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Is regional growth in Italy endogenous?

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ABSTRACT

This paper investigates the extent to which the natural rate of growth of the Italian regions is endogenous, in the sense that it is affected by actual growth. Using annual data over the period 1977-2003, we find mixed support for the endogeneity hypothesis. Furthermore, in line with recent findings in the literature, our analysis provides evidence of asymmetries in Okun's Law when growth is endogenous.

JEL Classification: O18, O40, R11

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La croissance régionale en Italie, est-elle vraiment endogène?

Lanzafame

Cet article cherche à examiner dans quelle mesure le taux de croissance naturel des régions italiennes est endogène, en ce sens que elle est touchée par la croissance réelle. A partir des données annuelles pour la période allant de 1977 jusqu'à 2003, on trouve du soutien mitigé en faveur de l'hypothèse endogène. Qui plus est, en accord avec des résultats récents dans la documentation, l'analyse fournit des preuves des asymétries dans la loi Okun quand la croissance est endogène.

Croissance endogène / Loi Okun / Régions italiennes

Classement JEL: O18; O40; R11

Ist das regionale Wachstum in Italien endogen?

Matteo Lanzafame

ABSTRACT

In diesem Beitrag wird untersucht, in welchem Ausmaß die natürliche Wachstumsrate in den italienischen Regionen insofern endogen ausfällt, als dass sie vom tatsächlichen Wachstum beeinflusst wird. Anhand von Jahresdaten aus dem Zeitraum von 1977 bis 2003 stellen wir fest, dass für die Hypothese der Endogenität unterschiedliche Belege vorhanden sind. Darüber hinaus liefert unsere Analyse in Übereinstimmung mit den jüngsten Ergebnissen der Literatur Hinweise darauf, dass das Okunsche Gesetz bei einem endogenen Wachstum Asymmetrien aufweist.

JEL Classification: O18, O40, R11

Keywords:
Endogenes Wachstum
Okunsches Gesetz
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¿Es endógeno el crecimiento regional en Italia?

Matteo Lanzafame

ABSTRACT

En este artículo investigamos en qué medida la tasa natural de crecimiento en las regiones italianas es endógena en la medida en que esté afectada por el crecimiento real. Con ayuda de datos anuales durante el periodo 1977-2003, observamos un apoyo mezclado para la hipótesis de endogeneidad. Además, de acuerdo con resultados recientes en la literatura, nuestro análisis ofrece ejemplos de asimetrías en la Ley de Okun cuando el crecimiento es endógeno.

Keywords:
Crecimiento endógeno
Ley de Okun
Regiones italianas

JEL Classification: O18, O40, R11

INTRODUCTION

Output growth in Italy has averaged about 2 per cent in the last three decades, with a standard deviation across the regional annual means of about 0.3. If the average growth rate over such a period of time is a good approximation of an economy's trend or *natural* growth rate, the typical Italian region's long-run output growth rate can be expected to be between 1.7 and 2.3 per cent. The difference between the two extremes of this growth band may not seem too important on a year to year basis, but one may take a different view when considering its long-run implications. With an average growth rate of about 2.3 per cent, Lazio's output nearly doubled in the last 30 years while, growing at annual average of about 1.7 per cent, it will take 11 more years for Sardegna's to do the same.

Regional growth disparities are a persistent feature of the Italian economy. Not surprisingly, they still attract much interest in the literature (e.g. DUNFORD, 2002; MAFFEZZOLI, 2006; PACI *et al*. 2002; PACI and SABA, 1998; TERRASI, 1999, 2000), not least because their study is naturally associated to the general debate and long-lasting questions on the determinants of economic growth.

Neoclassical growth theory provides straightforward answers to these questions, suggesting that the growth rate of output which an economy converges to in the long-run is equal to the sum of the growth rates of labour productivity, determined by technological progress, and the labour force. This is what HARROD (1939) defined as the "natural rate of growth", which is both the trend growth rate that the economy converges to and the short-term ceiling to growth, which turns cyclical expansions into recessions. Both in the Harrod model and in the benchmark neoclassical growth model the natural rate of growth is exogenous, completely determined on the economy's supply side, so that it cannot be affected by (fiscal or monetary) demand-side policies.

If for a policy maker such a conclusion is somewhat disheartening, from a theoretical viewpoint it is rather unsatisfactory. A number of alternative theoretical approaches have, in various ways, attempted to "endogenise" growth, ranging from the Cumulative Causation school promoted by KALDOR (1966) to the more recent New Growth Theory models (e.g.

BARRO, 1991; GROSSMAN and HELPMAN, 1991; LUCAS, 1988; ROMER 1986, 1990). By and large, these attempts have been successful in highlighting several possible channels via which policy and/or demand-side variables can affect long-run growth, so much so that the question most growth theorists are now debating is (not whether but) to what extent and in what way growth is endogenous.

This paper is devoted to the examination of this issue in relation to regional growth in Italy. Taking as our starting point LEÓN-LEDESMA and THIRLWALL (2002a) (hereafter LLT), we investigate the hypothesis that the natural rate of growth (g_N) of the Italian regions may, under certain conditions, be endogenous to actual growth, so that it may be influenced by demand-side factors as well[1]. More specifically, we ask the following two questions: Firstly, is the Italian regions' natural rate of growth exogenous or is it endogenous to short-term growth? Secondly, is the relationship between the short-term growth rate and the natural rate of growth positive or negative? That is, do cyclical downturns (or growth decelerations) affect the natural rate of growth positively or negatively?

Furthermore, as will be illustrated, the procedure proposed by LLT relies on the estimation of a version of Okun's Law (OKUN, 1962) to obtain an estimate of g_N. This allows us to address the additional interesting question of whether non-linearites in regional growth affect the pattern of unemployment changes over the business cycle.

Our results indicate that the endogeneity hypothesis is supported only for 8 out of the 20 Italian regions, with the relation between short- and long-term growth being positive in 6 cases and negative in the other 2. Moreover, when growth appears to be endogenous we also find significant asymmetries in Okun's Law.

The dataset used in this paper consists of annual data on regional GDP and regional unemployment rates over the 1977-2003 period. The regional GDP series have been retrieved from the CRENoS database[2], while the unemployment series have been reconstructed relying on data collected by ISTAT, the Italian national statistical agency, through its “Quarterly Labour Force Survey” (*Rilevazione Trimestrale sulle Forze di Lavoro*, RTFL)[3].

The remaining part of the paper is organised as follows. The second section briefly describes Italy’s regional economic development, while the third reviews the theoretical literature on the natural rate of growth and lays out the details of the LLT procedure. The fourth section points out a number of problems with the LLT technique and proposes using the HANSEN (1997) threshold estimation procedure to correct for them. The fifth section carries out the econometric testing of the endogeneity hypothesis for the Italian regions. Finally, the sixth section concludes.

REGIONAL DEVELOPMENT IN ITALY

Despite the intense process of economic development experienced in the post-war years, which made of it one of the world’s leading economies, Italy is still characterised by profound regional disparities. In particular, significant economic differentials distinguish the well-off northern and central regions from the less developed Mezzogiorno, which comprises the six southern regions of Abruzzo, Molise, Campania, Puglia, Basilicata and Calabria and the two islands of Sicilia and Sardegna. As an example, in 2003 GDP per capita in the South was about 67 per cent of the national average, while unemployment was about 17.7 per cent, more than three times as high as in the Centre-North.

FIGURE 1

Though remarkably persistent, regional inequalities in Italy have gone through different phases and, in particular, displayed a decreasing trend until the early 1970s, as the less advanced regions caught up with the rest of the country (e.g. PACI and PIGLIARU, 1997). In the second half of the 1970s, however, the Mezzogiorno's convergence came to a halt and, despite heavy public intervention and the growing importance of funding from European institutions, gave way to a slightly divergent trend. As a result, at the beginning of the 2000s the regional dispersion of GDP per capita and the size of the North-South divide were still very similar to the 1970s (LANZAFAME, 2006).

The reversion of the convergence trend was primarily driven by a significant widening of regional unemployment differentials. While regional labour productivity started to gradually converge again in the 1990s, overall output growth is not fast enough in the laggard regions so as to increase the pace of job creation, thus disparities in terms of income per capita remain significant. This opens up the question, crucial from an economic policy point of view, of whether such developments can be simply ascribed to different exogenous natural rates of growth across the Italian regions or whether they reflect, at least to some extent, the effects of endogenous forces on growth.

THE ENDOGENEITY OF THE NATURAL RATE OF GROWTH

Theory and the LLT estimation approach

The Harrodian assumption of an exogenous natural growth rate is now well-established in growth theory, reflected in the exogenously given steady-state growth rate that economies are predicted to gravitate about. The widely accepted implication is that demand-side policies affect output only temporarily, as only supply shocks can have permanent effects on output growth.

LLT question the legitimacy of this proposition. They argue that there are many reasons to believe that the natural growth rate may in fact be, to some extent, endogenous and react positively to changes in the actual growth rate, as both the growth rate of labour productivity and that of the labour force are likely to be affected by significant swings in economic activity brought about by changes in demand.

The conjecture of a positive functional relation between the growth rate of output and that of labour productivity is hardly new in the literature. Embodied in the so-called Verdoorn's Law (VERDOORN, 1949), such a causal link is, for instance, at the basis of models in the cumulative causation tradition, as put forward by DIXON and THIRLWALL (1975) and LEÓN-LEDESMA (2002), among others. In this context, learning by doing (ARROW, 1962) and/or static and dynamic macro-economies of scale (YOUNG, 1928) have been advanced as explanations for the positive association between output growth and productivity growth. Similar ideas have also been used in models of endogenous business cycles (e.g. STADLER, 1990; BLACKBURN, 1999; FATÁS, 2000).

Opposite arguments have also been put forward which suggest a counter-cyclical pattern of technological progress and/or productivity growth. Among these is the idea that cyclical slumps may have a "cleansing effect" on the economy, ridding it from the most inefficient units and, thus, raising average productivity (CABALLERO and HAMMOUR, 1994). More generally, it has been argued that, because of the lower opportunity cost in terms of forgone production, recessions are characterised by the reallocation of resources towards long-run productivity-enhancing activities, such as training, human capital accumulation, the introduction of new technologies (SAINT-PAUL, 1997). Thus, the suggestion in this case is that the determinants of long-run growth reflect the Schumpeterian forces of "creative destruction" (SCHUMPETER, 1939, 1950).

While the *sign* of the relation is, thus, still matter of an unresolved theoretical debate, not least because of inconclusive empirical evidence, both approaches concur in assuming the *existence* of a causal relation between output and productivity growth. The implication is that not only real but also demand shocks can affect trend productivity growth and, thus, alter the long-run path of output. As a result, the treatment of short- and long-run growth as two essentially unrelated phenomena is challenged at its roots.

As for the hypothesis that labour force growth responds positively to output growth, this can be convincingly supported both on empirical and theoretical grounds. The empirical evidence indicates that labour force participation rates, as well as hours worked, are pro-cyclical while migration theories, supported by historical and current evidence on (intra- and international) labour migration flows, confirms that buoyant economies tend to attract migrant workers, thus providing a further growth-induced increase of their labour supply (e.g. MASSEY *et al*., 1993; HATTON and WILLIAMSON, 1998, 2002).

Overall, therefore, the exogenous-growth assumption is now questioned by a substantial body of theoretical and empirical work. More precisely, what is currently more explicitly doubted is the relative safeness of this hypothesis. In fact, even if one accepts as sound the arguments regarding the endogeneity of labour productivity and labour force growth to the growth of output, what can be (and has been) argued is that such relations, though present, are not strong enough to affect the trend of long-run growth significantly[4].

As mentioned, LLT take a different view and suggest that, under certain conditions, faster growth in the short-run can lift the natural growth rate. In particular, LLT see the positive relations between output growth and the growth rates of productivity and the labour force as being subject to switches between low and high growth states. In other words, the relation between the actual and the natural growth rates is a non-linear one, subject to a *threshold effect* which determines the switch between the growth regimes[5]. In such a context, a reliable estimate of the threshold, i.e. the natural rate of growth, assumes a key importance and LLT propose an empirical framework to ascertain it.

Following THIRLWALL (1969), LLT note that, since the natural rate is defined as the sum of the growth rates of labour productivity and the labour force, unemployment will rise whenever the actual rate of growth (g_t) falls below the natural rate, while it will fall when g_t rises above g_N. That is, the natural rate of growth is that particular growth rate consistent with the natural rate of unemployment (or NAIRU) and, thus, with a non-changing unemployment rate. LLT suggest that a simple estimation technique to pin down the value of g_N is to rely on the following specification of Okun's Law

$$\Delta\%U_t = \alpha_1 - \beta_1 (g_t) \qquad (1)$$

In equation (1) the percentage change in the unemployment rate at time *t* is expressed as a linear function of the growth rate of output, so that, imposing the long-run assumption that $\Delta\%U_t = 0$, an estimate of the natural rate of growth can be retrieved as α_1/β_1.

The use of this approach, however, is problematic. THIRLWALL (1969) and LLT argue that, because of the likely dependence of labour force participation on the growth rate of output and the effects of labour hoarding, the estimates of both α_1 and β_1, the so-called Okun coefficient, may be downward-biased. Furthermore, note that a significant α_1 would imply the presence of a deterministic trend in the unemployment rate and, though it can in some cases be a reasonable simplification to approximate the behaviour of the unemployment rate in the short- or medium-term, this is an implausible assumption in the long-run. Thus, both theoretical and empirical considerations suggest that estimation of equation (1) may produce insignificant results[6].

To overcome these drawbacks, LLT propose reversing the dependent and independent variables in (1) and estimate

$$g_t = \alpha_2 - \beta_2 \left(\Delta\% U_t \right) \tag{2}$$

Setting $\Delta\% U_t = 0$, one can see that the estimate of α_2 from equation (2) will be equal to the natural rate of growth. Estimation of (2), however, poses some problems of its own, as the assumed endogeneity of $\Delta\% U_t$ means that the coefficient estimates will again be biased. Moreover, that expressed in equation (2) is a static relation, while the likely presence of persistence in output growth suggests a dynamic formulation would be more appropriate.

Having obtained a reliable estimate of the natural rate, LLT suggest one can proceed to testing the endogeneity hypothesis via the introduction of a dummy variable (D) in equation (2), so that a differential intercept is allowed for whenever the actual growth rate is higher than the natural. That is, they estimate

$$g = \alpha_3 - \beta_3 \left(\Delta\% U \right) + \lambda_3 D \tag{3}$$

where

$$D = \begin{cases} 1 & g_t > g_N \\ 0 & otherwise \end{cases} \tag{4}$$

In such a framework, the endogeneity hypothesis will be supported if λ_3, the coefficient of the intercept dummy *D*, is significantly different from zero.

One problem with equation (3) is that, as illustrated by the introduction of only an intercept dummy, the switch between the low- and high-growth regimes is held to give rise solely to a level shift in the relationship, while the slope coefficient, assumed to be negative, remains unaffected. If this assumption is wrongly imposed, the estimation of equation (3) will be subject to an additional source of bias which may significantly affect the results. The growing body of empirical evidence on the asymmetric behaviour of the Okun coefficient across growth-regimes (e.g. LEE, 2000; SILVAPULLE *et al*., 2004; VIREN, 2001) suggests this might well be the case.

Thus, the estimated threshold g_N should be used to construct intercept as well as slope dummy variables and these should be employed in testing the endogeneity hypothesis via the regression of

$$g_t = \alpha_5 + \beta_5\left(\Delta\%U_t\right) + \lambda_5 D + \theta_5\left(D\Delta\%U_t\right) \tag{5}$$

where, *D* is the intercept dummy defined in (4) and $D\Delta\%U_t$ is the slope dummy on the percentage change of unemployment. In the single-equation setting, the constant-slope assumption can then be tested according to the significance of θ_5, while in the case of a system regression framework the general model formalised in (5) should be tested against its restricted version (3).

Problems with the LLT approach

The LLT procedure is essentially a technique for the estimation of threshold effects in output growth which, when the slight adjustment giving rise to (5) is introduced, can also be used to investigate the further interesting issue regarding the presence of asymmetries in Okun's Law. Nevertheless, the LLT technique is also affected by a number of problems, mainly arising from its theory-driven nature, as the resulting modelling structure imposed on the data is founded on problematic assumptions[7]. In particular, note that if the endogeneity hypothesis is correct equations (1) and (2) will be mis-specified, as both assume a linear relationship between the variables concerned, so that both will provide a biased estimate of *the* natural growth rate, as there is not a single g_N but two[8].

To overcome these problems we adopt a data-driven approach to the estimation of threshold effects as a more reliable alternative to uncover the presence of significant growth non-linearities. Firstly, given the problems associated to the estimation of equation (1), we rely solely on Thirlwall's reversal approach. Secondly, taking account of the likely persistence in output growth, we opt for the following dynamic version of equation (2)

$$g_t = \alpha_6 + \delta_6 g_{t-1} - \beta_6 \left(\Delta\%U_t\right) \qquad (6)$$

Thirdly, we impose on equation (6) the long-run restriction that $\Delta\%U_t = 0$ consistent with $g_t = g_N$, so that it simplifies to an autoregressive (AR) process of order one for g_t. Fourthly, we rely on the methodology formalised by HANSEN (1997) to ascertain the presence of significant threshold effects in this autoregressive model[9]. By construction, this is equivalent to testing for a significantly non-linear relationship between g_t and g_N.

The Hansen TAR procedure

The Hansen (1997) approach is based on the following threshold autoregressive (TAR) model

$$y_t = x_t'\phi I\left(q_{t-1} \le \gamma\right) + x_t'\eta I\left(q_{t-1} > \gamma\right) + e_t \tag{7}$$

where y_t is a stationary time-series, $I(\cdot)$ is the indicator function, $x_t(\gamma) = \left(x_t' I\left(q_{t-1} \le \gamma\right) \;\; x_t' I\left(q_{t-1} > \gamma\right)\right)'$, $x_t = \left(1 \;\; y_{t-1} \;\; \ldots \;\; y_{t-p}\right)'$ with $p \ge 1$ indicating the autoregressive order, $q_{t-1} = \left(y_{t-1}, \ldots, y_{t-p}\right)$ is the threshold variable and γ is the unknown threshold parameter.

The sample observations are split into two groups (e.g. growth regimes) and the model coefficients are allowed to vary depending on whether $q_{t-1} \le \gamma$ or $q_{t-1} > \gamma$. Setting $\xi = \left(\phi' \;\; \eta'\right)'$, one can rewrite (7) as

$$y_t = x_t\left(\gamma\right)' \xi + e_t \tag{8}$$

Conditional on γ, equation (8) is linear in ξ so that Least Squares (LS) estimation is appropriate[10]. CHAN (1993) and HANSEN (2000) recommend using sequential conditional Least Squares to obtain the estimates of the regression parameters $\left(\xi, \gamma\right)$. Specifically, for each of the values taken up by the threshold variable q_{t-1}, the threshold regression model (8) is estimated and the sum of squared errors $S_n\left(\gamma\right)$ is obtained. The LS estimate $\hat{\gamma}$, then, is the one that minimises $S_n\left(\gamma\right)$.

Once the estimate of the threshold $\hat{\gamma}$ is obtained, the coefficient estimates can be computed as $\hat{\xi} = \hat{\xi}(\hat{\gamma})$. To ascertain the significance of the threshold effect, one can simply test the linear constraint $H_0: \phi = \eta$. As under the null the threshold γ is not identified, the classical F-test does not have a standard distribution, but asymptotically valid p-values for the hypothesis test can be constructed relying on the bootstrap procedure suggested by HANSEN (1996).

TESTING THE ENDOGENEITY HYPOTHESIS

Threshold tests

Using annual data over the period 1978-2003, in what follows we apply the HANSEN (1997) TAR approach to regional output growth in Italy to test for the presence of significant non-linearties in g_t[11,12]. We set $p = 1$, as the general-to-simple testing carried out shows that an autoregressive process of order one appropriately describes the short-run dynamics. To ensure the model is identified for all the possible values of the threshold, we follow ANDREWS (1993) and HANSEN (1996) in trimming the bottom and top 15 per cent quintiles of threshold variable, so that the search for a threshold is restricted to 70 per cent of the observations.

We use two different definitions of the threshold variable, i.e. either $q_{t-1} = g_{t-d}$ or $q_{t-1} = \Delta g_{t-d}$. The first choice is a standard delay lag, while the second corresponds to the Momentum-TAR or M-TAR model proposed by ENDERS and GRANGER (1998). While the TAR model allows for a change in the rate of autoregressive decay according to whether the (lagged) growth rate of output is above or below a certain threshold rate, in the M-TAR model the change in the autoregressive coefficient will depend on whether g_t has increased or decreased faster than a certain threshold rate. That is, the M-TAR model reflects the idea that the appearance of nonlinearities in output growth might be triggered by an acceleration or deceleration of growth faster than a certain threshold rate.

Table 1 presents the results from the application of the TAR model, while the M-TAR estimates are reported in Table 2. The delay lag d is estimated together with the remaining parameters in equation (8). Though we performed the tests using values of d up to 5, only the results for d up to 3 are reported, as no rejections of the null were detected for $d > 3$.

TABLE 1

TABLE 2

Overall, the tests provide evidence of a significant threshold effect for 8 out of the 20 Italian regions' output growth rates. The TAR model indicates the presence of a threshold for Friuli Venezia Giulia, Basilicata and Sicilia, the M-TAR model for Toscana, Molise, Calabria and Sardegna, while Liguria is the only region for which the null of no threshold is rejected by both models and in a few other instances the tests reject the null with more than one threshold variable[13]. In relation to the first question at the centre of this paper, this evidence runs against the view that growth endogeneity, at least as defined by LLT and in this paper, is the general principle determining the economic performance of the Italian regions.

This contrasts with the qualified support for the endogeneity hypothesis that LLT find for all the countries in their sample – critically, including Italy. Thus, our results draw attention to the regional dimension of the growth process suggesting that, particularly for countries like Italy characterised by important regional differences, country-level studies may provide misleading results. More significantly, they indicate that growth-promoting economic policies in Italy should be largely region-specific. For the 12 Italian regions which fit well the neo-classical picture of exogenous growth these policies should focus on supply-side intervention, as there is no significant evidence that demand-side factors can affect growth permanently[14].

With respect to that suggested by LLT, the results also paint a more variegate picture as regards the non-linearity of regional growth in Italy. In three regions, i.e. Molise, Calabria and Sardegna, the threshold effect turns out to be triggered by a *deceleration* of growth, at various lag lengths, while the remaining regions are characterised by either a positive threshold rate of output growth or, in the case of Toscana, by a positive threshold Δg_t. This heterogeneity opens up different possible scenarios as regards the relative importance of the aforementioned mechanisms which can potentially spur endogenous growth. Further, it is interesting to note that 5 out of the 8 regions for which the tests indicate the presence of a significant threshold effect belong to the less-advanced Mezzogiorno, suggesting that the role of these factors may be more important in the latter.

Threshold effects and the LLT hypothesis

We now turn to the analysis of the impact of the ascertained threshold effects on regional growth in Italy. Both the regional context which our analysis relates to and the characteristics of our dataset point to the use of a Panel Data (e.g. Least Square Dummy Variables, LSDV) or system regression approach as the most suitable. We opt for Seemingly Unrelated Regressions (SUR) techniques, which allow for a fully flexible modelling strategy and exploit cross-regional correlation to increase the efficiency of the estimates.

Because of the finding of a significant threshold for Calabria when $q_{t-1} = \Delta g_{t-2}$, the time-period under analysis is now restricted to the years 1982-2003. As only 14 per cent of the observations for Basilicata's output growth rate fall in the high-growth regime, the inclusion of this region in the model leads to collinearity problems, so that it is necessarily excluded from the sample. Further, the small region of Valle d'Aosta is also excluded as, due to the just-mentioned time-series reduction, the SUR estimator is only feasible with a cross-sectional dimension of 18 or less.

We carry out our investigation considering the following three models:

$$g_t = \alpha_5 + \beta_5 \left(\Delta\%U_t\right) + \lambda_5 D + \theta_5 \left(D\Delta\%U_t\right) \quad (5)$$

$$g_t = \alpha_9 + \delta_9 g_{t-1} + \lambda_9 D + \omega_9 D g_{t-1} \quad (9)$$

$$g_t = \alpha_{10} + \delta_{10} g_{t-1} + \beta_{10} \left(\Delta\%U_t\right) + \lambda_{10} D + \omega_{10} D g_{t-1} + \theta_{10} \left(D\Delta\%U_t\right) \quad (10)$$

where

$$D = \begin{cases} 1 & q_{t-1} > \gamma \\ 0 & otherwise \end{cases} \quad (11)$$

and the intercept and slope dummies are introduced only for the regions characterised by a significant threshold effect, to allow the relevant parameter changes between the low- and high-growth regimes.

Equation (5), as shown in the previous section, reflects the ideas put forward by LLT, while equation (9) fits the TAR model in (7) or (8) to the growth rate of output g_t. Finally, nesting (5) and (9), equation (10) is the general model which takes account of both the relation between output growth and unemployment (following LLT) and the autoregressive dynamics of g_t (building on the TAR approach). Thus, equations (5) and (9) result from the imposition of exclusion restrictions on (10), which should be formally tested to select the most parsimonious model.

Taking this into account, we proceed as follows. We start by regressing the three models via SUR techniques and, relying on the Likelihood Ratio test and the multivariate versions of the Akaike and Schwarz Information Criteria, test for all possible cross-sectional restrictions as well as the exclusion restrictions on (10). We find that all the tests indicate the common-β_{10} equation (10) as the most appropriate model. This can be interpreted as a two-regime Okun's Law, allowing for some degree of persistence in output growth. The non-rejection of the common-β_{10} restriction implies that there is no significant cross-regional heterogeneity in the sensitivity of unemployment to output growth when the latter is not in the high-growth state.

From an econometric viewpoint, equation (10) is an Autoregressive Distributed Lag (ADL) model, or ADL (1, 1). The dynamic nature of the model allows one to distinguish the short-run relation between output growth and unemployment changes, which corresponds to Okun's Law, from the long-run equilibrium value of the rate of growth of output, which defines the natural rate of growth. Specifically, the long-run equilibrium g_N in the cases to which a linear relationship applies is given by

$$g_N = \left(\frac{\alpha_{10}}{1-\delta_{10}} \right) \quad (12)$$

Equation (12) also specifies the natural rate of output for the low-growth regime of the 7 regions to which, because of significant threshold effects, a non-linear relation is fitted. In such instances, the high-growth regime g_N is given by

$$g_N = \left(\frac{\alpha_{10} + \lambda_{10}}{1-\delta_{10} - \omega_{10}} \right) \quad (13)$$

Both expressions show that the natural rate of growth will be dependent on the degree of persistence in output growth. More specifically, the expression in (13) illustrates that the switch from one growth regime to the other will affect g_N not only, as in the LLT approach, through the intercept shift in the relation (given by λ_{10}), but also via the change in the degree of persistence in output growth, determined by the size and sign of the ω_{10} coefficient.

TABLE 3

As for the outcome of the threshold tests, the results from the estimation of the common-β_{10} equation (10) model, reported in Table 3, provide a fairly heterogeneous account of the features of regional growth in Italy. The common β_{10} coefficient is strongly significant and, as expected takes on a negative sign. This confirms the countercyclical pattern of unemployment in the absence of non-linearities in the relation with output growth, as well as in the low-growth regime of the 7 cases in which this relation is non-linear. However, the coefficient on the $D\Delta\%U_t$ slope dummy variable turns out to be positive in 6 out of 7 cases, in 5 significantly so. This is in line with the findings of a number of recent papers, indicating the presence of asymmetries in Okun's Law[15].

Furthermore, it is interesting to note that in the high-growth regime the asymmetric Okun coefficient is significantly positive in 3 cases (Friuli Venezia Giulia, Calabria and Sardegna), indicating that unemployment turns pro-cyclical. The same parameter is still significantly negative in one instance and not significant in the remaining three cases (i.e. unemployment turns a-cyclical). This evidence supports the view that both productivity and labour force participation are endogenous (and positively related) to output growth and suggests that, when considered in a non-linear framework and within the context of a high-growth regime, a pro-cyclical evolution of unemployment is a concrete possibility, rather than a mere theoretical nuisance[16].

Turning to the assessment of the endogeneity hypothesis, one can start by observing that for both Molise and Calabria, taken at face value, the results seem highly implausible and present interpretation problems. This is likely to depend on the uneven distribution of the observations between the two growth regimes, as only 24 percent of them fall in the slow-growth case for Calabria and just 29 percent for Molise.

The estimates for Friuli Venezia Giulia, Toscana and Sardegna (broadly) fit the picture depicted by LLT. The natural rate of growth rises in the high-growth regime, though only marginally in the case of Sardegna[17]. Liguria and Sicilia, on the other hand, are characterised by a fall in g_N in the high-growth scenario, brought about, respectively, by a negative and an insignificant coefficient on the intercept dummy variable *D*. Thus, the theories positing a positive effect of recessions or slow growth on productivity growth, as reviewed by SAINT-PAUL (1997), seem to provide a better theoretical background for the endogenous pattern of these two regions' growth process.

Ultimately, the presence and type of endogenous growth depend on the technological features and structure of an economy. More specifically, as the extensive literature on Verdoorn's Law shows[18], the type of self-reinforcing endogenous growth which LLT point at, based on learning-by-doing and dynamic economies of scale, is primarily characteristic of manufacturing activity. Thus, the finding of LLT-type endogenous growth for relatively more industrial regional economies, such as Toscana's and Friuli Venezia Giulia's[19], is not very surprising. The fact that both regions also displayed a falling unemployment rate in the period brings further support to this reading of the results, as in the LLT scenario technological progress is "job-creating", with faster growth increasing labour productivity so that, at given labour costs, employment and the labour force increase too. Such a process seems to describe well the "evolution" of Friuli Venezia Giulia and Toscana (e.g. DUNFORD, 2002).

Liguria and Sicilia, on the other hand, are predominantly services-based economies, so less likely to experience growth-induced endogenous productivity growth[20]. Service activities are usually more labour-intensive, so that lower growth in the down-turn of the cycle will be met by proportionally larger decreases in the employment rate and, possibly, the introduction and/or wider use of labour-saving technologies. As a result, labour productivity can actually increase when output growth slows down and unemployment rises, so that the natural rate of growth rises above the actual growth rate. The experience of both Liguria and Sicilia seems to broadly fit this picture as, in the period under analysis, both regions were characterised by a fairly good labour productivity performance, with growth rates close to the national average of about 2.6 percent, and upward-trending unemployment rates (LANZAFAME, 2006).

CONCLUSIONS

Taking as a starting point their diverse performance over the nearly three decades covering the period 1977-2003, this paper investigates to what extent and in what sense the Italian regions' growth process can be defined as endogenous.

Our study follows the approach proposed by LEÓN-LEDESMA and THIRLWALL (2002a), who put forward a simple technique, based on a variant of Okun's Law, to estimate the natural rate of output growth. We suggest and introduce a number of corrections to the LLT methodology and, given its drawbacks as a threshold estimation approach, rely on the HANSEN (1997) TAR method to test for threshold effects in regional output growth in Italy. We find evidence of significant non-linearities in g_t for only 8 out of the 20 Italian regions, suggesting that for most of the Italian regions growth is not endogenous, at least in terms of the endogeneity hypothesis as defined in this paper. The important implication is that in most cases the growth differentials characterising the Italian regions reflect structural, supply-side factors. For policy-makers, the message is that in most regions the effects of demand-side intervention will be short-lived, and in these cases supply-side policies (e.g. R&D subsidies) should be relied upon to improve long-term growth.

When using the estimated thresholds to further investigate the implications for the endogeneity hypothesis, we find the LLT's conjecture as regards the positive link between current and long-run growth is not fully supported by the data, as the results provide evidence of a higher natural rate when g_t is in the slow-growth regime in the case of two regions. We provide an interpretation of these results relying upon evidence on the structural composition and evolution of these regions' economies in the period under analysis. In our view, the LLT-type development of Friuli Venezia Giulia and Toscana can be accounted for by the important role played by the industrial sector in these two regions, while the negative sign of the relation between the actual and natural growth rates of Liguria and Sicilia can be explained by the preponderance of the services sector.

Finally, in the 8 cases in which growth does appear to be endogenous, the results also indicate the presence of significant non-linearities in Okun's Law, with unemployment switching from a counter- to a pro-cyclical (or acyclical) pattern in booms. This reinforces the view that both labour productivity and labour force participation react endogenously to growth.

In conclusion, the work carried out in this paper provides only partial support to the endogeneity hypothesis. Further, to the extent that regional growth in Italy does appear to be endogenous, our results highlight significant cross-regional heterogeneity as regards the nature and sign of the relation between the short-term growth rate and the natural rate of growth. This reinforces the view that the reduction of the regional differentials in Italy should be tackled via largely region-specific policies.

APPENDIX

TABLE A1

NOTES

1. For simplicity, in what follows we will sometimes refer to this as the "endogeneity hypothesis".

2. CRENoS is the *Centro Ricerche Economiche Nord Sud* (Centre for North South Economic Research). Detailed information about it and the CRENoS database is available online at http://www.crenos.it.

3. The design of the RTFL survey and its definition of unemployment have undergone various changes over the years which, since an official ISTAT reconstruction for the entire period is not as yet available, create some complications for empirical work. In our case, two modifications introduced in 1984 and 1992 create two breaks in the series which, whenever necessary throughout the econometric work in this paper, will be dealt with via the use of two impulse dummy variables. All the relevant information on the RTFL can be found on the ISTAT website at http://www.istat.it/.

4. This attitude is well summed up by BLANCHARD and QUAH (1989) in their study of the dynamic effects of demand and supply disturbances. In discussing their interpretation of temporary and permanent disturbances to output as, respectively, demand and supply shocks, they argue that, among other things, "The presence of increasing returns, and of learning-by-doing, also raises the possibility that demand disturbances may have some long-run effects. […] We agree that demand disturbances may well have such long-run effects on output. However, we also believe that if so, those long-run effects are small compared to those of supply disturbances. To the extent that this is true then, our decomposition is "nearly correct"…" (p. 659).

5. On these issues, see the comment by BOGGIO and SERAVALLI (2002) and LEÓN-LEDESMA and THIRLWALL's (2002b) reply.

6. A separate concern regards the first-difference form in which Okun's Law is specified in equation (1). As noted by ATTFIELD and SILVERSTONE (1997), if both output and unemployment are I(1) variables as well as cointegrated, equation (1) will be misspecified. Most alternative formulations and estimations of Okun's Law rely on

cyclical measures of both output and unemployment, usually obtained via some filtering procedure (e.g. Hodrik-Prescott filter), but these methods have also been criticised as being *ad hoc* (e.g. by LEE, 2000). A further alternative is represented by the structural time series approach proposed by HARVEY (1985, 1989), which builds upon the unobserved component model to decompose each series into its constituting components (i.e. trend, cyclical, seasonal, irregular). However, though promising, this method is not viable in our case because of the short and low frequency (annual, as opposed to quarterly or monthly) time series at our disposal. Thus, in keeping with LLT, we opt for the first-difference model.

7. To some extent, LLT recognise this when, as a more data-based solution, they propose to take the natural rate to be equal to a 3-to-5 year moving-average of the actual growth rate.
8. In a companion paper LEÓN-LEDESMA and THIRLWALL (2002b) observe that equations (1) and (2) will provide an average estimate of g_N in both growth regimes, so that the implication of their approach is that the natural rate of growth will be subject to an upward shift whenever the economy grows faster than on average. This assumption, however, may be questioned.
9. For a similar approach to the estimation of non-linearities in output, albeit applied in a different context, see LEÓN-LEDESMA (2006).
10. Note that under the additional assumption that e_t is iid $N\left(0,\sigma^2\right)$, LS is equivalent to maximum likelihood estimation.
11. As a preliminary step, we ran ADF unit root tests on g_t to check for the possible non-stationarity of output growth and these rejected the null of a unit root in all cases, except that of Lombardia. However, visual inspection of a plot of Lombardia's g_t revealed the likely presence of a break in 1994. The application of the PERRON

(1997) unit root test with structural breaks rejected the unit root null at the 5 per cent level. The results of the unit-root tests are reported in Table A.1 in the appendix to this paper.

12. We are aware of the fact that using the growth rate of output, as opposed to its log-level, may be subject to critiques, as in so doing we lose some information. However, in keeping with LLT's analysis, this choice is dictated by our interest in the potential nonlinearity and endogeneity of the natural rate of growth.
13. Following HANSEN (1997), in such cases the selection of the appropriate threshold estimate is determined by the smallest associated residual sum of squares.
14. It is worth noting that our results do not exclude the presence of endogenous growth-enhancing mechanisms in the 12 regions for which we do not find any evidence of non-linearities in growth. Rather, they indicate that, if present, these mechanisms are not significant enough for their effect to be picked up in our tests.
15. Though somewhat mixed, in most cases the empirical evidence on asymmetries in Okun's Law is in the sense of unemployment reacting always inversely to output changes, but more strongly so in the downturn of the cycle than in the upturn. For instance, using US quarterly data for the period 1965:1-1999:1, CRESPO CUARESMA (2003) finds that "Cyclical unemployment is (approximately twice) more responsive to contemporaneous economic growth when the latter is in the 'recessionary' regime" (*ibid.*, p. 449) and that, when using HP-filetered data, the Okun's coefficient drops to only about -0.07 in the high-growth state (*ibid.*, Table 4).
16. See the recent job-search and matching literature focusing on models of equilibrium unemployment with endogenous labour market participation (e.g. HAEFKE and REITER, 2006; TRIPIER, 2002; VERACIERTO, 2004).

17. Recall that, as mentioned, in the case of Sardegna the non-linear pattern in g_t is triggered by a deceleration in output growth faster than 2.5 percent (Table 2). This implies that, whatever the value of g_t, Sardegna will be in the "high-growth" regime unless $\Delta g_t < -0.025$. Seen in this light, the trivial difference in Sardegna's estimated g_N in the two growth-states is not surprising.
18. See McCOMBIE and THIRLWALL (1994).
19. Both regions displayed a share of industrial output higher than the national average for most of the period under analysis, with Toscana's still standing at 30.5 percent in 2001 against a value of 28.9 percent for Italy as a whole [LANZAFAME (2006)].
20. The industrial sectors of both Liguria and Sicilia, already relatively small by national standards at the beginning of the 1970s, have gradually shrunk in the last three decades. In 2001 the share of industrial output was only about 20 percent for Liguria and 17 percent for Sicilia, while the respective values for the services sector were about 77 and 78 percent [LANZAFAME (2006)].

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Fig. 1. Italian regions

Table 1. Hansen threshold test, TAR model

	$q_{t-1} = g_{t-1}$			$q_{t-1} = g_{t-2}$			$q_{t-1} = g_{t-3}$		
Region	γ	F-Test	P-value	γ	F-Test	P-value	γ	F-Test	P-value
Piemonte	1.060	4.326	0.202	3.643	1.860	0.662	-0.205	2.206	0.564
Valle d'Aosta	0.442	2.188	0.615	0.129	4.003	0.203	0.129	4.820	0.128
Lombardia	1.904	2.105	0.642	0.804	3.492	0.271	1.784	4.321	0.193
Trentino Alto Adige	0.083	3.762	0.268	0.755	1.884	0.624	0.755	4.259	0.197
Veneto	3.696	1.058	0.953	1.419	2.503	0.481	4.102	1.443	0.836
Friuli Venezia Giulia	3.851	7.557	0.033	3.851	4.918	0.127	0.072	2.308	0.529
Liguria	-0.346	4.044	0.209	1.920	8.097	0.022	1.920	6.349	0.059
Emilia Romagna	2.632	2.119	0.645	1.725	4.904	0.121	3.269	3.847	0.227
Toscana	1.075	0.491	0.997	2.675	3.801	0.239	4.090	0.960	0.924
Umbria	0.114	1.655	0.731	1.401	2.107	0.542	2.055	1.175	0.902
Marche	1.722	2.114	0.647	0.410	3.238	0.292	1.654	2.359	0.467
Lazio	1.487	2.895	0.450	1.152	2.328	0.581	3.428	3.417	0.303
Abruzzo	2.592	1.438	0.814	2.314	0.877	0.935	1.811	1.062	0.888
Molise	0.614	1.545	0.771	3.793	3.598	0.240	6.436	2.183	0.563
Campania	0.138	1.970	0.721	1.771	2.051	0.621	3.703	2.870	0.391
Puglia	1.150	1.682	0.768	1.238	1.608	0.765	2.167	1.397	0.807
Basilicata	4.294	8.432	0.022	3.575	4.970	0.108	-0.471	3.811	0.207
Calabria	0.756	3.805	0.253	2.705	2.092	0.646	1.553	3.216	0.374
Sicilia	-0.098	5.223	0.115	2.023	7.705	0.026	2.511	2.094	0.552
Sardegna	1.496	3.381	0.352	1.415	1.792	0.679	0.551	4.339	0.190

Notes
The p-values are generated using 10000 bootstrap replications.

Table 2. Hansen threshold test, MTAR model

	$q_{t-1} = \Delta g_t$			$q_{t-1} = \Delta g_{t-1}$			$q_{t-1} = \Delta g_{t-2}$		
Region	γ	F-Test	P-value	γ	F-Test	P-value	γ	F-Test	P-value
Piemonte	0.870	1.247	0.890	2.286	1.287	0.898	-0.135	4.041	0.233
Valle d'Aosta	-0.693	1.067	0.930	-0.522	4.589	0.148	-0.244	2.275	0.573
Lombardia	-1.090	2.953	0.375	-2.298	2.897	0.419	0.150	3.082	0.354
Trentino Alto Adige	1.963	2.345	0.584	0.524	4.257	0.183	-2.492	1.263	0.891
Veneto	2.032	3.114	0.384	-1.336	0.823	0.960	0.696	3.186	0.341
Friuli Venezia Giulia	-0.545	1.734	0.714	-1.957	2.061	0.645	0.793	3.813	0.251
Liguria	0.973	7.398	0.037	-2.368	4.008	0.233	-1.243	1.564	0.825
Emilia Romagna	-2.008	3.083	0.388	-3.454	4.005	0.210	2.593	4.104	0.201
Toscana	0.598	9.269	0.011	1.509	4.177	0.167	1.159	0.368	0.999
Umbria	-1.879	2.070	0.633	2.480	3.127	0.324	0.726	4.575	0.141
Marche	0.662	3.519	0.291	0.660	1.387	0.826	2.785	3.256	0.327
Lazio	0.307	1.310	0.852	-1.583	4.878	0.137	-1.456	1.843	0.690
Abruzzo	-0.646	1.619	0.706	-0.182	0.882	0.937	1.210	-1.069	0.842
Molise	-2.815	1.232	0.860	-1.966	6.195	0.064	-1.652	2.541	0.475
Campania	2.119	3.534	0.299	-1.320	3.707	0.294	0.141	1.150	0.899
Puglia	-0.710	1.553	0.762	-1.852	1.368	0.801	0.420	1.988	0.617
Basilicata	3.413	4.191	0.188	4.944	4.103	0.195	3.655	3.814	0.237
Calabria	-2.105	3.283	0.331	-0.349	5.386	0.095	-5.031	6.973	0.044
Sicilia	1.688	2.666	0.508	-0.897	2.245	0.609	-1.794	3.391	0.317
Sardegna	-0.025	6.121	0.076	1.455	2.255	0.588	-1.101	4.130	0.206

Notes
The p-values are generated using 10000 bootstrap replications.

Table 3. Common-β_{10} equation (10) model, SUR estimation

Region	α_{10}	δ_{10}	β_{10}	λ_{10}	ω_{10}	θ_{10}	Slow-growth g_N	High-growth g_N	$(\delta_{10}+\omega_{10})$	$(\beta_{10}+\theta_{10})$	$\bar{R}^2$
Piemonte	1.666^	-0.007	-0.226^	-	-	-	1.655^	1.655^	-	-	0.152
Valle d'Aosta	-	-	-	-	-	-	-	-	-	-	-
Lombardia	1.316^	0.350^	-0.226^	-	-	-	2.026^	2.026^	-	-	0.365
Trentino Alto Adige	2.744^	-0.370^	-0.226^	-	-	-	2.003^	2.003^	-	-	0.070
Veneto	2.016^	0.101^	-0.226^	-	-	-	2.243^	2.243^	-	-	-0.138
Friuli Venezia Giulia	1.530^	0.229^	-0.226^	15.254^	-2.468^	0.777^	1.959^	5.182^	-2.239^	0.551^	0.315
Liguria	1.942^	0.117^	-0.226^	-1.003^	-0.403^	-1.014^	2.200^	0.731^	-0.286^	-1.241^	0.533
Emilia Romagna	1.702^	0.193^	-0.226^	-	-	-	2.110^	2.110^	-	-	-0.049
Toscana	1.026^	0.192^	-0.226^	4.608^	-1.157^	0.055	1.270^	2.868^	-0.965^	-0.171	0.383
Umbria	1.656^	0.073^	-0.226^	-	-	-	1.786^	1.786^	-	-	-0.089
Marche	2.155^	0.046	-0.226^	-	-	-	2.260^	2.260^	-	-	-0.098
Lazio	1.813^	0.238^	-0.226^	-	-	-	2.378^	2.378^	-	-	0.154
Abruzzo	1.875^	0.149^	-0.226^	-	-	-	2.203^	2.203^	-	-	0.341
Molise	4.030^	0.780^	-0.226^	-3.473^	-0.505^	0.087	18.291^	0.767*	0.274^	-0.139	0.416
Campania	1.989^	-0.120^	-0.226^	-	-	-	1.776^	1.776^	-	-	0.194
Puglia	2.133^	0.081	-0.226^	-	-	-	2.321^	2.321^	-	-	0.075
Basilicata	-	-	-	-	-	-	-	-	-	-	-
Calabria	8.108^	1.389^	-0.226^	-5.581^	-1.915^	0.306^	-20.847^	1.656^	-0.526^	0.080^	0.796
Sicilia	1.532^	0.656^	-0.226^	-0.082	-0.869^	0.314^	4.452^	1.195^	-0.213^	0.088	0.308
Sardegna	0.657^	0.717^	-0.226^	3.780^	-1.568^	0.360^	2.319^	2.397^	-0.851^	0.134^	0.224

Notes:
^ and * indicate, respectively, significant at the 1% and 5% level of significance.

Table A.1. Unit root tests on g_t

Region	ADF		IO2	
	Lags	t-ratio	Lags	t-ratio
Piemonte	0	-4.136^	-	-
Valle d'Aosta	0	-6.180^	-	-
Lombardia	0	-2.336	7	-5.653*
Trentino Alto Adige	0	-9.150^	-	-
Veneto	0	-4.147^	-	-
Friuli Venezia Giulia	0	-3.241*	-	-
Liguria	1	-8.394^	-	-
Emilia Romagna	1	-4.500^	-	-
Toscana	0	-4.439^	-	-
Umbria	0	-10.120^	-	-
Marche	0	-4.282^	-	-
Lazio	0	-3.806^	-	-
Abruzzo	0	-4.366^	-	-
Molise	1	-7.745^	-	-
Campania	0	-4.704^	-	-
Puglia	0	-3.939^	-	-
Basilicata	0	-3.961^	-	-
Calabria	0	-11.740^	-	-
Sicilia	0	-4.807^	-	-
Sardegna	0	-5.918^	-	-

Notes:
The IO2 is the "Innovational Outlier" model with a change in the slope and the constant, proposed by Perron (1997) as one of three models for his unit-root test with an endogenously selected structural break;
Lags selected with a general-to-simple procedure;
^ and * indicate, respectively, significant at the 1% and 5% level of significance.