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PRODUCTIVITY AND SPATIAL DIFFUSION OF TECHNOLOGY IN GREECE: AN EMPIRICAL ANALYSIS

Serafeim Polyzos*, Dionyssis Minetos**
University of Thessaly

Labros Sdrolias***
Technological Education Institute of Larissa

ABSTRACT

A great number of studies concerning Greece and other countries have indicated that there are important differences in productivity of economic sectors amongst the different regions. This article focuses on the enterprises that employ more than 20 persons, analyses the observed differences in the productivity of the secondary sector and investigates the influence of technology on the configuration of enterprises' productivity. The spatial scale of analyses is the one defined by the Greek prefectural administrative level. The basic determinant factors of productivity are concretely described and the relationships between technology and productivity and between technology and geographical distance are estimated. The article concludes by commenting on both the existing spatial differences in productivity and the diffusion of technology in the light of their influence on regional inequalities in Greece.

Key Words: regional productivity, technology diffusion, spatial analysis

INTRODUCTION

In the field of economics, the concept of productivity constitutes a foundation stone as well as a characteristic measure of an enterprise's effectiveness. In addition, it can be a representative indicator of competitiveness for a whole sector of production as well as for a geographical region. Productivity shows the degree of exploitation of the factors of

*spolyzos@prd.uth.gr, **dminetos@prd.uth.gr, ***lsdrolias@teilar.gr

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production and therefore indicates the level of the production capacity, organization and infrastructure of an enterprise, a sector or a region (Polyzos 2003).

"Productivity" can be defined as the rate of manufacture, creation, or delivery of a desired output or commodity in relation to the inputs used to create the above outputs. A positive change in productivity is achieved when a greater quantity of output is produced using the same level of inputs, or alternatively, when the same output is produced by using reduced quantities of the factors of production. In cases where the denominator of the ratio outputs/inputs consists of only one of the inputs used in the production process then the ratio estimates the "partial productivity." Alternatively, when the denominator is made up of the total inputs used in the production process then the ratio estimates the Total Factor Productivity (TFP). Due to certain difficulties, i.e. lack of information, data of poor quality, in acquiring a reliable estimation of the TFP, a considerable number of studies use the labour productivity instead (Skountzos 1992, Vagionis and Spence 1994).

Pursuing improvements in productivity has long been a major focus and a critical target for both enterprises and regions (Aschauer 1989, Benhabib and Spiegel 1994, Xu 2000). This is because productivity contributes considerably to the development of the wider issue of competitive advantage of each enterprise and region. Enterprise viability in a competitive economic environment is tightly connected to the level of labour productivity. This is easily understood if one bears in mind that in estimating productivity the total employment expenditure involved in the production process is the greater consideration. In a lot of cases productivity is directly connected to the level of enterprise earnings and to the level of wages paid to employees.

Productivity is a composite result which is highly dependent on the inputs introduced in the production process as well as on a number of interrelated factors. Some of these factors - although mostly associated with regional productivity - have a wider application and they are the underlying factors of any kind of economic productivity such as commercial, regional, national etc (Abreu, de Groot and Florax 2004). The factors which affect the level of productivity could be classified into three categories: the technological, the non-technological, and the remaining factors.

The technological factors, most of the times, bring about structural changes in the productive process and they usually result in decreasing the cost of production. These factors mostly refer to the adoption of innovations, the application of new investments, the creation of novel infrastructures, the improvements in the quality and the features of

goods and services as well as the improvements in the production control systems (Glytsos 1988, Aschauer 1989, Abreu *et al.* 2004). In addition, they are tightly connected to certain improvements in the technical level of production through the introduction of sophisticated technical equipment and breakthrough technology. The adoption of technologies which ameliorate the skills of personnel with high professional and educational level contributes to the development of technologically-intense companies. In turns, this leads to the emergence of activities of the "new economy" (Polyzos 2003).

The non-technological factors mainly refer to the issue of "labour" and they are related to labour composition and quality. Finally, the remaining factors concern the labour relations, the level of utilization of the employees' skills and abilities, the type of management adopted by the enterprises, the relevant legal and institutional framework, etc.

The incorporation of advanced technology and innovations into the production process as well as the improvements in enterprise management methods lead to the establishment of more efficient exploitation and use patterns of the factors of production. Therefore, these factors change the businesses comparative advantage and contribute determinedly to the regional economic development. The new investments influence both, the labour productivity through the substitution of human labour by technology and the TFP. This is because investments are the means through which the new production methods and the new technological knowledge are incorporated into a company's capital equipments. Thus, the technology, amongst others changes the characteristics and the scale of the productive process namely the quality and the quantity of the output (Nelson and Phelps 1966, Richardson 1978).

The technological progress has long been recognized by the macroeconomic theory as one of the most important factors of economic growth (Nelson and Phelps 1966, Richardson 1978, Abreu *et al.* 2004). This is because through the use of the new technology, with a given quantity of capital and labor a greater quantity of output can be produced raising the productivity of the economic system. Enterprise productivity is closely related to the firms' attitude towards the technological breakthroughs as well as the firms' ability of adopting and applying the emerging innovative production systems. In the international literature concerning the issue of the spatial diffusion of technology, two broad schools of thought can be identified (Abreu *et al.* 2004). The first school emphasizes the importance of the absorptive capacity. That is the enterprise's ability of adopting technology for use. The second view about the diffusion of technology across regions

emphasises the importance of bilateral ties. Regions have different stocks of knowledge and diffusion occurs through bilateral channels such as trade (Blanas 2003). The pace of technological change depends on the dynamics of the diffusion and adoption of innovations. In turns, the regional or enterprise pace of adopting innovations is influenced by a number of factors such as the compatibility of the innovations with the existing environment, the degree of complexity that a particular innovation involves, the degree to which the results of adoption are visible to society, etc.

The remainder of this article is organised as follows. Section 2 describes the spatial differences in productivity amongst the Greek prefectures. It also examines the temporal changes in productivity focusing on the sector "industry." For the purpose of the present analysis they have been used data concerning industries that employing 20 or more persons. In Section 3, we describe the determinant factors of productivity placing particular emphasis on the factor "technology" and its spatial diffusion. Section 4 constitutes an empirical investigation of the industrial sector. The concentration is on uncovering the possible correlations between on the one hand, the regional productivity and on the other hand the determinant factors. In addition to the mathematical calculations, the relationships between productivity and the most important factors suggested by the analysis are shown diagrammatically. The last part (Section 6) contains the conclusions drawn by the empirical investigation.

SPATIAL DIFFERENCES IN PRODUCTIVITY LEVELS IN GREECE

Considerable evidence coming out from a lot of studies suggests that there are significant as well as persistent differences in regional productivity across the Greek prefectures. The comparison of the prefectural productivity levels in the secondary sector and also in the rest of the productive sectors of the economy reviles significant spatial differences (Christopoulos and Tsionas 2004, Glytsos 1988, Polyzos 2003, Polyzos and Arambatzis 2006, Polyzos and Petrakos 2000, Skountzos 1992). In addition, there are significant differences in the level of regional economic growth, as these have been portrayed by the relevant indicators used in the studies cited above.

Both in the microeconomic and the macroeconomic level, the importance of productivity for promoting economic development has been strongly stressed by a lot of

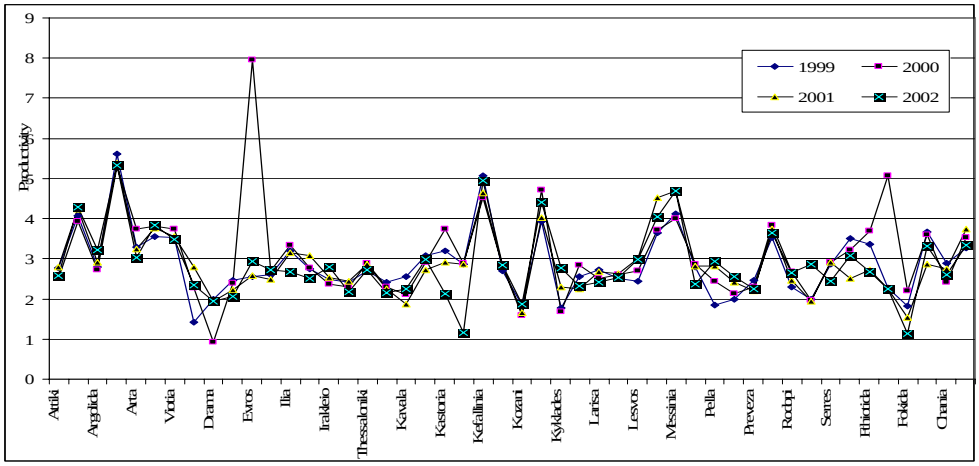
researchers. On the microeconomic level, it has been suggested that productivity influences strongly the enterprise competitiveness, the size of the profits produced as well as the viability of the firms (Richardson 1978, Khanam 1996, Xu 2000). On the macroeconomic level, productivity has a significant influence on the regional ranking in terms of the spatial economic competition, the improvement of the regional competitive advantage and the reduction of spatial inequalities (Polyzos and Petrakos 2000, Christopoulos and Tsionas 2004, Polyzos 2003, Polyzos and Arambatzis 2006). Generally speaking, the dynamics of the regional economic competitiveness are considered to be tightly connected to the concept of enterprise productivity.

This section deals with the regional inequalities and differentiations in productivity in the industrial sector in Greece on spatiotemporal manner. The geographical unit of analysis is that of the prefectural administrative level (NUTS III). The analysis concentrates on productivity patterns in the industrial sector with special attention to the enterprises which employ ≥ 20 persons (NSSG 2002). For this type of enterprises there is satisfactory information on the prefectural level.

Figure 1 displays the differences in labour productivity (value added employment) amongst the Greek prefectures. It also depicts the temporal development of productivity levels for the period 1999-2000. There can be observed important differences in the levels of productivity amongst the prefectures. These differential productivity patterns exhibit a diachronically permanent character. For a period of about four years depicted by the diagram, the values of productivity for the same prefectures display low fluctuations. Only a small number of prefectures present high fluctuations. The prefectures displaying the highest values of labour productivity are: Arkadia, Aitoloakarnania, Achaia, Viotia, Korinthia, Messinia, Magnisia, Chalkidiki and Rethymno. On the other hand, the prefectures presenting relatively low values of labour productivity are: Fokida, Samos, Kozani and Grevena.

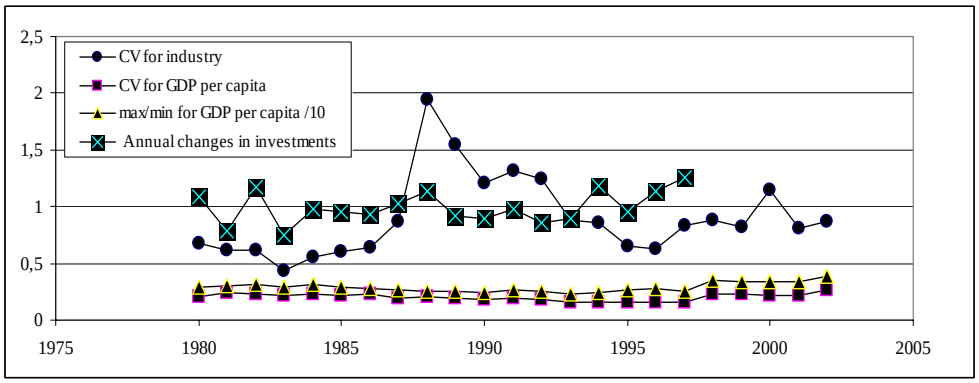
The remaining part of this section deals with the spatiotemporal development of four critical indicators which, to a large extent, describe the course of interregional economic changes. In particular, Figure 2 presents (a) the temporal changes in the coefficient of variation (CV) concerning productivity in the industrial sector (b) the development of the CV of GDP per capita, (c) the rate max/min for GDP per capita for the Greek prefectures and (d) the annual alteration in investments in the sector.

Figure 1. Productivity in the Greek prefectures during the period 1999-2002



As we can see by examining Figure 2, the CV of industrial productivity exhibits significant temporal changes. These changes are intensified during the period from 1987 to 1990. In addition, the patterns of change in the industrial investments present a relative correlation with the progress of the industrial productivity. On the other hand, the remaining two indicators present a relatively counter- development. This leads to the conclusion that the interregional inequalities in this specific sector of production have a significant effect on the observed inequalities of GDP per capita amongst the prefectures.

Figure 2. Temporal Changes in major industrial indicators



THE DETERMINANT FACTORS OF PRODUCTIVITY

The relevant international literature suggests a large number of factors that influence decisively the spatial differences in productivity not only in the secondary sector but also in the rest of the economic sectors (Skountzos 1992, Vagionis and Spence 1994, Xu 2000, Polyzos and Arambatzis 2006). At the same time, these factors are usually associated with regional productivity and they are also the underlying factors of any kind of economic productivity. Some factors of critical importance that have be reported are: (a) Innovations and the technology used by the enterprises, (b) the human capital and the employees' professional, managerial and technical skills, (c) the investment with special importance to the quantity and quality of the applied capital, (d) the level of regional infrastructures, (e) the level of spatial competition, (f) the urbanization, localization and agglomeration economies, and finally, (g) the enterprises' sizes.

The aforementioned factors are expected to have an impact on the relative regional economic performance. They may also give some indication as to why certain regions fall short in terms of their productive potential. However, the attempt to quantify all of the aforementioned factors is not an easy task. In most of the cases, the required statistical data do not exist or they are of questionable quality. For this reason, we attempt to estimate the correlation between the industrial productivity in the Greek prefectures and only those factors that can be quantified. The focus of the correlation analysis is on investigating the existence of potential relationships between the labor productivity and the quantifiable determining factors mentioned. Following, the potential relationships between the determinant factors and productivity are analyzed and explained on a theoretical basis.

Innovation and the Technology Used by the Enterprises

The invention and application of new technologies, products and production processes, are important factors that influence the growth of productivity. Innovations, new technologies and cutting-edge production processes do not develop with the same pace in space, nor are they occurring in an accidental manner. They are produced by a few world-leaders (companies and research institutes) in relatively few countries (Abreu *et al.* 2004). In most of the cases, they emerge in large urban centers with extensive and diverse labour force. Usually, this labor force possesses "open and supple" professional skills, receptive and communicative attitude towards new information and high educational level (Polyzos

and Petrakos 2000). In addition, the aforementioned urban centers incorporate powerful advantages deriving from the existence of large industrial complexes and agglomeration economies that foster the promotion and financing of relevant research programs. The emerging innovations are then spatially diffused and adopted by other firms across other regions and countries. However, a number of studies suggest that there are important barriers preventing the effective spatial diffusion of technology (Polyzos and Petrakos 2000). This is the case, especially between developed and developing countries and to a lesser extent amongst the regions of a particular country. Therefore, the weak spatial diffusion of technology and knowledge could be a factor that causes regional economic inequalities (Richardson 1978, Vagionis and Spence 1994).

Some studies have also shown that the less developed regions encounter greater difficulties in absorbing the new technological breakthroughs (Benhabib and Spiegel 1994, Eaton and Kortum 1996, Xu 2000). This is likely to be a key explanation of the observed regional variations in innovative performance. New innovations are not always readily transferable. Instead, they need to be modified and adapted to the specific industrial, regional and national circumstances. For instance, if a particular technological progress requires highly skilled workers, firms located in regions with least educated and least skilled labor force may not be able to take full advantage of the new technology.

Amongst others, the factor "distance" influences strongly technology and information flows. In terns, the characteristics of these flows (volume, speed and cost) affect the magnitude of technology and information adoption by enterprises. Extensive distances lower the rate of information flow and place difficulties on movements and personal contacts. Temporally speaking, the influence of the factor distance on the spatial diffusion of technology does not remain constant. In a rapidly modified world, it usually changes in an inverse mode in relation to the technological improvements in the communication networks. The economic prosperity favors progress in the spatial transmission of information since there is a reduction in the marginal cost of technological knowledge transmission. At the same time, the technological development and the introduction of new communication networks (telecommunications, Internet, etc.) make it easier for spatial diffusion process to occur (Salomon 1986).

The distance factor continues to play an essential role, despite the fact that the improvements in the means of information transmission have increased the capacity for communicating and for easier diffusion of technology. Distance constitutes one of the

determinant factors of the observed differences in regional productivity. Empirical studies have shown that the final decision about adopting a particular technological innovation depends on "face to face" contacts, particularly in the cases where the innovation includes high risk (Khanam 1996, Salomon 1986). Despite the fact that the continuous progress in telecommunications and the reduction in the costs of communicating have had a positive effect on substituting personal contacts by "face to face" communications, the distance factor still influences the negotiations between the stakeholders. It also influences the marketing strategies of the enterprises which hold advanced technology. Finally, issues like confidentiality, deals about patents and the need for a tactful treatment towards research contributors, all lower the pace of process of spatial diffusion and highlight the importance of distance to the diffusion process (Polyzos and Petrakos 2000).

The spatial diffusion of technological progress requires time the length of which depends on the involved distance. Thus, at least to some extent, distance results in (a) the emergence of differentiations in the regional production functions, (b) the configuration of distinctive productivity levels and (c) the emergence of unequal regional development patterns. Furthermore, the pace of transmission in technological knowledge is closely related to the degree of receptivity which characterizes the recipients. In other words, the patterns of transmission depend on the general attitude that the regional productive units exhibit towards the new technological breakthroughs.

Another indicator of a region's ability to adopt the new technologies is the share of jobs in the high-technology sectors in relation to the total employment. The adoption of a new technology involves uncertainty and risk – although the distinction between the term of uncertainty and the term of risk is blurring – and therefore most companies hesitate to embrace the innovations quickly. This initial reluctance by the firms to internalize innovations is analogous to the "revolutionary elements" of the particular innovation, since each significant innovation involves a high level of uncertainty and risk. The revolutionary innovations usually require the firms to make fundamental modifications to the existing productive structures, significant changes in their financing strategies as well as changes in their organizational and commercial approach. On the other hand, a less significant innovation involves lower uncertainty and it is usually more compatible with the contemporary structural characteristics of most of the enterprises.

In the literature there are two main theoretical perspectives about the diffusion of technology across countries or regions. According to the traditional economic thought the

spatial diffusion of innovations is a matter of minor importance, since the technological progress under competition is available to everyone (Abreu *et al.* 2004, Richardson 1978). This view suggests that there is a "common pool of knowledge" to which all countries have access. Thus, the level of the available technology is the same for all countries. The only constraint for a particular technology to be diffused and subsequently adopted and used is the country's ability to understand and make use of the new technology. This view emphasizes the importance of absorptive capacity. That is the ability of nations to adopt foreign technology and use it in the domestic market. A prominent example of this view is Nelson and Phelps (1966) model. The speed of adopting any new technology depends on the ability of individuals and firms to implement new ideas. It also depends on the gap between the technologies that are currently used by the firms and the state-of-the-art technologies. The factor that influence the degree of absorptive capacity in this case is the level of education (Abreu *et al.* 2004).

Several empirical studies have provided evidence in support of importance of absorptive capacity (Benhabib and Spiegel 1994, Eaton and Kortum 1996). These studies also suggest that certain institutes may influence the level of the absorptive capacity. Government policies promoting research, networks of scientists and universities usually encourage the adoption of foreign technology. While technology is global, countries differ in their resistance to adopt new technologies due to the greater or lesser influence of domestic lobbies and the state bureaucracy (Benhabib and Spiegel 1994, Eaton and Kortum 1996).

The second theory about the diffusion of technology across countries emphasises the importance of bilateral ties. According to this perspective, countries and/or regions possess different stocks of knowledge and the process of diffusion occurs through bilateral channels such as trade and investment. Two major mechanisms of diffusion have been identified: (a) direct learning about foreign technology and (b) employing specialised and advanced intermediate products developed abroad (Porceddu and Rabbinge 1997).

Most of the empirical literature about technology diffusion processes has focused on trade and Foreign Direct Investment (FDI) adopting the international scale as the level of analysis. Studies that deal with diffusion process in a lower spatial level (for instance, the diffusion of technology on a regional level) are scarcer. Some empirical studies have suggested that the rate of economic growth of a country is closely related to the growth rate of the neighbouring countries, and also that the trade alone cannot explain the extent

of the observed spatial dependence (Xu 2000). Finally, some other studies have suggested that spill over effects are important for economic growth (Coe and Helpman 1995, Moreno and Trehan 1997), or that the technology diffusion processes may follow a certain spatial pattern (Coe and Helpman 1995, Moreno and Trehan 1997)or even that technological adoption depend on some national characteristics such as the stock of human capital and the composition of imports (Coe and Helpman 1995, Moreno and Trehan 1997).

As regards Greece, it is believed that both the production of domestic technology and the importation of foreign one is mainly takes place in the two large metropolitan centres of the country, Athens and Thessaloniki (NSSG 2003). The aforementioned urban centres host almost 50% of the country's population, 70~80% of the large-size industry, a great variety of services, the most important universities and almost all the research institutes. In addition, Athens and Thessaloniki are the major entrances of the country through which people, technology and goods are distributed.

The quantification and calculation of the level of technological progress used by the enterprises is a difficult task. In some similar studies, the technological factor has been connected to the regional urbanization level, to the level of investments made by the enterprises and to the time-distances from the centres of production, importation and management of technology (Polyzos and Petrakos 2000, Vagionis and Spence 1994). In this article we estimate the correlation between on the one hand, the productivity of the industrial sector in the Greek prefectures and on the other hand, the following three variables: (a) the distance from Athens and Thessaloniki of the rest Greek prefecture in a pair-wise manner, (b) the level of urbanization in each prefecture and (c) the investments per added value made during the last five years in the industrial sector. The results of the calculations are presented in Table 1.

Skills or Human Capital

Human capital is a key factor of economic growth. It refers to the major characteristics of the people's productive potential such as those related with the level of education, the professional skills and the level of specialization and qualification. Educational levels and professional qualifications determine the effectiveness of population in the place of work. For introducing and operating advanced production techniques highly-skilled workers are essential. These personnel adapt faster to innovations, play a key role to the creation of

knowledge, and are more able of and likely to receiving training at work. Nowadays, an increasing proportion of jobs in the economy require high levels of skills (Nelson and Phelps 1966).

In Greece, these is not available statistical information about the employees' skills by economic sector and prefecture. The existing statistical data are aggregate and refer to the total population (not only to the labour force). However, the data show that there are large variations across the Greek regions and prefectures as regards the composition of the population in terms of their skills (Polyzos and Arambatzis 2006). In order to estimate the relationships between productivity and human capital, we use the educational attainment level and the level of professional training of the population in each prefecture. The assumption is that the educational attainment level and the level of professional training reflect satisfactorily the workers' level of professional training in each economic sector. For our calculations we use the relevant statistical data from another study by Polyzos and Arabatzis (2006). The final results are presented in Table 1.

Investment and the Quantity or the Quality of the Used Capital

The level of investment in physical capital influences the regional and/or enterprise productivity level. Thus, this is a critical indicator of the regional growth potential. Investments produce capital. As the invested capital which comes into the productive process increases, the system of "capital - workers" grows raising the sectoral productivity. In addition to capital quantity, a number of other factor such as the age, the technical quality and the degree of capital utilization are of great importance to the labour productivity (Polyzos and Petrakos 2000).

In summary, investment in physical capital is an important determinant of growth in the regional economy. However, the available data on net investment in manufacturing suggest that the variations in business investment are unlikely to be crucial in explaining regional productivity differentiations. The main difficulty in calculating the relationship between productivity and capital is related to the fact that there are not suitable statistical data. Unfortunately, there are not regional capital stock data available and the only available statistical information concerns the investments made in the industrial sector. For this reason we estimate the correlation between the productivity and the investments in the industrial sector (or the total private investments) in each prefecture.

The Level of Regional Infrastructures

It is widely accepted that regional infrastructures have long played a major role in enhancing economic performance. They contribute to the reduction of the production cost and to the increase of productivity on almost every regional economic activity (Aschauer 1989). Of the different kinds of infrastructures, those that are crucial to the enhancement of productivity are the transportation infrastructures (Polyzos 2001). The integration and enlargement of the road systems are examples of how improvements in infrastructure help economic growth, not least by reducing the cost of trade across regions. Investments in infrastructure have a direct economic effect by reducing transportation costs for firms, workers and consumers. In addition, falling transportation costs increase the effective size of regional and local markets.

Aschauer (1989), by using the generalized Gobb-Douglas production function, comes to the conclusion that the elasticity of productivity for public capital is 0.39. In addition, he suggests that the transportation infrastructures, the energy distribution networks, the water supply and waste water treatment systems have a larger influence on productivity compared to the infrastructures related to health services and education. In another relevant study Munnel (1990) analyses the decreasing levels of productivity in the USA and concludes that the major factor responsible for this diminution is the reduction in public investments concerning general public works and infrastructure.

In the present in the analysis we employ the "population potential" which is estimated by using the interregional distances. Interregional distance is a measure of the interregional transport infrastructures or in other words, an indicator of the level of accessibility sustained by each prefecture. The transportation infrastructure and, in particular, the interregional one is of significant importance to economic development. However, it is questionable whether investing in infrastructure alone is an effective economic development tool in depressed areas (Khanam 1996, Polyzos and Petrakos 2000). Indeed, investments in transportation infrastructure may be more effective in response to increasing demand from firms and workers.

The Spatial Competition

Generally speaking, spatial competition is an important factor which has a crucial role in driving productivity growth, not least by pushing the firms to invest in the new technologies as well as to adopt alternative operational and organisational practices. It

contributes to the reduction of slack in enterprises. In addition, it is crucial to the reorganization of the market structures by reallocating resources away from inefficient firms or declining sectors, to more efficient firms and growing sectors (Skountzos 1992).

The level of competition in an economy may vary significantly across regions and localities. In sectors where goods and services are not easily traded, transportation costs, poor information and differences in consumer tastes will segment markets. Where markets are regional or local, in particular in poorer or more remote regions, they may become dominated by only a few firms. In contrast, firms in large and densely populated regions with good access to markets are more likely to experience higher levels of competition. Not only can these markets support a greater number of competitors, but also firms and consumers are likely to have comparatively easy access to a wide choice of suppliers.

The levels of intensity of competition between the firms or regions may play an important role in explaining regional and local productivity differences. Firms in less developed and more remote regions may face less competition, and hence fewer incentives to innovate and to reduce costs. One indicator of the intensity of competition in certain market is the number of competitors in this market. Hence, in the course of the present study we estimate the correlation between productivity and the number of the enterprises in each region.

Urbanization, the Localization and the Agglomeration Economies

The concentration of many enterprises of the same sector (*localization economies*) or different sectors (*agglomeration economies*) in a region results in the specialization of productivity and in the creation of a specialised labor pool (Sasaki 1985). Moreover urbanization, agglomeration and localization lead to the reduction of risks and uncertainties, to greater diffusion of technology and innovations, to the reduction of production costs and finally to the increase in productivity.

The Enterprises' Size

The large sizes of enterprises influence positively their total efficiency. This is because in the large firms the division of labor is more effective and there is more scope for better organization and utilization of both the fixed and the human capital (Sasaki 1985). However, it is possible that in some cases the above relation is not valid. For instance, the

excessively large size of enterprises might make them less flexible and also increases the fixed costs (Sasaki 1985, Benhabib and Spiegel 1994). Moreover, there is a critical size over which the productivity could be influenced negatively. For the purpose of this investigation we assume a positive relationship between the size and the middle productivity of enterprises.

CORRELATION ANALYSIS BETWEEN PRODUCTIVITY AND ITS DRIVING FACTORS

Following, they are calculated the correlations between productivity and the aforementioned indicators. We suppose that the indicators represent fairly well the original factors of influence. Therefore, for the purpose of the present study, we use for each prefecture the following indicators: the geographical distance from Athens or Thessaloniki, the urban population, the rate of urban population, the investments/added value, the population quality, the indirect population potential, the direct population potential, the total population potential, the total private investments, the level of prosperity, the annual employment, the rate of the secondary sector, the number of enterprises, the productive dynamism, the added value/number of enterprises and the gross product/added value.

In this article, we do not aim at estimating the degree to which each of the aforementioned factors influence the configuration of productivity. We only investigate whether or not there is a positive relationship in place. For this reason we do not use a production function. Instead, we estimate the correlation between productivity and each determinant factor. Correlations are estimated assuming both a linear relationship between productivity and the indicators and a non-linear one. In the case of non-liner relationship, we estimate the correlation between ln (productivity) and ln (factor). Finally, we construct some selective scatter-plot in order to achieve increased supervision the corresponding correlations.

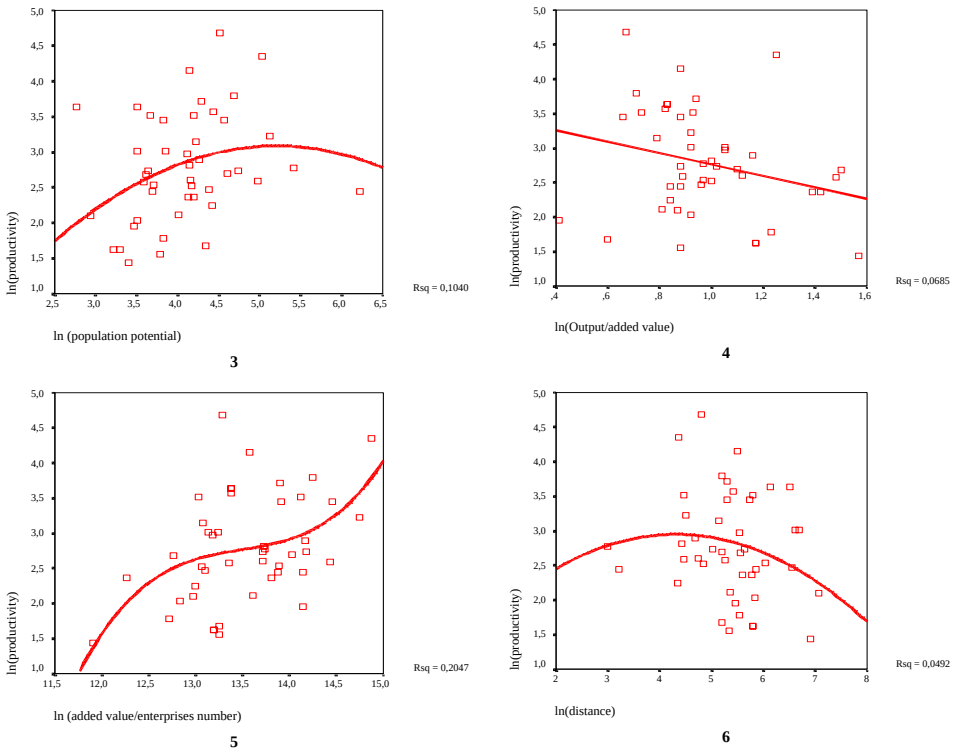
The results of the calculations are presented in Table 1. These results do not verify absolutely our initial expectations. Certain coefficients are negative, and also the coefficients of some variables are not statistically significant. The analysis of the results and the importance of the determinants included in the estimations lead to the following conclusions:

Table 1. Correlation Coefficients between Regional Productivity and Selective Regional Economic Indicators

	Geographical distance	ln(Geographical distance)	Urban population	Rate of urban population	ln(Urban population)
Productivity	**-0.210** *(0.107)*		-0.051 (0.741)	0.021 (0.89)	
ln(Productivity)		**-0.199** *(0.121)*			0.108 *(0.480)*
	ln(Rate of urban population)	**investments /added value**	**ln(investments /added value)**	**Population quality**	**ln(Population quality)**
Productivity		0.005 *(0.472)*		-0.092 (0.545	
ln(Productivity)	**0.314*** *(0.036)*		**0.285** *(0.057)*		-0.077 (0.615)
	Indirect population potential	**Total population potential**	**ln(Total population potential)**	**Direct population potential**	**ln(Direct population potential)**
Productivity	**0.417**** *(0.004)*	0.117 *(0.442)*		0.001 *(0.995)*	
ln(Productivity)			**0.300*** *(0.045)*		**0.224** *(0.103)*
	ln(Indirect population potential)	**Total private investments**	**ln(Total private investments)**	**Prosperity indicator**	**ln(Prosperity indicator)**
Productivity		-0.011 (0.944)		-0.155 (0.310)	
ln(Productivity)	**0.368*** *(0.013)*		-0.026 *(0.864)*		-0.152 *(0.320)*
	Annual employment	**ln(Annual employment)**	**Rate of secondary sector**	**ln(Rate of secondary sector)**	**Number of enterprises**	**ln(Number of enterprises)**
Productivity	-0.042 *(0.782)*		-0.047 *(0.761)*		0.044 *(0.773)*	
ln(Productivity)		0.059 *(0.699)*		-0.033 *(0.830)*		0.129 *(0.395)*
	Productive dynamism	**ln(Productive dynamism)**	**Added value/number of enterprises**	**ln(Added value/number of enterprises)**	**Gross product / added value**	**ln(Gross product / added value)**
Productivity	0.122 *(0.425)*		**0.391*** *(0.008)*		-0.283 *(0.059)*	
ln(Productivity)		0.172 *(0.218)*		**0.449**** *(0.002)*		-0.255 *(0.091)*

Notes: N=45, values of significant of t in the parentheses, **correlation is significant at the 0.01 level (2-tailed), *correlation is significant at the 0.05 level (2-tailed).

Figures 3. The relationships between productivity and the indicators



(i) The geographical distance, the rate of urban population, the investments/added value, the indirect, direct and total population potential, the added value/number of enterprises have a positive as well as statistically significant influence on the regional productivity. This means that the diffusion of technology, the urban agglomerations, the interregional transportation infrastructures and the size of enterprises influence the regional productivity. This can also be observed in the figures 3-6. Here, the relationships between productivity and the most important of the employed factors are presented diagrammatic for increased comprehension.

(ii) According to the estimations, the remaining determinants do not have statistically significant influence on productivity. Moreover, in certain cases they have a negative influence on productivity. A possible explanation for this is the low suitability of some of the used statistical data. In particular, the data used refer to the

whole economy and not only to the industrial sector which is the focus of this study. For instance, the statistical data concerning the skills of the workforce are collected on a spatial scale (regions, municipalities etc) and not on a sectoral scale.

CONCLUSIONS

Improvements in labor productivity contribute significantly to increasing the output of enterprises. They also contribute to the national and regional economic development. Labor productivity is the most important factor of the relationship between the economic output and the labor inputs. In other words is a measure of a firm's capacity to produce the same volume and quality of goods by using less labor inputs. Thus, labor productivity is a key factor to the regional competitive advantage.

In this study, much of the evidence about the factors influencing regional labour productivity in the industrial sector (enterprises with ≥ 20 employees) and consequently regional economic performance suggests that the diffusion of technology, the urban agglomerations, the interregional transportation infrastructures and the size of the enterprises are the key forces which drive productivity growth in Greek prefectures. These factors, however, do not work in isolation. For instance, certain improvements in transportation infrastructures influence the diffusion of technology, the population potential and the cost of supplying for enterprises. Moreover, an increased ability of an enterprise to adopt the new technological breakthroughs requires that all employees are familiar with technology and have the capacity to translate their knowledge into improved work practices.

Therefore, government policy attempting to improve the performance of the Greek enterprises and regions should not simply focus on one of these factors. Instead, they are required interventions on a number of policy fronts that need to be spatially explicit according to the different conditions within each region and locality.

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