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**PROVINCE CAPITALS VS. THEIR NEIGHBORS  
– THE ASSESSMENT OF CHANGES BY DYNAMIC  
CLASSIFICATION OF EMPLOYMENT STRUCTURES<sup>1</sup>**

**Summary:** The purpose of the study is to identify the groups of cities and counties (NUTS 4), located in an immediate neighborhood and characterized by similar employment structures and paths of their changes. The groups of cities and counties, were found using dynamic classification. Ward method was used to define the number of groups and k-means method was applied for the final classification. The analysis covers the period of ten years (based on the statistical data availability in the Central Statistical Office – Local Data Bank), i.e. the years 2005-2014.

**Keywords:** city, environment, employment structure, sectors, dynamic classification, NUTS 4.

**JEL Classification:** R1, R11.

**Introduction**

There are 919 cities in Poland (since from 1<sup>st</sup> January 2016), including one with the population exceeding 1 million residents – Warszawa<sup>2</sup> (1,75 million), the next four – Kraków, Łódź, Wrocław, Poznań – population between 500 thousand and 1 million, and 11 with the number in the range of 200-499 thou-

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<sup>2</sup> According to the data provided by the Central Statistical Office (accessed: 15.05.2016).

sand, of which the following are the province capitals: Gdańsk, Szczecin, Bydgoszcz, Lublin, Katowice, Białystok and Toruń. There are 23 cities in the group of those with the population ranging between 100-199 thousand, of which the province capitals are as follows: Kielce, Rzeszów, Olsztyn, Gorzów Wielkopolski, Zielona Góra, Opole.

Cities, and mainly the large ones, represent growth poles and play such functions as e.g.: offering conditions for innovation and competition [Blotevogel, 2006]. The role of cities as important areas in creating regional development and economic integration was reflected in the European Union regional policy at the beginning of the 90s in the 20<sup>th</sup> century. Such timeframe is connected with the reform of structural funds in 1988 and the Treaty on the functioning of the European Union effective in 1993, which identified cohesion as one of the primary goals of the community policy.

City is a territorial unit, the area of which is subject to permanent socio-economic and urban space transformations. The changes in modern city structure result from phenomena and processes occurring in both economy and society, such as: globalization, demographic problems, population mobility, growth rate diversification, changing demand. City structure transformations can be analyzed from many angles, one of which is the job market changes.

The purpose of the study is to identify groups of more homogeneous – cities and counties (NUTS 4 level territorial units), using dynamic classification, which are located in their immediate proximity – presenting similar sectoral employment structures and similar paths of changes.

## **1. City as a research subject**

Since the earliest times a city has been the subject of research for the representatives of such disciplines as history, geography, urban planning, architecture, sociology, psychology, social studies, anthropology, political studies, nature and law. It lies within the centre of research interests of environmentalists, municipal engineers, culture experts [Parysek, 2015].

Many classifications were developed based on city research and grouped cities in various hierarchical and functional divisions. K.A. Kuć-Czajkowska [2009] lists and describes the positions of selected European capitals based on studies carried out by: R. Brunet [1989], P. Trauner [1994], P. Treuner and M. Foucher [1994], P. Bonavero and S. Conti [1996], B. Jałowiecki [1999]. Moreover, the research focused on the classification of cities was conducted by e.g. K. Dziewoński [1962], D. Pumain [1999], S. Marschal [2005], ESPON

[2007], S. Conti and C. Salone [1999], M. Smętkowski [2010], M. Smętkowski, B. Jałowiecki and G. Gorzelak [2009].

The subject literature provides theoretical concepts attempting to explain the process of city development and its regional impacts [Hołowiecka, 2004]. The relationships between a city and its proximity, in B. Domański's [2008] opinion, can constitute the background for analyses of the special case relationship between a city and its peripheries, described by two basic schools of thought:

- rapid development of the city core areas is taking place at the expense of peripheral areas, which advances their dependence on the core (centre); results in washout, e.g. qualified staff, capital and other resources are drained out [Myrdal 1957].
- in the long run, it is possible to spread the core development into peripheral regions, primarily as a result of innovation and capital flow [Friedman 1966], which acts as an incentive for gradual integration, as well as the core and periphery duality elimination along with the development of a more balanced spatial structure.

The impact of large cities on their regional proximity and the related peripheral centres are divided by M. Castells [1998], as M. Pięta-Kanurska indicates [2010], into: the effects of economic development spreading caused by the positive impact of a city on the region and the effects resulting in an advancing polarization and city strengthening at the expense of the region. Even though these effects take place simultaneously, their neutralization does not occur.

The impact conditions of an agglomeration on regional development are discussed by W.M. Gaczek [2010] in the context of the way growth poles functioning, the effects of which vary and depend on the environment dynamics, defined by Perroux as the combination of three forces responsible for economic growth: human capital, capacity for innovation and institutions. The capacity to innovate ingrained in a socio-economic territorial unit is the result of e.g. human and institutional capital, business structure (size, sectors, management methods, internal capital), as well as their territorial organization.

## **2. Method, data and research objects**

The proposal of a research procedure based on spatio-temporal data usually covers the following stages:

1. The construction of a spatio-temporal data cube (objects – years – variables).
2. Global normalization (extreme values of the characteristics are determined for the entire period jointly).

3. Dynamic cluster analysis [Markowska, 2012], including finding the number of groups – based on data cube (rows stand for taxonomic units analyzed jointly – the total of all years and columns represent adequate variable) – using Ward method and the final classification based on *k*-means method.

Our analysis skips the normalization stage, since the values of all characteristics are expressed in the same unit – percentages.

The data cover workers in their primary place of employment (as at 31<sup>st</sup> December), i.e. the persons performing work providing earnings or income. The number of employed is specified in accordance with the statistical classification of economic activities. The Central Statistical Office (CSO) resources do not take into account economic entities employing up to 9 workers, clergymen and those employed in budgetary units operating in the sector of national defence and public safety at NUTS 4 level. The resources of the Local Data Bank (LDB) provide data jointly for with individual agriculture together with employment in organizations, foundations, unions, by the actual place of work and activity type. The data about employment in private agriculture, as at 31<sup>st</sup> December were estimated in the years 2002-2009 based on the results of the National Census of Population and Housing and the Agricultural Census in 2002 and also based on the Agricultural Census 2010<sup>3</sup> carried out in 2010.

The following system of section groups in the Statistical Classification of Economic Activities has been adopted (as used by the Polish Central Statistical Office):

- I. Agriculture, forestry, hunting and fishing (agricultural sector).
- II. Industry and construction: 1/ mining and extraction; 2/ industrial processing; 3/ electricity, natural gas, steam and hot water production and supply; 4/ water supply; 5/ sewage and waste management; reclamation; 6/ construction (industrial sector).
- III. Trade; repair of motor vehicles; transport and warehouse management; accommodation and gastronomy; information and communication (trade sector).
- IV. Financial and insurance activities; real estate services (financial sector).
- V. Other services: 1/ professional, scientific and technical activities; 2/ administration and supporting activities; 3/ public administration and national defence, compulsory social security; 4/ education; 5/ health care and social assistance; 6/ activities related to culture, entertainment and recreation; 7/ other services (service sector).

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<sup>3</sup> Based on the notes and demographics in data descriptions provided by the LDB.

The analysis period, based on the resources available in the LDB referring to NUTS 4 level, covers the years 2005-2014.

Province capitals (simultaneously functioning as townships) were taken as the objects of the study as well as the adjacent counties. The total of 18 province capitals and 44 counties were included in the overall assessment. In ten cases the province capitals are surrounded by land counties as a kind of ‘cordon’ with an adjectival name derived from the particular city (Table 1).

**Table 1.** Analyzed units\*

City	The number of surrounding counties	Counties
Białystok	1	białostocki
Zielona Góra	1	zielonogórski
Gorzów	1	gorzowski
Rzeszów	1	rzeszowski
Olsztyn	1	olsztyński
Bydgoszcz	1	bydgoski
Toruń	1	toruński
Opole	1	opolski
Poznań	1	poznański
Kielce	1	kielecki
Lublin	2	lubelski, świdnicki
Kraków	2	krakowski, wielicki
Łódź	3	łódzki wschodni, pabianicki, zgierski
Wrocław	3	średzki, trzebnicki, wrocławski
Szczecin	4	goleniowski, gryfiński, policki, stargardzki
Gdańsk	4	Gdynia, Sopot, gdański, kartuski
Warszawa	7	legionowski, miński, otwocki, wołomiński, piaseczyński, pruszkowski, warszawski zachodni
Katowice	9	Chorzów, Mysłowice, Siemianowice Śląskie, Tychy, Sosnowiec, Ruda Śląska, będziński, mikołowski, bieruńsko-łędziński

\* Polish: białostocki = English: Białystok County, however, for clarity Polish names are used in the article, e.g. the name of Białystok refers to a city, whereas białostocki to the neighboring county.

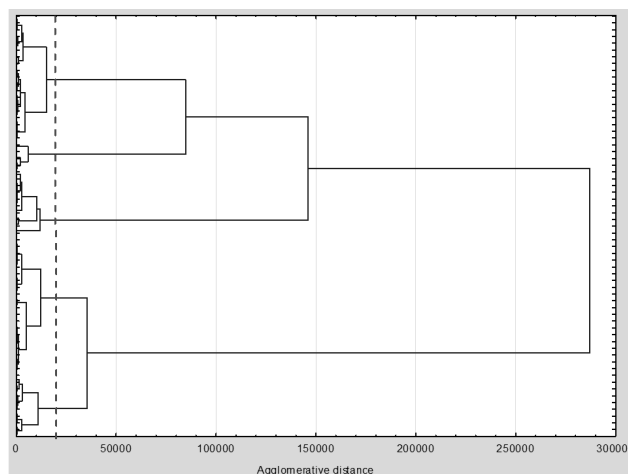
In two cases province capitals are adjacent to other cities with county status: Gdańsk and Katowice, with Katowice representing a province capital surrounded by the largest number of counties (6 cities with county status and three townships).

### 3. The classification results of province capitals and the surrounding territorial units at NUTS 4 level

The data cube includes 62 counties (18 province capitals and 44 neighboring ones) within the 10-year timeframe (2005-2014) – 620 rows and 5 columns (variables). The dendrogram developed using Ward method and the selected

classification results are provided below. The visual evaluation of the presented dendrogram suggests the division into five groups (Figure 1), with the centres of gravity (average share of employment in the identified sections) presented in Table 2.

**Figure 1.** The dendrogram of counties as taxonomic units (2005-2014) developed using Ward method



The grouping covered 620 taxonomic units (each county and a province capitals were described using the data about employment structure within the 10-year timeframe).

**Table 2.** Sectoral division of employment structure (%) – mean values in groups

Group number	Group code	Size	Sector				
			agriculture	industry	trade	finance	services
1	S	236	1,57	25,83	26,75	6,63	39,21
2	I-T-S	115	14,09	35,35	24,40	2,82	23,34
3	I	77	3,92	55,40	15,18	3,27	22,22
4	A	43	54,43	18,50	8,94	0,97	17,16
5	I-A	149	27,33	36,11	13,62	1,76	21,18

The first group includes the total of 236 taxonomic units, of which 21 were present in it throughout all the years covered by the assessment (Table 3). This group is characterized by definitely the highest average share of employment in the service sector and also the highest, comparing to other groups, average share of employment in trade and finance sector – this cluster includes units featuring the prevailing service oriented structure of employment.



**Table 4 cont.**

<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>	<i>11</i>	<i>12</i>
warszawski zachodni	1	1	1	1	1	1	1	1	1	1	10
będziński	1	1	1	1	1	1	1	1	1	1	10
poznański	1	1	1	1	1	1	1	1	1	1	10
starogardzki	1	1	1	1	1	1	1	1	1	1	10
gdański	1	1	1	1	1	1	1	1	1	1	10
zielonogórski	1	1	1	1	0	0	1	1	1	1	8
pabianicki	0	0	0	0	0	1	1	1	1	1	5
zgierski	0	0	0	0	0	1	1	1	1	1	5
wrocławski	0	0	0	1	1	0	0	1	1	1	5
bydgoski	0	0	0	0	0	1	1	1	1	1	5
pruszkowski	1	1	1	0	0	0	0	0	0	0	3
łódzki wschodni	0	0	0	0	0	1	1	0	0	0	2
legionowski	0	0	1	0	0	1	1	1	1	1	1
Gorzów Wielkopolski	0	0	0	1	0	0	0	0	0	0	1
Total per year	10	10	11	11	9	12	13	13	13	13	115

The third group, characterized by the average share of employment in the sector of industry at the level exceeding 55%, included the total of 77 taxonomic units, with six of them present in each of the analyzed years (Table 5). This group includes four townships: Mysłowice, Ruda Śląska, Tychy and Siemianowice Śląskie – the immediate proximity of Katowice.

**Table 5.** Classification results – units in the third group (I)

County	Year										Group size
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	
Mysłowice	1	1	1	1	1	1	1	1	1	1	10
Ruda Śląska	1	1	1	1	1	1	1	1	1	1	10
mikołowski	1	1	1	1	1	1	1	1	1	1	10
bieruńsko-lędziński	1	1	1	1	1	1	1	1	1	1	10
Tychy	1	1	1	1	1	1	1	1	1	1	10
policki	1	1	1	1	1	1	1	1	1	1	10
Siemianowice Śląskie	0	1	1	1	1	1	1	1	1	1	9
pabianicki	1	1	1	1	1	0	0	0	0	0	5
wrocławski	0	0	0	0	0	1	1	0	0	0	2
goleniowski	0	0	1	0	0	0	0	0	0	0	1
Total per year	7	8	9	8	8	8	8	7	7	7	77

The least numerous group number four, characterized by the definite predominance of employment in the sector of agriculture throughout the period of ten years, included four counties and two more in the first years of assessment only (toruński and krakowski) – Table 6.



**Table 6.** Classification results – units in the fourth group (A)

County	Year										Group size
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	
lubelski	1	1	1	1	1	1	1	1	1	1	10
rzeszowski	1	1	1	1	1	1	1	1	1	1	10
białostocki	1	1	1	1	1	1	1	1	1	1	10
kielecki	1	1	1	1	1	1	1	1	1	1	10
toruński	1	1	0	0	0	0	0	0	0	0	2
krakowski	1	0	0	0	0	0	0	0	0	0	1
Total per year	6	5	4	4	4	4	4	4	4	4	43

The fifth group, second in terms of size, includes units characterized by employment structure, in the analyzed years 2005-2014, similar in terms of this group average, i.e. industry and agriculture specific counties (Table 7).

This part of analysis approached counties in individual years separately, without a priori division into core counties and the neighboring ones, and primarily without assigning the neighboring counties to their core cities.

**Table 7.** Classification results – units in the fifth group (I-A)

County	Year										Group size
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	
miński	1	1	1	1	1	1	1	1	1	1	10
wielicki	1	1	1	1	1	1	1	1	1	1	10
świdnicki	1	1	1	1	1	1	1	1	1	1	10
gorzowski	1	1	1	1	1	1	1	1	1	1	10
gryfiński	1	1	1	1	1	1	1	1	1	1	10
średzki	1	1	1	1	1	1	1	1	1	1	10
trzebnicki	1	1	1	1	1	1	1	1	1	1	10
opolski	1	1	1	1	1	1	1	1	1	1	10
kartuski	1	1	1	1	1	1	1	1	1	1	10
olsztyński	1	1	1	1	1	1	1	1	1	1	10
krakowski	0	1	1	1	1	1	1	1	1	1	9
goleniowski	1	1	0	1	1	1	1	1	1	1	9
toruński	0	0	1	1	1	1	1	1	1	1	8
łódzki wschodni	1	1	1	1	1	0	0	1	1	1	8
zgierski	1	1	1	1	1	0	0	0	0	0	5
bydgoski	1	1	1	1	1	0	0	0	0	0	5
wrocławski	1	1	1	0	0	0	0	0	0	0	3
zielonogórski	0	0	0	0	1	1	0	0	0	0	2
Total per year	15	16	16	16	17	14	13	14	14	14	149

Such classification, along with the identification of the assignment to groups and the dynamic analysis is presented in the next section.





**Table 14.** Kraków and the neighboring counties in the period 2005-2014  
– classification results

County	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Kraków	S	S	S	S	S	S	S	S	S	S
krakowski	A	I-A	I-A	I-A	I-A	I-A	I-A	I-A	I-A	I-A
wielicki	I-A	I-A	I-A	I-A	I-A	I-A	I-A	I-A	I-A	I-A

**Table 15.** Gorzów Wielkopolski and the neighboring counties in the period 2005-2014  
– classification results

County	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Gorzów Wielkopolski	S	S	I-T-S	S	S	S	S	S	S	S
gorzowski	I-A	I-A	I-A	I-A	I-A	I-A	I-A	I-A	I-A	I-A

The surrounding counties (forming a close ring around the city) of the three province capitals (Rzeszów, Białystok and Kielce) were included in the fourth group, characterized by the prevailing share of agriculture specific sector in employment structure (Tables 16-18). There are province cities in Poland which have a typically agricultural support and the resulting employment structure in the neighboring counties.

**Table 16.** Rzeszów and the neighboring county in the period 2005-2014  
– classification results

County	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Rzeszów	S	S	S	S	S	S	S	S	S	S
rzeszowski	A	A	A	A	A	A	A	A	A	A

**Table 17.** Białystok and the neighboring county in the period 2005-2014  
– classification results

County	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Białystok	S	S	S	S	S	S	S	S	S	S
białostocki	A	A	A	A	A	A	A	A	A	A

**Table 18.** Kielce and the surrounding county in the period 2005-2014  
– classification results

County	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Kielce	S	S	S	S	S	S	S	S	S	S
kielecki	A	A	A	A	A	A	A	A	A	A

The next two cities Lublin and Toruń (Tables 19 and 20) are surrounded by counties characterized by agriculture specific (lubelski) or industry-agriculture employment structure (świdnicki) in case of Lublin, or changes from agriculture specific to industry-agriculture one (toruński).



**Table 23.** Zielona Góra and the neighboring county in the period 2005-2014 – classification results

County	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Zielona Góra	S	S	S	S	S	S	S	S	S	S
zielonogórski	I-T-S	I-T-S	I-T-S	I-T-S	I-T-S	I-T-S	I-T-S	I-T-S	I-T-S	I-T-S

**Table 24.** Bydgoszcz and the neighboring county in the period 2005-2014 – classification results

County	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Bydgoszcz	S	S	S	S	S	S	S	S	S	S
bydgoski	I-A	I-A	I-A	I-A	I-A	I-T-S	I-T-S	I-T-S	I-T-S	I-T-S

**Table 25.** Wrocław and the neighboring counties in the period 2005-2014 – classification results

County	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Wrocław	S	S	S	S	S	S	S	S	S	S
średzki	I-A	I-A	I-A	I-A	I-A	I-A	I-A	I-A	I-A	I-A
trzebnicki	I-A	I-A	I-A	I-A	I-A	I-A	I-A	I-A	I-A	I-A
wrocławski	I-A	I-A	I-A	I-T-S	I-T-S	P	P	I-T-S	I-T-S	I-T-S

The presented classification results indicate that the majority of ‘rings’, i.e. counties surrounding province capitals are stable over time in terms of employment structure specificity.

## Conclusions

Sectoral structural analyses at a lower level than NUTS 2 aggregation, due to data unavailability in the system of particular sections in the Statistical Classification of Economic Activities, remains difficult. The only possible assessment can be carried out in the grouped sections – in the system presented by the Central Statistical Office within the framework of Local Data Bank. Classification changes prevent performing long-term analyses, therefore the assessment provided in the article covered a decade only.

Based on the results of the carried out dynamic classification the following conclusions can be drawn:

- out of the total 62 evaluated NUTS 4 level units as many as 49 (i.e. 79% analyzed) presented the relatively stable employment structure in the period 2005-2014 – their assignment to groups did not change;
- in the analyzed period almost all province capitals – out of 180 counties as taxonomic units only Gorzów Wielkopolski was an exception in 2008 – were characterized by the service specific employment structure;

- for all Polish province capitals several types of neighborhood can be identified in terms of sectoral employment structure:
  - in the proximity of which the units characterized by service, industry-trade-service and industry-agriculture specificity are present (Warszawa and Gdańsk),
  - presenting a stable neighborhood structure: industrial (6 counties), service (2) and industry-trade-service (1) (Katowice),
  - surrounded by counties characterized by agriculture or industry-agriculture specific employment structure (Toruń and Lublin),
  - tight ring around a city characterized by the dominating share of agriculture specific employment structure (Rzeszów, Białystok and Kielce),
  - surrounded by the counties of industry-agriculture specific employment structure (Olsztyn, Opole, Kraków, Gorzów Wielkopolski).

The identification of prevalent sectoral employment structures on the one hand and the awareness of their transformation tendencies (trends) on the other support planning in terms of job market. It is also helpful for the business oriented decision making process in the context of locating business operations, or for local government units regarding the implementation of education profiles in upper-secondary schools, having in mind the anticipated demand for staff.

The results of conducted research can offer a useful tool in assessing the implementation and realization of the functional areas concept, primarily the functional areas of province centres<sup>4</sup> which, owing to their significance in terms of development, were grouped in the following way [Krajowa Strategia Rozwoju Regionalnego, 2010]: 1) Warszawa due to its predominant importance; 2) metropolitan centres (Kraków, Wrocław, Łódź, Gdańsk, Poznań, Szczecin, Bydgoszcz-Toruń, Lublin and Rzeszów); 3) other regional centres with an administrative function (province capitals: Opole, Kielce, Olsztyn Zielona Góra and Gorzów Wlkp.).

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<sup>4</sup> This province capital and the adjacent counties with population density exceeding 150 persons/km<sup>2</sup>.

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#### **MIASTA WOJEWÓDZKIE A ICH OTOCZENIE – OCENA ZMIAN W STRUKTURZE ZATRUDNIENIA Z WYKORZYSTANIEM KLASYFIKACJI DYNAMICZNEJ**

**Streszczenie:** Celem pracy jest identyfikacja grup miast i otaczających ich powiatów charakteryzujących się podobną strukturą zatrudnienia oraz kierunkiem jej zmiany. Grupy miast znaleziono przy pomocy metod klasyfikacji dynamicznej. Liczbę grup ustalono przy pomocy metody Warda, a ostateczny podział uzyskano metodą k-średnich. Analiza obejmuje okres 10 lat (2005-2014) i wykorzystano w niej informacje dostępne w Banku Danych Lokalnych GUS.

**Słowa kluczowe:** miasto, środowisko, struktura zatrudnienia, sektory gospodarki, klasyfikacja dynamiczna, NUTS 4.