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SPATIAL DISTRIBUTION OF ECONOMIC ENTITIES AND THEIR CLASSIFICATION ACCORDING TO TECHNOLOGY LEVELS IN THE DOLNOŚLĄSKIE VOIVODESHIP (1)

ABSTRACT. Contemporary socio-economic processes increase the significance of domains which rely heavily on intensive knowledge utilization. It concerns, above all, the II and III sector of the economy.

The purpose of this study was to examine the shaping of spatial diversity of economic entities in the industry sector measured by technology levels and the service sector assessed by intensity of research and development at the local level. The analysis also concerned factors determining the creation of these diversities as well as relationships between the occurrence of economic entities in production activity and the service sector. The survey was conducted at the level of NTS 4 units (counties) in the Dolnośląskie Voivodeship in 1998 and 2004.

The analysis revealed an increase in the participation of entities belonging to the high tech service sector and high tech industry sector at the local level of the Dolnośląskie Voivodeship. This participation was accompanied by a tendency of their spatial structures to become alike. It indicates that general conditions of emergence of companies characterized by the highest level of research and development intensity within the II and III sector of the economy are becoming alike.

The development of high tech industry companies is connected with the general development of services. This interrelation increases together with intensity of research and development within sector III (high tech services and knowledge-based services). It also increases with time.

There exists a high, positive correlation between the value of the entrepreneurship index in the II and III sector and the general level of entrepreneurship. The crucial factor determining the formation of new economic entities in the group of high tech industry companies and high tech services is the overall rise of entrepreneurship index.

KEY WORDS: high technology, research and development, economic entities, local scale, Dolnośląskie Voivodeship.

INTRODUCTION

Contemporary socio-economic processes increase the significance of the domains which rely heavily on intensive knowledge utilization. Among these domains we can enumerate high technology economic entities, so-called “high tech” entities, characterized not only by a high level of spending on research and development (R & D) activity but also by a high level of innovation, short life cycle of products and technological processes, and thus quick processes of innovation diffusion. Moreover, these enterprises have a substantial percentage of their employees in the so-called scientific-research personnel, who are highly qualified. They also develop strategic cooperation with other high technology firms as well as national and overseas research institutions. It is also thought that the companies belonging to high technology sector incur considerable financial outlays and run investment risks related to the quick “ageing” of the investments (Informacja..., 2003).

The notion of “high technology industry” appeared in the mid 60s of the 20th century. In literature there exist two criteria for qualifying particular sectors of economy as high technology industries (Karpiński, 1998):

- 1) on the basis of the intensity of scientific-research works measured by the percentage of scientific-research workers employed in the R&D sector compared to the total employment in the industry.
- 2) on the basis of the percentage of expenditure on research and development activity, called R&D intensity index. It may be estimated both in relation to sectors of industry (the sector method), as well as in relation to particular products (the object method).

The development of high tech industry companies constitutes one of the factors determining competitiveness in the economy on a national and regional scale, as these units generate inventions and innovations, create new knowledge and employ qualified and creative personnel. It manifests itself, among others, through (Fic, 2004):

- an increase in technological competitiveness between enterprises and a constant improvement of quality parameters of products and services,
- an increase in the functional effect of products, measured by technical-economic parameters,
- technical development spreading together with a quantitative increase in the high technology sector, as the production of “high tech” goods and services encourages the introduction of new, technologically advanced goods into the market,
- technological progress in medium and low technology (industry) sectors
- the rise in the demand for the products of this sector, which is reflected in the

rising demand for additional goods and the creation of new consumer needs,
 – a fall in high tech products imports.

Besides high tech industry, services play a very important role in economic development, above all, specialized services which are characterized by the increasing participation of specialists and scientists in the employment structure. It is worth noting that apart from the direct influence over the level of particular technology utilization they shape general conditions of economic activity conduct, including the conditions concerning the conduct of industrial units.

In national and foreign literature the research into industry conducted according to technology levels focuses mainly on the analysis of particular sectors in the economic structure (Grupp, Muent, 1997, Iansiti, West, 1999), the volume of sold production of new and modernized goods, expenditure on R&D in particular sectors and the participation of employees. Spatial analyses usually refer to the national and regional scale – 2 level of Nomenclature of Territorial Units for Statistics (NTS) (Piekarec, Rot, Wojnicka, 2000; Fic, 2004; Kozioł, 2004; Janasz, 2005; Chojnicki, Czyż, 2007). There are very few studies concerning the shaping of diversities in local systems, which could help define real factors behind the creation of such entities. In particular it concerns the analysis of the service sector, which can be assessed on the basis of employee classification by levels of “R&D intensity” used by OECD (Organisation for Economic Co-operation and Development) and EUROSTAT. In Poland such analyses on a national scale are conducted solely by the Central Statistical Office (Główny Urząd Statystyczny – GUS).

PURPOSE, DATA AND METHOD

The purpose of the present study was to examine the shaping of spatial diversity of economic entities in the industry sector by technology levels and the service sector by intensity of research and development on a local scale. The analysis concerned also the conditions connected with arising of these diversities and mutual relationships between the occurrence of units belonging to particular sections of production and service activities (Niedbalska, 1999).

The study was conducted at the level of NTS 4 units (counties) in Lower Silesia in 1998 and 2004. Statistical data of the economic entities in particular sections were obtained from the REGON register (National Official Business Register) run by the Central Statistical Office. In the present study, industrial processing entities of medium-low and medium-high technology have been analysed jointly and called medium technology. Moreover, particular levels of classification of entities by technology and R&D intensity were called categories in order to facilitate mutual comparisons and maintenance of uniform terminology (Table 1, 2).

Separation of the production sector by technology levels was conducted on the basis of the most recent list of subjects published by OECD in 1997 (Table 1). However, classification of economic entities within the service sector was based on the classification of employees by intensity of R&D (Table 2). Both classifications have been accepted and used in Polish and European statistics (GUS, EUROSTAT, OECD) and in researches conducted for the purpose of this article.

Table 1. Classification of the section: Industrial processing by technology levels according to the Polish Classification of Activities (PKD)

SYMBOL OF THE DIVISION	THE NAME OF THE DIVISION
HIGH TECHNOLOGY – I category	
24.4	Manufacture of pharmaceuticals, medicinal chemicals and botanical products
30	Manufacture of office machinery and computers
32	Manufacture of radio, television and communication equipment and apparatus
33	Manufacture of medical, precision and optical instruments, watches and clocks
35.3	Manufacture of aircraft and spacecraft
MEDIUM – HIGH TECHNOLOGY – II category	
24 bez 24.4	Manufacture of chemical products, without pharmaceuticals products
29	Manufacture of machinery and equipments (non elsewhere classified-n.e.c.)
31	Manufacture of electrical machinery and apparatus n.e.c.
34	Manufacture of motor vehicles, trailers and semi-trailers
35.2+35.4+35.5	Manufacture of railway and tramway locomotives and rolling stock Manufacture of motorcycles and bicycles; Manufacture of other transport equipment n.e.c
MEDIUM – LOW TECHNOLOGY – II category	
23	Manufacture of coke, refined petroleum products and nuclear fuel
25	Manufacture of rubber and plastic products
26	Manufacture of other non-metallic mineral products
27	Manufacture of basic metals
28	Manufacture of fabricated metal products, except machinery and equipment n
35.1	Building and repairing of ships and boats
LOW TECHNOLOGY – III category	
15	Manufacture of food products and beverages
16	Manufacture of tobacco products
17	Manufacture of textiles
18	Manufacture of wearing apparel; dressing and dyeing of fur
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
21	Manufacture of pulp, paper and paper products
22	Publishing, printing and reproduction of recorded media
36	Manufacture of furniture; manufacturing n.e.c.
37	Recycling

Source: Nauka i technika..., 2004; Hatzichronoglou, 1997.

Table 2. Classification of service activity used to analyse the levels of “R & D intensity” (knowledge intensity)

	SYMBOL OF THE SECTION	NAME OF THE SECTION
„HIGH TECH” SERVICES – I category		
64		Post and telecommunications
72		Computer and related activities
73		Research and development
KNOWLEDGE-INTENSIVE SERVICES – II category		
61		Water transport
62		Air transport
65		Financial intermediation, except insurance and pension funding
66		Insurance and pension funding, except compulsory social security
67		Activities auxiliary to financial intermediation
70		Real estate activities
71		Renting of machinery and equipment without operator and of personal and household goods
74		Other business activities
80		Education
85		Health and social work
92		Recreational, cultural and sporting activities
LESS KNOWLEDGE-INTENSIVE SERVICES - LKIS – III category		
50		Sale, maintenance and repair of motor vehicles and motorcycles; retail of automotive fuel
51		Wholesale trade and commission trade, except of motor vehicles and motorcycles
52		Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods
55		Hotels and restaurants
60		Land transport; transport via pipelines
63		Supporting and auxiliary transport activities; activities of travel agencies
75		Public administration and defence; compulsory social security
90		Sewage and refuse disposal, sanitation and similar activities
91		Activities of membership organizations n.e.c.
93		Other service activities
95		Activities of households as employers of domestic staff
99		Extra-territorial organizations and bodies

Source: author’s own study on the basis of Science and technology..., 2004.

The method of economic entities classification used in this study is characterized by a high level of data aggregation, which is due to the fact that the total expenditure on R&D activity in a given sector of technology is ascribed solely to the main type of activity of the firms within this sector, (it is defined at the registration stage). In numerous cases, it is different from the activity actually conducted. It may result in an overestimation of technological intensity in some

sectors at the cost of underestimation in the others. A significant flaw of this method is also the fact that a lot of goods produced by firms that are numbered among high technology firms in fact represent medium or low technology and the other way round.

The flaws of this method may be eliminated through classifying economic entities according to products. This classification is constructed on the basis of detailed data concerning expenditure on R&D activity by groups of products. Due to the lack of statistical data at a regional level it can't be used in this study.

The analysis presented in this paper was based on data obtained from the REGON register which means that we must allow for the fact that the data it contains is over represented. The register has accurate data concerning all the newly-created entities, but its recording systems of entities which ceased to operate or suspended its activity is highly imperfect. From a number of studies conducted by the Central Statistical Office it appears that only 60% of the registered economic entities are actually functioning (Warunki..., 2001).

ANALYSIS

In the group under examination, entities from the service sector predominated (almost 90% of the total number of units). Industrial enterprises accounted for the remaining 10%. This stems from the existing economic structure and specificity of the service sector, which is characterized by a great number of micro-size companies (employing up to 9 workers) and small-size companies (up to 49 workers) as well as the highest growth dynamics since the beginning of socio-economic transformation in Poland.

The industry and service sectors were dominated by category III units. The share of this category in the industry sector was, however, lower (55%) than in sector III (70%) (Fig. 1). At the same time, the share of high technology industry in overall industry was higher (almost 8%) than high tech units in services altogether (below 2%). A relatively less favourable structure of entities belonging to the service sector was probably a result of the fact that in the early stage of transformation the highest growth dynamics of the private sector was noted in those sectors of the economy in which the conduct of business activity was connected with minimal financial outlays and little participation of human capital (e.g. wholesale and retail trade).

In the period between 1998–2004 there occurred a decrease in the number of category III entities participation and an increase in the participation of category I and II units. (Fig. 1). This was the result of limited possibilities of quantitative increase of the units caused by the growing competition, especially in those segments of the market which did not require significant financial outlays. This

process resulted in a nationwide decrease in the growth rate of new economic entities since the mid-90s (Raczyk, 2004). Additionally, it was accompanied by the intensification of qualitative changes consisting in the creation of a system of links between economic entities, organizational restructuring, and the intensification of knowledge and technology utilization in the processes of goods and services provision. It was particularly clearly visible in the service sector, especially in category II.

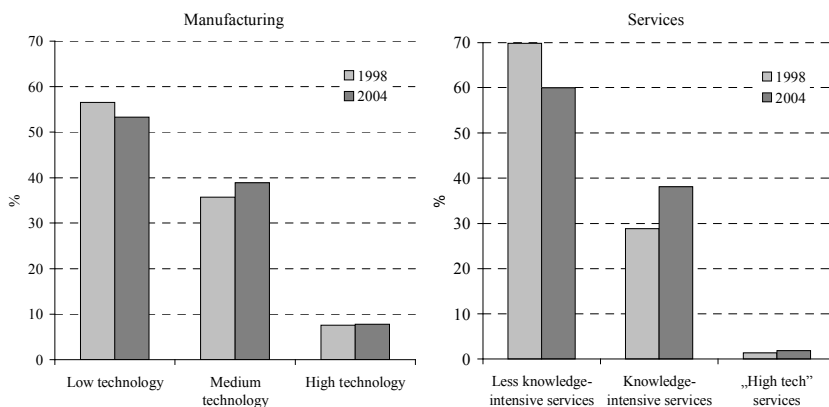


Fig. 1. Share of economic entities in the section of production activity by levels of technology development and the service sector by intensity of research and development between 1998–2004 for the counties of the Lower Silesia voivodeship

Source: author's own study based on data from the Central Statistical Office (GUS).

It needs to be highlighted that the number of economic entities within high tech production activity was characterized by a much lower growth dynamics than the high tech service sector. It was probably connected with the specificity of industrial activity, mainly including higher investment outlays (e.g., for a machine park) than in the service sector.

Among high-tech industrial companies nearly 67% constituted units from section 33 of the Polish Classification of Activities (Polska Klasyfikacja Działalności – PKD) (Table 1). About 25% of the units came from section 32. Sections 24.4, 30 and 35.3 played a marginal role, as far as the number of entities is concerned, although between 1998 and 2004 their participation increased slightly. In the period under examination the most important changes occurred in section 32 (a decrease of nearly 9%). Therefore, the changes in the unit structure indicate a clear and persistent prevalence of enterprises from section 33. This fact might

result from the acceleration of restructuring processes among companies manufacturing radio, TV and telecommunication equipment. These processes cause further concentration of production in the already existing companies and liquidation of a number of smaller, relatively less competitive ones.

Similarly, in the high tech service sector one section was predominant (section 72). It is the effect of the dispersed structure of service outlets and easiness of setting up such units thanks to dynamically growing market of IT services. Moreover, the development of section 72 is mainly connected with human capital management and does not require significant financial outlays at the start-up (no capital barrier). As a result, during 1998–2004 period no major changes resulting from the prevalence of section 72 were observed in the structure of high tech services despite significant increase in the total number of entities.

In the analysis of category II service activity we must emphasize an increasing significance of the sectors connected with so-called business environment institutions (Jakubowicz, 2000) (i.e. sections 65, 67, 70). They constitute the most dynamically developing sector of the economy and by and large define the success of the development of socio-economic processes.

In 2004 high technology industrial companies predominated in cities with the status of county and in Dzierżonów and Lubin counties (Fig. 2). Therefore, they were mainly connected with the biggest cities in the voivodeship. Moreover, they existed in the areas of long-standing tradition in the production of specific, technologically advanced products and were characterized by professional staff, even when the general level of human capital wasn't very high (e.g., in Dzierżonów county). Their appearance was usually accompanied by the specialization of these areas in particular industry sectors (e.g., section 33 in Dzierżonów and Świdnica counties).

Spatial distribution of changes in the development level of the high tech industry sector indicates that the highest growth was observed in the areas which were the beneficiaries of the system transformation period in the 90s in Poland. This increase occurred mainly in the counties with the highest number of investments (both national as well as foreign ones) located in the neighbourhood of urban areas with a well-developed network infrastructure and a high rate of human capital (e.g., Wrocław county) (Fig. 2).

The reorganization processes of high tech enterprises (including their division) also contributed significantly to an increase in the number of entities. As a result, new companies, easily adjusting to the needs of the market economy were set up and initiated the formation of new ones. This was probably the case in Dzierżonów county, in which, despite the liquidation of big enterprises (e.g., DIORA factory) the number of new (usually small) companies started to grow dynamically.

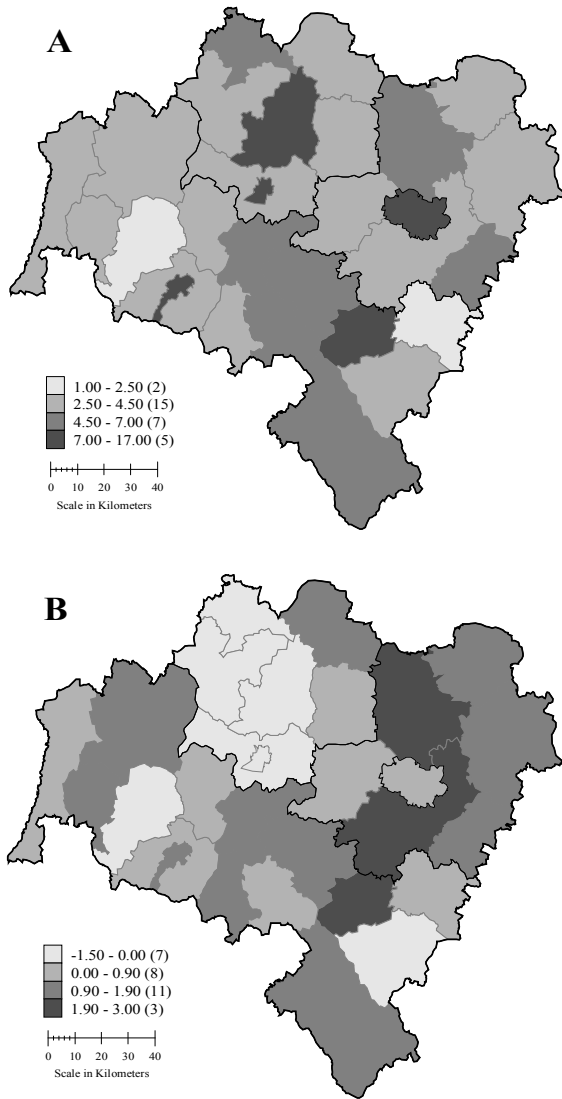


Fig. 2. Economic entities of the high tech industry sector per 10, 000 inhabitants (A) and changes in the index between 1998–2004 (B) in the counties of the Lower Silesia voivodeship

Source: author’s own study based on data from the Central Statistical Office (GUS).

The slowest increase in the number of new entities falling into the category in question took place in Legnica and the counties of Legnica, Lubin, Głogów, Polkowice, Lwówek, and Ząbkowice. Minor changes in the regions of Legnica-

Głogów Copper Mining District indicate that the areas where traditional industry sectors prevail (excavation and processing of copper) do not generate new high technology companies, even when the participation of enterprises is relatively high (e.g., Lubin county, Głogów county) (Fig. 2).

In the longer perspective, continuation of the observed trends may cause numerous changes in the spatial distribution of the category I entities. It is caused by changing conditions affecting the creation of such units.

In the high tech service sector in 2004, the highest level of entrepreneurship occurred in cities with the status of county (Wrocław, Jelenia Góra and Legnica) (Fig. 3) It is a result of the fact that certain factors play a crucial role in the creation of such units: the level of human capital development and the demand for services provided by these entities mainly in urban areas or their immediate neighbourhood (e.g., Wrocław county, Trzebnica county, Oława county, Jelenia Góra county).

Spatial distribution of high tech service activities in 2004 was analogous to that of 1998 (Fig. 3) It indicates that the most important conditions connected with the emergence of new entities haven't changed significantly in contrast to the high tech industry sector. It is noticeable that the changes which occurred between 1998–2004 make the spatial structures of category I industry and services become alike. In the longer run, it may lead to increased spatial disproportions as the areas with high values of both indices will continue to be characterized by a dynamic increase in the number and significance of entities belonging to this category. In this context, the areas with a relatively low level of development of the analysed sectors will find themselves in the least favourable situation.

The conducted research indicates that the emergence of high tech industry companies is connected with the level of the service sector development in general (Table 3). The extent of this interrelation increases together with the intensity of research and development in sector III (high tech services and knowledge-based services). It also rises with time (1998–2004), which signifies that the formation of new entities is related to a high level of development of the service sector, and in particular, category I services. It is hard to tell, however, whether the decisive role in the technological development of the economy is played by the service sector or the industry sector. It seems that there is a positive feedback between these interrelations. Surely, the level of service sector development constitutes one of the most important factors creating favourable conditions for new high tech industry entities to arise. However, these relationships should be examined individually in relation to particular territorial units.

The high level of entrepreneurship in low and medium technology industry does not show significant connections with particular categories of the service sector (Table 3). In other words, such units arise in the areas characterized by a high level of service development in all categories.

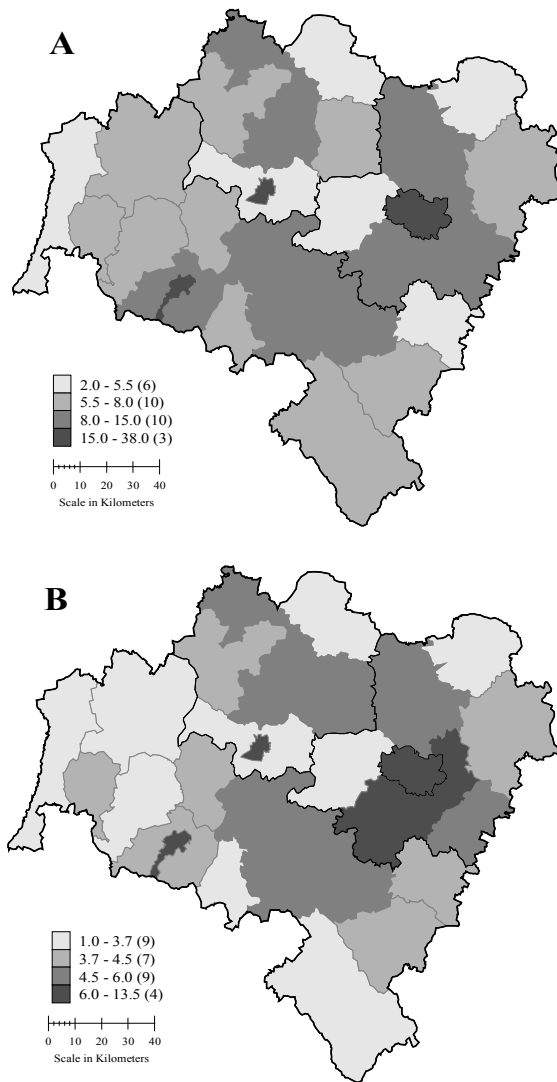


Fig. 3. Economic entities of the high tech service sector per 10,000 inhabitants (A) and the change in the index between 1998–2004 (B) in the counties of the Lower Silesia voivodeship

Source: author's own study based on data from the Central Statistical Office (GUS).

Interestingly, the interrelation between the level of entrepreneurship in the high tech service sector and the high tech industry sector in 2004 was observed in all sections of the categories in question. The same occurred in the sections in which no such connection were observed at the early stage of the research (1998),

(for example section 32 with the correlation coefficient of 0.46 in 1998 and 0.52 in 2004). It might suggest that either the conditions determining the creation of units in the service sector and category I of the industry sector are becoming alike, or the occurrence of a certain subpopulation of firms numbered among this category encourages the formation of units in different sections of these sectors. It proves the earlier conclusion suggesting that the spatial structures of the high tech service sector and high tech industry sectors are becoming alike.

Table 3. The correlation coefficient of the industrial entrepreneurship index by technology levels and the service sector by research and development intensity in 1998, 2004 in the counties of the Dolnośląskie Voivodeship

SPECIFICATION		YEAR	SERVICE ENTREPRENEURSHIP		
			LESS KNOWLEDGE-INTENSIVE SERVICES	KNOWLEDGE-INTENSIVE SERVICES	„HIGH TECH” SERVICES
Industrial entrepreneurship	Low technology	1998	0.441	0.367	0.452
		2004	0.453	0.292	0.394
	Medium technology	1998	0.226	0.215	0.304
		2004	0.305	0.142	0.286
	High technology	1998	0.652*	0.890*	0.840*
		2004	0.703*	0.771*	0.884*

* – correlation is significant on the level 0.01

Source: author’s own study based on data from the Central Statistical Office (GUS).

This research indicated that the presence of companies with foreign capital (foreign entrepreneurship) is connected with the level of high tech industrial entrepreneurship and service entrepreneurship in general (Table 4). The extent of this interrelation rises together with the intensity of research and development within sector III (high tech services and knowledge-based services). It may be the result of the development of foreign entrepreneurship in areas with a relatively high level of category I services. Alternatively, it may be a sign of a high level of innovation of foreign companies. The same interrelations can be observed in relation to the index of “large” entrepreneurship (the number of commercial partnerships per 10,000 inhabitants).

The value of the entrepreneurship index in industry and services category I is connected to the general development of entrepreneurship (Table 4). It is explained by the interrelations described above. It seems, therefore, that the most important factor conditioning the arising of new economic entities within the

Table 4. Correlation coefficients of foreign and large entrepreneurship indices and industry by technology levels and the service sector by intensity of research and development in 2004 in the counties of the Dolnośląskie Voivodeship

SPECIFICATION	INDUSTRIAL ENTREPRENEURSHIP			SERVICE ENTREPRENEURSHIP		
	LOW TECHNOLOGY	MEDIUM TECHNOLOGY	HIGH TECHNOLOGY	LESS KNOWLEDGE-INTENSIVE SERVICES	KNOWLEDGE-INTENSIVE SERVICES	„HIGH TECH” SERVICES
Foreign entrepreneurship (companies with participation of foreign capital per 10,000 inhabitants)	0.451	0.248	0.515*	0.679*	0.716*	0.753*
Large' entrepreneurship (commercial partnerships with domestic capital per 10,000 inhabitants)	0.401	0.300	0.782*	0.770*	0.880*	0.932*

* - correlation is significant on the level 0.01

Source: author's own study based on data from the Central Statistical Office (GUS).

group of high tech industrial units and high tech services is encouraging entrepreneurship in general. Activities oriented solely to the development of the high tech industry sector recommended by a number of strategic documents formulated by regional and local self-governments as well as central authorities may prove insufficient in this context.

CONCLUSIONS

The analysis conducted in Lower Silesia indicates the following:

- category III (low technology) predominates in the structure of economic entities examined by technology levels, both in industry as well as service sectors,
- high and medium technology enterprises are becoming increasingly more important,
- spatial distribution of category I industry relates to settlement system and is connected with the areas of long-lasting industrial traditions,
- high technology service sector plays an important role in the main urban centres of the region,
- development of the industry sector and category I services relates to the areas with high level of socio-economic development. In the longer perspective, it may lead to more pronounced spatial disproportions in the region,

- basic conditions of category I entities formation in the period under examination have been changed and became analogous to those in the service sector. It resulted in the structures of both sectors (including sections within them) becoming alike in respect of high technology,
- among economic indicators under research the strongest relationship between service sector entities and category I industry has been observed with regard to various forms of entrepreneurship.

The changes laid out in this paper indicate positive transformations in the economy of the Lower Silesia region. It may be assumed that analogous processes occurred nationwide and were typical of the countries undergoing transformation processes. Owing to Poland's accession to the European Union and increased competitive pressure we can expect continuation of this tendency as well as growth in the significance of category I units. The pace of this process will condition the competitiveness of regional and local systems.

NOTES

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