A new approach for -convergence estimation in Italy

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2007

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1. Introduction

The convergence hypothesis has been widely analysed in the economic literature. In particular many study focused their attention on testing the existence of conditional convergence (β-convergence). The last term derives by the β-coefficient of the neoclassical growth model (Solow 1956) and it is a measure of the speed of convergence of an economy towards its steady state. We can say that there is β-convergence if there is an inverse relationship between per capita growth rates and its initial level. In other words if regions with lower initial per capita income grow faster then they converge to the relatively more developed regions.

As regards Italian regions some studies tried to explain large economic disparities in particular between the Centre-North and South areas (Faini 1983, Di Liberto and Symons1998, Lodde 2000, Forni and Paba 2000, Paci and Pigliaru, 1999, Vamvakidis 2003) but the debate is still open. The great part of the empirical analyses show that convergence took place during the 1960s with some finding evidence of divergence (Paci and Saba 1998, Paci and Pigliaru 1999). This process stopped during the period 1970-1995. The latter divergence is mainly due by a slow growth in the South regions while the rest of Italy converges; besides Italian regions converge again since the mid 1990s, although with a relative small speed (Vamvakidis, 2003).

In this paper we follow a new approach recently proposed by Vogelsang and Tomljanovich (2002) to test the presence of β-convergence among Italian regions, in the period 1980-2003, in presence of a trend break in the series. The break year is considered either known (1992) and endogenously estimated from the data. The benefits of this methodology is the overall validity both for general serial correlation in the data and persistent correlation in the error terms without requiring unit root pre-tests. Generally the econometric results relative to the known trend break date model show the presence of a convergence process for the considered regions. The results of the known trend break date model are more robust that those relative the unknown one.

The paper is organized as follows: section 2 describes the methodology; section 3 discusses the econometric results and section 4 concludes. The appendix shows tables containing the econometrics results.

2. Methodology

In this section we review the methodology used to test the presence of β-convergence among Italian regions. We followed the approach recently proposed by Vogelsang and Tomljanovoch (2002) for trend function hypothesis tests purposes. The benefits of this methodology is the overall validity both for general serial correlation in the data and persistent correlation in the error terms without requiring unit root pre-tests.

The general hypothesis of β-convergence requires that richest economies grow slower than ones with per capita income below the average level. Therefore an appropriate analysis of this process consists of testing hypotheses on the parameters of a deterministic trend function of the relative per capita income. Let be y_t the logarithm of the ratio of per capita income of a region to the average income at country level, the trend function of y_t will be as follows:

$$y_t = \mu + \beta t + u_t \tag{1}$$

where t indicates the trend and u_t zero mean random errors serially correlated. Given this expression μ represents the initial level of y while β is its growth rate. For the misspecification and interpretation problems deriving by the presence of serial correlation both in data and error terms Vogelsang and Tomljanovoch (2002) proposed modified statistics to use in testing the significance μ and β derived by simple OLS regressions.

Two are the regressions proposed by the authors. The first is given by:

$$y_t = \mu_1 DU_{1t} + \beta_1 DT_{1t} + \mu_2 DU_{2t} + \beta_2 DT_{2t} + u_t \tag{2}$$

where $DU_{1t} = 1$ if $t \le T_b$ and 0 otherwise, $DU_{2t} = 1$ if $t > T_b$ and 0 otherwise, $DT_{1t} = t$ if $t \le T_b$ and 0 otherwise, $DT_{2t} = t - T_b$ if $t > T_b$ and 0 otherwise, with T_b as the break year which could generate a change in the parameters of the trend function. We will consider the break both known (equal to 1992[1]) and unknown. In the last case it will be estimated endogenously from the data. Parameters μ_1 and μ_2 indicate whether relative income of a region, respectively before and after the break, is either below ($\mu<0$) or above ($\mu>0$) the average country level while β_1 and β_2 are growth rates during the two periods.

The second regression is as follows:

$$y_t = \mu_1 SDU_{1t} + \beta_1 SDT_{1t} + \mu_2 SDU_{2t} + \beta_2 SDT_{2t} + S_t \tag{3}$$

[1] We considered 1992 as break year in the regressions since in this year Italy abandoned the European Monetary System and the Italian currency began to follow a flexible exchange rate regime with considerable effects on competitiveness and therefore on international commerce.

where, using partial sums, $z_t = \sum_{j=1}^{t} y_j$, $SDU_{it} = \sum_{j=1}^{t} DU_{ij}$, with i=1,2 and $SDT_{it} = \sum_{j=1}^{t} DT_{ij}$,with i=1,2.

For the convergence hypothesis all the parameters 佝$_i$ and 仉$_i$ should be statistically significant and have signs consistent with convergence, that is 仉$_i$ <0 when 佝$_i$ >0 and or the contrary. In testing these hypotheses Vogelsang (1997) provides modifications of the t_y and t_z[2] statistics computed by the standard OLS regressions in order to gain more robustness for results in presence of serial correlations in the data and errors I(0) or I(1). For the y_t regression the appropriate modified t-statistics are simply $T^{-1/2}\ t_y$ where T is the sample size. For the z_t regression the appropriate modified t-statistics are defined as $t\text{-}PS_t = T^{-1/2}\ t_z exp(-bJ_T)$, where b is a constant and J_T is a statistics proposed by Park and Choi (1988) and Park (1990) for testing the null hypothesis that trend function errors (eq. 1) have an autoregressive unit root and

$$J_T = (RSS_y \text{ み } RSS_j)/ RSS_j$$

where RSS_y is the OLS residual sum of squares from regression (2), and RSS_j is the residual sum of squares from regression[3]

$$y_t = \mu_1 DU_{1t} + \beta_1 DT_{1t} + \mu_2 DU_{2t} + \beta_2 DT_{2t} + \sum_{i=2}^{9} c_i t^i + \mu_t \qquad (4)$$

The $t\text{-}PS_t$ statistic contains the parameter b which choice depends on the significance level in the sense that it is given such that the asymptotic critical value of the statistics is the same when the errors are stationary (I(0)) and when they have a unit root (I(1)). A value equal to zero will be given if errors are known to be I(0), in this case, therefore, no J_T correction will be necessary.

Asymptotic distributions for the modified statistics depend on the break date used in the regressions and in particular whether the break date is assumed known or unknown. When unknown the break date can be estimated from the data. We will follow the estimation method proposed by Vogelsang and Tomljanovoch (2002). This method consists in the estimation of the regression 2 for break dates in the range T_b*, T_b* + 1,..., T - T_b*, with T_b* = 佽T where 似indicates the amount of trimming. For each regression the T^{-1} multiplied by the Wald statistic for testing the no break hypothesis (佝$_i$<0) or above (佝$_1$ = 佝$_2$ joint to 仉$_1$ = 仉$_2$) is computed. The endogenous break date is the one correspondent to the largest normalized Wald statistic. This procedure avoid some data-mining problems related to an *a priori* choice but, giving fewer statistically significant point estimates potentially damps the results in favour of the 仉まonvergence.

Critical values for both the modified statistics are tabulated by Vogelsang (1997).

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[2] t_y and t_z are the t statistics for testing 佝$_i$=0 and 仉$_i$=0 in regressions (2) and (3).

[3] Vogelsang (1998) recommended that the polynomial order should be 9 because for greater orders the increase in power of the $t\text{-}PS_t$ test is paltry.

3. Results

This section presents results of the econometric model described in the previous one. Sample data consists of the GDP per worker in terms of PPP for all Italian regions (NUTS2 level) during the period 1980-2003. Estimation results are showed in the appendix, tables 1-4. Table 1-3 show the estimated coefficient together with the modified *t*-statistics (in parentheses) of the y_t regression (equation 2), z_t regression (equation 3) without J_T correction and with J_T correction, respectively for both known and unknown trend break date models. In particular, below each point estimates, in the table 1 the $T^{-1/2}t_y$ statistics are presented in parentheses, table 2 shows the t-PS_T statistics (using b=0), in table 3 the t-PS_T statistics are computed applying the J_T correction and presented for 10% and 5% tests (the first value in parentheses are relative to 10% test).

The tables reports the modified *t*-statistics critical values at 10% and 5% in the last two rows and the estimated break date for the unknown trend break date model in the last column.

Table 4 synthesizes the results of table 1,2 and 3. 仉convergence requires μ>0 and 仸0 or μ<0 and 仸0, so the letter *C* indicates point estimates compatible with 仉convergence and statistically significant at least at 10% level; *c* signifies points estimates compatible with 仉convergence but with only one coefficient statistically significant at least at 10% level; the *D* evidence the presence of a divergence process with both coefficients statistically significant and only one coefficient statistically significant, respectively; finally, E denotes very small and statistically insignificant point estimates which indicates that 仉convergence has occurred.

The first outcome is that estimates of μ_1 are often statistically different from zero either in the known and unknown trend break date model. This result evidence that initial per capita GDP were not the same respect to the Italian average for almost all the regions.

The results of the known trend break date model are more robust that those relative the unknown one. In fact, when 1992 is considered as break date the statistical significance of the coefficients is remarkably stronger.

Generally the econometric results relative to the known trend break date model show the presence of a convergence process for all the Italian regions in the considered period. Before 1992 (pre-break) all regions, except for Piemonte, Lombardia and Umbria, show a convergence process. Specifically Piemonte and Lombardia strongly diverge (D) while Umbria presents some evidence of divergence (d) in the pre-break period. In the post-break period these three regions weakly converge too. After 1992 only Veneto, Liguria, Emilia, Molise, Sardegna show a weak divergence process while all the other regions converge. These four Italian regions showed some evidence of strong convergence in the pre-break period. All the other regions converge in both pre and post break periods. In particular, Valle d'Aosta, Lazio, Marche, Puglia, Calabria, Abruzzo and Sicilia show some evidence of β-convergence before and after 1992; Campania shows a strong convergence process before the considered break date and some evidence of β-convergence after, Trentino, Friuli, Toscana, Basilicata present some evidence of strong convergence in the pre-break period and weak convergence in the post-break one.

When the break date is assumed unknown results strongly depend on the econometric model used to estimate the β-convergence. The overall outcome is, therefore, less pronounced. In particular, the outcome for Piemonte, Valle D'Aosta, Lombardia, Veneto, Friuli, Liguria, Emilia, Toscana, Umbria, Abruzzo, Basilicata, Sardegna and Sicilia is not far different from the known break date model. Trentino Alto- Adige and Campania seem, on the contrary, to diverge in the post break period when the break date is chosen endogenously. For the rest of the sample results are relatively different from the known model and in some cases the resulting evidence is of divergence. The latter outcome reflects the characteristics of the weakness for the β-convergence case generated by the econometric approach.

4.Conclusions

The objective of the paper is to verify the presence of β-convergence among Italian regions considering a trend break in the series on the base of the methodology recently used by Vogelsang and Tomljanovoch (2002).

When we consider a known trend break date model (break year=1992) the results evidence the presence of a convergence process for most of the Italian regions in the considered period.

The outcome relative to the unknown break date model, on the contrary, strongly depend on the econometric model used to estimate the β-convergence. The results appear to be less uniform.

Appendix

*Table 1.*Results of the y_t regression estimation

Yt	Known	break	date	T_b=1992	Unknown	break	date		
Region	**μ_1**	仮1	**μ_2**	仮2	**μ_1**	仮1	**μ_2**	仮2	**T_b**
Piemonte	0,072** (1,643)	0,004* (0,724)	0,104* (2,145)	-0,0033 (-0,471)	0,0583 ** (1,628)	0,005 (0,493)	0,133** (8,177)	-0,003** (-2,457)	1984
Valle d'Aosta	0,230** (5,068)	-0,002 (-0,408)	0,193** (3,866)	-0,006 (-0,947)	0,237 ** (7,244)	-0,003 (-1,375)	0,1120 (1,294)	0,002 (0,087)	1999
Lombardia	0,138** (5,537)	0,002* (0,706)	0,154** (5,625)	-0,002 (-0,679)	0,127** (7,850)	0,004 * (1,828)	0,160** (12,035)	-0,002* (-1,659)	1989
Trentino Alto Adige	0,122** (3,504)	-0,003* (-0,785)	0,067 (1,759)	-0,009 (-0,173)	0,121** (4,486)	-0,003 (-1,247)	0,044 (0,987)	0,003 (0,302)	1996
Veneto	0,042** (1,559)	-0,002* (-0,755)	0,026 (0,90)	0,0002 (0,046)	0,022* (0,691)	0,004 (0,524)	0,010 (0,636)	0,001 (0,759)	1985
Fr. Venezia Giulia	-0,074** (-1,818)	0,007** (1,351)	0,049 (1,092)	-0,0003 (0,051)	-0,074** (-1,818)	0,007** (1,351)	0,049 (1,092)	-0,0003 (0,051)	1992
Liguria	0,134** (3,706)	-0,003* (-0,771)	0,077* (1,945)	0,001 (0,334)	0,132 ** (2,816)	-0,002 (-0,189)	0,086** (3,084)	0,0004 (0,151)	1986
Emilia	0,078** (2,835)	-0,003** (-1,01)	0,046 (1,532)	0,0013 (0,310)	0,100 **(3,92)	-0,009* (-1,70)	0,041* (2,733)	0,001 (0,728)	1986
Toscana	0,040** (2,416)	-0,002** (-1,275)	0,001 (0,085)	0,0010 (0,381)	0,0375** (2,222)	-0,001 (-0,796)	-0,0004 (-0,028)	0,001 (0,532)	1990
Umbria	-0,310** (-0,716)	-0,001 (-0,240)	-0,183 (-0,385)	-0,001 (0,267)	-0,008 (-0,234)	-0,006 (-1,008)	-0,028 (-0,996)	-0,0003 (-0,104)	1988
Abruzzo	-0,065** (-5,252)	0,003 (0,516)	-0,052** (-3,315)	-0,0004* (1,566)	-0,065** (-5,252)	0,003 (0,516)	-0,052** (-3,315)	0,0002* (1,566)	1992
Basilicata	-0,260** (-4,401)	0,007** (1,000)	-0,117 (-1,798)	0,007 (0,784)	-0,242** (-5,252)	-0,139 (0,516)	0,003** (-3,315)	0,008* (1,566)	1990
Campania	-0,130** (-2,988)	0,004* (0,749)	-0,127** (-2,656)	0,002 (0,225)	-0,1478** (-3,209)	-0,1071 (1,021)	0,0084 (-1,206)	-0,0007 (-0,057)	1989
Lazio	0,145** (5,219)	-0,002 (-0,580)	0,122** (3,989)	-0,005 (-1,068)	0,144** (5,734)	0,1068 (-0,676)	-0,001** (3,178)	-0,0039 (-0,661)	1994
Marche	-0,124** (-4,044)	0,001 (0,320)	-0,070* (-2,084)	0,003 (0,688)	-0,1198** (-4,111)	-0,0794 (0,073)	0,0003* (-2,725)	0,0040 (1,029)	1991
Molise	-0,160** (-3,486)	0,008** (1,404)	-0,057 (-1,133)	0,000 (0,012)	-0,1564** (-3,209)	-0,0534 (1,021)	0,00733 (-1,206)	-0,0003 (-0,057)	1990
Puglia	-0,171** (-3,815)	0,001 (0,251)	-0,177** (-3,576)	0,004 (0,498)	-0,1631** (-3,678)	-0,128* (1,286)	0,0001** (-3,227)	-0,004 (-0,192)	1998
Calabria	-0,230** (-5,17)	0,002 (0,353)	-0,218** (-4,46)	0,007 (0,947)	-0,231** (-7,038)	-0,140 (0,751)	0,002 (-1,941)	-0,004 (-0,194)	1998
Sicilia	0,016* (0,437)	-0,002 (-0,394)	-0,046 (-1,115)	0,000 (0,037)	0,018 (0,559)	-0,056* (-1,400)	-0,002 (-0,586)	0,001 (0,259)	1993
Sardegna	0,053** (1,119)	-0,013** (-2,207)	-0,074 (-1,437)	-0,003 (-0,347)	0,017 (0,404)	-0,083 (-0,316)	-0,002 (-2,327)	-0,0009 (-0,259)	1986
I(0) 10% cv	**±0,389**	**±0,676**	**±1,820**	**±1,560**	**±0,671**	**±1,47**	**±2,370**	**±1,480**	
I(0) 5% cv	**±0,504**	**±0,887**	**±2,390**	**±2,040**	**±0,875**	**±2,000**	**±3,000**	**±2,010**	

Table 2. Results of the z_t regression estimation without J_T correction

Zt b=0	**Known break date T_b=1992**				**Unknown break date**				
Region	**μ_1**	仭1	**μ_2**	仭2	**μ_1**	仭1	**μ_2**	仭2	**T_b**
Piemonte	0,0669**	0,0052**	0,090**	-0,0015	0,059**	0,004	0,134**	-0,003**	1984
	(3,819)	(1,763)	(2,582)	(-0,259)	(2,996)	(0,702)	(28,142)	(-7,838)	
Valle d'Aosta	0,227**	-0,0018*	0,188**	-0,006**	0,238**	-0,0037**	0,099	0,0068	1999
	(17,783)	(-0,849)	(7,360)	(-1,457)	(24,360)	(-3,225)	(0,706)	(0,116)	
Lombardia	0,135**	0,0027**	0,146**	(-0,001)	0,126**	0,0049**	0,158**	-0,002**	1989
	(13,290)	(1,606)	(7,205)	(-0,477)	(23,794)	(4,476)	(29,534)	(-3,153)	
Trentino Alto Adige	0,123**	-0,0036**	0,073**	-0,002	0,121**	-0,0033**	0,049**	0,0018	1996
	(14,466)	(-2,541)	(4,307)	(-0,728)	(25,429)	(-5,211)	(0,289)	(-0,489)	
Veneto	0,044**	-0,002**	0,027**	0,0003	0,020	0,0051	0,0068	0,0016**	1985
	(5,045)	(-1,971)	(1,571)	(0,007)	(0,904)	(0,716)	(0,875)	(2,090)	
Fr. Venezia Giulia	-0,074**	0,006**	0,058**	-0,001	-0,074**	0,006**	0,058**	-0,001	1992
	(-5,090)	(2,772)	(1,986)	(-0,269)	(-5,090)	(2,772)	(1,986)	(-0,269)	
Liguria	0,137**	-0,004**	0,082**	0,001	0,131**	-0,001	0,088**	0,001	1986
	(11,947)	(-2,124)	(3,590)	(0,291)	(5,325)	(-0,224)	(7,685)	(0,106)	
Emilia	0,0803**	-0,0039**	0,0530**	0,0005	0,098**	-0,0089**	0,0395**	0,0012**	1986
	(7,799)	(-2,275)	(2,576)	(0,151)	(8,563)	(-2,806)	(7,368)	(2,149)	
Toscana	0,0399**	-0,0025**	-0,0012	0,0016*	0,0375**	-0,0019**	-0,0020	0,0013**	1990
	(8,763)	(-3,298)	(-0,142)	(1,034)	(8,560)	(-2,329)	(-0,361)	(1,673)	
Umbria	-0,026 **	-0,002**	-0,003	-0,003	-0,004	-0,008**	-0,0249**	-0,0004	1988
	-(1,690)	(-0,9267)	(-0,097)	(-0,743)	(-0,269)	(-2,022)	(-1,786)	(-0,244)	
Abruzzo	-0,0644**	0,002**	-0,055**	0,0003	-0,064**	0,002**	-0,055**	0,0002	1992
	(-8,720)	(2,396)	(-3,768)	(0,112)	(-8,720)	(2,396)	(-3,768)	(0,112)	
Basilicata	-0,2511**	0,0057**	-0,1018**	0,0060*	-0,239**	0,002	-0,140**	0,008**	1990
	(-14,739)	(1,969)	(-2,990)	(1,038)	(-14,368)	(0,892)	(-6,607)	(2,918)	
Campania	-0,136**	0,005**	-0,142**	0,003	-0,151**	0,009**	-0,110**	-0,0007	1989
	(-10,775)	(2,582)	(-5,629)	(0,838)	(-7,913)	(2,345)	(-5,703)	(-0,291)	
Lazio	0,1455**	-0,002**	0,1254**	-0,005**	0,144**	-0,0019*	0,110**1	-0,004*	1994
	(16,203)	(-1,437)	(6,989)	(-1,777)	(19,565)	(-1,733)	(4,741)	(-0,957)	
Marche	-0,120**	0,0004	-0,064**	0,003*	-0,117**	-0,0003	-0,077**	0,004**	1991
	(-16,056)	(0,332)	(-4,313)	(1,194)	(-15,078)	(-0,238)	(-6,244)	(2,190)	
Molise	-0,158**	0,007**	-0,052**	-0,0009	-0,1550*	0,007**	-0,050**	-0,0009	1990
	(-14,394)	(4,227)	(-2,373)	(-0,253)	(-12,092)	(2,863)	(-3,090)	(-0,412)	
Puglia	-0,176**	0,002**	-0,187**	0,005**	-0,165**	0,0003	-0,134*	-0,003	1998
	(-12,804)	(1,000)	(-6,807)	(1,155)	(-14,803)	(0,244)	(-1,236)	(-0,079)	
Calabria	-0,229**	0,0018**	-0,218**	0,007**	-0,230**	0,0019**	-0,125**	-0,008	1998
	(-18,683)	(0,869)	(-8,830)	(1,784)	(-34,823)	(2,404)	(-1,951)	(-0,363)	
Sicilia	0,012**	-0,0009	-0,052**	0,0006	0,015*	-0,001	-0,062**	0,002	1993
	(1,427)	(-0,669)	(-3,037)	(0,216)	(1,806)	(-1,204)	(-2,935)	(0,565)	
Sardegna	0,053**	-0,013**	-0,078**	-0,002	0,018	-0,002	-0,087**	-0,0004	1986
	(3,274)	(-4,739)	(-2,422)	(-0,410)	(0,722)	(-0,320)	(-7,287)	(-0,340)	
I(0) 10%cv	**±0,854**	**±0,683**	**±1,030**	**±0,908**	**±1,570**	**±1,330**	**±1,140**	**±0,936**	
I(0) 5% cv	**±1,120**	**±0,883**	**±1,350**	**±1,200**	**±2,190**	**±1,760**	**±1,500**	**±1,270**	

Table 3. Results of the z_t regression estimation with J_T correction

Zt b[illegible] **Region**	**Known break Date T_b=1992**				**Unknown break date**				
	μ_1	仉1	**μ_2**	仉2	**μ_1**	仉1	**μ_2**	仉2	**T_b**
Piemonte	0,066** (3,527) (3,473)	0,0052** (1,517) (1,434)	0,090** (2,385) (2,348)	-0,0015 (-0,223) (-0,210)	0,059* (1,699) (1,543)	0,004 (0,167) (0,091)	0,1341** (3,930) (7,520)	-0,003* (-1,929) (-0,684)	1984
Valle d'Aosta	0,227** (13,967) (13,317)	-0,0018 (-0,537) (-0,452)	0,1884** (5,781) (5,512)	-0,0063* (-0,921) (-0,776)	0,2381** (13,930) (12,668)	-0,0037 (-0,784) (-0,434)	0,099 (0,101) (0,188)	0,006 (0,029) (0,010)	1999
Lombardia	0,135 (0,335) (0,162)	0,0027 (0,001) (0,0001)	0,146 (0,181) (0,088)	-0,001 (-0,0004) (-3,3E-05)	0,126** (5,714) 4,484	0,004 (0,121) (0,026)	0,158** (0,208) (7,892)	-0,002 (-0,092) (-0,275)	1989
Trentino Alto Adige	0,123** (8,12) (7,255)	-0,003* (-0,851) (-0,565)	0,073** (2,419) (2,160)	-0,002 (-0,244) (-0,162)	0,121** (16,163) (14,966)	-0,003* (-1,657) -1,026	0,049 (0,409) 0,527	0,0018 (0,094) 0,0252	1996
Veneto	0,044** (2,305) (1,975)	-0,002 (-0,446) (-0,256)	0,027 (0,718) (0,615)	0,0003 (0,0016) (0,0009)	0,0206 (0,272) (0,221)	0,005 (0,034) (0,009)	0,006 (0,013) (0,233)	0,0016 (0,107) (0,182)	1985
Friuli Venezia Giulia	-0,074 (-0,651) (-0,434)	0,0068 (0,056) (0,013)	0,058 (0,254) (0,169)	-0,001 (-0,005) (-0,001)	-0,074 (-0,651) (-0,434)	0,0068 (0,056) (0,013)	0,058 (0,254) (0,169)	-0,0013 (-0,005) (-0,001)	1992
Liguria	0,1379 (0,705) (0,403)	-0,0041 (-0,009) (-0,001)	0,0828 (0,212) (0,121)	0,0011 (0,001) (0,0001)	0,1310* (2,439) (2,136)	-0,0015 (-0,031) (-0,013)	0,088** (0,510) (2,053)	0,001 (0,015) (0,009)	1986
Emilia	0,0803** (1,864) (1,406)	-0,0039 (-0,150) (-0,054)	0,0530 (0,615) (0,464)	0,0005 (0,010) (0,003)	0,098** (12,191) (12,944)	-0,008** (-6,856) (-9,958)	0,039** (25,119) (1,969)	0,0012* (5,146) (0,187)	1986
Toscana	0,0399** (5,728) (5,268)	-0,0025* (-1,473) (-1,089)	-0,001 (-0,093) (-0,085)	0,0016 (0,462) (0,341)	0,0375** (5,734) (5,357)	-0,0019 (-0,845) (-0,553)	-0,0020 (-0,089) (-0,096)	0,001 (0,621) (0,146)	1990
Umbria	-0,026 (-0,244) (-0,167)	-0,002 (-0,023) (-0,006)	-0,0030 (-0,014) (-0,009)	-0,003 (-0,018) (-0,004)	-0,004 (-0,104) (-0,089)	-0,0080 (-0,185) (-0,068)	-0,024 (-0,067) (-0,477)	-0,0004 (-0,023) (-0,021)	1988
Abruzzo	-0,0644** (-2,830) (-2,267)	0,0029 (0,284) (0,128)	-0,0556* (-1,223) (-0,980)	0,0002 (0,013) (0,006)	-0,0644 (-0,261) (-0,144)	0,0029 (0,000) (0,000)	-0,0556 (-0,113) (-0,062)	0,0003 (0,000) (0,000)	1992
Basilicata	-0,2511** (-4,680) (-3,733)	0,0056 (0,224) (0,099)	-0,1018 (-0,950) (-0,757)	0,0060 (0,118) (0,052)	-0,2394** (-5,752) (-4,924)	0,0028 (0,088) (0,034)	-0,1402** (-0,275) (-1,766)	0,0089 (0,304) (0,255)	1990
Campania	-0,1363** (-12,512) (-12,885)	0,0055** (3,428) (3,811)	-0,1423** (-6,537) (-6,732)	0,0036** (1,114) (1,238)	-0,1515 (-1,493) (-1,124)	0,0093 (0,035) (0,006)	-0,1104** (-0,017) (-1,524)	-0,0007 (-0,005) (-0,025)	1989
Lazio	0,1455** (11,138) (10,345)	-0,0021* (-0,706) (-0,541)	0,1254** (4,804) (4,462)	-0,0054 (-0,873) (-0,669)	0,1441** (12,484) (11,567)	-0,0019 (-0,556) (-0,346)	0,1106 (0,997) (1,267)	-0,0046 (-0,315) (-0,084)	1994
Marche	-0,1204** (-6,624) (-5,564)	0,00042 (0,062) (0,033)	-0,0646** (-1,779) (-1,495)	0,0030 (0,223) (0,119)	-0,1171** (-6,170) (-5,302)	-0,0003 (-0,025) (-0,010)	-0,0774** (-0,281) (-1,669)	0,00422 (0,241) (0,191)	1991
Molise	-0,1583** (-9,529) (-8,785)	0,0078** (1,933) (1,443)	-0,0521** (-1,572) (-1,449)	-0,0009 (-0,116) (-0,086)	-0,1550** (-7,288) (-6,687)	0,0071 (0,796) (0,466)	-0,0504 (-0,533) (-0,826)	-0,0009 (-0,118) (-0,036)	1990
Puglia	-0,1762** (-3,215) (-2,448)	0,0023 (0,073) (0,027)	-0,1872* (-1,709) (-1,302)	0,0053 (0,084) (0,032)	-0,1657** (-2,835) (-2,141)	0,0003 (0,004) (0,001)	-0,1346 (-0,004) (-0,331)	-0,0030 (-0,001) (-0,007)	1998
Calabria	-0,2297** (-9,970) (-8,809)	0,0018 (0,264) (0,169)	-0,2189** (-4,712) (-4,163)	0,0074 (0,542) (0,347)	-0,2307** (-17,143) (-15,199)	0,0019 (0,401) (0,190)	-0,1257 (-0,167) (-0,521)	-0,0082 (-0,063) (-0,032)	1998
Sicilia	0,0123 (0,422) (0,332)	-0,0009 (-0,066) (-0,028)	-0,0527 (-0,898) (-0,706)	0,0006 (0,021) (0,009)	0,0153 (0,537) (0,437)	-0,0016 (-0,056) (-0,016)	-0,0627 (-0,043) (-0,784)	0,0022 (0,028) (0,049)	1993
Sardegna	0,0531 (0,443) (0,299)	-0,0130 (-0,107) (-0,026)	-0,0786 (-0,328) (-0,221)	-0,0022 (-0,009) (-0,002)	0,0186 (0,335) (0,294)	-0,0023 (-0,046) (-0,020)	-0,0878** (-0,508) (-1,947)	-0,0005 (-0,051) (-0,030)	1986
I(0) 10% cv	**±0,854**	**±0,683**	**±1,030**	**±0,908**	**±1,570**	**±1,330**	**±1,140**	**±0,936**	
I(0) 5% cv	**±1,120**	**±0,883**	**±1,350**	**±1,200**	**±2,190**	**±1,760**	**±1,500**	**±1,270**	

Table 4. Synthesis of the econometric results

	$t\text{-}Ps_T$:I(0) Errors assumed				$t\text{-}Ps_T$: robust to I(1) Errors				$T^{-1/2}t_y$: robust to I(1) Errors			
	T_b=1992		T_b unknown		T_b=1992		T_b unknown		T_b=1992		T_b unknown	
Region	Pre-break	Post-break	Pre-break	Post-break	Pre-break	Post-break	Pre-break	Post-break	Pre-break	Post-break	Pre-break	Post-break
Piemonte	D	C	d	C	D	c	d	C	D	c	d	C
Valle d'Aosta	C	C	C	E	c	C	c	E	c	c	c	E
Lombardia	D	C	D	C	E	E	d	c	D	c	D	C
Trentino Alto Adige	C	C	C	d	C	c	C	E	C	E	c	E
Veneto	C	D	E	d	c	E	E	E	C	E	d	E
Friuli Venezia Giulia	C	C	C	c	E	E	E	E	C	E	C	E
Liguria	C	d	c	d	E	E	c	d	C	d	c	d
Emilia	C	d	C	d	c	E	C	D	C	E	C	d
Toscana	C	c	C	c	C	E	c	E	C	E	c	E
Umbria	D	E	d	d	E	E	E	E	d	E	E	E
Abruzzo	c	C	c	C	C	c	C	c	c	c	E	E
Basilicata	C	E	d	D	C	C	c	C	c	E	c	c
Calabria	c	c	d	E	C	C	C	d	c	c	c	E
Campania	C	c	d	d	C	c	C	d	C	C	E	d
Lazio	c	c	d	d	C	C	C	C	C	c	c	E
Marche	c	c	d	d	c	C	d	C	c	c	d	c
Molise	C	E	d	E	C	d	C	D	C	d	c	E
Puglia	c	c	D	c	C	C	c	d	c	c	c	E
Sardegna	C	E	E	E	C	d	E	d	E	E	E	d
Sicilia	c	E	c	E	c	c	c	c	E	E	E	E

C indicates point estimates compatible with β-convergence and statistically significant at least at 10% level;
c signify points estimates compatible with β-convergence but with only one coefficient statistically significant at least at 10% level;
D evidence the presence of a divergence process with both coefficients statistically significant at least at 10% level;
d signal point estimates consistent with divergence with only one coefficient statistically significant at least at 10% level;
E denotes very small and statistically insignificant point estimates which indicates that β-convergence has occurred.