

Urban public policy models as a reaction to the analysis of natural flows. The example of gravity fields of metropolises

Michał Kudłacz, Ph.D Sc.

(12pt., centred)

Statistical Office In Krakow

Poland

m.kudlacz@stat.gov.pl

Abstract

Here write the abstract (300 to 400 words; 11 pt. justified, spacing 1,0)

This article presents a synthetic analysis of the problem related to urban development. It concerns the relationship of the metropolis with the regional environment. It refers to the quantitative (indicative) understanding of the relationship between the metropolis and its surroundings. Quantitative methods were used in the research, which made it possible to present certain generalized conclusions regarding the nature and dynamics of the relationship indicated above, and secondly, certain dilemmas related to the limitations regarding the possibility of using quantitative methods in the conducted analyzes were indicated. The analysis was carried out by examining Polish cities, although the methods used and the dilemmas associated with them are universal. This paper presents only a fragment of extensive research and only one of three examples for which the author conducts constant analyzes of influence and relationships. The research has been conducted since 2002, but the indicators below refer to the years 2016-2022 if the dynamics of phenomena were counted and for 2022 in the case of static phenomena.

Keywords: urban policies, urban development, the impact of metropolises on the development of regions, the potential gravity model.

1. Introduction (12pt., bold)

The subject of the analysis in this paper is the issue of using quantitative methods in research on cities and urbanity, the nature of behavior and the impact of cities on specific phenomena. Therefore, these are issues related to urban economy, urban development policies, public policies, geography and spatial (territorial) development. As is commonly known, this type of research involves indicator analyses, but questions arise, firstly, regarding the possibility of using specific quantitative methods, and secondly, the availability of statistical data: comparable and adequate. It can be said that economic analyzes are a kind of "fuel" for drawing conclusions in the area of broadly understood public policies and research on territorial development. Examples of illustrating

the indicated dilemmas regarding the adequacy, effectiveness, purposefulness and accuracy of conclusions based on quantitative data include a scientific and research problem: the metropolis-regional environment relationship.

In a certain practical sense, it was easiest for the author to consider the above dilemmas on the example of Polish cities, due to the author's origin, knowledge of these urban systems, and access to comparable data from databases of Polish public statistics; as well as the comparability of Polish cities, which are good examples for conducting comparative studies due to the fact that the Polish settlement system is polycentric. It was therefore a natural, simplest solution, while the polemic on the adequacy of the methods is universal and implementable to virtually any examples (settlement systems) in the world. Certainly, in different cases we will obtain different answers regarding the different availability of indicator data, their adequacy, quantitative methods, etc. The research methods used resulted directly from the availability of data, so the limitations in the possibility of using specific methods are a consequence of the limited availability of data. This paper also aims to stimulate discussion on the possibilities of expanding data availability.

The problem of the relationship between the metropolis and the regional environment is, on the one hand, well researched in the literature on the subject, but on the other hand, this problem is ambiguous in its assessment. Already in the 1930s, Christaller wrote about the theory of place benefits, showing that economic benefits can be gained due to the location in relation to various types of resources that can be used to dynamize development paths. This concept was introduced in a slightly different dimension by Francois Perroux in the late 1950s in the concept of "development poles", writing first about the development of entrepreneurship, which was transposed to issues related to regional development. According to Perroux, there are development poles (strong enterprises or entrepreneurial industries) that can stimulate the development of other industries or enterprises, even those completely unrelated to the first one. This way of thinking was then translated into issues related to territorial development: economically strong cities can influence other territories (e.g. municipalities), unrelated in

interests to the former, by creating natural opportunities to use the potential of the metropolis (core city, development pole): sales market, labor market resources, knowledge and innovation resources, etc. The development of these communes is not in the direct interest of the metropolis and is therefore not the main perspective of the development policy. Here, being more privileged due to location matters. In the 1980s, the Anglo-Saxon and Scandinavian schools developed, which also referred to the metropolis-regional environment issues: the spill-over concept and the theory of diffusion of innovations. Both say that there are certain natural channels for the transfer of resources from the city to the development that stimulate this environment, pointing out that location can create opportunities for the development of other areas (but the opposite is also possible), that the mere presence of the city worsens opportunities development of other areas: a city may "take" resources from territories if they are peripheral to these strong cities, that is, if it is "too far" to commute to large metropolitan cities to work, study, etc. every day, then, especially young people, move there. By moving out of a place with little prospects, they further weaken it, strengthening the metropolis with their arrival (becoming its resource). Thus, this leads to the perpetuation of the phenomenon of socio-economic polarization, i.e. the widening of the development distance, material status and development opportunities (prospects) between the privileged and the excluded, as discussed in more detail below. The problem is that these phenomena are quite common, and a certain dilemma is the occurrence of both phenomena at the same time: the spillover of resources and, on the other hand, their drainage. Since the second half of the 20th century, the global and regional economy has been commonly understood in the context of "nodes" of the flow of goods, services, information, financial capital and human resources. Metropolises are a natural reservoir of knowledge and innovation, financial resources, labor market, sales market, etc. It is also worth looking at the social dimension of the perception of metropolises, related to the quality of life, which to some extent explains the "popularity" of economically strong cities. In times of globalization of the economy, one of the dominant megatrends was metropolisation, i.e. a common trend all over the world related to people moving to economically strong cities, where, in addition to traffic jams, unhealthy air, lifestyle diseases and rush, they can also count on above-average high earnings and job security, much better opportunities for development and self-fulfillment as well as the perfection of services provided in the city. Therefore, as estimated by the World Bank, in 2050, approximately 75% of the population of over 9 billion will live in metropolises or their functional surroundings (direct range of positive impact). The world was therefore divided territorially into the so-called "nodes", i.e. places that create, accumulate and exchange resources, and the so-called "communication tunnels", i.e. peripheral spaces where resources "do not stop". A characteristic fact is that the fastest and most effective transport connections in the world are metropolis-metropolis connections. The

described concept belongs to liberal theories explaining the nature and logic of territorial development in the local dimension from an economic point of view, which divides the world into territories that are growing and places that are losing, retreating in relation to other, economically strong settlement systems. If this logic were to be followed, then it would be theoretically necessary to assume that the way a metropolis influences its surroundings may be positive or negative, strong (significant) or weak (insignificant), and the dynamics of this relationship may have an increasing or, on the contrary, decreasing tendency. It is worth noting at this point that the concepts described above are not the only ones that explain the nature of the relationship between the metropolis and its surroundings, but those already indicated illustrate a certain dilemma, the dualism of these relationships, which requires examination using quantitative methods. The research dilemma posed by the author here concerns how economically strong cities influence the development of the regional environment, but not in general, but in detail. The regional environment is the administrative regions in Poland (NUTS-2). The study was carried out on the example of the city of Cracow and the Lesser Poland Voivodeship, the city of Wroclaw and the Lower Silesian Voivodeship, and the city of Warsaw, which is the capital of the Masovian Voivodeship.

Below, only some of the research on the issues of the metropolis-regional environment relationship is presented. The following assumptions were made:

The following assumption (thesis) is of fundamental importance, fully justified in the light of known concepts of regional development:

If a given city influences the development of its surroundings, then, according to the principle of gravity, this influence has a decreasing distribution in relation to the distance (range of influence).

In the light of this thesis, appropriate measures of the development of territorial units surrounding the city under study should show a decreasing tendency as their distance from the metropolis increases. Taking this into account, in an appropriately designed study, the distance from the metropolis will be of fundamental importance. The leading hypothesis of the analysis presented in this part of the work is the one resulting from the principles of gravity:

The level and dynamics of development of territorial units constituting a given region depends on their distance from the voivodeship city.

The following research assumptions were adopted:

1. The basic unit of analysis will be the commune. Larger units, e.g. counties, although with a richer information base, seem to be too generalized to verify the hypothesis formulated above.

2. The adoption of the commune as the unit that is the basis for the analysis results in the fact that no indicators synthesizing the general level of development are available at this territorial level. In order to assess development phenomena, it is therefore necessary to use generally large sets of information that illuminate various aspects of development phenomena. Therefore, the analysis was based on an extensive set of 82 appropriately constructed indicators.

From the methodological point of view, the analysis was based on relatively simple methods of examining interdependence, namely correlation analysis and regression calculus. Appropriate regularities were searched for in the collections of all municipalities, separately for each of the examined voivodeships. The vast majority of the indicators taken into account are stimulatory in nature¹. Only a few concern destimulants. To avoid misunderstandings, it should be noted that the set of indicators also includes features whose properties (stimulant or destimulant) depend on the context of their use. For example, a clear destimulant is the feature "unemployed compared to the working-age population". However, when analyzing, for example, the feature "percentage of the population at post-working age", we notice that it is a destimulant if it is to be measured. demographic resilience of a given territorial unit. However, when we use it to reflect the level of overall development, it becomes a stimulant. The high share of the population in post-working age can be interpreted as a consequence of the high level of health care and a healthy lifestyle of the population. These distinctions are taken into account in subsequent assessments.

Four more general groups of phenomena can be identified which are covered by the discussed features. These are:

1. Demography and elements of the local labor market.
2. Infrastructural equipment regarding the living conditions of the population.
3. Revenues and expenses of municipalities.
4. Business entities.

The relationship between each indicator and the distance from the metropolis was examined. The research will be carried out separately for each year (6 years) and each voivodeship (3 voivodeships). This means that appropriate statistics had to be prepared for 18

¹ A stimulant is a feature whose higher values indicate a higher level (dynamics) of development of the individual it describes; destimulant, on the contrary, higher values are assigned a lower level of development.

independent data sets. The size of each of these sets is determined by the number of features (82)² and by the number of territorial units of each of the surveyed voivodeships (169 - Lower Silesia; 181 - Lesser Poland Voivodeship, 314 - Masovian Voivodeship).

Attention should be paid to the information value of the adopted features: most of them, in addition to direct own information, also provide knowledge about many other properties of the territorial units they concern. A classic example would be indicators illustrating the phenomenon of migration. It is known that the intensity of this phenomenon is related to the degree of mobility of a given community, which to some extent may measure the quality of both social and human capital. The migration balance is closely related to the degree of satisfaction of a given community with local conditions and standard of living.

Recognizing that the features that turned out to be significantly correlated with the distance of communes from their metropolises represent different aspects of the level and dynamics of development of territorial units, the findings of the conducted analysis lead to an important general conclusion - confirming the hypothesis put forward above: as we move away from the metropolis, the manifestations of development deteriorate socio-economic. From this conclusion, which is basically irrefutable in the light of the results obtained, a conclusion can be drawn by induction, directly related to the subject of research: metropolises have a positive impact on the development of the areas surrounding them.

the main findings of the conducted research should be emphasized once again:

1. Each of the indicators taken into account, characterizing the communes of the three studied voivodeships, highlights some aspect of the level or dynamics of their development. When considering and interpreting the relationship with the development of communes, we were not limited only to the phenomenon exactly represented by a given feature, but to a much broader spectrum of phenomena that are either determinants of their value (e.g. the amount of income from personal income tax) or their consequences (e.g. business entities from sections deciding on institutional support for local business).

2. The main part of the indicators taken into account in their spatial distribution was related to the distance of communes from the voivodeship capital. With a very small exception: this relationship is inversely proportional for stimulants and directly proportional for destimulants. This leads to an unquestionable conclusion: as the distance from the metropolis increases, the general level of development of communes decreases.

² For some years it was not possible to obtain the full number of characteristics. The indicators presented in the appendix of this paper were selected for the final examination and standardization of the features.

1. The above statement allows for a highly probable assumption that the source of the observed regularity is the metropolis; its development potential influences the development dynamics of the surrounding areas. According to the properties of the spatial distribution described by the gravity model, this influence decreases as the distance from the source of the influence increases. The certain universality of the established regularity strongly supports the validity of such a conclusion. It concerns a relatively large number of features and is simultaneously observed in all three voivodeships. Definitely the strongest in the Masovian Voivodeship, but it should also be noted that the potential of the Warsaw metropolis is significantly higher than that of the other two cities.

Using an appropriate methodology, a synthetic index of the development of communes was calculated. For this purpose, a relatively simple "min-max" method of summed standardized features was used³. The basis for the generalized assessment are selected features showing a significant relationship with the distance of communes from their metropolises⁴. It is worth recalling that with the adopted method, the synthetic development index takes values in the range [0; 1].

³ Calculations were also made based on the so-called development pattern method. Its results showed high convergence with the method of summary standardized features. Therefore, they were no longer included.

⁴ It is worth explaining that the method of summary standardized features is not one based on the so-called Euclidean space. Therefore, the feature reduction procedure based on their correlation matrix was abandoned.

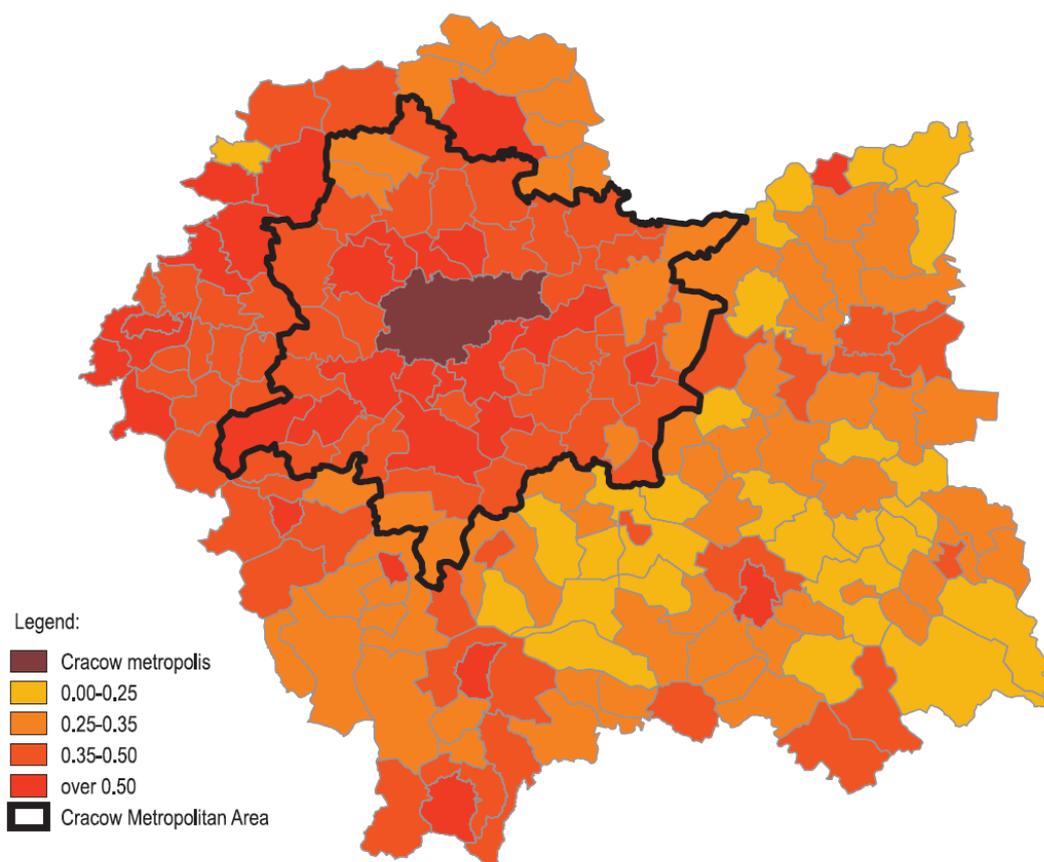


Figure 1. Spatial distribution of economic potential in individual gminas of Małopolskie Voivodeship

A careful analysis of a sample map for Krakow and the Lesser Poland Voivodeship reveals what is most important from the point of view of the topic being implemented, namely: the relationship between the achieved development of territorial units and their location in relation to the voivodeship city. There are relatively more communes with a higher level of development closer to the metropolis than in more distant areas. In the case of the Lower Silesian and Lesser Poland voivodeships, there is a clear asymmetry in the spatial distribution of differences in development. In the first of them, a large concentration of potential takes place in the latitudinal zone, exposing the close surroundings of Wrocław; in the Lesser Poland Voivodeship, however, there are differences between its western and eastern parts⁵. This asymmetry is not noticed in the Masovian Voivodeship. In all the studied voivodeships, the pattern described is "disturbed" by a number of "islands" that do not fit the described pattern.

⁵ Wyższa koncentracja potencjału rozwoju w zachodniej części województwa małopolskiego może być wynikiem oddziaływania konurbacji śląskiej.

They are most often the result of the activity of larger cities in individual voivodeships, which create their own local development poles.

The areas in the immediate vicinity of the studied metropolises deserve special attention. They are marked on maps as metropolitan areas. First of all, it is worth noting the relatively high development potential of these areas, which clearly differs from other parts of voivodeships. They concentrate municipalities with development indicators in the highest numerical ranges. Three important conclusions follow from this observation:

1. The concentration of high development indicators in the metropolitan area undoubtedly fits into the argumentation of our main hypothesis, about the influence of metropolises on the development of regions in the examined cases. It would be difficult to find a driving force behind such a spatial distribution of development potentials other than the influence of the central city.

2. The relatively uniform and high level of development of the metropolitan area, with the corresponding role of a large city, justifies the recent efforts to achieve appropriate organizational integration of metropolitan areas, allowing for the synchronized management of their development (including the discussion of drafts of the so-called "Metropolitan Act"). .

3. The obtained results confirm that metropolitan areas, understood as the appropriately delimited surroundings of metropolises, are not a virtual reality, but an actual one (although this generalization is presented on the basis of only three voivodeships).

Summary

The obtained results allow us to formulate some very interesting conclusions regarding the impact of metropolises on the surrounding areas.

1. A significant part of the indicators included in the analysis do not show a significant correlation with the distance of communes from the metropolis. However, it would be difficult to expect a full correlation in this respect. One of the features of the analysis carried out - its purpose - is to search for the assumed relationship in a broader set of features, and it should be admitted that quite a set of indicators confirming such a relationship was identified (the dependence of development on the distance from the metropolis).

2. The correlation coefficients included in the tables, although statistically significant, are far from their maximum values (-1; +1). But also in this respect it should be borne in mind that the study concerns a certain general regularity, the development of the values of development

indicators depending on the distance of communes from the metropolis. Such regularity, if it exists, is disturbed by many factors whose influence we cannot eliminate.

Therefore, it can be assumed that statistical significance is synonymous with substantive significance. Even a small correlation allows us to conclude about the city's influence on the appropriate development of the surroundings.

3. Perhaps the most important comment concerns the sign of the vast majority of correlation coefficients. This is a negative correlation, which means - as predicted by the gravity model - that the intensity of a given phenomenon decreases with distance from the provincial city. Only a few features show a positive correlation, which, as it turns out, is also generally logical in the light of the relationship under consideration, because it basically refers to the so-called development destimulant (the higher the value, the worse the development certificate of a given territorial unit). Positive correlation is indicated by:

a) the level and dynamics of unemployment, which means that the further from the metropolis, the greater the intensity of unemployment,

b) the percentage of the population at pre-working age, which can also be considered a destimulant, because in Poland it is noted that demographic resilience concerns areas that are less economically and civilizationally developed,

c) the only exceptions in this respect are: the percentage of the population of post-working age, the share of entities in section H and the dynamics of the percentage of the population of working age

4. The substantive significance of the considered regularity (the influence of the city on the development of the surroundings) is confirmed by another clearly visible property resulting from the determined correlations. Features correlated with the distance of communes from the provincial city retain the same coefficient sign in all years for which this correlation is statistically significant. Therefore, the randomness of the results obtained cannot be suspected when the existence of a given regularity is repeated many times. The correlation coefficients of all features included in tables 4.7 - 4.9, without exception, indicate the same direction of dependency in all years. Additionally, if a given indicator appears in more than one voivodeship, the direction of the relationship is again the same without exception.

5. There are differences between individual voivodeships in the degree to which the studied phenomena are correlated with the distance from the metropolis. These differences concern both the number of features showing significant correlations with distance and the height of correlation coefficients. The discussed regularity is least visible in the Lower Silesian Voivodeship, slightly more in the Małopolskie Voivodeship, and most clearly in the Masovian Voivodeship. Perhaps this is due to differences in the overall potential of the metropolis, measured e.g. by population; Wrocław approx. 630 thousand, Kraków 760 thousand, Warsaw

1,700 thousand. In the Masovian Voivodeship, apart from a large number of significantly correlated features, the coefficient values do not raise any doubts as to the significance of the relationships they reflect.

In the light of the research conducted, several additional conclusions should be drawn.

Firstly, the theoretical concepts presented in the literature, which are to constitute a justification for the chosen direction of the analyses, require critical judgment. From the entire spectrum, those that most adequately cover the defined tasks should be selected. This issue was the subject of more detailed considerations, also in the second chapter. The presented findings show that the theory of development poles, the theory of cumulative causality and models of gravity and interregional flows constitute a particularly important theoretical context for the empirical analyzes of this work. Although the latter two models refer to specific analysis techniques, their general concept allows us to delve into the essence of the connections between the metropolis and the surrounding region, thus providing an important support in the interpretation of the obtained results.

Secondly, an important limitation of the scope of the analyzes performed is the available information base on the compounds under consideration. This has serious substantive consequences. The above-mentioned limitations mean that in the analyzes used there is sometimes a need to refer to substitute concepts that only indirectly reflect the examined relationships. Such procedures are necessarily also used in this work. They were outlined in the part discussing the scope of the analyzes performed (subchapter 3.1). An important issue in such a situation is to justify the validity of the research approach used.

Thirdly, limitations in the availability of statistical data also determine the analysis techniques used. The statistical requirements of many methods, very interesting in the light of the research objectives, are too high in relation to the possibility of obtaining the necessary numerical data. A classic example here is the method of interregional flows. This ultimately leads to the use of methods that are simple in nature, generally less comprehensive in covering the examined relationships, but at the same time with clearly interpretable results. In further analyzes, the group of correlation and indicator methods is most widely used. It is also worth mentioning that difficulties in obtaining statistical data also result in the previously described need to use the so-called symptomatic indicators.

References

1. Chojnicki Z. (1966), *Applications of gravity and potential models in spatial and economic research*, PWN, Warsaw, 1966.

2. Korcelli P. (1995), *The Polish urban system and its international links*, [in:] M. Palomaeki, J.A. Karunaratne (eds.) (1995), *Urban development and urban life*, Acta Vasaensia, Geography, 45 (6), Universitas Vasaensis.
3. Kudłacz M., (2013), *Development of Metropolitan Areas in Poland Based on the Example of Cracow Metropolitan Area*, "Studia Regionalia", vol. 35, pp. 207-222.
4. Kudłacz M., (2012), *The place of metropolises in the development potential of regions on the example of the Lower Silesian, Małopolskie and Masovian voivodeships*, "Zeszyty Naukowe University of Economics in Kraków", No. 888, pp. 77-95.
5. Kudłacz M., (2012), *Development of metropolitan areas in Poland - natural processes and development programming on the example of the Warsaw Metropolitan Area* [in:] Molendowski E. (ed.), *Globalization and regionalization in modern times*, University of Economics in Krakow, p. 156-167.
6. Myrdal G. (1958), *Economic theory and economically developed countries*, PWG, Warsaw, 1958.
7. Pacione M. (2002), *Urban geography, and global perspective*, Routledge, 2002.
8. M.E. Porter (2003), *The Economic Performance of Regions*, "Regional Studies", vol. 37, no. 6–7, pp. 549–578.
9. Rogers E. M. (1995), *Diffusion of innovations*, The Free Press, New York 1995,
10. J. Simmie (2003), *Innovation and Urban Regions as National and International Nodes for the Transfer and Sharing of Knowledge*, "Regional Studies", vol. 37, no. 6–7, pp. 607–620.

ANNEX

Selected features to study the impact of metropolises on the development of the region

1. Distances
2. Population density
3. Percentage of women
4. Percentage of population in cities
5. Net migration to population (per thousand inhabitants)
6. Average value of migration balance
7. Migration rate (check-in-check-out)/(check-in + check-out)
8. Percentage of the population at pre-working age
9. Percentage of the population of working age
10. Percentage of the population in post-working age
11. Percentage of the population with higher education
12. Percentage of councilors with higher education
13. Working people to the working-age population
14. Working in the agricultural sector to the working-age population

15. Those working in the industrial sector to the working-age population
16. Those working in market services to the working-age population
17. Professionally active to the working-age population
18. Active people of working age to the total population of working age
19. Unemployed to the working-age population
20. Usable area of completed apartments per thousand inhabitants
21. Total dwellings per thousand inhabitants
22. Electricity consumption in households in cities per thousand population
23. Total budget revenues per capita
24. Own income per capita
25. Share of own revenues in the total revenues of the commune budget
26. Property tax revenues per capita
27. Property income per capita
28. Income from participation in PIT per capita
29. Income from share in corporate income tax per capita
30. Total budget expenditure per capita
31. Capital expenditure per capita
32. Share of investment expenditure in the total expenditure of the commune budget
33. Population density dynamics
34. Dynamics of the percentage of the population at pre-working age
35. Dynamics of the percentage of the working-age population
36. Dynamics of the percentage of the population in post-working age
37. Business entities from the modern industry per thousand inhabitants
38. Number of jobs in industries classified as modern per thousand inhabitants