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# POLISH TECHNOLOGY PARKS AND REGIONAL DEVELOPMENT: ARE THEY EFFECYIVE?

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**Abstract:** The effective development of regions depends not only on the size of the national income, but also on the source of its origin. Differences in approach to the factors describing the competitiveness of regions and cities have evolved from a more general level in the direction of specialization, including both factors related to the quality of human capital and economic potential. Technology parks are an example of a high concentration of innovative human capital. In the past five years several new park initiatives were established in Poland. The activities of parks should be the development measured, for example, by employment growth in the regions, and innovativeness of companies. The main aim of the study is a multi-dimensional assessment of spatial differentiation in development of technology parks in Poland in terms of dynamics and identification the factors affecting the socio-economic development of cities and regions. The study used data from a project of PARP entitled "Benchmarking technology parks in Poland." The selected methods of multidimensional comparative analysis in terms of dynamics was selected to study the effectiveness of the parks.

**Keywords**: multidimensional comparative analysis, effectiveness, technology parks

## INTRODUCTION

The main objective of the technology parks, which are one of the main instruments of innovation policy, is to increase the competitiveness of the Polish economy. Although the first technology parks were created in Poland in the mid-nineties, it was this type of co-financing projects from EU funds that led to their rapid development. With the development of parks, there was also a need to

evaluate the effectiveness of their performance and to identify the main directions of development.

Technology parks in Poland are located especially within large cities, such as, Wrocław, Poznań and Gdańsk. The weaker regions with less developed urban centers, which are in transition results deviated from their industrial roots, technology parks do not exist or they are in the embryonic phase such as it is in Lubuskie region. Therefore, the level of development of the spatial differentiation parks is significant, and hence their efficiency of operation.

The main goal of this work is a multi-dimensional assessment of the level of spatial differentiation of the development of technology parks in a dynamic approach on the basis of the data from the years 2009-2011 in Poland and an indication of the factors affecting the efficiency of the system.

In order to verify this posed to the study, the following research hypotheses were taken:

1. The variation in the development of technology parks in Poland (including the different stage of development of parks) results in the need for a comprehensive approach to study the efficiency of their operations taking into account this diversity.
2. Analysis of the effectiveness of the parks requires evaluation from the perspective of many different factors that describe not only the potential infrastructure technology parks or their financial results using methods for making multi-dimensional assessment of the level of development of parks.

For the study of spatial differentiation in the development of technology parks in Poland a taxonomic measure of the development $z_i$ in a dynamic approach was used which was based on the statistical information collected during the study „Benchmarking of technology parks in Poland –2010 and 2012 edition".

## THE ECONOMIC IMPORTANCE OF THE TECHNOLOGY PARKS AND THEIR IMPACT ON THE COMPETITIVENESS OF THE REGIONS

In the literature, there are many institutions whose activities relate to innovation policy. These institutions can function independently or function such as technological parks, they are as follows: science parks, research parks, industrial parks, research and innovation centres. The definition can be significantly different depending on the country in which these institutions operate.

Polish legislation separately interprets the term technology park and industrial park[1]. In the case of the definition of a technology park the main

[1] Under the Act of 20 March 2002 on financial support for investment (Dz. U. Nr 41, pos. 363)

emphasis is put on the implementation of scientific knowledge in business practice and the development of enterprises that use modern technology. One of the major areas of technology parks is also the implementation of a function of incubation of the existing park incubators. However, the main purpose of industrial parks is to support restructuring processes, business development and local labor markets [Pelle et al. 2008].

The need for the creation of technology parks is associated with the possibility to create positive externalities as a result of research and development park (as an institution) and businesses operating within the park (park tenants).

The high concentration of knowledge and human capital can lead to significant changes to improve the competitiveness of the regions in which parks operate. It is very important if we take into account the changes in the approach to the factors describing the competitiveness of the regions, which have evolved from a more general level in the direction of specialization, including both factors related to the quality of human capital and economic potential.

The main changes concern the increasingly observed the duality of the labor market, associated with significant differences between the primary and secondary market [Gębski 2009]. From this point of view, among the new factors of competitiveness of regions and cities listed include [Sassen 2006, Parteka 2007]:

- instead of general human, the part of them that is capable of manufacturing and service permanently on the market;
- not so much the size of a scientific center in the vicinity, which is located in the technology park as its ability to generate innovation and absorb them;
- willingness to rapid changes in the economic profile and the variety and flexibility in the so-called specialization. Smart specialization, and not so far indicated the stability of the development of cutting-edge sectors and specializations fixed region.

In Poland, the potential for innovation due to the structure of companies is only for located mainly in small and medium-sized enterprises. Unfortunately the company of this size does not usually have the infrastructure or facilities or more research to implement new technology solutions more effectively. The solution in this regard may be the support of the business environment to facilitate access both to information as well as technical infrastructure, services and financial assistance for example, by the possibility of using seed capital [Kowalak 2010].

Technology parks are a good example of this type of support for small and medium-sized enterprises. In the past five years there have been several in Poland new initiatives parks created by the regional authorities, universities, and private owners. Each of the entities forming or co-participating in creating the park aims at different targets, including: the growth of entrepreneurship and employment in modern companies with high potential for innovation, for example in case of regional authorities and commercialization of knowledge and innovation, for

example in the case of higher education . In this context there is a different way of approaching the effectiveness of the park.

The evaluation of the effectiveness of the technology parks in Poland is made as part of research commissioned by the Polish Agency for Enterprise Development, "Benchmarking of technology parks in Poland" [Hołub-Iwan et al. 2012].

Benchmarking is defined most commonly as a modern tool for managing the organization, the essence of which is to identify best practices in the business capable of achieving success in the industry and in the policy area. The benchmark indicator is one form of the benchmarking, under which compares similar to each organization based on a set of highlighted indicators.

The main aim of conducted research is a comparison of the rate and direction of development of parks. The conducted research involves two steps, which aim is to determine the phase of the life cycle of the park and stage appropriate essential benchmarking study. It should be noted that despite a full set analyzed in this study, the evaluation is done through the prism of a single cluster or in a set of two features within the map of strategic groups. The analysis does not take into account the time factor and conducted comparisons remain static. As a complement to the analyses, the use of taxonomic meter of development $z_i$ was offered in a dynamic approach.

## THE USE OF TAXONOMIC MEASURE TO ANALYSE THE DEVELOPMENT OF SPATIAL DIFFERENTIATION OF DEVELOPMENT LEVEL OF TECHNOLOGY PARKS IN POLAND

The statistical information was analyzed collected during the investigation „Benchmarking technology parks in Poland" - edition 2010 and 2012 for 13 selected technology parks in both editions of the survey.

In the first stage of research, the collected information has been subjected to a preliminary analysis. From the set of potential diagnostic features eliminated variables that do not meet the accepted criteria of formal and substantive. It is assumed that the final set of features should include the variables [Zeliaś et al. 2000]: with high spatial variability with low correlating and an asymmetric distribution. Finally, a set of 46 diagnostic features were selected for the final set of 15 variables.

This collection, which became the basis for further empirical research created the following features:

1. Value of funds raised from the European Union (or as grants from other international organisations)/ revenues (%).
2. Total revenue/park assets (%).
3. Number of cooperating companies/ number of tenants.
4. Number of collaborating independent experts/ number of tenants.

5. Number of projects executed by a technology park in partnership with other institutions.
6. Park building area ($m^2$).
7. Number of tenants.
8. Number of start-up companies/number of newly created companies.
9. Ratio of used park building area (%).
10. Number of services provided to tenants during the last 12 months/ number of tenants.
11. Expenditure on ICT of the park/total sales (%).
12. Innovative companies/number of park tenants (%).
13. Park tenants engaged in R&D activity/number of park tenants (%).
14. Employees with a scientific degree of a PhD at least or an academic title/total number of park employees (%).
15. Number of scientific-industrial teams realizing research initiatives.

The scope of the variables used to determine the level of development of technology parks surveyed contains features describing the one hand, the potential of parks infrastructure (building area, or the percentage level of its use), on the other hand is focused primarily on the indication of the potential of the parks in the possibility of developing co-operation with the environment (e. g. the number of research groups - industrial pursuing scientific initiatives that the number of cooperating companies in terms of the number of tenants), and in assessing the potential of companies operating in the park for innovation (e.g. number of legally protected patents and trademarks in terms of the number or percentage of tenants the share of innovative firms in the total number of tenants park).

The extracted both from the substantive criteria and formal statistical variables formed the basis of a comparison and classification of discrete spatial units (technology parks) into groups with similar levels of development.

For the study of the spatial differentiation of the development of technology parks, a taxonomic measure of the development was implemented, on the basis of the following formula [Nowak 1990]:

$$z_i = \frac{1}{K}\sum_{k=1}^{K} z_{ki} \,, \tag{1}$$

where:

$z_i$ – value of a taxonomic measure of development for *i*-object,
$z_{ki}$ – standardized value of *k*-feature in *i*-object,
$K$ – number of features examined.

As a basis for standardization of individual characteristics, assumed average values determined on the basis of statistical information analyzed for 13 technology parks in 2009 year. In order to make comparative analysis, variable

$z_i$ was transformed into synthetic variable determined on the basis of the following formula:

$$z'_i = \frac{z_i}{\max\{z_i\}} \qquad (i = 1,...,m), \tag{2}$$

Facilities ordered by decreasing value of taxonomic measure development are divided into groups with similar levels of development of the phenomenon under study. The study examined the set of all technological parks divided into 4 groups, including values of the meter with the development of the following ranges [Zeliaś 2004]:

- the first group of parks, for which $z_i \geq \bar{z} + S_z$,
- the second group of parks, for which $\bar{z} + S_z > z_i \geq \bar{z}$,
- the third group of parks, for which $\bar{z} > z_i \geq \bar{z} - S_z$,
- the fourth group of parks, for which $z_i < \bar{z} - S_z$.

Results of grouping parks in 2009-2011 are presented in Table 1.

Table 1. Dividing technology parks according to the synthetic meter of the level of development in 2009-2011

| Lp. | Group | 2009 | | Group | 2010 | | Group | 2012 | |
|---|---|---|---|---|---|---|---|---|---|
| | | Park/phase | $z_i$ | | Park/phase | $z_i$ | | Park/phase | $z_i$ |
| 1 | I | Park 5/EM | 1,000 | I | Park 6/M | 1,000 | I | Park 8/G | 1,000 |
| 2 | | Park 16/M | 0,924 | | Park 5/EM | 0,986 | II | Park 14/G | 0,587 |
| 3 | II | Park 14/G | 0,624 | II | Park 7/M | 0,816 | | Park 6/M | 0,485 |
| 4 | | Park 6/M | 0,569 | | Park 14/G | 0,802 | | Park 5/EM | 0,412 |
| 5 | | Park 15/M | 0,563 | | Park 16/M | 0,797 | III | Park 16/M | 0,350 |
| 6 | | Park 7/M | 0,527 | III | Park 9/M | 0,625 | | Park 9/M | 0,336 |
| 7 | | Park 9/M | 0,525 | | Park 12/EM | 0,578 | | Park 15/M | 0,326 |
| 8 | III | Park 1/M | 0,421 | | Park 8/G | 0,568 | | Park 7/M | 0,313 |
| 9 | | Park 13/EM | 0,349 | | Park 1/M | 0,538 | | Park 2/M | 0,304 |
| 10 | | Park 2/M | 0,325 | | Park 2/M | 0,523 | | Park 1/M | 0,289 |
| 11 | | Park 8/G | 0,276 | | Park 15/M | 0,510 | | Park 19/EM | 0,274 |
| 12 | IV | Park 12/EM | 0,214 | | Park 19/EM | 0,482 | IV | Park 13/EM | 0,200 |
| 13 | | Park 19/EM | 0,186 | | Park 13/EM | 0,357 | | Park 12/EM | 0,161 |

Source: own analysis,
where G – growth phase, EM – early maturity phase, M – maturity phase

In the table, in addition to the development of the standardized measure also the information is included about the group which is assigned to the park and the life cycle phase of the park is indicated:

- a growth phase (G),
- an early maturity phase (EM)
- or a maturity phase (M), which was defined in the benchmarking study in 2012.

The analysis of the results shown in the table, demonstrate significant changes in the ordering of the units (parks) during the years of analysis. For some parks these changes are more favorable but for others less favorable. This is particularly noticeable in the case of two parks qualified for the growth phase (the park no 8 and the park no 14), whose position had improved significantly, which in 2011 topped the rankings.

In the case of dynamic analysis is an important issue despite the place occupied by various parks also measure the value obtained in the subsequent years of the analysis. It is clear that in spite of the improvement of the position of indicated parks, the measure in the following years is lower than in 2009. This means lower growth rate compared to 2009.

The study was conducted in the dynamic approach for all analyzed years. Including time in the spatial differentiation of the development of technology parks in Poland allowed the isolation of parks, where we see the growth rate of parkland on the same level of development and those for which the deterioration in the level of development takes place.

As a result of the transformation manner used, the analyzed variables are measured in the interval scale. The dynamic analysis was, therefore, conducted using the methods which can be used in the case of this type of scales.

The analysis of dynamics was conducted using the absolute chain increment on the basis of the formula: [Zeliaś et al. 2000]:

$$\Delta_{i(t+1,t)} = z_{it+1} - z_{qit} \, (i = 1, \ldots, 13; \, t = 1, 2, 3) \tag{3}$$

where:

$\Delta_{i(t+1,t)}$ – absolute chain increment of a $Z_i$ synthetic variable for an $i$ object calculated for $t$ and $t$+1 time units.

Subsequently, the mean pace of change in time was determined on the basis of the formula:

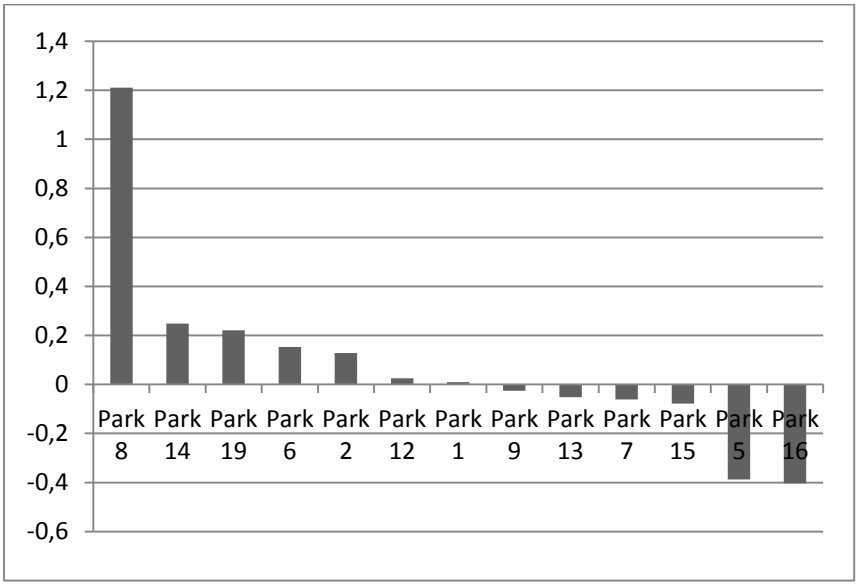
$$G_i = \frac{z_{i3} - z_{i1}}{2} \, (i = 1, \ldots, 13) \tag{4}$$

where:

$G_i$ – mean pace of change in time of the $Z$ synthetic variable for the $i$ object.

In the Figure 1 the distribution of the average rate of change for each analyzed technology parks is presented.

Figure 1. Average rate of change in the development of taxonomic meter of technology parks




Source: own calculations

The mean pace of change in 2009-2011 of taxonomic meter development is characterized by a right-sided asymmetry. The median value (0,0089) lower than the arithmetic average (0,0758) means that a bigger number of parks (7) reached during the analyzed period higher change rate.

To the group of parks, for which the synthetic variable increase in 2011 compared to 2011 was the largest belongs park 8 (1.211). In the group with average values above the average rate are parks which were classified in 2011 to the third and fourth typological groups(park No. 2, No. 3 and park No. 13), with the values of taxonomic meter below the average. However, the negative rate of change was observed in the case of six parks, including park No. 5, which in 2011 was classified to typological Group II with the values of taxonomic meter above the average.

## CONCLUSION

Parks increasingly recognize the need for both active acquisition of new tenants as well as their maintenance in the park. Due to the wider spectrum of business parks, the intermingling of different areas of the business, a more comprehensive approach to evaluating the effectiveness of the technology park and

considering the level of development of the park, not only from the point of view of the individual indicators, but also on the basis of a number of studies classified as diagnostic variables.

The previous studies of the effectiveness of the technology parks in Poland, for example, in the study of PARP despite a full set of variables, have been based primarily on an assessment of individual indicators or sets of two features in the map of strategic groups. The analysis has not taken into consideration the time factor. A good solution in this case is to use the methods of multidimensional comparative analysis, including e.g. taxonomic meter development in a dynamic approach. The use in the studies of this type the taxonomic meter of development enabled, due to the simultaneous analysis of multiple variables collected, to determine ranking position occupied by parks participating in the study and the analysis of the rate of development of surveyed parks.

Measuring the effectiveness of technology parks is so important that it is the parks with a developed system of pre-incubators and incubators are one of the elements that describe the so-called, the modern metropolis of knowledge, or clusters of institutions, entrepreneurs and investors focused on functioning in the Knowledge-Based Economy [Maskell 1997, Parteka 2007].

## REFERENCES

Gębski M. (2009) Wybrane teorie rynku pracy, Studia i Materiały, Miscellanea Oeconomicae Nr 2/2009,Kielce, str. 325-335.

Hołub-Iwan J., Olczak. A. B., Cheba K. (2012) Benchmarking parków technologicznych w Polsce edycja 2012, PARP, Seria Innowacje.

Kowalak B. (red.), Benchmarking parków technologicznych w Polsce – edycja 2010, Warszawa, PARP.

Maskell P., Malmberg A. (1997) Towards an explanation of regional specialization and Industry Agglomeration, European Planning Studies, No. 5).

Matusiak B. (2011) Strategiczne obszary rozwoju parków technologicznych, PARP, Seria Innowacje.

Nowak E. (1990) Metody taksonomiczne w klasyfikacji obiektów społeczno-gospodarczych, PWE, Warszawa.

Parteka T. (2007) Innowacyjne region, kreatywne metropolie, IV Sesja Parlamentu Hanzeatyckiego, Hamburg.

Pelle D., Bober M., Lis M. (2008) Parki technologiczne jako instrument wspierania innowacji i dyfuzji wiedzy, Instytut Badań Strukturalnych, Warszawa.

Porter M. (2001) Porter o konkurencji, PWE Warszawa.

Sassen S. (2006) Cities in a World Economy, Pine Forge Press, Thousand Oaks.

Zeliaś A (red.) (2000) Taksonomiczna analiza przestrzennego zróżnicowania poziomu życia w Polsce w ujęciu dynamicznym, Wydawnictwo Akademii Ekonomicznej w Krakowie, Kraków.

Zeliaś A. (2004) Poziom życia w Polsce i w krajach Unii Europejskiej, PWE Warszawa.