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Why growth rates differ? Path of innovation in Italian provinces.

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ABSTRACT

This paper analyses the way in which innovation and absorptive capacity affect the productivity of Italian provinces. It builds on the Neo-Schumpeterian literature which investigates how technology gaps explain development disparities between countries and regions. The study is carried out at the provincial level, which allows a more fine-tuned analysis of the resource endowment linked to knowledge generation and economic performance. Moreover, it distinguishes between two very different types of innovation: those directly dependent on R&D and new knowledge generation which are generally measured by the number of patents; and those relying on the adaptation of processes, products and materials and thus mostly based on the exploitation of already existing knowledge, which are here measured by a new index based on registered utility models and industrial designs. Main results indicate a case of divergence in productivity levels instead of one of catching up among the Italian provinces; moreover, they suggest that the main effort to get productivity gains in this country has been carried out through a reduction of employment and of its related costs instead of via increasing R&D and human capital.

Keywords: innovation, patents, utility models, industrial designs, provinces, proximity

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1. INTRODUCTION

In the present context of growing globalization, the development of transport and of communication and information technologies (ICT) has considerably improved the exchange of codified knowledge. At the same time, innovation processes have become increasingly dependent on the ability to combine the items of the available knowledge stock, which is not uniformly distributed among different countries, regions and territories. In the international scenario, these differences have lead to rapid improvements and inexplicable failures, increasingly attracting the attention of scholars, which have long tried to analyse the mechanisms underlying innovation and growth in search for the strategic resources needed to start off these processes.

The Italian context provides an excellent case for the analysis of catching-up processes at the territorial level. Today, the debate on regional development in Italy faces a clear impasse: indeed, after half a century of regional policies (both ordinary and extraordinary), regional disparities have not significantly decreased and this critical node for the Italian State still remains largely unresolved. If calculated as per capita GDP, the wealth of Southern regions is still a third below the national average (see table 1), the same difference obtained 50 years ago. No Southern region has managed to get closer to the average national wealth, remaining at best well below the 90% of the average per capita GDP (as in the case of Abruzzo and Sardegna). On the whole, despite income differences between regions have decreased in the last 50 years (see the variability index in table 1), the most substantial achievement has been made in the first two decades (indeed, since eighties the variability index is substantially stable around 25-26 per cent).

The policies which have tried to address such disparities have gone through different phases inspired to the prevailing theories on economic growth. In the first decades after the second world war, the leading theory held an adequate endowment of physical resources to be the main engine of growth. In line with this, at the centre of any strategy of development were the direct and indirect effects of introducing leading businesses in the local productive context (Hirschmann 1958; Perroux 1955). This in the beliefs that economic development could be fostered by simply ensuring a high concentration of capital (including both productive activities and infrastructure) in the regional area. Then, from the Nineties onwards, a stronger emphasis has been placed on local development and on the need to develop another essential type of resource: social capital. The attention has thus moved to programmes taking into account the role of small and medium size firms and local institutions (Trigilia 2005). Both strategies, however, have not been able to substantially close the development gap between regions in the Centre-North and regions in the South.[1]

Given this background, in the present paper we draw on the Neo-Schumpeterian literature investigating how technology gaps can explain economic disparities among different territories to analyse the way innovation and absorptive capacity can affect the productivity of different areas. Up until now, most studies on economic development in Italy have been focused on regional disparities (Quatraro, 2009, Evangelista et al. 2000); moreover, the relationship between innovation and growth based on the "technology gap" model (Fagerberg, 1988)[2] has been rarely explored. Therefore, in order to advance the knowledge about this issue and to provide new insights on the territorial disparities obtained by Italy over the last 18 years, we apply this model to provincial-level data (NUTS III).

The first technology gap models (Fagerberg, 1988, Verspagen, 1991) have been tested on data on national economies, which are extremely extensive and internally heterogeneous. Then, since the interest for regional systems of innovation has increased, growing attention has been devoted to sub-national territorial contexts, especially to administrative regions at NUTS II level (for a review of the studies on European regions, see Sterlacchini 2008), whilst scarce attention has been paid to more narrow contexts (Acs et al., 2002). Since provinces represent more homogeneous areas than countries and regions, they should allow a more detailed analysis of the resource endowment (in terms of business networks, large urban centres, medium urban centres, Universities, private and public Research centres) linked to knowledge generation and economic performance. Undoubtedly, the main limitation entailed by this territorial dimension is the lack of statistical data. However, with respect to the goal pursued by our research, the information available is adequate and not significantly inferior to the one available for larger territorial dimensions.

Besides the closer territorial analysis, our main contribution to the existing literature stems from the inclusion of a new index of incremental innovation based on registered utility

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[1] A more detailed description of their limitations is beyond the scope of this paper, but the literature has already amply discussed this issue (see Toniolo, 2013).

[2] Of course, the Italian provinces have already been subject of studies with links to the theme of innovation and growth, see for instance Crescenzi et al. 2013 on the relation between social capital and innovation.

models and industrial designs, which allows us to distinguish and keep separated the effects attributable to two very different kinds of innovations: those directly dependent on R&D and new knowledge generation and those relying on adaptation of processes, products and materials and thus mostly based on the exploitation of already existing knowledge. Hence, compared to most previous studies where the innovation capacity of different territories is merely approximated by the number of internationally registered patents[3], by this way, we can capture innovation that occurs through *processes of diffusion*, such as when firms innovate by modifying and adapting technology already developed by other firms or institutions (imitation) or when all innovations are acquired from external sources (adoption), as in the case of the purchase of machinery embedded new technologies.

The rest of the paper is organised as follows. In section (2), we briefly present the theoretical works which provide the background of this study; in section (3), we introduce the empirical model and describe the econometric strategy, besides presenting the innovation indexes employed; in section (4) we outline the main results. Finally, section (5) concludes.

2.1 BACKGROUND OF THE STUDY

The literature has traditionally analysed the differences in national economic growth in terms of convergence towards one or more steady state equilibria (Mankiw et al, 1992).

On the one hand, the neo-classical approach assumes that technology and its spill-over effects are public goods, taking them to be free and readily available. Hence, under this model, countries leading the innovation process make their knowledge stock readily available to the ones behind and, in so doing, they support the process of growth of the latter. Most importantly, growth rates converge in the long run. This is because the countries initially behind have the opportunity to grow at a higher rate than the leaders, which instead experience a comparatively lower rate of growth.

On the other hand, theorists of endogenous growth hold that economic growth is influenced by investment in R&D and human capital (Romer, 1990; Lucas, 1988). This accumulation does not depend on external factors, but it is rather the result of an internal intentional process, which is a fundamental part of any economic system. They deny the assumption that knowledge is a pure public good (i.e. freely available) and therefore also reject the resulting claim that countries converge towards the same steady state. Rather, different steady states can be achieved from a given resource endowment and policies aimed at supporting the

[3] On the limitations related to the use of patents as innovation index see Capriati 2013.

growth of the knowledge stock can effectively foster growth and bring about a better equilibrium. By this way, however, these theorists take the relation between knowledge and growth to be linear and deterministic, neglecting all the social, institutional or entrepreneurial mechanisms that actually affect the path of an economy. As we shall see later on, such mechanisms instead play a crucial role in the Schumpeterian approach.

Both Neo-classical and Endogenous growth models have shown a certain empirical validity in studies of more developed countries (e.g. OECD countries), but they have been less successful in the analysis of less developed countries in Asia, Africa and Latin America. Indeed, in these cases, various studies have shown the rates of growth of leading and following countries to have a tendency to progressively diverge. Even in a developed area like the European Union, there are also studies showing that the growth rates of countries in the Centre-North and in the South tend to progressively diverge (Cappellen et al., 1999; Sterlacchini, 2008). Some regions which were likely candidates for joining the process of catching up have clearly failed to do so, in particular due to weaknesses in their institutional, formative and productive endowments. This is explained by the fact that the ability to benefit from innovation depends on the ability to combine the items of the knowledge stock one has acquired from both internal and external sources. This is why some authors hold that, when considering global development, we should no longer focus on the transfer of technologies, but rather on *"the broader organisational, economic and social embedding of such technologies in a development environment and the way they unleash or block specific development and growth opportunities"* (Freeman-Soete 2009, p. 587).

But what does the capacity to take advantage of the technological opportunities that the world market makes available to countries depend on? From a historical point of view, Abramovitz highlights the importance of a set of conditions that he calls *"social capabilities"*. These include: technical qualifications and the general level of education; solid experience in the organisation and management of large firms; a capital market which can mobilize the resources necessary for innovation; government stability and effectiveness in defining and guaranteeing the respect of the rules able to support growth; honesty and trust (Abramovitz, 1986).

A concept similar to the one outlined by Abramovitz is the one of *"absorptive capacity",* namely the ability to absorb knowledge and technology from external sources. According to Cohen and Levinthal (1990), this can be specifically defined as *"the ability of a firm to* *recognize the value of new, external information, assimilate it and apply it to commercial ends"* (ibid p. 128). Although originally referred to single firms, this concept has also been used at a larger scale, for regions and countries.

Starting from the idea that innovation prompts change thanks to the interactions between technological potential and social capacity, some scholars have outlined a systemic approach to the analysis of these dynamics. This approach is based on the notion of *"national innovation system"* (Lundvall, 1992; Nelson, 1993; Edquist, 2005) defined as *"the network of institutions in the public and private sectors whose activities and interactions initiate, import, and diffuse new technologies"* (Freeman 1987, pg.1). As Lundvall has put it: *"The National System of Innovation is a social system. A central activity in the system of innovation is learning, and learning is a social activity, which involves interactions between people. It is also a dynamic system, characterized both by positive feed-back and by reproduction."* (Lundvall, 1992, pg. 2).

Innovation systems are contexts which favour the generation and diffusion of innovation. In these systems, the learning deriving from the interaction of workers, entrepreneurs and firms has a central role, in particular for the diffusion of tacit, non-codifiable, knowledge, which is especially important for non-formalised activities of innovation (i.e. different from R&D). The fact that these paths of innovation and growth are the result of complex relationships between institutions, firms and societal systems, suggests that each national system is the historical result of these interactions and, therefore, that numerous approaches to development can be tried by each system. In other words, there is no one single path, perhaps indicated by the country leader, but rather numerous ways to exploit historically determined knowledge, social and institutional relationships (Abramovitz, 1986). The central role of *complex social interactions* as well as of *tacit knowledge exchange* in activating change makes the process of innovation also strongly characterised by *spatial proximity*. Complex social interactions give rise to processes of *learning by interacting* in the broad sense meant by Lundvall (1992), that is entailing knowledge flows from various sources: firms (clients, suppliers, competitors); research organisations (universities, public and private research centres) and public agencies (centres of technological transfer, development agencies, company incubators). However, if various forms of interactions occur in the process of innovation, the creation of distinctive capabilities and competitive products depends on the production and use of tacit knowledge (Asheim-Gertler, 2005): compared to explicit/codified knowledge, which is more easily accessible thanks to the widespread availability of ICT's, this is more difficult to exchange over long distances, since it heavily depends on the social and institutional context in which it is produced. This leads to consider the importance of physical closeness and thus the centrality of the territory, in particular of the regional systems of innovation.

Starting from these considerations, the Neo-Schumpeterian approach envisages both divergence and convergence as possible outcomes of the process of growth (Abramovitz,1986, Fagerberg, 1988). While endogenous development theorists interpret the relationship between knowledge and economic growth through a linear model, evolutionists do not take this relation for granted, but rather consider it dependent on the presence of social, institutional and economic capabilities (Capriati, 2013a). The Schumpeterian approach takes growth to be a process of disequilibrium created by the interaction of two forces: innovation, which tends to increase technological differences among countries, and imitation/diffusion which tends to decrease them (Fabergerg, 1988). This can result in either divergent or convergent paths. In order to benefit from innovation, countries/territories need a wide range of absorptive capacities (Abramovitz, 1986): institutional and social conditions, as well as human capital, R&D, and so on. Achieving a threshold level of these capacities is a precondition to start an innovation-fuelled process of growth. In other words: "*Technological catch-up is not a question of replacing an outdated technological set up with a more modern one, but to continually transform technological, economic and institutional structures"* (Fagerberg-Verspagen, 2002, p. 1292)

2. Econometric analysis

Given the theoretical framework discussed, our analysis of the development disparities among the Italian provinces is set in a non-deterministic theoretical context, which enables to highlight different paths of innovation and growth at local level. For the scope of this study, we chose to rely on a standard Neo-Schumpeterian "technology gap" model which analyses the relations among growth and innovation (see Fagerberg, 1988, Sterlacchini, 2008, among others):

$$Q = ZD^{\alpha}N^{\beta}C^{\gamma} \qquad (1)$$

Where: Z is a constant; Q = GDP per employed; D = knowledge originating from outside the country/territory; N = knowledge originating from inside the country/territory; C = country's ability to take advantage of knowledge (including both knowledge originating from outside and inside the country/territory).

By taking logs and differentiating eq. (1) with respect to time, we have:

$$q = \alpha d + \beta n + \gamma c \qquad (2)$$

Where lower case denote growth rates.

As further step, Fagerberg (1988) assumes *"that the contribution of the diffusion of internationally available knowledge to economic growth (d) is an increasing function of distance (T/Tf) between the level of knowledge appropriated in the country (T) and that of the country on the technological frontier (Tf)"* (p. 439). Accordingly, we obtain the final specification of the "technology gap model"

$$q = \alpha\,(T/Tf) + \beta n + \gamma c \qquad (3)$$

In order to empirically test this model, all the non-measurable variables have to be approximated by adequate indexes. The knowledge stock available in a territory cannot be directly measured, but it can be approximated by the level of productivity, assuming the latter to be strongly correlated to the available knowledge stock: the lower the initial level (i.e. in the previous year) of productivity of a country, the higher the emulation potential it can put to use (in the current year). The influence exerted by the differences in technological endowment (T/Tf) can thus be approximated by the GDP per employed in the previous year. The growth of the internal innovation in a country (n) is generally approximated by the number of patents in the country (usually over population or people employed) or by expenditure in R&D over GDP[4]. The changes in the ability to employ internal and external knowledge (c) are usually measured through the percentage of the population holding a high school qualification.

[4] A more interesting choice is the one made by Crescenzi (2005), who introduces a synthetic index that, besides the aforementioned data, takes into account the data on the number of workers employed in R&D divided by the total number of workers.

3.1 DATA

The empirical investigation is based on various sources of data at the provincial level (NUTS III): most information comes from the National Institute for Statistics (ISTAT), exception made for patent information which is from the European Patent Office (EPO) and the Italian Office for Patents and Trademarks (UIBM).The final dataset covers 103 Italian provinces (as they were before the introduction of the new provinces in 2001, for which the lack of available data would not allow an adequate analysis) observed for 18 years, from 1995 to 2012, for a total of 1751 observations (balanced panel).

3.2 INNOVATION INDEXES

A clarification has to be made on the two indexes that we employ to measure the growth of innovation in each province. In most previous studies focusing on countries and regions, this has generally been approximated by the number of patents over population or people employed or by the expenditure in R&D over GDP.

It is widely recognized that employing statistics on patents to account for innovation has several important limitations, especially in the context of a territorial analysis[5]. In this paper, we argue that a major shortcoming of this measure, widely used to examine the innovation capacity of different territories, is that it completely fails to capture innovation that occurs through process of *diffusion*, such as when firms innovate by modifying and adapting technology already developed by other firms or institutions (imitation) or when all innovations are acquired from external sources (adoption), as in the case of the purchase of

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[5] First because many important innovations are not patented, whilst many patents only refer to modest discoveries with low commercial value (Hu, Mathews, 2005, Buesa et al. 2006) and may reflect the firms' strategic aim of hindering possible competition; second, because we cannot know if all the patents issued are used (Sirilli 2010). Furthermore, when using the number of patents as proxy of innovation in a territorial analysis, it is important to be aware of other closely related problems. For instance, since different productive sectors have different propensity towards patenting (Smith, 2005), territories with the same innovative ability, but different specializations, might have different propensities towards patenting. Also, patenting is linked to firms' more general strategic choices, which is especially true for large firms that tend to concentrate the activities of R&D and the formal agents applying for patents in their central offices. Finally, each territory has different availability of services, institutions and scientific networks, which can positively or negatively influence the propensity of firms to protect their inventions through patenting.

machinery embedded new technologies. We believe this is especially important for Italy, since the productive system of this country is dominated by low and medium-low tech industries where firms with less R&D capabilities are generally more committed to incremental and embodied technological change, which implies making only small-scale improvements to add or to sustain the value of the existing products and processes. Since imitation/incremental adaptation in countries like Italy is likely to be more important relative to innovation/"new to the world" technologies", it follows that patents can describe the functioning of an important, yet limited, segment of the innovation process. Indeed, from the first contributions of Schmookler (1966) and Scherer (1965), we can observe a strong correlation between the expenditure in R&D and the number of patents in business and industry (Pakes-Griliches 1980; Griliches et al. 1988), which makes clear that patents can be considered as a good indicator of the output of the activities of *invention*, usually measured by the expenditure or by the number of researchers employed in R&D activities (Griliches 1990).

More recently, some scholars have thus focused their attention on the information provided by forms of protection of intellectual property other than patents. These new research interests reflect the obvious incompleteness of previous analyses exclusively focused on patents and thus demonstrate the need to explore new approaches (Capriati, 2013b). Beneito (2006), for instance, in analysing the characteristics of innovation in Spanish firms, has used *utility models* alongside patents, considering the former to be more suited to identify *incremental innovations*. This type of modifications is typical of small and medium size firms, which are generally more focused on changes and adaptations of existing products and processes. Another important contribution to this type of analysis comes from the recent work of Korean scholars (Kim et al., 2012), who have explored the relationship between forms of Intellectual Property Right (IPR) and economic development, showing that utility models are better representations of innovation rooted in adaptation, imitation and incremental innovation, which are typical of less developed economies; on the contrary, the protection of patents supports innovation and growth only in developed countries. In other words, patents seem to positively influence the industrial activities only when countries have reached a certain threshold of autonomous ability of innovation, supported by a solid base of scientific and technological infrastructures.

Building on this, we believe it is worth to extend the set of the data employed beyond the use of inventions protected by the most important patenting offices (EPO and UIBM) and thus to include an indicator of incremental innovation, that is of innovation conceived as progressive adaptation of new goods and services for the market. In the national system of IPR[6], at the UIBM (the Italian Office for Patents and Trademarks), we can find four categories of industrial property, namely *inventions, decorative models and designs, utility models and trademarks*[7]*:*

- an *industrial invention* is a new industrial method or process, a tool, utensil or mechanical device that constitutes an innovation of the state of the art which can be employed in the industrial field; in order to count as such, the new discovery has to be novel (i.e. not included or known in the state of the art), original (i.e. the outcome of a creative effort), of industrial nature (i.e. it can be produced and used in the industrial sector) and lawful (i.e. in accordance with public order and morality).
- a *utility model* is a discovery that improves the efficacy or comfort of application or of use of machines, machine-parts, tools or utensils or other objects.
- an *industrial design or model (decorative models)* is the appearance of the whole product or of one of its parts, resulting, in particular, from the features of the lines, the contours, the colours, the shape, the superficial structure and/or the material of the product itself and/or its ornament;

Industrial inventions are forms of protection of intellectual property generally sought be inventors operating at the national scale, who generally do not deem necessary an international (at least European) protection of their rights and most probably operate outside large public and private organizations. They should thus include agents more strongly linked to the system of medium size local firms and to individual inventors. Nevertheless, inventions protected at national level can be associated with those protected at European level as result of the research activity on new industrial methods or processes that constitute an innovation of the state of the art and not merely a change of already existing products or processes[8].

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[6] Not all countries employ the same types of protections. For countries protecting utility models see Kim et al., 2012

[7] All definitions adopted come from ministerial sources (see www.sviluppoeconomico.gov.it).

[8] It has to be stressed that among the inventions protected at national level could also be present some that have been later protected at international level. To the best of our knowledge, it is not possible to distinguish between them, which implies that the data might be affected by partial duplication. However, the choice to process these data by a principal component analysis should have mitigated this problem.

The latter two types of protection seem to be more apt to describe the intrinsic features (utility models) and the external features (designs) of the innovative intervention. Compared to utility models, industrial designs are equally important: indeed, if we are interested in the ability to modify products, we should not discard exterior changes, which are essential for tracking consumers' tastes. Italian industry has always been a leader in design innovation and has consistently shown considerable capacity to aesthetically improve and modify products.
Drawing on this classification, we have thus distinguished between two types of measures of technological change: the first referred to the protection through patents of inventions and, ultimately, of the research results at the base of the development of new products and processes (*research output*); the second to the protection of changes of functioning or design of products and processes and thus of *incremental innov*ation.[9] For the scope of this study, these two measures have been constructed by the means of a principal component analysis (PCA), a technique of multivariate analysis that permits to reduce the number of variables while retaining a relevant part of the original information. Hence, associating, on the one hand, European patents and Italian patents, on the other, national utility models and industrial designs, and processing these original variables with PCA, we have obtained two synthetic indexes, **Resout** for *research output* and **Increm** for *incremental innovation*, by retaining in each case the first component, namely the only showing associated eigenvalue greater than 1 (in accordance with the widely used Kaiser-Guttman criterion) and a proportion of variance explained highly enough (above 70%)[10].

Maps 1-2 reports for each of the Italian provinces the average values of these two indexes (Resout and Increm) computed on the whole period. In the first map, which refers to the synthetic index of research output (Resout) divided by the number of people employed, we can note that patents of inventions are mostly concentrated in Northern regions or in the Centre, especially in Tuscany and Marche. Conversely in the South, except for some provinces in Abruzzo and Campania, there are medium-low and low levels of patenting. The second map, which considers the synthetic index of Incremental Innovation (Increm) per

[9] Of course, incremental innovation includes processes which are wider than the ones captured by the data employed on utility models and industrial designs, but given the available information and the arguments outlined above, they can be considered a good approximations for these processes.

[10] More in detail, as for Resout the variance explained by this component is 85% of the total; turning to Increm, the variance explained is 83%.

people employed, shows quite a different picture: indeed, we can see mostly high and medium-high values in provinces in the Centre-North-East, with some offshoots in Abruzzo, Campania and Puglia.

3.3 METHODOLOGY

As well known by scholars of panel theory, specification (3) cannot be correctly estimated *via* Ordinary Least Squares (OLS), since this would imply several problems related to omitted variables and endogeneity. Indeed, specific features of territorial growth may be correlated with the independent variables, determining the loss of important information and a bias due to omitted variables. In addition, many predictors are potentially endogenous with respect to the dependent variable. A way to solve these issues would be to use instrumental variables (IV) techniques, but this does not seem to be a feasible option since it is quite difficult to find a useful instrument that is correlated with the endogenous explanatory variable but not with the error terms. In the past few years, these problems have led some authors - Caselli et al. 1997, Benhabib and Spiegel 1997, 2000 and Lee-Kim, 2009 - to use regression techniques based on models specifically developed to overcome these limitations - i.e. unobserved country heterogeneity, omitted variables bias, errors of measurement and endogeneity (Arellano-Bond, 1991), that is the generalized method of moments (GMM). According to Bond et al. (2001, p.5), *"The basic idea is to write the regression equation as a dynamic panel data model, take first-differences to remove unobserved time-invariant country-specific effects, and then instrument the right-hand-side variables in the first-differenced equations using levels of the series lagged two periods or more, under the assumption that the time-varying disturbances in the original levels equations are not serially correlated"*. Estimations obtained applying this method show several advantages: first of all, they are not affected by omitted variables time invariant (the so-called country specific fixed effects); secondly, an overall better estimation of the coefficients - due to the use of instrumental variables - is assured, this way also overcoming problems related to endogeneity and measurement errors. In a context of growth models and when it comes to deal with not too large panel data set and persistent time series, Bond et al. (2001) suggest to use the system version of the GMM (see also Blundell-Bond, 1998, Arellano, Bover, 1995, Lee-Kim, 2009), since it is better able to reduce the bias typical of small series (very common in this type of analysis). Accordingly, our estimations have been first carried out by using the GMM estimator in Blundell and Bond (1998) version (GMM-system).

Since the present analysis is based on territorial data at the sub-regional level (NUTS III), some issues concerning the specification of the model that have to do with the effects of the spatial dimension are also raised. In particular, the effects due to geographical proximity have to be taken into account. Spatial econometrics (Anselin 1988, 1999, LeSage-Pace, 2009) arises as a branch of traditional econometrics with the aim to tackle problems related to the use of data linked to geographical entities. Among the issues covered, the spatial inter-dependence (or autocorrelation) and heterogeneity (or heteroschedasticity) are of uttermost importance. With this respect, the solutions provided by traditional econometrics appear largely insufficient. More in detail, the inter-dependence or spatial autocorrelation comes as a consequence of the presence of a functional relationship between something that takes place at a point in space and something else happening at other points. In other words, characteristics of a particular phenomenon in a region cannot be entirely explained by causes internal to the region, as they are also related to other causes pertaining to other regions, more or less distant. The second type of spatial effect, heterogeneity, is instead correlated to the lack of stability within space of the examined relations, which implies that the functional forms and the coefficients of the model vary due to the geographical location and are not homogeneous across the dataset.

Three are the main ways (Anselin 1988, LeSage-Pace, 2009) to include space in econometric models, which differ from each other in the components of the model on which a spatial correlation is assumed:

$y = \rho Wy + \beta X + \varepsilon$

$y = \beta X + u; \quad u = \rho Wu + \varepsilon$

$y = \rho Wy + \beta X + \rho WX + \varepsilon$

where :

ρ = the spatial autoregressive parameter;

Y = N x 1 vector of observations on the outcome variable;

X = N x j matrix of observations on the predictor variables;

β = j x 1 vector of regression coefficients;

W = N x N spatial weights matrix;

u = N x1 vector of disturbance component

ε = N x 1 vector of normally distributed, homoskedastic, and uncorrelated errors

The first model is called Spatial Autoregressive Model (SAR) and assumes a simple spatial extension of the linear regression model with the introduction of a matrix of weights (spatial weights matrix W), which allows to estimate the spatial component of the dependent variable.
The second model is the Spatial Error Model (SEM), used to handle spatial dependence due to omitted variables or errors in measurement through the error term.
The third model is the Spatial Durbin Model (SDM), which includes spatial lags of the explanatory variables as well as of the dependent variable. For the purposes of this study, we have chosen to account for the spatial lags of the dependent variable, which has led to a SAR representation of the Neo-Schumpeterian technology-gap model.

Therefore, four econometric models have been tested in the context of panel data analysis: the first two by using fixed effects and GMM-system; the other two with a spatially augmented fixed effects and GMM-system specifications.

3.4 THE EMPIRICAL MODEL SPECIFICATION

Based on what discussed so far, we can thus define two empirical specifications of the model of growth shown in equation (3).

The first one is the following dynamic equation:

$$\ln(Prod_{i,t}) - \ln(Prod_{i,t-1}) = \alpha + (\beta_1 - 1)\ln(Prod_{i,t-1}) + \beta_2\ln(Resout_{i,t-1}) + \beta_3\ln(Increm_{i,t-1}) + \beta_4\ln(Humcap_{i,t-1}) + \beta_5\ln(Z_{i,t-1}) + a_i + \varepsilon_{it}$$

which can be also written as

$$\ln(Prod_{i,t}) = \alpha + \beta_1\ln(Prod_{i,t-1}) + \beta_2\ln(Resout_{i,t-1}) + \beta_3\ln(Increm_{i,t-1}) + \beta_4\ln(Humcap_{i,t-1}) + \beta_5\ln(Z_{i,t-1}) + a_i + \varepsilon_{it} \quad (4)$$

where i and t indicate, respectively, the province and year.
More in detail, $Prod_{i,t}$ stands for provincial productivity measured by the ratio of GVA per person employed; a time-lagged dependent variable ($Prod_{i,t-1}$) has been also included to account for the fact that provinces' productivity change only slowly over time. Next, α is a constant; research output (Resout) and incremental innovation (Increm) are the two

innovation indexes previously discussed; human capital (Humcap) stands for the changes in the ability to employ internal and external knowledge, measured by the percentage of the population holding at least a high school qualification; Z represents a set of controls. In particular, these latter include for each province: the population density (Popdens); the ratio between the industrial and the total added value (Indust); the ratio between exports plus imports and added value (Open); the ratio between employed and total population (Empl). The first control variable is a good approximation of agglomeration economies which can advantage more urbanised provinces. Also, this index indirectly shows the level of accessibility of a territory, since less populated provinces are more likely to be less accessible (Sterlacchini, 2008). The second variable represents aspects of the provincial productive structure and, in particular, the weight of the industrial sector, which has of course a special significance for the innovation processes. The third control assesses the level of openness to foreign markets of each province. The last indicator shows the rate of employment, and thus the ability of an economy to create job opportunities. Finally, a_i is the time invariant fixed effect and ε_{it} indicates the usual error terms. The dynamic specification defined (4) has been tested by using the panel fixed effects and the generalized method of moments estimator (GMM-sys). The choice of this latter estimator is particularly appropriate, given the inclusion of the lagged dependent term in the regression and for the reasons explained in the previous section.

Our second specification takes into account the potential spatial effects.

$$\ln(Prod_{i,t}) = \alpha + \beta_1 \ln(Prod_{i,t-1}) + \beta_2 W(Prod_{i,t-1}) + \beta_3 \ln(Resout_{i,t-1}) + \beta_4 \ln(Increm_{i,t-1}) + \beta_5 \ln(Humcap_{i,t-1}) + \beta_6 \ln(Z_{i,t-1}) + \varepsilon \quad (5)$$

It is worth noticing that W has been added to the variables and parameters already described: this represents the standardized N x N spatial weights matrix which defines the structure of spatial dependence for our dependent variable (SAR model), built on the N = 103 Italian provinces following the method of the queen contiguity. Specification (5) has thus been tested by using the panel fixed effects and the GMM-system estimators adapted to the context of a spatial analysis.

The technology gap literature (Faberger, 1987, 1988; Verspagen 1991), particularly that focusing on the regional scale (Rodiguez-Pose 1999, Crescenzi 2005, Sterlacchini 2008), has shown that there is a minimum threshold of absorptive capabilities, below which it is difficult to move from knowledge (both internal and external) to innovation and growth. Since, as we have seen, some Italian provinces are struggling to start an independent process of growth, it might be also helpful to divide all the provinces in different groups and to see whether these entail a different behaviour with respect to innovation and growth. In order to identify these groups, a mixed criterion is followed: "historic-geographical" and "economic". According to the first one, which is both a geographical and historical criterion[11], we have identified two groups of provinces, namely those in South and those in the Centre-North. In this respect, the pure economic criterion adds that - as shown in the introduction - even in the most successful cases (Abruzzo and Sardegna), regions in the South never exceed - during the almost 60 years considered - the 90% of the national average income per capita (see tab.1), remaining overall just slightly over half of the income of the Centre-North.

Therefore, besides our base specifications (4 and 5), to explore whether the relation under study is driven by specific groups of provinces (i.e. those in the South vs those in the Centre-North), we have also included three interaction terms among the covariates: South*Resout; South*Increm; South*Humcap, where South is a dummy variable that takes the value 1 if the province belongs to the "Mezzogiorno" area[12], and 0 otherwise; Resout, Increm and Humcap are the variables of our main interest and which mainly characterise our model.

Overall, the correlation matrix (tab. 3) shows quite low indexes. They go above 0.6 only in three cases: for Research Output (Resout) and the provinces' share of employment (Empl); between provinces' openness (Open) and their industrial quota (Indust); and between the former (Indust) and employment (Empl).

3.5 ESTIMATION RESULTS

Tables 4 and 5 show the results of our econometric analysis. The first table reports the results obtained by testing specification (4) by using Panel fixed effects (XTFE) and the Panel system GMM estimator (GMM-sys); and specification (5) with spatially augmented Fixed

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[11] Indeed, before the Reunification in 1861, most Southern regions were part of the Kingdom of the Two Sicilies.

[12] The regions which belong to this area are the followings: Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria, Sicilia and Sardegna. The total number of provinces belonging to these regions is 67.

Effects (SPFE) and System GMM (SPGMM-sys). Next, in table 5, the macro-regional interactions have also been introduced in each specification.

Starting from table 4, we find lagged productivity (Prod $_{t-1}$) to be positive, significant and with a high coefficient[13] in all of the specifications tested. This result contradicts almost all previous empirical studies based on the technology gap models, where the lagged dependent term shows a negative sign, pointing to a process of catching up of the areas lagging behind in development. On the contrary, our analysis signals that, in Italy, at least in the last two decades, there has been a process of "falling behind" of the provinces which started from lower levels of productivity and/or a process of acceleration of the provinces that already have high productivity[14].

All the variables included turns out to be highly significant, exception made for the one relative to incremental innovation (Increm). While this might *prima facie* seem anomalous, it is not so. Indeed, as we have discussed above, this index results from the combination of two forms of protection of intellectual property (utility models and industrial designs), which concern activities such as modification and adaptation of products and equipment. These activities are especially widespread in countries and/or phases of development characterised by unsophisticated economic, social and technological infrastructures. As these infrastructures improve, the "minor" forms of protection (utility models) decrease, while more "cutting edge technological" protections (patents) increase (Kim et al. 2012). This implies that we should not interpret the non-significant coefficient found as showing that incremental innovation has no contribution to growth, but rather as pointing that incremental innovation progressively loses its influence on growth rates[15].

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[13] This latter feature is lost only in the case of the specifications SPFE.

[14] Recent studies (SVIMEZ 2014) have shown that this dynamic of divergence has worsened during the "Great Recession" (2008-2014) of the last years.

[15] To provide further evidence on this, we have re-run the system GMM regression by applying time delays to this variable from one to five years. The results obtained from this estimation have confirmed the hypotheses of Kim et al. (2012) concerning the preliminary role of incremental innovation activities with respect to the consolidation of an autonomous innovation capacity of territories. Indeed, the coefficient associated to Increm becomes significant at 10% already by the third lag; moreover, it appears with a higher magnitude and a higher significance (at 1%) by the fourth lag. These results are stable when we include the "Southern" interactive

As for the variable estimating the results of the research activity (Resout), it can be noticed that, even though significant, it has very low parameters. Recalling that the log transformations allow us to assume the coefficients as elasticity, the effect of a 10% increase in the results related to the research activity affects productivity between 0.02 and 0.08%, depending on the regression model. This result demonstrates how little research influences growth in Italy. This is not surprising given that this country suffers from a limited capacity to improve its efficiency since long time: over the period considered, for instance, the real GDP per person employed has grown by 0.1% per year on average. A recent study covering the first decade of the millennium, ranks Italy last among the OECD countries in this respect (see OECD, 2012). Of course, the limited impact of the results of research activity on growth is an important cause of this worrying long-term performance.

The level of education (Humcap) has, instead, a significant and positive impact on the growth of productivity. The coefficients are not very high, though substantially higher than those related to the results of research: across the four models, an increase of 10% of education causes an increase between 1.2 and 2% of provinces' productivity.

Specific results on the control variables included also offer some interesting insights which allow to better qualify these findings. First, the unemployment rate is significant across all the regressions with a high and negatively significant coefficient. This variable seems to affect more than any other the productivity of Italian provinces, with variations of the productivity between 4.6 and 6.6% for each decrease in employment of 10%. This overall supports that the adopted recovery strategy for productivity has been almost centered on the reduction of employment. The other control variable which suggests some further reflections on growth processes at territorial level is the one concerning the provinces' openness to foreign trade (Open). This variable has negatively significant coefficients in six cases out of eight specifications tested (tabb. 4-5). Overall the coefficients are low, pointing to the existence of a slightly negative impact of this variable on productivity levels. The combination of this result with the ones previously discussed on research and employment leads to hypothesize the following causal relationship: being more open to international trade and competition has not

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dummies (see table 5) in our base specifications: indeed, the associated coefficient becomes significant at 1% by the fifth lag, with a coefficient that is triple in magnitude compared to the one of the first lag.

forced businesses to catch up on the ground of research and innovation but rather on that of costs, in particular through staff reductions; this strategy, far from being successful, has made the production system more vulnerable to competition from newly industrialized countries, which has placed the economic system in a condition of further weakness in the competitive scenario.The population density is always significant in all the eights models of regression tested, although with conflicting signs: negative in the four regressions tested with fixed effects and positive in the other four regressions tested by the system GMM. It is therefore difficult to make general remarks on the impact of this variable.The variable that accounts for the weight of industry on the entire economy (Indust) shows positive and significant coefficients in all the eight regressions run - with a variation of productivity fluctuating between 1.4 and 2.3% for every 10% change - which confirms the important role that industrial activities still play in contributing to the growth of productivity and efficiency at the territorial level.

Focusing on the results obtained from spatial regression also shown in table 4, we can see that the coefficient of the variable detecting spatial dependence between the levels of income in each province ($W^*Prod_{i,t-1}$) is positive, significant and with high magnitude in both spatial regressions. This confirms the presence of strong positive interaction effects based on geographical proximity (i.e. spatial spillovers) among the observed provinces: in other words, some provinces see their level of efficiency to increase due to the growth of the others. This result thus confirms the importance of spatial proximity for territorial growth.

Turning to table 5, as can be seen, incremental innovation (Increm) remains not significant whatever the estimation method and even when this term is interacted with the dummy variable “South”, which accounts for being a province in the less developed “Mezzogiorno” area. Therefore, in this respect our previous considerations hold.

With respect to research output (Resout) and human capital (Humcap), the interactive terms are instead significant[16], though both negative in sign. The interpretation of this result should be made with caution: it would be a mistake to conclude that a greater increase in resources for research and education has a negative impact on the productivity of Southern regions; it is

[16] Exception made for the spatial estimation of the GMMsys of the coefficient of the interactive variable Sud*Resout

instead more likely that the levels of research output and human capitals are such low there that they produce a negative elasticity. Indeed, this result should be read in conjunction with another result discussed above, that is the growing gap between the productivity levels of the Italian provinces: absolute changes being equal, provinces characterized by lower levels of research output and education (such as the southern ones) have higher percentage variations in these two factors compared to provinces with higher levels[17]. Hence, in a phase where the dynamic of the productivity of the southern provinces appears overall divergent in comparison with that of the northern provinces, the relationship between the percentage changes (elasticity) is negative. This supports that the apparent negative impact of Resout and Humcap for Southern provinces is likely the result of a perverse combination of low levels of research and innovation and a process of "falling behind".

4. CONCLUSIONS

The aim of this paper has been to examine the economic differences in the Italian territory by employing a technology gap analysis.

It is worth to remind that the context of this analysis is critical for two reasons: first, because Italy is a developed country with the lower growth of productivity in the last two decades; second, because this country is characterised by a strong dualism, both economic and social, between regions and provinces in the North and those in South.

The analysis carried out in this paper has allowed to deepen the knowledge about this issue. Indeed, the introduction of two different innovation indexes has enabled to distinguish between two different types of innovation: one - lead by public and private centres - mainly based on cutting edge technological change; and another more concerned with modifying features and exterior aspects of products and equipment.

As for the former, our econometric tests have highlighted a positive, though slight, relationship between the results of research activity and productivity. This confirms that the lack of growth in Italy can be in part imputed to a very marginal use of the most valuable resources of technological change. Turning to the latter, the non-significant coefficients emerged should not be taken to be incongruent: indeed, this finding shows that imitation processes become less and less relevant as the productivity of a territory increases, likely

[17] A similar phenomenon has been noted in the literature to explain the negative signs found in the growth regressions with respect to the variable human capital (see, for instance, Benhabib-Spiegel, 1997).

because this moves towards cutting-edge technologies. Rather, as our analysis of the time lags of this variable has confirmed, in accordance with what already found by Kim et al. (2012), incremental innovation represents a sort of pre-condition for the construction of an autonomous capacity of research, and thus its effects materialize only after a certain time laps. Also, the analysis carried out has allowed to point out and measure the effects of spatial proximity, thus showing high levels of economic interdependence between the Italian provinces. Finally, the joint reading of the results confirms a possible interpretation of the delay of Italy in terms of efficiency[18]. In this respect, an advantage of relying on the Neo-Schumpeterian models is that they do not take for granted neither convergence nor that higher investments in strategic resources (R&D, human capital and patents) will automatically and inevitably lead to growth. Rather, the evolutionary approach more realistically assumes that different contextual (path dependency) can equally lead to the rapid growth or to the decline of a territory: as we have seen, the lagged productivity in our models turns out to be with a positive coefficient, rather than negative like in the majority of the previous analyses on this issue, which signals a case of divergence in productivity levels instead of one of catching up.

Another important result can be interpreted as a consequence of the institutional and structural path dependency of the national productive system: the main effort to get productivity gains has been carried out through the reduction in employment and related costs. Indeed, this choice is the result of a productive structure largely hegemonized by mature industries that incorporates low levels of technical change, few large enterprises, prevalence of strategies based on price competition rather than innovation, a labor market legislation favoring the temporary and low-cost use of labor force.

If we add to this the findings on the variable included to capture the effect of openness to international trade, we have the key elements to describe a picture where greater openness to foreign trade, instead of stimulating the innovative capacity of firms as well as an increased engagement in R&D, has resulted in a defensive response based on the reduction of employment and related costs. This strategy, far from giving results in terms of expanding markets, has pushed the system into a trap of low productivity and low innovation. In this critical situation, the gap between the Southern provinces and those in the Centre-North that still manage to keep an (albeit weak) presence on the competitive scenario becomes wider and wider.

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[18] On this topic, it is worth to report the extensive research sponsored by the Bank of Italy, available on the website of the Institute (see in particular Bugamelli et al. 2012).

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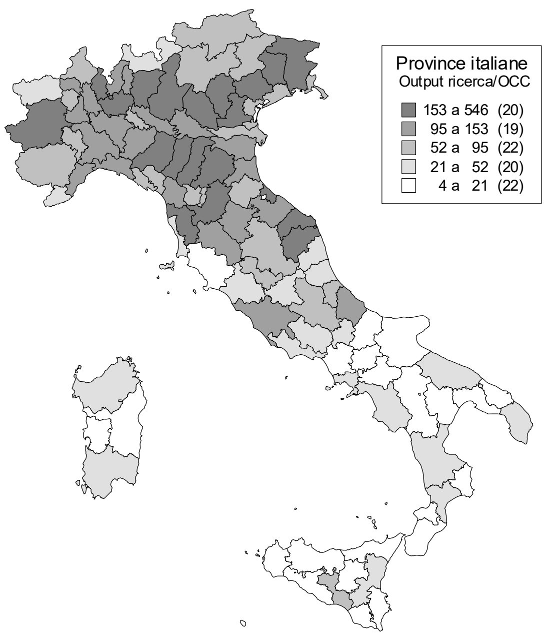
Table 1 – Italy. Regional Gross Domestic Product per capita 1955-2012 (Italy = 100)

	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2012
Piemonte	138.4	129.6	119.0	119.3	113.9	113.7	114.7	116.4	115.4	111.7	108.9	109.0
Valle d'Aosta	210.5	198.3	170.7	156.2	145.9	141.0	137.4	131.2	126.5	129.5	132.1	134.4
Lombardia	148.8	144.0	130.4	126.5	122.9	125.1	127.5	131.2	129.3	131.2	129.9	129.0
Trentino Alto Adige	127.5	119.5	117.3	113.2	115.1	122.3	121.6	122.2	124.3	130.0	124.9	131.6
Veneto	93.6	106.5	107.9	105.1	107.4	108.5	110.8	114.9	120.9	118.8	115.1	115.2
Friuli Venezia Giulia	95.0	96.5	99.5	105.0	108.2	115.7	112.0	117.8	122.4	110.4	110.8	113.5
Liguria	117.0	128.9	122.2	114.3	111.0	117.5	115.5	114.8	113.7	101.7	102.7	106.5
Emilia Romagna	106.7	114.4	115.8	113.8	120.8	129.5	124.2	126.4	130.6	128.4	121.1	123.0
Toscana	101.8	106.3	110.0	108.8	109.7	109.5	111.0	107.2	107.2	108.8	108.7	109.6
Umbria	79.6	79.2	85.9	85.6	90.4	97.9	95.1	95.1	96.5	96.1	94.4	90.9
Marche	98.3	91.4	96.2	98.2	107.4	107.0	103.4	103.5	104.8	99.9	99.9	99.8
Lazio	127.2	123.5	113.8	113.1	108.7	107.9	112.1	111.8	109.5	115.2	121.6	113.9
Abruzzo	70.9	67.4	70.2	76.9	82.1	87.6	87.9	88.3	88.0	86.9	81.1	87.1
Molise	62.6	57.5	65.4	63.7	67.6	73.8	74.4	74.4	74.9	73.2	72.5	78.1
Campania	71.5	70.5	75.0	72.5	71.3	69.0	71.0	67.1	63.7	63.1	64.1	63.8
Puglia	64.7	64.6	74.2	73.8	76.0	73.1	70.9	70.3	68.7	66.1	65.8	67.1
Basilicata	59.6	50.1	60.8	69.2	73.9	66.5	64.3	61.4	65.5	70.1	69.8	70.1
Calabria	60.8	56.8	61.6	65.7	65.7	59.1	61.5	56.1	58.5	62.2	64.7	64.6
Sicilia	62.0	58.1	67.7	71.9	74.8	68.3	66.8	65.9	64.6	64.4	66.3	65.6
Sardegna	80.7	74.8	80.4	86.8	83.9	76.2	74.6	73.9	72.6	75.8	80.1	76.9
Centro-Nord	***119.8***	***121.0***	***116.3***	***114.6***	***114.0***	***116.3***	***116.9***	***118.5***	***119.0***	***118.8***	***117.7***	***117.0***
Mezzogiorno	***66.7***	***63.9***	***71.0***	***73.0***	***74.1***	***70.3***	***70.1***	***68.0***	***66.8***	***66.8***	***67.7***	***67.9***
Italia	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*
COEFF. DI VAR	**0.386**	**0.386**	**0.294**	**0.254**	**0.228**	**0.250**	**0.247**	**0.261**	**0.262**	**0.257**	**0.249**	**0.249**

Source: Istat

Map 1 – Research Output per person employed



Map 2 – Incremental Innovation per person employed

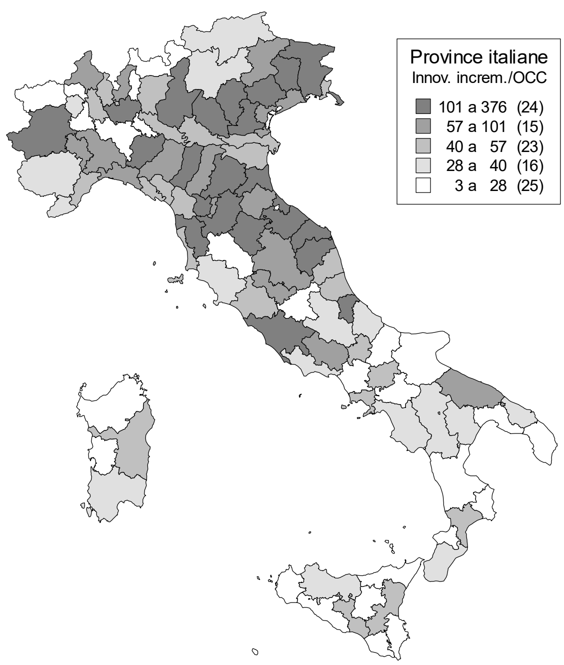


Table 2 - Descriptive statistics of variables used in the empirical analysis (1854 obs.)

Variable	Definition	Mean	Std. Dev.	Min	Max
Prod	Log of GVA per employed	3.91	0.12	3.49	4.50
Resout	Log of Research Output per employee	2.17	1.51	-7.55	4.61
Increm	Log of Incremental innovation per employee	2.07	2.18	-11.18	5.19
Humcap	Log of share of population with secondary and tertiary education	5.76	0.20	5.00	6.25
Indust	Log of GVA in industry as share of total	-1.35	0.33	-2.28	-0.68
Open	Log of Exports+Imports as share of GVA	-1.23	0.94	-5.05	1.47
Employ	Log of employees as share of total population	-0.94	0.19	-1.47	-0.55
Denspop	Log of population density	5.14	0.76	3.58	7.87

Tabella 3 – Correlation matrix

	Prod	Resout	Increm	Humcap	Indust	Open	Employ	Denspop
Prod	1							
Resout	0.5276***	1						
Increm	0.2004***	0.4734***	1					
Humcap	0.3775***	0.3527***	0.3368***	1				
Indust	0.429***	0.5071***	0.1886***	0.0421*	1			
Open	0.5417***	0.5773***	0.265***	0.3133***	0.6661***	1		
Employ	0.5205***	0.6496***	0.3729***	0.4373***	0.574***	0.608***	1	
Denspop	0.2614***	0.3002***	0.1978***	0.1692***	0.0542***	0.2969***	0.1586***	1

Legenda: * p< 0,1; **p<0,05; ***p<0.01

Table 4 – Determinants of growth of GVA per person employed. Italy (103 provinces)

Variable	XTFE	XTGMMsys	SPFE	SPGMMsys
Prod$_{t-1}$	0.4485***	0.4313***	0.0061***	0.2965***
	0,0191	0,0202	0,0012	0,0181
W*Prod$_{t-1}$			0.3989***	0.6115***
			0,0311	0,0319
Resout	0.0022**	0.0077***	0.0031***	0.0059***
	0,0011	0,0012	0,0011	0,0011
Increm	-0,0001	-0,0005	0,0004	-0,0005
	0,0006	0,0007	0,0006	0,0006
Humcap	0.1328***	0.1163***	0.1982***	0.1194***
	0,0100	0,0232	0,0100	0,0090
Indust	0.1399***	0.2299***	0.1701***	0.2161***
	0,0133	0,0153	0,0139	0,0137
Open	-0.0093**	0.0341***	-0.0186***	0.0083*
	0,0038	0,0055	0,0039	0,0047
Employ	-0.4724***	-0.5018***	-0.6590***	-0.4631***
	0,0207	0,0232	0,0209	0,0202
Denspop	-0.1999***	0.0166*	-0.2970***	0.0427***
	0,0327	0,0091	0,0339	0,0084
_cons	2.1492***	1.3213***	2.2909***	-0.6920***
	0,1669	0,1549	0,2042	0,1403
Year Dummy	no	yes	no	no
Obs	1751	1751	1751	1751
Provinces	103	103	103	103
r2	0,5345		0,8885	
Sargan test (p value)		0,530		0,135
Moran MI Error Test (p value)			0.000	0.000
Note:***, **, and * in the cells indicate the levels of significance of 1%, 5%, and 10%, respectively;				
standard error in parentheses				

Table 5 – Determinants of growth of GVA per person employed. W/Dummy South (36 provinces)

Variable	XTFE	XTGMMsys	SPFE	SPGMMsys
$Prod_{t-1}$	0.4487***	0.3441***	0.0059***	0.2909***
	-0,0192	-0,0188	0,0012	0,0173
$W*Prod_{t-1}$			0.4171***	0.5869***
			0,0323	0,0311
Resout	0.0054**	0.0101***	0.0072***	0.0087***
	0,0022	0,0022	0,0023	0,0023
South*Resout	-0.0041*	-0.0042*	-0.0053**	-0,0041
	0,0025	0,0025	0,0027	0,0026
Increm	0,0006	-0,0014	0,0007	-0,0002
	0,0009	0,0009	0,0009	0,0009
South*Increm	-0,0012	0,0018	-0,0002	-0,0004
	0,0012	0,0012	0,0012	0,0012
Humcap	0.1340***	0.1446***	0.2152***	0.1163***
	0,0130	0,0208	0,0131	0,0088
South*Humcap	-0.0011*	-0.0444***	-0.0296*	-0.0180***
	0,0151	0,0030	0,0155	0,0026
Indust	0.1396***	0.1371***	0.1709***	0.1773***
	0,0133	0,0149	0,0139	0,0142
Open	-0.0091**	-0.0104*	-0.0185***	-0.0092*
	0,0038	0,0057	0,0039	0,0051
Employ	-0.4721***	-0.6003***	-0.6652***	-0.4878***
	0,0208	0,0216	0,0211	0,0201
Denspop	-0.2100***	0.0464***	-0.3466***	0.0484***
	0,0384	0,0085	0,0402	0,0085
_cons	2.1884***	1.155142***	2.4244***	-0.6516***
	0,1853	0,1385	0,2119	0,1374
Year Dummy	no	yes	no	no
Obs	1751	1751	1751	1751
Provinces	103	103	103	103
r2	0,5345		0,889	
Sargan test (p value)		0,597		0,226
Moran MI Error Test (p value)			0.000	0.000
Note:***, **, and * in the cells indicate the levels of significance of 1%, 5%, and 10%, respectively;				
standard error below coefficient				