Determining and analysis of economical clusters of St. Petersburg

Alexander Vasilievich Babkin[1], Tatiana Jurievna Kudryavtseva[1], Aleksandra Viktorovna Bakhmutskaya[2]

[1]St. Petersburg State Polytechnical University, Polytechnicheskaya street, 29, St.Petersburg, 195251, Russia
[2]Committee on Transport Infrastructure Development, Karavannaya street, 9 lit A, St.Petersburg, 191023, Russia

Abstract. The article presents the results of industry cluster structure research of the St. Petersburg economy. There were found significant cluster groups, which include "Biopharmaceutical", "Trade", "Information Technology", "Scientific research". "Analytical Tools", "Communication equipment", "Plastic", "Leather", "Aerospace". All clusters are evaluated from the point of view of uniqueness, coherence and economic effectiveness for the level of wages criteria, profits and investments. Group "Biopharmaceuticals", "Analytical tools" and "Communication equipment" are the most unique in the city, i.e. they are poorly represented or absent in other regions of the North-West Federal District. Cluster "Biopharmaceuticals" leads by the connectivity index with other cluster groups in the region and enterprises of the cluster are characterized by the maximum level of profits, wages and investments.
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Introduction

This article describes the results of the algorithm study testing of the regional economy cluster structure, formed on the basis of a synthesis of research results M. Portera, the European Cluster Observatory and Russian scientists.

Spatial and theoretical issues involved in the regional economy were studied by many foreign authors, such as: Von Thunen, Launchardt, Weber, W. Isard, E. Schooler, J. Campbell, H. Roepke, S. Czamanski, P. Slater. A significant contribution to the formation of the concept of the new economic geography and the theory of external economies made by: A. Marshall, K. Arrow, P. Romer, P. Krugman, M. Fujita, A. Venabls, G. Duranton, J. Henderson, S. Rosenthal, B. Strange, etc. Clusters, as a tool to increase the competitiveness of the region are considered in the scientific works of M. Porter, O. Solvela K. Ketelsen, M. Enright, M.-P. Menzel, D. Fornahla, E. Bergman, E. Feser, G. Lindqvist [1-6]. In clusters' research the following Russian scientists are engaged: LS Markov, V.M. Markova, G.B. Kleiner, A.V. Babkin, E.E. Immodest, I.V. Pilipenko, V.P. Tretiak, D.V. Grushevskii, A.Y. Yudanov, A.Y. Skopin, S.M. Kadochnikov, P.V. Vorobiev, E.S. Kutsenko and others [7-11].

However, despite the large number of papers on this topic, the problem of an innovative economy building through the creation and development of clusters is still barely developed. One of the key issues of the clusters' theory is the problem of the identification. International experience shows, that existing methodological approaches with low diversity of tools vary considerably in practice. You can point out many techniques to identify clusters, but most of them are based on two main approaches. In the first, which can be called "from beneath", the clusters are identified in specifically selected areas, based on the presence of previously known enterprises and industries leaders. The second approach uses a technique conventionally called "from above" where spatial localization of enterprises are sought, which are pointed to specific kinds of economic activities.

Approaches for identifying clusters "from above" traditionally divided into two types: 1) functional, oriented at an identification of industrial clusters; 2) spatial, oriented at an identification of geographical clusters.

Now it is generally accepted that the best results of identifying clusters "from above" is achieved through a combination of industrial and spatial approaches. These approaches include a synthetic approach of M. Porter (Harvard Business School) [4]. The M. Porter method became a classic and one of the most widely used in other countries. Many European and a few local attempts of an identification and mapping of the clusters do not just use the Harvard approach as a technique, but are based on its results; followers of his methodology are scientists of the European Cluster Observatory and Russian scientists [3, 5, 10].

Methodology

Having analyzed the results of M. Portera research, the European Cluster Observatory and Russian scientists, we propose to use an algorithm to identify and analyze cluster of the economy of the region, which is shown in Fig. 1.

As it is shown in Fig. 1 in the first step a division of the studied area into regions must be performed. Then, in accordance with the M. Portera

procedure, it is necessary to divide the entire set of industries NACE classifier into 3 types: local, traded (basic) and resource-dependent, with the help of the criteria used in the methodology of M. Portera, as for further research only tradable sectorы are needed. Mainly they constitute the cluster groups. To determine the composition of the cluster groups, i.e. for the formation of branches in cluster groups, we used the result of M. Porter's research. Cluster groups are co-localization patterns of industries or economic agglomeration that unite kind of activities that are interrelated and tend to co-localization.

In the following stages analysis is carried out in accordance with the procedure of the European Cluster Observatory, which is supplemented by the procedure proposed by Russian scientists to determine the level of development of cluster groups.

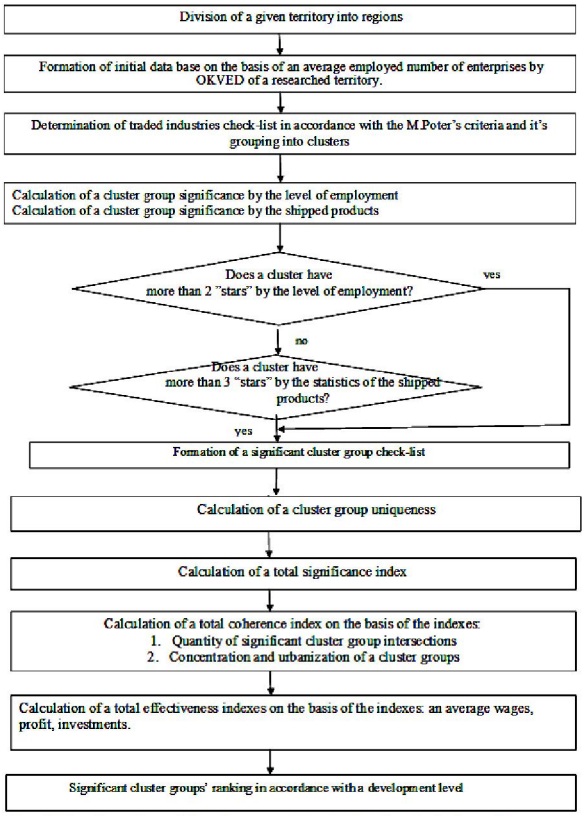

Fig. 1. The algorithm of the determination of developed clusters of a region

The methodology of M. Portera was finalized and implemented in the project of the European Cluster Observatory [6] for the detecting and mapping economic agglomerations in the scale of the European Union. Economic agglomeration - clusters were analyzed using indicators "localization coefficient" (1), "size" (2), "focus" (3).

$$LQ = \frac{Emp_{ig}}{Emp_g} / \frac{Emp_i}{Emp} \quad (1)$$

where LQ – localization coefficient*;* Emp_{ig} – the quantity of employed in cluster group *i* in the regiong; Emp_g – the general quantity of employed in the region *g*; Emp_i – the quantity of employed in cluster group *i*; *Emp* – the general quantity of employed.

$$Size = \frac{Emp_{ig}}{Emp_i} \quad (2)$$

where Size – the size of the cluster group *i;* Emp_{ig} – the quantity of employed in cluster group i in the region g; Emp_i – the quantity of employed in cluster group i.

$$Focus = \frac{Emp_{ig}}{Emp_g} \quad (3)$$

where Focus – the focus of the cluster group *i;* Emp_{ig} – the quantity of employed in cluster group i in the region g; Emp_g – the quantity of employed in the region g.

G. Lindquist [3] as a threshold value, characterizing significant cluster groups in the region, sets the following criteria:

1) the coefficient of localization (1) ≥ 2;

2) a region should be among 10% of the leading regions by size (2);

3) a region should be among 10% of the leading regions by focus (3).

Compliance to each criterion means that a cluster group is assigned by "star" (maximum is 3 "star"s). The number of "stars" determines the strength of a cluster group. As a result, the implementation of the described technique allows obtaining data of the number and strength of significant cluster groups in all regions of studied country or group of countries.

However, the procedure of detecting of the cluster groups by the methodology of the European Cluster Observatory is insufficient. It makes it impossible to assess whether these groups have priority with respect to each other, how effective enterprises are, how these groups relate to each other, etc. Another reason for the failure of the calculation is too limited range of indicators (three) under stringent quantitative restrictions and only on the basis of statistics of employment, so in accordance with the algorithm in Fig. 1 calculation methodology is supplemented by statistics indicators of localization of shipped products.

In accordance with the algorithm, the components of the aggregate development of cluster groups are calculated, which are shown in Table 1, and developed by Kiselev A.N., Kutsenko E.S., A.P. Karnaukh [10]. This figure can assess more accurately the potential development of clusters of this or that industry trend in the region. The

cumulative rate of development of the cluster group integrates an extended amount of analyzed indicators and involves existing statistics more. Such structuring of the indicators allows not only evaluating the overall development of cluster groups, but to determine the proportion of such development as well. In conclusion, the algorithm clusters are ranked in terms of development.

Table 1. The total index constituents of the cluster groups' development level

Indexes' groups	Indexes' check-list
The indexes of the a cluster group significance	• Indexes of a cluster group significance on the basis of indexes localization, size, focus, calculated by a number of employees and by shipped products cost; • index of uniqueness of a cluster group – Jinny coefficient
The indexes of a cluster group coherence	• quantity of significant cluster group intersections; • indexes of concentration and urbanization of a cluster group
The indexes of an economic effectiveness of a cluster group	• an average wages of employees by a cluster group • profit by a cluster group • investments by a cluster group

Results

As a result of the implementation of the described procedure the following results of a study of the cluster structure of St. Petersburg in comparison with the North-West Federal District were obtained.

Fig. 2 shows the ranks of Saint Petersburg in all identified cluster groups in the North-West Federal District. Rank 1 means that St. Petersburg is a leader in this cluster group, i.e. this cluster group is most concentrated in this region compared to other regions of the county. The diagram assesses accurately the significance of the cluster group within the established criteria.

By the quantity of employed the greatest effect on the economy of St. Petersburg have the following clusters: "Plastics", "Information Technology", "Scientific research activity", "Biopharmaceuticals", "Trade", "Communication equipment", "Analytical Tools", "Aerospace machinery". Enterprises of the given clusters in St. Petersburg generate the greatest employment, compared to similar businesses in the North-Western Federal District, i.e. clusters have a maximum size of the cluster group, as well as prevail in the city's economy by employment statistics, i.e. clusters have a maximum focus. In terms of "size" the city is a leader in almost all the cluster groups; it means that the multi-variant development of cluster groups takes place (Fig. 2).

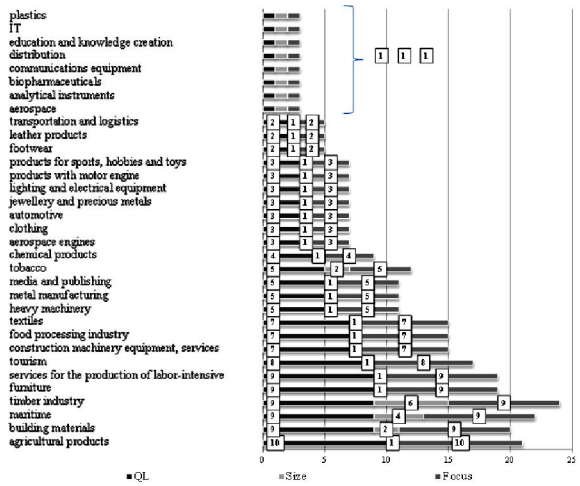

Fig. 2. Rank of Saint Petersburg by cluster groups of North-Western Federal District

Fig. 3 is a diagram, which shows the results of the ranking of cluster groups according to the degree of non-uniformity of their distribution in regions of North-Western Federal District. The most unique in St. Petersburg, rather rare for other entities Northwest FD is a cluster group of "Biopharmaceuticals". Further, the following groups: "Analytical Tools", "Communication equipment", "Leather" and "Aerospace". Other groups demonstrated the lowest uniqueness, i.e. they are present in other regions of the North-West Federal District anywhere.

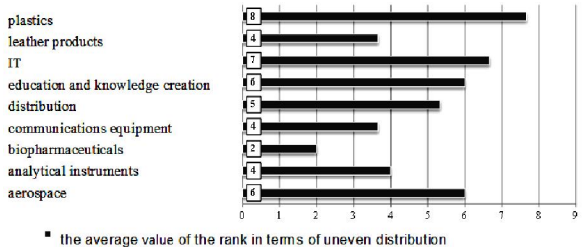

Fig. 3. An average value of a cluster group significance rank of Saint Petersburg by the uniqueness index

Thus, the calculation results of the significance of the indicators' group, we can conclude that in St. Petersburg there are nine significant cluster groups. The greatest significance has the "Biopharmaceuticals" cluster, because an employment in this group is very unevenly distributed in regions of North-West Federal District, and this group is concentrated in St. Petersburg. The group leads by the number of the shipped products and by the number of employees in enterprises in this group compared with the industrial structure of the

North-West Federal District. Further, in decreasing order of importance the following cluster groups: "Trade", "Information Technology", "Scientific research". Groups: "Analytical instruments", "Communication equipment", "Plastic", "Leather" are equally important for the city. However, the least unique group is "Plastics." Group "Aerospace" is the least important for the city.

Next, we will consider the results of the calculations of the cluster group branches' connectivity indexes. The connectivity data of the cluster groups will help improve the efficiency of cluster policy by means of efforts focusing on support and development of branches of intersecting cluster groups. Fig. 4 shows the intersection of the significant cluster groups.

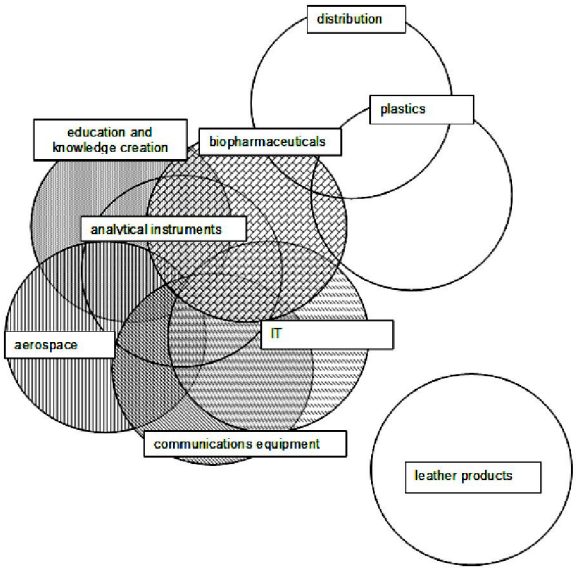

Fig. 4. Saint Petersburg significant cluster group intersections

According to the analysis calculations we can draw the following conclusions. A leader in terms of connectivity is a group of "Biopharmaceuticals" – it is associated with the most significant cluster groups in St. Petersburg. Next, it is necessary to point out closely related high-tech cluster groups, "Analytical Tools", "Communication equipment", "Information Technology", "Aerospace". The group "Trade" shows a low rate of coherence with other relevant groups, but the values of the urbanization is the highest, which means that it tends to the other cluster groups that are most represented in St. Petersburg, however, it demonstrates the presence of positive effects of the employees number increasing of the group. The group "Leather" has no relations with other groups, i.e. its support will only affect this given group.

Further, according to the algorithm the cluster groups' effectiveness indicators were analyzed. The results are shown in Fig. 5-8.

Wage levels' leaders are cluster groups: "Information Technologies", "Scientific research" (Fig. 5). Group "Trade", "Leather" are almost two times as behind as others. In other groups, the average wage is about the same.

The cluster group "Leather" by the level of the average level of investment lies behind the other groups (Fig. 6). The group of "Plastics" is also lagging, where the average investment rate slightly below 1 million rubles. All the other groups have approximately the same values for this index and the average level of investment value in these groups is around 1.5 million rubles.

The absolute leader in terms of profit (Fig. 7) is a group of "Plastics", which exceeds the level of all other groups for almost 20 times. The group of "Leather" products, on the contrary, generates the lowest profit. Gains in other cluster groups are rather evenly distributed between 1.5 and 2 million rubles. However, in the group of "Biopharmaceuticals" profit level slightly higher at 2.6 million.

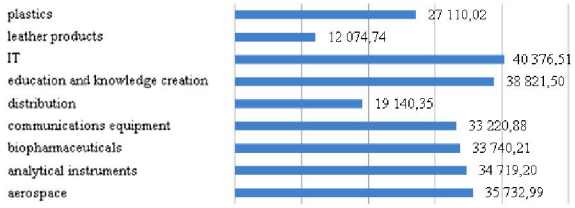

Fig. 5. An average wages level in cluster groups, rubles

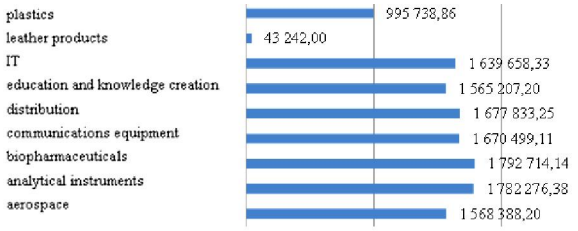

Fig. 6. Level of investments in cluster groups, rubles

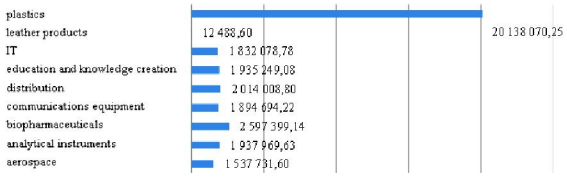

Fig. 7. Level of profit in cluster groups, rubles

The results of the synthesis of the cluster groups in terms of economic efficiency scores are shown in Fig. 8

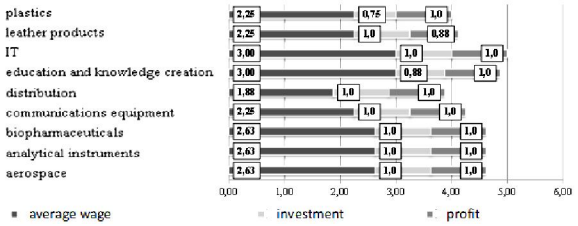

Fig. 8. An economic effectiveness index of enterprises in cluster group, points

The leaders in the aggregate indicator of economic efficiency are following cluster groups: "Information Technology", "Scientific research". This means that the enterprise of the given cluster groups in St. Petersburg has the greatest economic effectiveness, compared with similar enterprises in other regions of the North-West Federal District. I.e. Enterprise industries, which are parts of these groups, show the highest level of profit wage and investment activity in comparison with similar businesses entities Northwestern Federal District. After the leading group are the following clusters, "Biopharmaceuticals", "Analytical tools", "Aerospace". The worst results the group "Trade" demonstrates. Enterprises of St. Petersburg are included in this cluster group, lagging far behind in terms of average monthly wages of similar enterprises subjects Northwestern Federal District.
Aggregate indicator of the cluster groups' significance is shown in Figure 9.

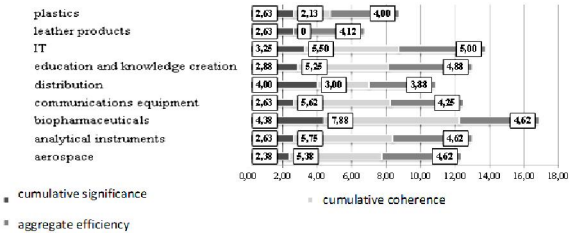

Fig. 9. A total index of significant cluster groups' development of Saint Petersburg, points

Thus, the study identified nine significant cluster groups in St. Petersburg, presented in Fig. 9. On the basis of statistical data on the number of employees and the shipped products, it was calculated that these groups prevail in the economy of St. Petersburg in comparison with the industrial structure, both the city and the subjects of the North-West Federal District. The group of "Biopharmaceuticals", "Analytical tools" and "Communication equipment" are the most unique in the city, i.e. these groups are thinly represented or absent in other regions of the North-West Federal District.

It is important to note that all nine groups are at different levels of their development. The leader of the groups is the developed cluster group of "Biopharmaceuticals". This group has the highest significance values, i.e. cluster has the maximum number of points for employment and for the volume of shipped products. That means that the share of employment (shipped products) of the cluster of St. Petersburg in total employment (products shipped) of all cluster groups in the North-West Federal District, as well as in total employment in St. Petersburg is the highest in comparison with the same indexes of the given cluster in the subjects of the North-West Federal District. It means that this cluster prevails in the economy of the city and the North West region by these indicators. The cluster "Biopharmaceuticals" is also the rarest for other subjects of Northwestern Federal District. This group is also leaders in terms of connectivity, i.e. activities, which are included in this group are also in the maximum number of other cluster groups. Enterprises of the cluster are characterized by the highest level of profit, wages and investment activity. Thus, it can be argued that the cluster "Biopharmaceuticals" is the most economically developed in St. Petersburg.

Conclusion

If we analyze the clusters in the order of decreasing of the development level, then we have the following groups: "Information Technology", "Analytical tools", "research activities" and "Communication equipment". These high-tech and science-intensive groups are closely linked and can form a single meta-cluster group. State support of one of these groups, as well as of intersecting branches of this group, will influence both the group itself and other relevant cluster groups.

The group of "Aerospace" has the lowest value of the significance index; it means that this cluster does not prevail in the city's economy in comparison with the cluster structure of the North-West Federal District.

The cluster group "Trade" lags considerably behind the leaders in terms of development. The group is characterized by rather low values of coherence and efficiency indicators, which means that this group has fewer industries covered by other relevant clusters and enterprise cluster characterized by lower level of economic efficiency.

Low rate of cluster groups' development of "Leather", "Plastics" is explained primarily by low level of coherence or lack of it – "Leather Goods". A support of these groups will not have a multiplicative

effect on other significant cluster groups of the city. Also, these groups are characterized by a relatively low level of wages, profits and investment activity of enterprises, which are parts of them.

A development of effective government support measures identified the cluster groups is an opportunity for St. Petersburg to create the conditions for economic modernization and develop the competitive clusters in the global market.

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Corresponding Author:
Dr.Babkin Alexander Vasilievich
St. Petersburg State Polytechnical University
Polytechnicheskaya street, 29, St.Petersburg, 195251, Russia

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