

A statistical method to measure the typology of regional economic growth: theory and evidence from Italy

*Un metodo statistico per misurare la tipologia di crescita economica regionale:
l'analisi del caso Italiano*

Mario Coccia

NATIONAL RESEARCH COUNCIL OF ITALY
Ceris-Cnr

Collegio Carlo Alberto, Via Real Collegio n. 30
10024 Moncalieri (Torino) - ITALY
Telephone: +39-011-68 24 925
Fax : +39-011-68 24 966
email: m.coccia@ceris.cnr.it

MAX-PLANCK-INSTITUTE OF ECONOMICS

The Entrepreneurship, Growth and Public Policy Group
Kahlaische Straße 10
D-07745 Jena (GERMANY)
Telephone: +49-3641-6865
Fax: +49-3641-68 69 90

Abstract. Il lavoro propone un modello lineare, basato su un'equazione di regressione, che misura la crescita economica regionale. La metodologia consente di analizzare la dinamica sottostante l'ipotesi neoclassica di convergenza, quando i paesi poveri crescono più di quelli ricchi, e mostra i tre patterns della crescita economica regionale rispetto al macro sistema di riferimento

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1. Introduction

The new economic growth theory is based on the convergence property, i.e. whether poor countries or regions grow faster than rich ones, which is a feature of neoclassical model (Solow, 1956) that has been analyzed as an empirical hypothesis only in the recent years (Barro, 1991). The classical approach to the convergence only estimates a cross section regression and he sees only the behavior of the representative economy (Barro and Sala-i-Martin, 2004). The new approach of club convergence (Quah, 1996) fails to take in account how different regions relate to one another and the interrelatedness of regions within the cross-regional total output distribution. To study convergence problems fully it is necessary to analyze the economic growth within the country system and the problem I propose to tackle is this: How are the inner dynamics of convergence and the patterns of regional economic growth? To answer this important economic question, is further elucidated an attempt to develop an alternative model that measures the regional economic growth and presents the underlying dynamics of the convergence property, considering the regions as sub-systems of a macro-system.

2. Model and Results

First of all, a given region can be considered as a system, a set of parts (material and immaterial) that interact and are coordinated in order to achieve a common purpose, i.e. to increase the well-being and wealth of the area. The systemic approach considers the *growth* of a system when the system evolves with proportionality among all the elements of the structure.

There is *development* if the system displays disproportionate (or allometric) growth features in relation to the whole.

The analysis investigates the economic growth of some Italian regions in relation to the North of Italy. In particular, this paper analyses the convergence property from a different point of view for understanding the inner dynamics of convergence and classifies the regions according to the typology of economic growth over time. The data are based on the region's i annualized growth rate of per capita Gross Domestic Product (GDP), all measured in 2003 Euros. The dataset is that of ISTAT (Italian National Institute for Statistics) for the 1980-2003 period, divided up into 20 regions of Italy. The economic issue is analyzed by a model of economic allometry which adds new elements to the convergence analysis. The model was originally developed by biologists in their study of morphological changes in organisms (Huxley, 1932). In fact, the term allometry denotes disproportionate change in the size of an organ as a consequence of change in the overall size of a biological system. The case of proportional change, on the other hand, is referred to as isometry.

The function of economic growth is given by:

$$y_t = a \cdot (x_t)^B$$

where

a is a constant

y_t be region i 's annualized growth rate of GDP per capita at time t ;

x_t be North Italy's annualized growth rate of GDP per capita at time t , such that $t \in \{1980, \dots, 2003\}$, all measured in 2003 Euros.

Let b_1 and b_2 be the growth rates of total outputs of economic systems Y (region) and X (North

Italy) respectively, such that $B = \frac{b_1}{b_2}$ measures the relative economic growth of the economic

system Y in relation to the economic growth X .

The Moving Average has been applied on data of growth rates of per capita GDP for flattening out the fluctuations underlying the GDP growth rate. As the time series have about 22 cases (the period of a Kuznets cycle) the moving averages have been calculated over the period of three year to avoid a reduction of data. After that these data are transformed in natural logarithmic before carrying out calculations.

In fact, the logarithmic form of equation $y_t = a \cdot x_t^B$ is a simple linear relationship:

$$\ln y_t = \ln a + B \ln x_t + \varepsilon_t \quad [1]$$

The following hypotheses are considered:

- if GDP per capita of the region represented on y -axis is lower than the GDP per capita of the macro region* represented on x -axis and $B = 1$, both total outputs (regions and North Italy) are growing at the same rate (*economic isometric growth of the regional system*); in this case the regional economic growth follows a steady-state growth (s^*). This is similar to balanced-growth path (Solow, 1956)
- if GDP per capita of the region represented on y -axis is lower than the GDP per capita of the macro region* represented on x -axis and $B < 1$, the component represented on the y axis (growth rate of per capita GDP) is growing more slowly than the component on the x axis (which represents the North Italy); this hypothesis presents a negative allometric growth of regions (*economic growth divergence of the regional system*) in relation to Macro-region*.
- if GDP per capita of the region represented on y -axis is lower than the GDP per capita of the macroregion represented on x -axis and $B > 1$, the y axis component is growing faster than the x axis component; there is a positive allometric growth or *economic development* of regional systems in relation to Macro-region*. This is a case of high convergence.

The model [1] has linear parameters that are estimated by the Ordinary Least-Squares Method (Spanos, 1986).

Table 1: Parametric estimates of the economic growth model of allometry, 1980-2004

Regions	Estimated relationship				
$\ln \text{Abruzzo}_i =$ $N=20$	0.406 (0.131)	+ 0.628 $\ln \text{NItaly}_i$ (0.110)	$R^2 \text{ adj} = 0.622$ $S = 0.525$	$F = 32.25$ (sig. 0.00)	$DW = 0.978$
$\ln \text{Basilicata}_i =$ $N=20$	0.669 (0.231)	+ 0.294 $\ln \text{NItaly}_i$ (0.224)	$R^2 \text{ adj} = 0.036$ $S = 0.789$	$F = 1.716$ (sig. 0.21)	$DW = 0.994$
$\ln \text{Calabria}_i =$ $N=22$	-2.027 (0.386)	+ 0.357 $\ln \text{NItaly}_i$ (0.108)	$R^2 \text{ adj} = 0.321$ $S = 0.419$	$F = 10.927$ (sig. 0.04)	$DW = 2.207$
$\ln \text{Campania}_i =$ $N=21$	0.170 (0.395)	+ 0.798 $\ln \text{NItaly}_i$ (0.340)	$R^2 \text{ adj} = 0.184$ $S = 1.643$	$F = 5.518$ (sig. 0.03)	$DW = 1.436$
$\ln \text{Lazio}_i =$ $N=22$	-2.742 (0.606)	+ 0.755 $\ln \text{NItaly}_i$ (0.170)	$R^2 \text{ adj} = 0.472$ $S = 0.658$	$F = 19.773$ (sig. 0.00)	$DW = 0.867$
$\ln \text{Marche}_i =$ $N=22$	0.215 (0.102)	+ 0.697 $\ln \text{NItaly}_i$ (0.102)	$R^2 \text{ adj} = 0.684$ $S = 0.396$	$F = 46.510$ (sig. 0.00)	$DW = 0.392$
$\ln \text{Molise}_i =$ $N=23$	0.353 (0.080)	+ 0.793 $\ln \text{NItaly}_i$ (0.069)	$R^2 \text{ adj} = 0.855$ $S = 0.358$	$F = 130.471$ (sig. 0.00)	$DW = 1.331$
$\ln \text{Puglia}_i =$ $N=20$	-0.025 (0.156)	+ 1.028 $\ln \text{NItaly}_i$ (0.156)	$R^2 \text{ adj} = 0.689$ $S = 0.498$	$F = 43.124$ (sig. 0.00)	$DW = 1.805$
$\ln \text{Sardegna}_i =$ $N=21$	-0.295 (0.298)	+ 0.582 $\ln \text{NItaly}_i$ (0.230)	$R^2 \text{ adj} = 0.213$ $S = 0.862$	$F = 6.407$ (sig. 0.02)	$DW = 0.932$
$\ln \text{Sicilia}_i =$ $N=20$	0.735 (0.118)	+ 0.261 $\ln \text{NItaly}_i$ (0.100)	$R^2 \text{ adj} = 0.234$ $S = 0.482$	$F = 6.780$ (sig. 0.02)	$DW = 1.289$
$\ln \text{Toscana}_i =$ $N=22$	-2.590 (0.295)	+ 0.651 $\ln \text{NItaly}_i$ (0.083)	$R^2 \text{ adj} = 0.744$ $S = 0.320$	$F = 62.017$ (sig. 0.00)	$DW = 1.973$
$\ln \text{Umbria}_i =$ $N=21$	0.534 (0.158)	+ 0.618 $\ln \text{NItaly}_i$ (0.122)	$R^2 \text{ adj} = 0.553$ $S = 0.456$	$F = 25.786$ (sig. 0.00)	$DW = 1.019$

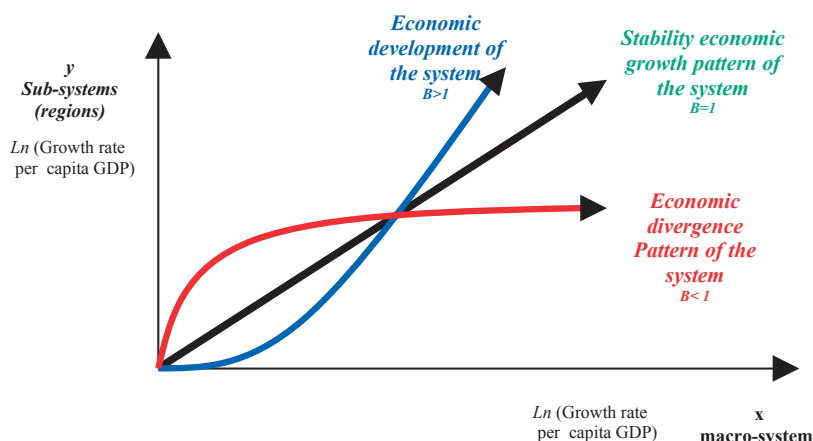
The second column is the estimate of the constant. Underneath it, in parentheses, its standard error. The third column is the estimate of β . Underneath it, in parentheses, its standard error. The fourth column has adjusted R^2 of the regression and below the R^2 , the standard error of the regression. The fifth column has the results of the Fisher test, to its right the significance. In the last column the Durbin-Watson test which is an indicator of autocorrelation of the time series.

The results of this research are presented in Table 1 which shows the parametric estimates and the typology of economic growth of regions in relation to North Italy (see if $\beta <, >, = 1$). The first thing to be said is that in few cases the results from the Durbin-Watson (D-W) test indicate the presence of serial correlation in the residual of the equations. In the other cases, however, the D-W's d statistic is in the zone of indeterminacy and of acceptance of null hypothesis. As the time series have a low number of cases (about 22 ones), it has not been possible smoothing the fluctuations by two steps of moving averages; the risk is the reduction of cases and the impossibility to apply the regression model. This is the reason because the model presents suspected positive autocorrelation but the GDP based on time series of long run (e.g. 60 years) ought to solve this problem. Anyway the parametric estimates of the models are unbiased, the t -test presents significance of the coefficients, and the R^2 values are high, except for few cases. Thus in the majority of cases the models explain more than 50% variance in the data. The results display (with level of significance 5%) that nine regions have negative economic growth allometry (three have a very low values), three regions have a behavior isometric whose one

region presents a quasi-positive economic allometry (economic development) in relation to the North Italy.

3. Concluding remarks

The comparison of this method with Barro and Quah analysis shows interesting results. In fact, Barro and Sala-i-Martin (1992; 2004 *chp. 11-12*) studied the convergence across European regions, including Italy. The resulting estimates show only convergence within 20 Italian regions close to 2 percent per year (Barro and Sala-i-Martin, 2004, p. 479-481) and one steady state, while according to Quah (1996) the economic growth of economic system can polarize into two steady states (rich and poor regions), called twin peaks. The new finding of this alternative approach is that the inner dynamics of economic growth of economic systems are three patterns of regional economic growth. A large evidence to support the hypothesis of three dynamics of growth is also available and presented in different way by Fagerberg and Verspagen (1996) at European level.



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