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Technological catch-up or neoclassical convergence? Identifying the channels of convergence for Italian regions

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Abstract

We investigate whether Italian regions have converged in terms of output per worker because of physical capital accumulation, human capital accumulation or thanks to technological catch-up. In order to identify channels of convergence we adopt the methodology recently proposed by Wong (2007) and Feyrer (2007) which combine growth accounting with convergence regressions. Merging two datasets of regional economic accounts (ISTAT and CRENoS) to obtain longer time series, we show that convergence has been realized mainly thanks to technological catch-up and, to some extent, through human capital accumulation. On the other hand, physical capital has been a factor of divergence.

Keywords: absolute and conditional convergence, channels of convergence, technological Catch-up; Capital Accumulation; Italian regions.

JEL Classification Codes: O47, E23, E13

1. Introduction

A fundamental question tackled in recent empirical researches on growth is whether rich economies produce higher levels of income because they employ a greater amount of physical and human capital or because they use better technologies and employ inputs more efficiently. Hall and Jones (1999), Klenow and Rodriguez-Clare (1997), Caselli (2005), among many others, have found that technological differences are the main causes of the uneven levels of development across countries, whereas less than half of the differences in development can be explained by different levels of accumulation of physical or human capital.

A distinct but related question – which has received much less investigation – is whether countries tend to *converge* thanks to factor accumulation or technological catch-up, that is, whether poor economies accumulate more rapidly human and physical capital and whether

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technical knowledge tends to flow across countries or instead differences in technologies tend to persist over time.

According to the standard growth theories, less developed economies grow faster than rich ones for two fundamental reasons: 1) Because of diminishing returns to capital, poor countries – which have lower endowment of capital – accumulate greater physical or human capital and, in addition, capitals tend to flow towards these economies characterized by higher returns (*Neo-classical convergence* or *capital deepening*); 2) Poor countries may adopt technologies and knowledge available in more advanced countries (*technological catch-up*).

Little evidence exists on this point mainly for the difficulties to separate empirically technological progress from capital deepening. In fact, in standard growth regressions the use of the initial level of output as explanatory variable may be interpreted both as a proxy for the endowment of capital and as a proxy for the level of technological efficiency of the economy. Therefore, it is not clear how much of the convergence that we observe is due to diffusion of technology rather than capital deepening of less developed countries (Bernard and Jones, 1996). Recently, Wong (2007) has proposed an innovative method to study these aspects, finding that the growth of TFP has been the predominant factor of convergence across countries.

The aim of this paper is to investigate whether Italian regions in the last forty years have shown convergence because of physical capital accumulation, human capital accumulation or thanks to technological catch-up. Aiello and Scoppa (2000), Maffezzoli (2006) and Di Liberto, Pigliaru and Mura (2008) have shown that TFP differences are fundamental in explaining differences in output levels for recent years.

In particular, Di Liberto, Pigliaru and Mura (2008) use panel data with the aim to estimate the role of technological convergence across Italian regions. They recover regional TFP values from regional fixed effects in panel estimations and then compare TFP levels in 1960 with TFP in 1990 finding strong evidence that a process of TFP convergence took place among Italian regions, in particular up to the mid-seventies. Maffezzoli (2006) uses the technique of Data Envelopment Analysis (DEA) measuring regional relative efficiency in 1980 and 2004 as the distance from the frontier in terms of output. He finds that less efficient regions in 1980 have recorded higher growth rates of efficiency, that is, convergence in TFP, whereas human and physical capital have contributed to increase uniformly regional product but without contributing to convergence.

We adopt the methodology used by Wong (2007) and Feyrer (2007) in order to identify channels of convergence. This methodology is based on a combination of growth accounting analysis and convergence regressions and allows to separately estimate the contributions of physical and human capital and technology in the convergence process.

In the analysis, in order to make more significant comparisons over longer periods of time, we build economic series by merging two available datasets of regional economic accounts: ISTAT (Italian National Statistical Institute) and CRENoS (Center for North-South Economic Research) which cover different time periods.

We confirm that Italian regions have shown a (weak) process of convergence (measured both as absolute and conditional convergence) and we are able to show that this convergence has been realized mainly thanks to technological catch-up and in part through human capital accumulation. On the other hand, physical capital has not contributed at all to convergence and, according to some specifications, it seems to have led to divergence. We discuss in depth in Section 4 this key and uncommon aspect of the Italian convergence process that has not been related to physical capital accumulation.

The paper is organized as follows. In Section 2 we briefly present the methodology used for identifying channels of convergence. In section 3 we present the data and discuss how we merge the datasets of ISTAT and CRENoS. In Section 4 we present our main results. Section 5 concludes.

2. The methodology for identifying channels of convergence

We follow the methodology of "channel decomposition" proposed by Wong (2007) and Feyrer (2007) in order to identify the channels of convergence.

This methodology combines the traditional growth accounting analysis (see Solow, 1957) – in which the growth of output is decomposed into the contributions due to the growth of capital and to technological progress (the "Solow residual") – with the growth regressions *à la* Barro (in which the output growth is regressed on the initial level of output). The aim of "channel decomposition" is to establish how much of the convergence that we observe in a sample of economies is due to capital accumulation and how much is generated by technological catch-up.

We use a standard Cobb-Douglas aggregate production function with constant returns to scale, to describe the production process in each region:

$$Y = K^{\alpha}(AhL)^{1-\alpha} \quad [1]$$

where Y is the aggregate level of output, K is the stock of physical capital, h denotes the human capital per worker, L is the number of workers, A is a measure of technological efficiency or Total Factor Productivity (TFP) and α is the output elasticity of capital, equal to the capital share of income under the assumption that factors are paid their social marginal product.

By dividing both sides of (1) for Y^{α}, then dividing by L and rearranging:

$$\frac{Y}{L} = \left(\frac{K}{Y}\right)^{\frac{\alpha}{1-\alpha}} Ah \quad [2]$$

Taking logs of both sides yields:

$$\ln\left(\frac{Y}{L}\right) = \frac{\alpha}{1-\alpha}\ln\left(\frac{K}{Y}\right) + \ln(h) + \ln(A) \quad [3]$$

Taking derivatives of both sides with respect to time we obtain:

$$g\left(\frac{Y}{L}\right) = \frac{\alpha}{1-\alpha} g\left(\frac{K}{Y}\right) + g(h) + g(A) = g(k) + g(h) + g(A) \quad [4]$$

where $g(h) = \partial \ln(h)/\partial t$ denotes the growth rate of human capital, $g(A) = \partial \ln(A)/\partial t$ denotes the growth rate of TFP, and we define $g(k) = \frac{\alpha}{1-\alpha} g\left(\frac{K}{Y}\right)$ as the growth rate of physical capital. Equation (4) represents the typical decomposition provided by the growth accounting approach.

On the other hand, in convergence regressions the rate of growth of output per worker is regressed on a constant and on the initial level of output (in log):

$$g\left(\frac{Y}{L}\right) = c + \beta \ln\left(\frac{Y}{L}\right)_{t0} \quad [5]$$

The estimation of a statistically significant parameter $\beta < 0$ implies that poor regions tend to grow faster than rich ones. This result is defined "absolute β convergence", since it is implicitly assumed that regions converge to the same steady-state. Alternatively, it is possible to analyze the existence of "conditional β convergence" taking into account in equation (5) additional variables which proxy for different levels of steady-states of the economies.

The methodology of Wong (2007) is based on the following simple intuition. Since $g\left(\frac{Y}{L}\right)$, on the left-hand side of (5), is identically equal to the sum of three components in equation (4), we can regress separately each single component in (4) as in equation (5), that is:

$$g(k) = c_k + \beta_k \ln\left(\frac{Y}{L}\right)_{t0} \quad [6]$$

$$g(h) = c_h + \beta_h \ln\left(\frac{Y}{L}\right)_{t0} \quad [7]$$

$$g(A) = c_A + \beta_A \ln\left(\frac{Y}{L}\right)_{t0} \quad [8]$$

By using a linear estimator it is possible to show that the sum of the β coefficients obtained in the separate regressions (6), (7) and (8) is equal to the β coefficient in equation (5), that is:

$$\beta \equiv \beta_k + \beta_h + \beta_A \quad [9]$$

To see this more clearly, consider that by estimating equation(5) by OLS yields:

$$\beta = \frac{COV(g(y); \ln(y_{t0}))}{Var(\ln(y_{t0}))} \quad [10]$$

where we use $y = Y/L$. By substituting $g(y) = g(k) + g(h) + g(A)$ in (10) we obtain: $\beta = \frac{COV(g(k) + g(h) + g(A); \ln(y_{t0}))}{Var(\ln(y_{t0}))}$. This can be written as:

$$\beta = \frac{COV(g(k); \ln(y_{t0}))}{Var(\ln(y_{t0}))} + \frac{COV(g(h); \ln(y_{t0}))}{Var(\ln(y_{t0}))} + \frac{COV(g(A); \ln(y_{t0}))}{Var(\ln(y_{t0}))} \quad [11]$$

It is easy to ascertain that the first term corresponds to β_k, the second term to β_h and the last term to β_A.

Therefore, given a certain value of β implying absolute (or conditional) convergence, the relative magnitudes of the β_j coefficients will indicate the importance of each channel in determining the convergence, that is, we can interpret β_k as the contribution of the accumulation of physical capital to convergence, β_h as the contribution of human capital and β_A as the contribution of technological catch-up.

3. The data

The main data sources we use are ISTAT (2005), "Regional Economic Accounts", containing the main economic variables for Italian regions for the period 1980-2004, the new Regional

Economic Accounts for the period 2000-2007 (ISTAT, 2008), and CRENoS (2000) dataset "Regio-IT" covering the period 1960-1996.[1] The variables of interest are Gross Domestic Product, employment and investments.

Analyses of regional development are plagued by the problem of short time series, since ISTAT periodically revises the criteria followed in the building of the economic series, but it does not rebuild series for the past for a sufficient long period using the same criteria.

To overcome this problem we merge the two datasets we have available: ISTAT and CRENoS series overlap for the period from 1980 to 1996. The correlation between these series is very high (0.98-0.99).

For each variable *X*, we exploit the overlapping period between the two series to determine, for each region, a coefficient $\hat{\psi}$ from the following regression:

$$X\_istat_t = \psi(X\_crenos_t) \qquad \text{for } t = 1980..1996$$

By forcing the constant to be zero, in practice we determine a factor of proportionality between the two series.[2] Subsequently, the estimated coefficient $\hat{\psi}$ is used to generate homogeneous data X_istat_t for the period 1960-1979 on the basis of CRENoS data:

$$X\_istat_t = \hat{\psi}(X\_crenos_t) \qquad \text{for } t = 1960..1979$$

We use the same procedure to combine data from the new ISTAT dataset (2000-2007) with the old dataset (1980-2004), exploiting the 5 overlapping data (2000-2004) to impute homogenous data for 2005-2007.

Finally, the new series are formed with the original ISTAT data for the period 1980-2004, and with the generated data for the period 1960-1979 and for 2004-2007.

Furthermore, we combine with the same method average years of education among labour force, exploiting data provided by Ciccone (2004), based on Census data, for the period 1961-2001 with data provided by ISTAT Labour Force Survey (for the period 1982-2007).

An analogous strategy in order to merge two datasets with partial overlapping data has been followed, for example, by Acemoglu, Johnson and Robinson (2002, p. 1237).

Measuring Output per Worker, Physical capital and Human Capital

All the variables are computed at constant 1995 price. The variable *y* is output per worker calculated as the ratio between regional Gross Domestic Product (*Y*) and the number of workers (*L*) (expressed in full-time standard measure).

Regional capital stocks K_t are calculated through the perpetual inventory method, through the equation $K_{t+1} = (1-\delta)K_t + I_t$, where I_t is total regional investment and δ is the rate of depreciation. The rate δ is set equal to 4%, in line with the effective average rate of depreciation, as calculated by ISTAT (2007).

The initial capital stock for each region in 1960 – as standard in the literature – is set to $K_{1960} = I_{1960}/(n+g+\delta)$, where *n* and *g* are the average growth of, respectively, employment and productivity. Note that to avoid attributing excessive weight to the initial data of capital stock, we start considering data from 1970.

The capital share of income α is calculated from the National Economic Accounts as one minus the labour share, which in turn is determined as the ratio between labour income earned

[1] The datasets are freely available respectively at www.istat.it and www.crenos.it

[2] The *t*-stat of ψ coefficients are typically extremely high (the median *t*-stat is about 100).

by employees and self-employed[3] over total income: $\alpha = 1 - \frac{Labour\_income}{Total\_income}$. The value of α we use is 0.302. This value is in line with to the one estimated by Gollin (1992) and Bernanke and Gurkaynak (2001) for Italy.

Human capital per worker is calculated through the Mincerian earnings functions. The stock of human capital per worker is determined as: $h = e^{\phi(s)}$ where s represents the average years of schooling per worker and $\phi'(s)$ indicates the rate of return on each year of schooling. In our baseline specification we assume that $\phi(s)$ is a linear function $\phi(s) = 0.068 * s$, using the average rate of return of education (6.8%) among OECD countries.

4. The role of capital accumulation and technological catch-up in convergence

We firstly determine the growth rates of output per worker, human capital and physical capital and then calculate the TFP growth rate as a Solow residual according to the growth accounting equation (4). Growth rates are calculated as differences between the log of the respective variable in 2007 minus the log value of 1970. We do not use data from 1960 since we are not very confident about the reliability of data on capital stocks for this period.

Output per worker has grown cumulatively of about 57% (or 1.55% per year). The growth of physical capital ratio has been equal to 5.5% or 0.15% per year. Human capital has increased of 36% (0.97% per year). Finally, TFP has grown of 16% (or 0.43% per year).[4]

Using these growth rates we then estimate, respectively, equations [5], [6], [7] and [8] to determine the β coefficients and infer which factors contribute more to the convergence process across Italian regions. In all the regressions the observations are weighted in accordance with regional population.[5] Furthermore, we take into account that equations are related (implying that OLS estimators are consistent, but not efficient) and we use the SURE model (Seemingly Unrelated Regression Equations) (Zellner, 1962) to obtain efficient standard errors allowing for correlation of error terms across equations.[6]

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[3] Self-employed workers are supposed to earn a labour income equal to employees.

[4] Starting from 1960 output has grown at an annual rate of 2.53% while human capital has grown at a rate of 0.85%.

[5] We also run un-weighted regressions (not reported) finding similar results.

[6] However, using standard OLS estimators (not reported) we obtain similar values for standard errors, leaving unaltered our main results.

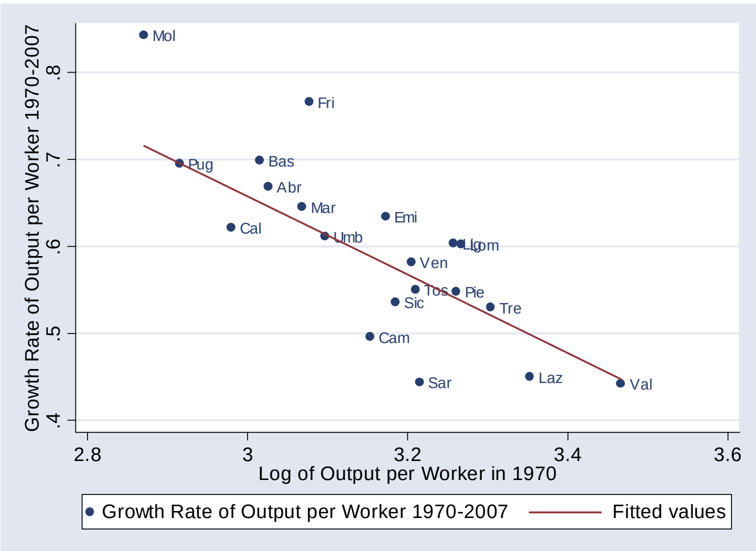
Table 1. Channels of Convergence (Absolute Convergence). SURE estimates.

	Dependent Variables: Growth Rates (1970-2007) of:			
	Output per Worker (1)	Physical Capital (2)	Human Capital (3)	TFP (4)
Output per Worker 1970 (log)	-0.450***	0.078	-0.154***	-0.374**
	(0.100)	(0.097)	(0.036)	(0.158)
Constant	2.006***	-0.193	0.849***	1.350***
	(0.313)	(0.311)	(0.114)	(0.505)
Observations	20	20	20	20
R-squared	0.459	0.031	0.479	0.218

In all the regressions we use as weights the number of inhabitants in the regions. Growth rates are measured as logarithmic differences. Standard errors are reported in parentheses. The symbols ***, **, * indicate that coefficients are statistically significant, respectively, at the 1, 5, and 10 percent level.

In column (1) of Table 1 the typical absolute convergence regression is estimated. The coefficient on the initial level of output per worker takes a value of –0.45 and it is strongly statistically significant. Figure 1 shows the relationship of the growth rate of income per worker (from 1970 to 2007) to the log of output per worker in 1970: it clearly emerges a standard process of absolute convergence.

Figure 1. Absolute Convergence across Italian Regions



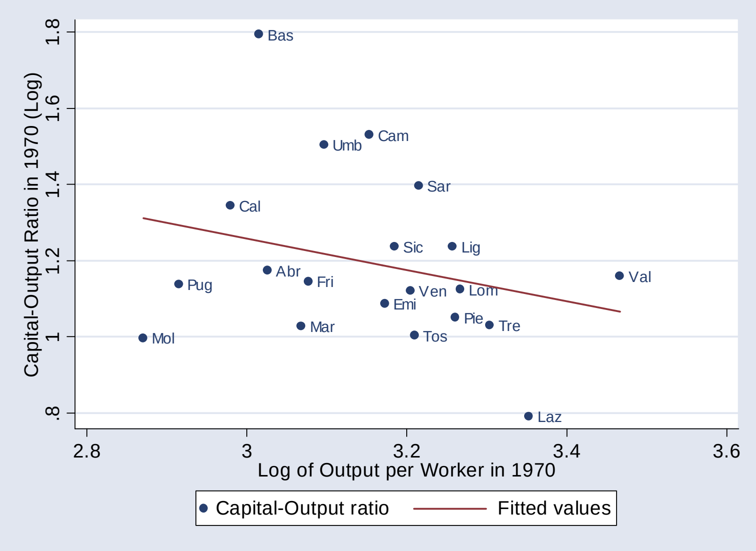
Although a process of convergence has taken place among Italian regions during the period 1970-2007, convergence has not been very rapid: the implied speed of convergence[7] (λ) is equal to 1.61%, implying that poor regions tend to close half of their output gap with respect to rich regions in about 43 years. This explains why large gaps among regions still exist today.

Regressions (2)-(4) of Table 1 help to understand how the estimated convergence has been obtained. Recall that the sum of $\beta_k + \beta_h + \beta_A$ is equal to β. The coefficient β_k (column 2) is positive but not significantly different from zero. This implies that the accumulation of

[7] The speed of convergence is calculated as $\lambda = -\ln(1+\beta)/T$ where T is the number of years (see Mankiw, Romer and Weil, 1992).

physical capital has not contributed at all to the convergence process. This is essentially due to the fact that in the early Seventies physical capital was not more abundant in richer regions, in contrast with what a neoclassical model of growth would predict. In fact, from Figure 2 it emerges that in 1970 less-developed regions tended to have higher capital-output ratios (the correlation between the capital-output ratio and output per worker in 1970 is equal to –0.42).

Figure 2. The negative relation between capital-output ratio and output per worker in 1970



More importantly, the regions which have recorded higher rates of growth of physical capital are not the regions that have grown more in terms of product per worker. In fact, regressing the growth of output on the growth of physical capital ratio, we find no statistically significant relation.

These findings are probably the consequences of badly designed development policies followed by Italian governments in the post-war period, consisting in large investments by public-owned firms in capital-intensive industries, huge subsidies to investments by private firms often in declining sectors to protect employment, bad management of public funds, wastes, corruption and so on. In fact, the stock of physical capital uses all private and public investment, simply summing all the amount invested. However, it is not reasonable to suppose that all the expenditure in investment represent productive capital, especially for the public sector (Pritchett, 2000). Agency problems plaguing government are more pervasive than in private sector since public sector firms often operate in monopolistic markets, there is no market for the ownership of assets and many goods provided by government are public goods. These problems give rise to distorted behaviour by public actors, such as corruption, “patronage” (transfers to political supporters) or simply shirking (low effort to reduce costs), which create a wedge between the actual cost of investment and its minimum economic cost.

Golden and Picci (2005) accurately analyze Italian regional endowment of infrastructures, comparing an index calculated on the basis of effectively existing physical infrastructures with an index of public expenditure for infrastructures (the amount of money spent over the years by government to this aim). They demonstrate the existence of wide differences among these two indexes: several regions (especially Southern ones) show a level of infrastructures much lower than their expenditure for public works (“missing infrastructure”). According to the authors, these differences can be attributed mainly to the existence of embezzlement, fraud and widespread corruption among politicians and public actors and also to waste and bad management. Golden and Picci (2005) elaborate a "corruption measure", as the ratio between the index of physical infrastructures and the expenditure index.

A further problem is related to the investments subsidized by the State. These subsidies to firms could distort investment choice: firms could over-invest (considering that their cost of capital is reduced) or invest in less efficient projects or sectors (public contributions are often conditional on investing in particular sectors or on using determined technologies), or the funds could be embezzled by entrepreneurs or simply wasted (see Giavazzi, 2005; Rossi, 2005). Italian regions have different shares of public investment (13-14% in the North, 22% in the South) and even more dishomogenous shares of public subsidies to investments (4% in the North, about 14% in the South) (see Scoppa, 2007).

All these factors – showing the investments in physical capital in many regions have been probably excessive and not strictly related to productive efficiency – contribute to explain why among Italian regions physical capital accumulation has not contributed to regional convergence.

As regards human capital, estimates in column (3) of Table 1 show that human capital has contributed significantly to convergence ($\beta_h = -0.15$). From the ratio β_h/β, a percentage of 34.2% can be attributed to human capital. In the early Seventies poorer regions had lower levels of human capital – the correlation rate between output per worker and human capital in 1970 is equal to 0.82– and poor regions have increased more intensely their educational levels (the correlation between human capital growth and its level in 1970 is equal to –0.74).

Finally, in column (4) of Table 1 we show that the convergence imputable to technological catch-up accounts for most of the total convergence occurred in the period under examination ($\beta_A = -0.37$): a considerable 83% (β_A/β) of convergence is due to technological catch-up.

On the whole, our results show that Italian regions have become more similar over time not for the accumulation of physical capital but mainly because of technological catch-up and in part for human capital. TFP growth, not factor accumulation, is what has driven convergence.

Admittedly, given that time series have been partially re-built a problem of measurement errors might be present. If the measurement error plagues the dependent variable and if the standard assumption – that the measurement error in *y* is independent of each explanatory variable – is true, then the OLS estimators are unbiased and the consequence is that the estimators have larger variances. On the other hand, in the case in which the measurement error affects an explanatory variable, the so-called "attenuation bias" in OLS could be at work and the estimated effect would be attenuated with respect to the true effect (see Wooldridge, 2010). In any case, given the very high correlation between the overlapping ISTAT and CRENoS series (correlation rates between these series are typically 0.98-0.99) on which variables have been rebuilt we are confident that measurement errors should be limited and our main conclusions remain qualitatively valid.

Conditional convergence

We have considered in the previous sections absolute convergence, not controlling for variables proxying for different steady-state levels: for regions within a country fundamental differences in institutions or preferences should be less important than across countries. The parsimonious specification also avoids to lose degrees of freedom given our small sample size (20 regions).

Nevertheless, given the historical dualism of Italian economy, as robustness exercise we now consider conditional convergence. Table 2 reports the β coefficients in a framework of conditional convergence, that is, we include macro-area dummies *North* and *Center* (the reference category is *South*) as proxies for steady-state values.[8]

As regards channels of convergence, results in the conditional convergence framework are not dissimilar to the ones obtained with absolute convergence. In column (1) we show that – as expected – convergence is more pronounced when we control for steady-state proxies ($\beta = -0.73$ and the implied speed of convergence is now 3.5%). Controlling for the initial level of output, regions in the North and Center appear to grow more rapidly.

Column (2) regarding physical capital growth shows that the accumulation of physical capital has not contributed to convergence since β_k is not different from zero. On the contrary, human capital has been a significant factor of convergence (column 3, $\beta_h = -0.15$). Finally, column (4) shows that most of the convergence $(\beta_A = -0.62)$ has been led by technological catch-up.

Table 2. Channels of Convergence in a Conditional Convergence Framework. SURE estimates.

	Dependent Variables: Growth Rates (1970-2007) of:			
	Output per Worker (1)	Physical Capital (2)	Human Capital (3)	TFP (4)
Output per Worker 1970 (log)	-0.726***	0.044	-0.152***	-0.618***
	(0.069)	(0.124)	(0.042)	(0.152)
North	0.131***	0.007	-0.009	0.133***
	(0.025)	(0.031)	(0.010)	(0.038)
Center	0.065**	0.024	0.013	0.027
	(0.023)	(0.038)	(0.013)	(0.046)
Constant	2.816***	-0.091	0.844***	2.063***
	(0.205)	(0.384)	(0.129)	(0.470)
Observations	20	20	20	20
R-squared	0.860	0.053	0.575	0.566

Notes: see Table 1.

Pooled regressions

In Table 3 we split the period from 1970 to 2007 into several sub-periods of span τ. We use first a time span of 9 years (panel a) (obtaining 20*4=80 observations; until year 2005) and then a time span of 5 years (panel b) (with 20*7=140 observations; until year 2004). We calculate the growth rate of our dependent variables over each sub-period and estimate pooled regressions in which the dependent variable is the initial level of output per worker in the respective sub-period. Furthermore, we control for the macro-area dummies *North* and *Center*.

The results obtained in pooled regressions widely confirm our previous findings. Regions have converged (conditionally); physical capital has not contributed at all (or it has been a factor of divergence) to the convergence process; human capital has significantly contributed to convergence although the magnitude of its contribution appears not very high; finally, the growth of TFP is the predominant engine of convergence.

[8] North includes the following regions: Piedmont, Valle d'Aosta, Lombardy, Liguria; Veneto, Trentino Alto Adige, Friuli Venezia Giulia, Emilia Romagna; Centre includes: Tuscany, Lazio, Marche, Umbria; South includes: Abruzzi, Campania, Apulia, Molise, Basilicata, Calabria, Sicily and Sardinia.

Table 3. Channels of Convergence: Pooled regressions with sample divided in sub-periods. SURE estimates

	Dependent Variables: Growth Rates over each sub-period of:			
	Output per Worker (1)	Physical Capital (2)	Human Capital (3)	TFP (4)
	a. Sample divided in sub-periods of 9 years each			
Initial Output per Worker (log)	-0.330***	0.048***	-0.023***	-0.356***
	(0.022)	(0.015)	(0.006)	(0.028)
North	0.060***	-0.005	-0.005	0.069***
	(0.011)	(0.007)	(0.003)	(0.014)
Center	0.035**	0.001	0.001	0.033**
	(0.013)	(0.009)	(0.004)	(0.017)
Constant	1.254***	-0.153***	0.167***	1.240***
	(0.077)	(0.050)	(0.020)	(0.096)
Observations	80	80	80	80
R-squared	0.740	0.128	0.229	0.667
	b. Sample divided in sub-periods of 5 years each			
Initial Output per Worker (log)	-0.165***	0.018*	-0.012***	-0.170***
	(0.021)	(0.011)	(0.004)	(0.025)
North	0.033***	-0.002	-0.002	0.037***
	(0.010)	(0.005)	(0.002)	(0.012)
Center	0.017	0.002	0.001	0.015
	(0.012)	(0.006)	(0.002)	(0.015)
Constant	0.638***	-0.054	0.091***	0.600***
	(0.072)	(0.036)	(0.012)	(0.084)
Observations	140	140	140	140
R-squared	0.407	0.022	0.113	0.260

Notes: see Table 1.

5. Concluding remarks

We have adopted the methodology proposed by Wong (2007) and Feyrer (2007) – combining growth accounting with convergence regressions – to individuate the channels of convergence for Italian regions. We provide evidence that for Italian regions a moderate process of convergence in terms of output per worker has taken place in the last forty years, but that physical capital accumulation has not contributed to the relative growth of poorer regions, whereas human capital (partially) and technological catch-up (predominantly) played a crucial role in convergence.

We have examined convergence both in an absolute and conditional framework finding very similar results. Furthermore, the main result of a dominant role of technological catch-up in guiding the convergence process among Italian regions is robust to model specifications, sets of data and alternative assumptions on parameters value (not reported).

Our results using channel decomposition approach are in line with Di Liberto, Pigliaru and Mura (2008) and with Maffezzoli (2006) who – using different methodologies (respectively, fixed effects in panel data and relative efficiency using DEA) and studying different sample periods – find that TFP convergence has contributed to more similar levels of product per worker among Italian regions. In addition, we find that human capital partially contributes to the process of convergence while physical capital has not contributed at all to it.

It is worthwhile to note that given the low number of variables used in the analysis (because of the small sample size) it is possible that TFP captures also hidden regional heterogeneity, not only technological change: as explained by Romer (1996, p. 25) TFP could differ among economies for the strength of property rights, cultural attitudes toward entrepreneurship and work, sectorial composition, un-measurable differences in the quality of inputs, and so on.

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