E C O N O M I C S B U L L E T I N

Human capital and "club convergence" in Italian regions

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Abstract

The aim of the study is to investigate the presence of “convergence clubs” among Italian regions applying the stochastic notion of convergence. Regions are sorted according to some human capital accumulation indicators using the Classification and Regression Tree Analysis (CART). The analysis evidences a strong stochastic convergence process which characterizes all the regions suggesting the presence of different growth patterns. Furthermore, results seem to highlight that human capital accumulation favours regional growth particularly in initially “backwards” regions.

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1. Introduction

Economic convergence is a vital field of research since nowadays one of the greater attempts is the elimination of income disparities both at country and region level. However, the literature shows puzzling results. Romer (1986) and De Long and Bradford (1988), for example, ascribed the failure of convergence among economies characterized by different initial conditions to the presence of increasing return to scale. On the contrary, Baumol (1986) and Barro (1991), among others, showed that controlling by human capital variables similar countries may converge. Bernard and Durlauf, (1996), though, found out that for economies showing multiple long run equilibria, cross-sectional tests tend to spuriously reject the null hypothesis of no convergence, therefore, in these cases a different notion of convergence should be considered. Carlino and Mills (1993), proposed and explored a stochastic definition of convergence using time series analyses. The stochastic convergence hypothesis is verified when per capita income disparities among economies follow a stationary process.

The aim of this study is to test the presence of "convergence clubs" among Italian regions applying the stochastic notion of convergence (De Siano and D'Uva, 2006) to groups of regions sorted according to some human capital accumulation indicators. The analysis refers to the period 1981-2003.

The role of human capital is widely analyzed in the growth literature for its contribute to the adoption of the types of change induced by globalization and new technologies. Human capital can be acquired through education, learning-by-doing or R&D activities. However, a crucial distinction has been made between models where human capital is needed for R&D purposes (Aghion and Howitt, 1998) and models where human capital enters directly in the production function (Lucas, 1988). The first view implies that growth is driven by the stock of human capital which may increase labour productivity, facilitating the adoption of skill-labour augmenting technology (Nelson and Phelps, 1966; Benhabib and Spiegel, 1994, 2002; Acemogulu, 2003; Caselli and Coleman, 2006). The second view implies that growth is driven by human capital accumulation process, which accelerates income growth transferring productive resources to schooling intensive sectors (Aghion and Howitt, 1998, Ciccone and Papaioannou, 2006). Although the empirical macro growth literature specifies growth as a function of initial human capital levels, a strand of the literature (Krueger and Lindahl, 2001), following the Mincer model[1], states that variation of the average schooling level may affect income growth. Part of the empirical analyses, however, finds insignificant and wrong sign effect of schooling change on economic growth (as for example Benhabib and Spiegel, 1994) but recently other studies (Topel, 1999; Krueger and Lindahl, 2001) showed that this result may be due to measurement error problems (measure of human capital, estimation approaches,…). In this paper, following the second view, we group regions for the club convergence test using some indicators of human capital accumulation.

The innovative element of the study is the application of an endogenous grouping method, the *Classification and Regression Tree Analysis* (Durlauf and Johnson, 1995, De Siano and D'Uva, 2005, 2004), instead of some *a priori* criteria as in the most part of literature. In particular this methodology allows a regression to be performed together with a classification analysis on the same "learning" dataset, without requiring any specification of the functional form for the predictor variables which are selected endogenously.

The rest of the paper is organised as follows: section 2 introduces the methodology of the empirical analysis, section 3 presents the dataset, section 4 shows the econometric analysis results and section 5 concludes. The appendix contains the graphs, the tables and the regression tree.

[1] Introducing the Mincerian wage equation in the macro growth model.

2. Methodology

The empirical analysis is divided in two parts. In the first we group regions through the *Classification and Regression Tree Analysis* (CART) on the basis of some human capital accumulation indicators. CART methodology**,** (Breiman *et al*., 1984) generates homogeneous groups of economies using, as predictors, the splitting variables which minimize the *intra*-group heterogeneity. The final outcome is a tree with "terminal nodes" where the average value represents the predicted value of the dependent variable. In our analysis the regression tree is carried out through the least squares method using the regional GDP growth rate as dependent variable and the variations of people with high school degree and bachelor degree as explicative variables.
The second part is aimed to test the stochastic notion of convergence within each group using the Carlino and Mills (1993) model. This method implies that if the logarithm of a region per capita income relative to the average of the group it belongs does not contain a unit root, the region converges. The model (Ben-David, 1994; Qing Li, 1999) is the following:

$$y_{i,t}^{j} = \alpha_i + \beta_i t + \varphi y_{i,t-1} + \varepsilon_{i,t} \qquad (2)$$

where $y_{i,t}^{j}$ is the log of region *i* per capita income in year *t*, *j* indicates the group the region belongs to and ε is a white noise error with 0 mean. Summing the equation 2 over *j* for each group and dividing the outcome by the number of regions within the group, we obtain:

$$\overline{y}_t = \overline{\alpha} + \overline{\beta} t + \varphi \overline{y}_{t-1} + \varepsilon_t \qquad (3)$$

where $\overline{y}_t$ is the group's average per capita income in year *t* (the group superscript is suppressed).
Subtracting equation *3* from *2* we have:

$$RI_{i,t} = A + Bt + \varphi RI_{i,t-1} + \varepsilon_t \qquad (4)$$

where $RI_{i,t}$ is the logarithm of region *i* per capita income relative to the group's average at time *t* $(y_{i,t}^{j} - \overline{y}_t)$.
For each region of the sample we apply the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979) using the ADF regression of equation 4:

$$\Delta RI_t = \mu + \beta t + \alpha RI_{t-1} + \sum_{j=1}^{k} c_j \Delta RI_{t-j} + \varepsilon_t \qquad (5)$$

Finally, considering the low power of the ADF test in the case of short time series, we run also the Kwiatkowski-Phillips-Schmidt-Shin (1992) test (KPSS) for trend stationarity. The null hypothesis of the KPSS test is the trend stationarity against the unit root alternative. The combined analysis of KPSS and ADF tests' results leads on the following possibilities (Qing Li, 1999):
-rejection by ADF and failure to reject by KPSS →strong convergence;
-failure to reject by both ADF and KPSS →weak convergence;
-rejection by KPSS and failure to reject ADF →no convergence;
-rejection by both ADF and KPSS → further analyses are required.

3. Data description

The sample consists of all Italian regions at NUTS2 level (20) in the period 1981-2003. For the econometric analysis we use the growth rate of annual per capita GDP (PPP) as dependent variable and human capital accumulation indicators -variations of people with high school degree (VARHSC) and bachelor degree (VARBA)- as explicative variables.
For the descriptive analysis we use the following labour market indicators:

- Total activity rate (1981-2001);
- Activity rate in age class 15-24 (1981-2001),
- Activity rate in age class 25-34 (1983-2001);

- Total unemployment rate (1983-2001[2]);
- Unemployment rate in age class <25 (1983-2001);
- Unemployment rate in age class ≥25 (1983-2001);
- Long term unemployment rate -longer than 12 months- (1987-2001);
- Internal migration (1981-1999);
- Total international emigration (1990-1999);
- International emigration for different age classes (1990-1999);
- Total international immigration (1990-1999);
- International immigration for different age classes (1990-1999).

Data are from the Eurostat New Cronos Regio and Istat databases.

The dynamic analysis of Italian regions per capita GDP shows an average growth rate equal to 32% in the considered period. In particular, Veneto, Marche, Abruzzo, Molise, Basilicata e Calabria show the highest growth rate (Txgdp, graph 1), while Valle D'Aosta, Sardegna, Lazio, initially among the richest (Lgdp81, initial per capita GDP level), display sluggish growth.

4. Empirical results

The econometric analysis, run through CART methodology, enabled us to build a tree with terminal nodes including regions showing a more homogeneous behaviour of per capita GDP growth rate on the base of the above human capital accumulation indicators. Besides, the combined analyses of KPSS and ADF tests (tables I, II and III) show that all the regions strongly converge towards the group average[3], suggesting the existence of different growth patterns. A description of each group follows.

Group 1

This group includes 9 regions: -Piemonte, Liguria, Emilia Romagna, Toscana, Umbria, Marche, Lazio, Campania, Sicilia- characterized by:

- the second highest GDP growth rate (30%) and the highest initial per capita income level (35896,7 mln of euros);
- the lowest increase of human capital accumulation given by the number of people with first and bachelor degrees (141% and 136%);
- the highest decrease of activity rate despite the highest initial level; age class 15-24 registers an increase while 25-34 a little increase;
- a decrease of total unemployment rate (0,9%), initially equal to 8,4%; in particular age class 15-25 unemployment rate (28,3%) shows a considerable decrease (26,4%);
- a decrease of within Italy migration (22,5%), while total migration decreases by 19,4% (juvenile migration shows the highest decrease, 28%).

Group 2

The group contains 5 regions -Valle d'Aosta, Lombardia, Friuli Venezia Giulia, Abruzzo, Sardegna- characterized by:

- the lowest GDP growth rate (26,3 %) and the second initial level (33352,9 mln of euros);
- a medium increase of human capital accumulation (164% for first degree and 149% for bachelor one);

[2] Unemployment data for Valle d'Aosta start from 1984.
[3] Except for Piemonte in group 1 which converges weakly.

- a medium activity rate, stable until the end of the period (49,3%); activity rate of 15-24 age class (initially 47,5%) decreases by 21% while class 25-34 (76,7%) increases by 2,7%;
- a 23% decrease of total unemployment rate (7,9% in 1983); age class 15-25 initial unemployment rate is the lowest among the groups (27,2%) and showed the highest decrease (33,7%); unemployment rate of people older than 25 years presents the lowest initial value (3,4%) and the second highest increase (51,9%); long term unemployment shows the highest decrease (30%);
- a 28% decrease of within Italy migration, while total migration increases by 17% (juvenile migration shows increase greater than 30%); international immigration shows little decrease (4,8%, young people's decrease is around 20%).

Group 3

This group contains 6 regions :-Trentino Alto Adige, Veneto, Molise, Puglia, Basilicata, Calabria- characterized by:

- the highest GDP growth rate (39,7%**)** despite the lowest initial per capita level (28920,9 mln of euros);
-the highest increase of human capital accumulation indicators (171% for first degree and 174% for bachelor one);
-the lowest initial activity rate (47.5%) with the second highest decrease (5,5%); the lowest rate also for juvenile classes (activity rate of 15-24 age class decreases by 14,9 % while class 25-34 decreases by 5,9%);
-an increase of 28% for total unemployment rate (initially the highest and equal to 9,1%); age class>25 shows a considerable increase (97,8%); the long term unemployment rate decreases by 7%;
-a decrease of within Italy migration (25%) as well as total migration (13,4%); among young people age class, 20-24 shows a more considerable decrease (16,5%); immigration decreases by 30,8% with the highest decrease presented by the youngest age classes (20-24 and 25-29).

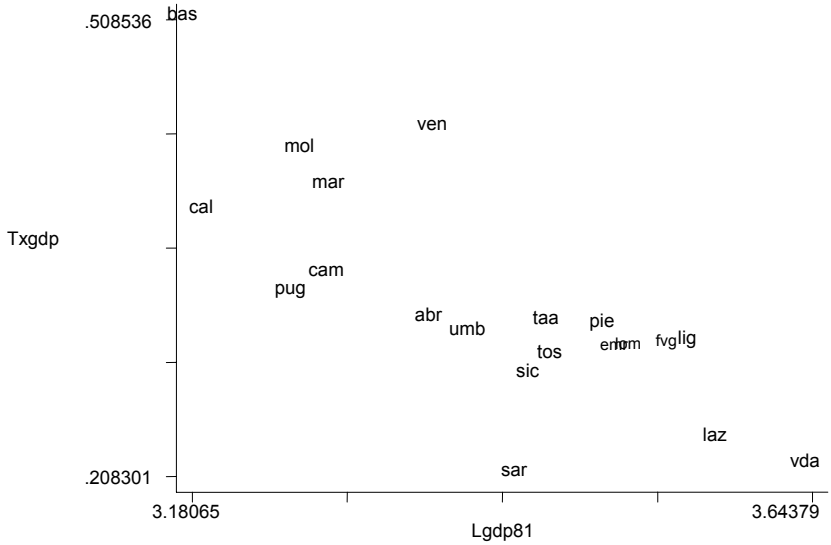
5. Conclusions

The objective of the paper is to test the presence of "convergence clubs" among Italian regions applying the stochastic notion of convergence. Human capital accumulation indicators have been used to generate the groups by CART analysis. The analysis evidences a strong stochastic convergence process which characterizes regions within the group they belong to for all the Italian regions, supporting the presence of different growth patterns. In the considered period, the results seem to highlight that the accumulation process instead of the existing stock of human capital favours regional growth in Italy. Furthermore the highest increase of human capital accumulation is observed in the regions that in 1981 show the lowest level of per capita GDP (group 3), suggesting the idea that human capital favours growth particularly in initially "backwards" regions.

References

-Acemoglu, D. (2003) Patterns of Skill Premia, *Review of Economic Studies*, **70**(1), pp. 199-230.
-Aghion P. and Howitt P. (1998), *Endogenous Growth Theory*, Cambridge, MA: MIT Press.
-Azariadis, C. and Drazen, A. (1990), Threshold externalities in economic development, *Quarterly Journal of Economics*, **105**, pp. 501-26.
-Barro, Robert J., (1991), Economic Growth in a Cross-Section of Countries, *Quarterly Journal of Economics*, **106**, pp.407-43.
-Baumol, W.J. (1986), Productivity growth, convergence and welfare: what the long run data show, *American Economic Review*, **76**, pp. 1072-1085.
-Ben-David, D. (1994), Convergence Clubs and Diverging Economies, unpublished manuscript, University of Houston, Ben-Gurion University and CEPR.
-Benhabib, J., Spiegel, M.M., (2002), Human Capital and Technology Diffusion, Federal Reserve Bank of San Francisco, *Working Papers in Applied Economic Theory serie*s, no. 2003-02, forthcoming in Aghion, P., Durlauf, S. (2005), *The Handbookof Economic Growth*, Amsterdam, The Netherlands: North-Holland.
-Benhabib, J., Spiegel, M.M., (1994), The Role of Human Capital in Economic Development, *Journal of Monetary Economics*, **34**(2), pp. 143-174.
-Bernard A.B. and Durlauf S.N. (1996), Interpreting tests of the convergence hypothesis, *Journal of Econometrics*, March,. **71**, no.1-2, pp. 161-73.
-Breiman L., Friedman J.L., Olshen R.A and Stone C.J.(1984), *Classification and Regression Trees*, Wadsworth, Belmont, CA.
-Carlino, G.A. and Mills, L.O. (1993) Are US Regional Incomes Converging? A Time Series Analysis, *Journal of Monetary Economics***, 32***,* pp.335-346.
-Caselli, F., Coleman, J.W. II., (2006), The World Technology Frontier, *American Economic Review*, **96**, no. 3, pp. 499-522.
-Ciccone, A., Papaioannou, E., (2006), Human Capital, the structure of production and growth, *ECB Working Paper series,* no. **623**.
-De Long, J. Bradford (1988), "Productivity Growth, Convergence and Welfare: Comment", *American Economic Review*, **78**, pp.1138-54.
-De Siano, R. and D'Uva, M. (2006), Club convergence in European regions, *Applied Economic Letters*, **13**, no.9, July, pp.569-574..
-De Siano, R. and D'Uva, M. (2005), Specialization and Local Growth: an application of CART Analysis to European Regions, *Studi Economici*, no. 87, 3, pp. 115-128.
-De Siano, R. and D'Uva, M. (2004), Specializzazione e crescita: un'applicazione alle regioni dell'Unione Monetaria Europea, *Rivista Internazionale di Scienze Sociali*, .**4**, pp. 381-398.
-Dickey D.A. and Fuller W.A. (1979), Distribution of the estimators for autoregressive time series with a unit root, *Journal of The American Statistical Association* , **74,** pp.427-431.
-Durlauf S.N., Johnson P.A., (1995) Multiple regimes and cross-country growth behaviour, *Journal of Applied Econometrics*, **10**, pp. 365-384.
-Freire-Serèn M.J (2001), Human capital accumulation an economic growth, *Investigaciones Económicas*, vol.XXV (3), pp. 585-602.
-Krueger A. B. and Lindahl M. (2001), Education for Growth: Why and For Whom?, *Journal of Economic Literature*, Vol.XXXIX, pp.1101-1136.
-Kwiatkowski, D., Phillips ,P.C.B., Schmidt, P. and Shin, Y. (1992) Testing the Null Hypothesis of Stationarity Against the Alternative of a Unit Root: How Sure are We that Economic Time Series have a Unit Root? *Journal of Econometrics*, **54**, pp. 159-178.
-Lucas, R.E. (1988) On the mechanics of economic development, *Journal of Monetary Economics*, **22**, pp. 3-42.
-Nelson, R.R., Phelps, E.S., (1966), Investment in Humans, Technical Diffusion, and Economic Growth, *American Economic Review*, **56**(1/2),pp. 69-75.
-Qing, Li (1999) Convergence Clubs: Some Further Evidence, *Review of International Economics,* **7,** no.1, pp. 59-67.
-Romer, P.M. (1986) Increasing returns and long run growth, *Journal of Political Economy*, **94**, pp. 1002-1037.
- Stokey, N., (1991), Human Capital, Product Quality and Growth, *Quarterly Journal of Economics*, **106**, pp. 587-616.
-Topel R. (1999), Labor Markets and Economic Growth in *Handbook of Labor Economics*, Ashenfelter O. and Card D., eds. Amsterdam, North Holland.

APPENDIX



Graph 1. Dynamic analysis of per capita Gdp

Table I. *Convergence test results of group 1*

Regions group 1	**ADF statistics**	**KPSS statistics *l=4***
Piemonte	-2.69	0.070
Marche	-3.79**	0.1283
Toscana	-4.48*	0.105
Campania	-3.74**	0.0570
Umbria	-4.51*	0.0586
Emilia Romagna	-4.68*	0.1362
Liguria	-4.05**	0.1051
Lazio	-6.72*	0.1662
Sicilia	-4.15**	0.0526

**and * denote statistical significance using unit root critical values at the 5% (-3.645) and 1% (-4.469) respectively; ** and * denote statistical significance using KPSS stationary critical values at the 5% level (0.146) and 1% level (0.216).

Table II. *Convergence test results of group 2*

Regions group 2	**ADF Statistics**	**KPSS statistics *l=4***
Valle d'Aosta	-6.53*	0.1107
Friuli Venezia Giulia	-4.08**	0.0867
Abruzzo	-4.93*	0.1026
Lombardia	-8.10*	0.0646
Sardegna	-4.79*	0.0733

**and * denote statistical significance using unit root critical values at the 5% (-3.645) and 1% (-4.469) respectively; ** and * denote statistical significance using KPSS stationary critical values at the 5% level (0.146) and 1% level (0.216).

Table III. *Convergence test results of group 3*

Regions group 3	**ADF statistics**	**KPSS statistics *l=4***
Veneto	-4.56*	0.0899
Trentino Alto Adige	-6.08*	0.0392
Molise	-7.20*	0.0811
Puglia	-3.45**	0.1368
Basilicata	-4.87*	0.0761
Calabria	-6.81*	0.0840

**and * denote statistical significance using unit root critical values at the 5% (-3.645) and 1% (-4.469) respectively; ** and * denote statistical significance using KPSS stationary critical values at the 5% level (0.146) and 1% level (0.216).

Regression Tree