Analysis of the applicability of selected methods for industrial clusters identifying

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***Abstract*—**Industrial clusters are not the new tools of economic development. But still from 90s of the 20 century industrial clusters were considered as suitable and available tool for supporting of the cooperation between enterprises, creating an environment for knowledge transfer, sharing and transformation of the innovations what are intended to bring financial and non-financial benefits and enhance their competitiveness. In practice there are difficulties, especially in phase of the industrial cluster births. The public sector grants special public finance for support of this phase. But we don't know if the established cluster has the potential for existence or not. Different methods can check beforehand whether there is potential for at least the framework of clusters, or in which industry and present the basic prerequisites for the emergence of the cluster and its effective functioning. Literature has identified a large number of methods, but experience shows that they are not all usable in practice. This paper aims to identify practical use method for identifying sectors in which the emergence of clusters possible.

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***Keywords*—**industrial cluster, region, identification, cluster potential, development.

I. Introduction

THE conception of the regional policy and regional development is still an evolving process. The economic growth is the limelight in context of the European regional policy. The main growth determinant is also increasing competition of the municipalities, regions and countries. It can be realized thanks to engines (centres of excellence, clusters) support. These centres are the carriers of the main part of the local and regional economic development. At these levels there are many tools of local and regional development used.

This paper focuses on selected methods for industrial cluster identification in regions, brings the taxonomy of many accesses to this problems. The comparison of the selected methods is not missing.

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II. Industrial Clusters and Cluster Initiatives

The cluster delimitations were objects of many regional scientists´ interests. We present fundamental definitions as follows:

According to [11,12] the local competition creates incentives to emulate best practice and boost pressures to innovate, while also connecting the strengths of competition with the virtues of selective cooperation. The concept of clusters was related to the "competitiveness" of industries and of nations.

Every operating cluster has some common characteristics [2]:

1) clusters are managed by entrepreneurs and public subjects,
2) the cooperation and competition are fundamental,
3) fixed relations between companies and public administration institutions (verified by [18]),
4) cluster is a system where every member is of the same importance,
5) cluster members have the common technologies, customers, distribution channels or labour markets and human capital.

The economic cluster is a geographic concentration of similar, related or complementary companies which have active channels for business transactions, communications and dialogs [for more see 3]. They share specialized infrastructure, labour markets and services. The clusters can contribute to the economic growth of both the cluster members and the whole region. This is possible due to following reasons:

1) clusters increase the productivity through the possibility of access to specialized inputs (including human capital), information and institutions,
2) clusters increase innovative capacities (due to competitiveness inside the cluster),
3) clusters stimulate quick production and attract new firms to the cluster,
4) clusters make the regional strategic planning of higher quality possible. This is caused by the knowledge of the entrepreneur environment.

The cluster initiative can be characterized as an organized effort focused on the growth and competitiveness increase in regions thanks to many companies and firms which can be clustered, governments (local and central) and research institutions and communities. Sölvell [16] presents some efficient models of the cluster initiatives and they present cluster initiatives as efforts focused on clusters formation in regions (they are presented by means of policy programmes).

The cluster initiatives represent mostly the prime-stage of the cluster formation. Anderson [1] says: "Cluster initiatives" are viewed as conscious actions taken by various actors to create or strengthen clusters. There are multiple relevant actors, and they may relate to each other in different ways. Governments and other public authorities are known to be responsible for most cluster initiatives, although there is a marked geographical variation.

Cluster initiatives are characterized as follows:

- every initiative is inimitable,
- initiatives are mostly situated in developed and transforming economies (they are largely connected to high technologies – information technologies, pharmacy, bio pharmacy, medicine, car industry, etc.),
- they are also generally located in innovation-friendly environments,
- the clustered companies, firms and other organizations are geographically nearby.

They used to be the key elements of the industrial, regional and innovative policies, especially in developed countries. They are suitable for "revival" of stagnant industries and also for the revitalization of non-operating clusters. The cluster and innovative potential are the integration of two fundamental part of one Porter thesis "the cluster is presumption of the innovations". If we define that the cluster existing is the presumption of innovations´ birth, we would like to be able to measure the ability or capacity for cluster existing in regional or spatial framework.

III. METHODS OF INDUSTRIAL CLUSTERS IDENTIFICATION

Many regional scientists (Porter [13-15], Sölvel [16], Bergman, Fesser [2,6], Skokan [15] and many others) patronize the ideas of diversification the identification methods according to the level where the clusters are analyzed. National (macro-level), industrial branch (mezzo-level) and firm level (micro-level) can be recognized.

The mezzo-level was considered as the most important in the 90-ties of the 20th century. The clusters are identified in European countries and regions at all levels contemporary. We recommend to diversify also national (state or country), regional (NUTS II or NUTS III) and also local level (municipal or micro-regional). This concept seems to be more suitable in the practice of small European regions.

Porter [12,14] presents the procedure (all in harmony with higher mentioned):

- analysis of cluster identification must start in big firm or firms concentration and continue up of down in **vertical chain** of firms and institutions;
- the horizontal view is the next step in what the industrial branch is identified. This branch must have the similar characteristics or being complementary products or services producers. The **horizontal chain** of industrial branch can be identified with the specialized inputs, technologies or similar relations in suppliers´ chain.

For identification of industrial branch and clustered firms Porter sets the institutions what can provide the specialized and qualified labour force, technologies, information, knowledge, capital or infrastructure, some other collective boards also with the actors of cluster. The public administration offices and government representatives finding is the last step. These actors can influence the whole cluster for example with money (grants) from public budget in phase of cluster birth.

Anderson [1] wrote in his paper the list of steps for cluster identification in regions:

1) *definition of economical region for analysis*. The main of the relations among firms, local government and institutions must be realized in this region. The other type of cluster is defined by actors (not only geographically). These actors can come from other regions, but they are connected with relations inside the cluster;
2) *analysis of the economical indicators* (unemployment, export, added value, turnover, benefit) in important industrial branch where the concentration can be find. Here the coefficient of specialization or localization (agglomeration) can be used.
3) *identification and selection of probable groups* in export branches where the relations are identified. The sense of this step is to set group of clustered subjects what can introduced the suppliers of inputs, components and services connected with the main production of the cluster.
4) *cluster definition* determination is the next step. During this step the interviews with the managers of all actors must be realized because for analyses the various data is needed.
5) *cluster map* increasing is the next step. The graphical visualization of the industrial branch and relations in cluster in region can be made.
6) *function of cluster* for the region is the last step. This step can be realized continuously.

For realization of the step No. 3 there are many methods for cluster identification in practice.

Subsequently presented methods for clusters potential identification can be used at macro-level and regional level. The clusters can not be identified in locations with lack of networking and trust. These two premises are the basic conditions of successful clusters. Firms without these conditions are called "conflux" of the firms, no cluster. The better concept than conflux is known as a quasi-cluster.

There are many lists of tools for cluster identification in literature and other sources. But if I want to do the taxonomy, we must collect the similar methods and grouped them together. We can use the data sources needed for calculations. Two groups of methods are:

- qualitative,
- quantitative.

Among quantitative methods we can count:

- localization coefficients (LQ),
- input-output analysis,
- shift-share analysis,
- Giniho coefficient of localization,
- Ellison and Glaeser index of agglomeration,
- Maurel-Sédillot index.

Among qualitative methods we can count:

- interviews with experts and management of the firms,
- researches (question-forms),
- case studies.

It is known also the method based on Porter diamond model what is the combination of suitable quantitative and qualitative method (based on the calculations and interviews results). The method of competitiveness advantage analysis is the name of this new method (CAA).

Among presented methods there are some which integrate in themselves some mechanisms from other methods. The Elison and Glaeser index is a clear example – it integrates geographic concentration, industrial concentration index and Hirschmann-Herfindahl index. That is why we can define some other methods for cluster identification:

- diversity index (RDI) for the measurement of regional industrial specialization according to Duranton and Puga in year 2000,
- index of geographic concentration measuring geographic concentration or spatial distribution of national industries.

Own taxonomy of the methods for cluster identification can be found in [10]. They grouped the methods into AHP (Analytical Hierarchy Procedure) methods and CBM (Community-Business Matching Model). The Perpetual Inventory method is also specific method for cluster identification. For more see [4] and [9] and [8].

Each of the methods affords specific results, and the interpretation is the most important phase of the whole identification process of clusters or industries suitable for clustering.

IV. Characteristics of Selected Methods for Cluster Potential Identification

A. Shift-share analysis

This is a simple, fast and relatively inexpensive method for analysis of regional growth and decline over the time. It allows analyzing the total economical results of the region and comparing them with other regions. In the context of regional employment or output of the industry, this tool has been used routinely since 1960 for assessing the relative importance of industry in the region. It allows easily finding and identifying the problematic industries in the region, which in future may require attention. Shift-share analysis shows how industry structure influences regional and local economies, examines regional economic trends and advises policy makers focused on the industry.

The substance of the traditional concept of analysis is to identify three types of growth (decline) in total employment in the region for a selected time period. They are [17]:

1) growth flows from national factors,
2) the portioning of the growth from individual branches,
3) growth flows from the competitiveness of local enterprises.

These three types of growth are calculated by using three factors:

- NGS (*national growth share*) - factor determining growth flows from national factors. The computational form is:

$$NGS = Er_{ji} \cdot \left(\sum_i En_{ki} / \sum_i En_{ji} \right) \cdot 100/100 \qquad (1)$$

where

Er_{ji} is regional employment in the sector ***i*** in year ***j***,
En_{ji} is national employment in the sector ***i*** in year ***j,***
En_{ki} is national employment in the sector ***i*** in year ***k.***

Component arising from national growth factors (NGS) measures the change in regional employment, which could occur if the regional employment grew at the same rate as national.

- LS (*local share*) – coefficient determining growth resulting from the competitiveness of local businesses:

$$LS = Er_{ji} \cdot \left\{ \left[\left(Er_{ki} / Er_{ji} - 1 \right) \cdot 100 / 100 \right] - \left[\left({En_{ki}}/{En_{ji}} - 1 \right) \cdot 100 / 100 \right] \right\} \quad (2)$$

where
Er_{ji} is regional employment in the sector ***i*** in year ***j***,
Er_{ki} is regional employment in the sector ***i*** in year ***k***,
En_{ji} is national employment in the sector ***i*** in year ***j,***
En_{ki} is national employment in the sector ***i*** in year ***k.***

The portioning of different sectors growth (LS) measures the different shift caused by differences in growth rates of the same industry between regional and national levels. The differences are the effects from existence of factors such as national resources, other comparative advantages or disadvantages, leadership and entrepreneurial skills and the effects of regional policy.

- IMS (*industry mix share*) – coefficient determining the growth based on different growth of individual industries. The computational form is:

$$IMS = Er_{ji} \cdot \left\{ \left[\left(En_{ki} / En_{ji} - 1 \right) \cdot 100 / 100 \right] - \left[\left(\sum_i En_{ki} / \sum_i En_{ji} - 1 \right) \cdot 100 / 100 \right] \right\} \quad (3)$$

The component of growth flows from competitiveness of local enterprises (IMS) measures the proportional shift caused by differences in industrial growth at the regional and national level.

Total employment created in the region is the sum of all the above three factors, therefore = (NGS + SS + IMS).

The application of shift-share analysis can be summarized into several steps:

- First must be selected the period for which the shift-share analysis is calculated;
- it is necessary to assemble data for analysis;
- then it is necessary to determine the individual coefficients by (1) – (3).

This approach allows identify which sectors contributed the most to employment creation in analyzed region. Finally, it is necessary to interpret the results.

B. Input-output analysis

Input-output analysis is aimed at quantifying the relations between actors (industries or sectors) in a segment (typically the economy or region). The symmetric input-output tables (tables SIOT) are the substance of this method. They serve as a source of data for quantification of cross-sectoral linkages. They are made from parts: a product by product or industry by industry. Tables are able to recognize the impact of government intervention in the economy as a whole, but also on various industries and households. It can analyze productivity, employment, sensitivity to the impact of changes in tax rates and regulation. Other instruments are the tables of supply and use.

Input-output analysis has the ambition to identify the chain of business and industrial clusters as a vertically integrated industry. There must be analyzed the relations and flows between analyzed subjects for finding the relations of proximity subject (for example also in industrial cluster). Prerequisite for all methods is that there are significant changes between the flows between and among close their surroundings.

The basic idea of this method is to find the maximum of connection (relationship), to measure its strength and consequently the so-called significant industry. The benefit is the ability to reduce the number of analyzed inter-relationships and determine the dimension of the interconnection of firms.

From input-output table (IO table), the individual flows between the entities are analyzed by IO table, must be deleted the weak inter-sectoral flows and relatively unimportant sectors. Consequently it can be possible to find the largest customer. The method continues in determining the percentage of intermediate products deliveries to the same industry and also percentage of intermediate supply to all sectors.

C. Ellison-Glaeser index of agglomeration

Indices and coefficients indicating the degree of concentration are used in classical location theory as well as the Gini index, the Hirschmann-Herfindahl index and location coefficients. Ellison and Glaeser [5] developed an index of Ellison-Glaeser (EG-index) on the basis of mentioned methods. EG-index assesses the agglomerated branches (industries) according to the level of employment and shifting workforce. Ellison and Glaeser agglomeration index is a modification of the spatial Gini index. EG-index (***γi***) is based on the Herfindahl-Hirschmann index (***Gi***) and the Herfindahl index (***Hi***).

EG-index analyses the level of agglomeration in the region within one industry. Index follows a decrease or an increase of the firms´ share to employment in the region or to the volume of production (they arise as the externalities of agglomeration advantages). Agglomeration is reflected in many companies grouping (***clustering***) on industrial areas. The most common reasons for the clustering of firms are:

- financial savings flowed from sharing expertise input factors and sharing production of the united inputs,
- economies of scale flowed from production of united inputs,
- reducing of total production costs through lower transaction costs,
- usage of the same technology, what can increase the probability of cooperation, sharing information,

knowledge, know-how and the improvement and development of new technologies (also innovations).

The default variable in the calculation of EG-index and its sub-indices is the employment. It assesses at three levels - by industry, regions and enterprises. The employments are the sum of employed persons E_{irp} over I industry, R regions or P enterprises.

EG-index can be interpreted as a measure of geographic concentration which is conditioned of industrial concentration. The index takes into account the industry distribution in region and size of a enterprises whit activities in the industry. There is the most important determinant factor for this index - if the industry actually tends to agglomeration.

D. Method of competitive advantage analysis (CAA)

It flows from Porter diamond model which describes the competitiveness model of economical environment in which the cluster exist. The model shows competitiveness in the microeconomic environment of cluster (we can discuss if all components are microeconomic) and its components. These can be analyzed and modelling.

This method is very demanding for input data, but that is the reason for very high interpretation ability. Method can help map the cluster potential in all main industrial branches in analyzed region. The dependence on opinions of managers from regional actors is the disadvantage of the method. It can be removed with big amount of target group.

The method is based on interview with managers or economical workers from firms in region where we can define the cluster potential. Among the questions there are many questions for opinion on:

- accessibility of specialized sources needed for production in the industrial branch (human, capital, infrastructure, nature),
- relations among the firms in region (aggressive relations, evaluation of entrepreneur climate etc.),
- suppliers chains (suppliers for demanding end customers),
- local subcontractor systems, flexibility of local firms,
- relations among the firms in region and their branch orientation.

Every respondent can evaluate his every answer by 4-point scale (1, 2 – positive; 3, 4 – negative). The result is calculates as difference positive and negative answers. There can be used also the weight of every answer (point weight) and ratio of every group of answer on all. The proportional (%) result expresses the positive or negative position of the result on the graphic tool (tetragon). The focus of the tetragon is -100 %, the extreme of every line is +100 %.

V. COMPARATION

From analyses of literatures sources these fundamental characteristics can be summarized from selected methods (see tables I – IV). The applicability aspects were the main point of view for summarizing because these methods are discussed in literatures and paper all over the world, but their applicability in practice doesn't match the expectations.

The objectives of every method must be to answer the question "if there is the cluster potential in the region" or "in which industry is the biggest potential for cluster birth in this region". As we can see from tables I – IV there is no availability for answering these questions. For practice the methods are not useful and effective.

TABLE I
The characteristics Input-output method

Input data	• statistical offices data • in Czech Rep. available only from year 2005
Timeliness data	• 3 – 5 years old • only for ex post analyses
Detailed data	• available only in two-digit level NACE codes
Method objectives	• analyzing and mapping of economical productivity and performance • forecasting of the economical trends
Difficulty	• low (use MS Excel)
Industrial clusters availability	• perspective branches (industries) can be determined on the national level • the regional data is not available, this is the limit of categorization industries to the regions • method can be used as orientation analysis, resp. initial analysis for determining of the best industries (start-up point for next analyses)
Industrial cluster potential measurement	• absolutely not suitable
Problems, barriers	• regional data missing • detailed data missing • non-actual data

TABLE II
The characteristics of Ellison-Glaeser index

Input data	• statistical offices data, data from Work offices • in databases there you can find only the selected industries and enterprises over 100 employees
Timeliness data	• actual – yearly or quarterly
Detailed data	• detailed to enterprises, regions and countries
Method objectives	• the calculation of the agglomeration rates according to the level of employment and labor forces spillovers - It can be decomposed into Ellison-Glaeser index, which self assesses agglomeration rate; Hirschman index, which measures concentration of the industry in the region and the

	Herfindahl-Hirschman index, which describes the distribution industry in the region
Difficulty	• if the data is available, the difficulty is very low (use MS Excel)
Industrial clusters availability	• it can identify the industries and regions with the suitable characteristics for industrial clusters birth
Industrial cluster potential measurement	• It can not measure the potential, but it can find what region and industry or branch have to be analyzed for more detailed results
Problems, barriers	• due to character of the data does not include small and medium-sized enterprises over 100 employees, which greatly reduces the explanatory ability • there are tables with limits and the results flows from the method are compared with them. If the tables with limits are set incorrectly, the results will be erroneous.

TABLE III
The characteristics of Shift-share analysis

Input data	• statistical offices data, data from Work offices • must be known: employment in branch (sector), region and national economy
Timeliness data	• analyses the past times (approx. 5 years)
Detailed data	• when the detailed data will be used (for three-digit level NACE codes) the results will be detailed and useful for regional level • for fundamental using the employment (in two-digit level) is sufficient
Method objectives	• The method enables the calculation of descriptive indicators in national economy and also in regional economies. • It is an analysis of the increase / decrease of the employment in the companies of the region related with growth or decline in the national economy. Another part shows the comparative advantage to develop a specific sector in the national economy.
Difficulty	• very easy (use MS Excel)
Industrial clusters availability	• the most applicable is CZ rate, which reflects an total shift of the employment in selected sectors of industry. To help increase of the employment in enterprises in the region can assume greater business potential.
Industrial cluster potential measurement	• it can identify a industry with the highest development rate. It can be indicated from the increasing of the employees number • it is able to analyze the industry in the region and compare them with each other • it is suitable to verify the initial hypotheses about the potential for the emergence of industrial clusters birth
Problems, barriers	• it can not analyze the causes of any changes in employment rate • the wrongly selected period means inaccurate results (implementation of large development projects in a given period can inaccurate the results) • the method can not be cleaned from the influence of economic cycles

TABLE IV
The characteristics of CAA – Method of competitive advantage analysis

Input data	• Interviews with managers of businesses what are classified to the basic file • Business databases to verifying data about employment, industry activities
Timeliness data	• Maximum actual
Detailed data	• Empirical materiel at the enterprise level • Allows to group businesses into sectors and regions (it is necessary to verify the explanatory power of data integration)
Method objectives	• On the assumption Porter's diamond model of competitive advantage and describes the particular microenvironment of the clusters, which contains certain essential components, which if they are not present, the cluster is not working effectively or not met the conditions for further development and existence.
Method objectives	• Identifying each part of the surroundings and environment in which clusters exist and function • scale assessment of analyzed conditions of existence and functioning of clusters in regions
Difficulty	• complicated phase of obtaining data from representative target group • for the base level (Porter's diamond creation) sufficient to Excel • More detailed processing requires a basic knowledge of mathematical methods - such as principal component method; for more see for example [7]
Industrial clusters availability	• Fully applicable
Industrial cluster potential measurement	• Method determines the sector in which there is an underlying set of assumptions for the existence and functioning of industrial clusters • It is possible to determine the degree of fulfillment of assumptions, comparing it in various sectors
Problems, barriers	• needed empirical data for a representativeness • validity of Porter's diamond model hypothesis (if not, it is not possible to verify the accuracy of the assay results) • extension of the analysis is available only by expert on computational intelligence

Applicability of selected methods for the cluster identification depends on the nature and complexity of calculation and also on the availability, quality and detailed input data. From the fundamentals of the methods there all described methods are applicable at different levels of spatial (from literature sources is known that except of Gini coefficient). From input view there are troubles and many obstacles.

Input values for the qualitative methods usage are obtained by direct questioning or through stakeholder interviews. For them it is necessary to properly select the range and scope of the interviewed representatives of companies and the range of information that is intended to obtain. Another problem is the interpretation of results with qualitative analysis. The final statement about cluster potential in the region or industrial is dependent on the professional opinion of respondents, and then the analyst. For practical applications, it may be noted that these methods provide better results than quantitative methods.

For quantitative methods the statistical data are necessary. Often the data about sectoral employment and input-output matrix data are gathered for the national level from the statistics of the Statistical Office. In regional level there the data about employment in different sectors and industries are also obtained (from databases or statistical proceedings), but only two-digit level NACE codes. This, however, often inadequate, and some methods are not so easy to use (eg. Ellison and Glaeser index of agglomeration).

There is no possible to use all selected method due to the unavailability of data or their inequality. Among the shortcomings of methods what use only with the quantitative inputs include especially:

- high dependence on the quality of input data,
- low number of factors that influence the outcome (often only one variable)
- complexity of the calculation,
- ambiguous results (the final result is a number that must be interpreted by the specialist. The result is then dependent on the subjective views and assumptions).

Described shortcomings of the methods cause their impotence for use in practice. Method CAA shortly described in this paper largely eliminates the disadvantages of two groups analyzed methods (suggested method is multilateral, based on available empiric data, gives an unambiguous result, it is computationally easy).

The result of comparison described methods can be this order:

1. **CAA – Method of competitive advantage analysis**
2. **Shift-share analysis,**
3. **Ellison-Glaeser index.**

Input-output analysis can not be recommended either for only initial character of analysis and also for due to the complexity of calculating. Shift-share analysis and Ellison-Glaeser index can be combined to verify other calculations.

An important conclusion is this: none of the quantitative methods is sufficient for separate analysis of the industrial clusters birth. It is necessary to recommend a combination of methods and proposed method of CAA. In practice there can be usage of these methods substitute of statistical analysis of the descriptive data from statistical books. This un-described method is very complicated and must be realized only by specialist and depends of course on specialist opinion and their experienced. This method can not be signed as objective and rigorous.

Moreover, it is necessary to note that different methods should be also used in various phases of the cluster initiating and birth.

VI. Conclusion

Prior to the establishment of the industrial cluster is necessary to analyze the region's economy and industrial structure and to determine whether there are necessary conditions for the emergence of the cluster. In the literature sources there many different methods that are recommended to explore the potential for cluster existence in the regions exist. Only the minimum of them are usable in practice. The reason is the high intensity of the current input data; high cost for needed experts conducting the analysis and only general output of some exploitable methods.

Given the results of analysis conducted in this paper, it is necessary to recommend a combination of several methods, ideally a combination of representative quantitative and qualitative methods for cluster potential exploration. It is possible to get a broader view on the development of the sector in the region and can decide whether it is possible to establish an industrial cluster, or encourage the emergence of industrial chains, or other forms of cooperation. Or there can be chosen a completely different kind of support for the development of the sector in the region.

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