuli V.G., Liguria, Lombardia, Piemonte
Trentino A.A., Veneto, Lazio, Marche, Toscana, Umbria, Abruzzo

Test	Statistic	P-value	Conclusion
LLC	-4.38	0.0264	*Convergence*
IPS	-1.56	0.4430	*No Convergence*
MADF	89.36	26.38	*Convergence*

Centre (N=5)

Lazio, Marche, Umbria, Toscana, Abruzzo

Test	Statistic	P-value	Conclusion
LLC	-2.78	0.0627	*No Convergence*
IPS	-1.63	0.3940	*No Convergence*
MADF	28.63	26.38	*Convergence*

North (N=7)

Friuli V.G., Liguria, Lombardia, Piemonte, Trentino A.A.
Veneto, Emilia Romagna

Test	Statistic	P-value	Conclusion
LLC	-3.88	0.0204	*Convergence*
IPS	-1.69	0.3130	*No Convergence*
MADF	24.79	26.38	*No Convergence*

For MADF, the critical value is reported instead of the p-value

Table 3: **Panel Unit Root Tests of TFP** - $\ln(\breve{y}_{it})$

All Regions (N=19)

Test	**Statistic**	**P-value**	**Conclusion**
LLC	-4.63	0.5183	*No Convergence*
IPS	-1.50	0.5330	*No Convergence*
MADF	139.53	26.38	*Convergence*

South (N=7)

Basilicata, Calabria, Campania, Molise, Puglia, Sardegna, Sicilia

Test	**Statistic**	**P-value**	**Conclusion**
LLC	-5.47	0.0214	*Convergence*
IPS	-2.17	0.0270	*Convergence*
MADF	69.84	26.38	*Convergence*

Centre-North (N=12)

Emilia Romagna, Friuli V.G., Liguria, Lombardia, Piemonte
Trentino A.A., Veneto, Lazio, Marche, Toscana, Umbria, Abruzzo

Test	**Statistic**	**P-value**	**Conclusion**
LLC	-2.62	0.6624	*No Convergence*
IPS	-1.29	0.8190	*No Convergence*
MADF	71.32	26.38	*Convergence*

Centre (N=5)

Lazio, Marche, Umbria, Toscana, Abruzzo

Test	**Statistic**	**P-value**	**Conclusion**
LLC	-1.77	0.4974	*No Convergence*
IPS	-0.94	0.9260	*No Convergence*
MADF	9.84	26.38	*No Convergence*

North (N=7)

Friuli V.G., Liguria, Lombardia, Piemonte, Trentino A.A.
Veneto, Emilia Romagna

Test	**Statistic**	**P-value**	**Conclusion**
LLC	-3.28	0.2584	*No Convergence*
IPS	-1.34	0.7000	*No Convergence*
MADF	20.09	26.38	*No Convergence*

For MADF, the critical value is reported instead of the p-value

Table 4: **Tests of Poolability of the β_s (1970-2001)**

All Regions

$\ln(\tilde{y}_{it})$			$\ln(\breve{y}_{it})$		
Statistic	**P-value**	**Conclusion**	**Statistic**	**P-value**	**Conclusion**
0.00	0.9683	*Homogeneity*	0.01	0.9342	*Homogeneity*

South:
Basilicata, Calabria, Campania, Molise, Puglia, Sardegna, Sicilia

$\ln(\tilde{y}_{it})$			$\ln(\breve{y}_{it})$		
Statistic	**P-value**	**Conclusion**	**Statistic**	**P-value**	**Conclusion**
0.10	0.7482	*Homogeneity*	0.30	0.5846	*Homogeneity*

Centre-North:
Emilia Romagna, Friuli V.G., Liguria, Lombardia, Piemonte, Trentino A.A., Veneto, Lazio, Marche, Toscana, Umbria, Abruzzo

$\ln(\tilde{y}_{it})$			$\ln(\breve{y}_{it})$		
Statistic	**P-value**	**Conclusion**	**Statistic**	**P-value**	**Conclusion**
0.68	0.4081	*Homogeneity*	0.96	0.3267	*Homogeneity*

South:
Basilicata, Calabria, Campania, Molise, Puglia, Sardegna, Sicilia

$\ln(\tilde{y}_{it})$			$\ln(\breve{y}_{it})$		
Statistic	**P-value**	**Conclusion**	**Statistic**	**P-value**	**Conclusion**
0.10	0.7482	*Homogeneity*	0.30	0.5846	*Homogeneity*

Centre:
Lazio, Marche, Umbria, Toscana, Abruzzo

$\ln(\tilde{y}_{it})$			$\ln(\breve{y}_{it})$		
Statistic	**P-value**	**Conclusion**	**Statistic**	**P-value**	**Conclusion**
0.57	0.4488	*Homogeneity*	0.52	0.4717	*Homogeneity*

North:
Friuli V.G., Liguria, Lombardia, Piemonte, Trentino A.A., Veneto, Emilia Romagna

$\ln(\tilde{y}_{it})$			$\ln(\breve{y}_{it})$		
Statistic	**P-value**	**Conclusion**	**Statistic**	**P-value**	**Conclusion**
0.00	0.9992	*Homogeneity*	0.00	0.9992	*Homogeneity*

Figure 1: **Income Labour Share of Italian Regions**

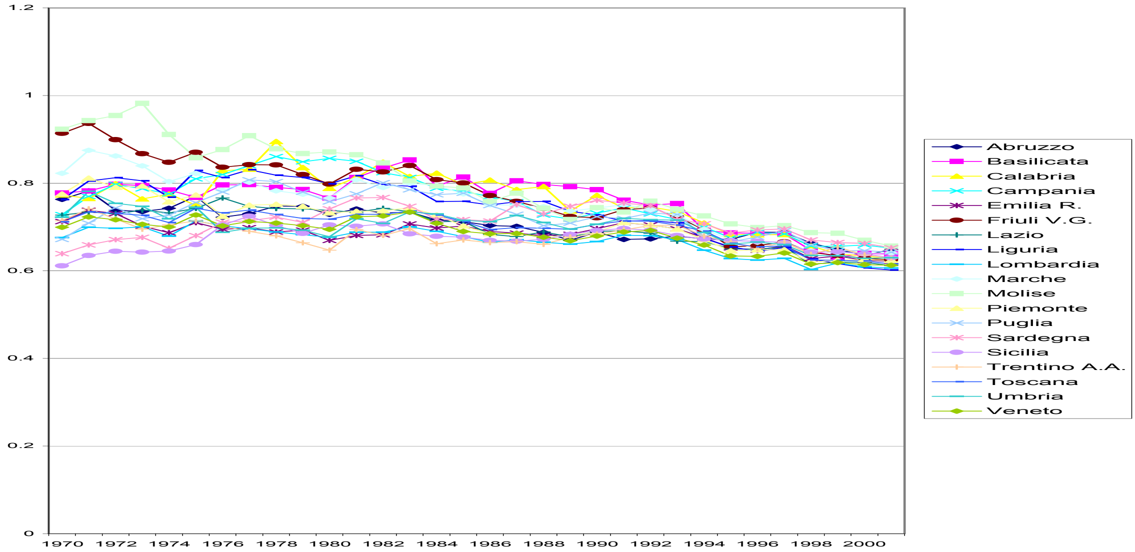

Figure 2: **Total Factor Productivity of Italian Regions**