

PARETO CHART: A TOOL TO EVALUATE DEVELOPMENT OF REGIONAL DISPARITIES

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Abstract: *This paper seeks to demonstrate how the Pareto chart can be used as a tool to evaluate development of regional disparities. The introduction of the chart is followed by its application to the regions of Visegrad Group states. The σ -convergence approach has been used as a benchmark to examine the estimates arrived at using Pareto chart. The results found that Pareto chart has a good predicative ability, since all conclusions of its application on regional disparities development have been confirmed by σ -convergence analysis. Moreover, the chart includes additional information about changes in some sample sections, growth, and eventually order. This extra information may be used to develop more comprehensive conclusions about changes in disparities over time. Furthermore, interpretation of the chart is very easy and calls for no extra knowledge acquisition in its use, which is an advantage for other fields' researchers, bureaucracy and political decision makers, and both expert and non-expert public. With all that in mind, we guess the Pareto chart is a very interesting tool to evaluate development of regional disparities, which can be used as the sole source of information or as a complement to another approaches of disparity measurement.*

Keywords: *disparity measurement, Pareto chart, Visegrad Group, development.*

JEL Classification: *R12, O47, Y10.*

Introduction

The long-term existence of significant socio-economic disparities across societies led towards quite logical attempts of analytical quantification during the development of economically oriented disciplines, while the quantification is a prerequisite for disciplines' effective directing. The reason for the interest in the issue of disparities is obvious, since economic systems burdened by high inequality are seriously limited by this handicap, and cannot fully realize their growth potential, thus effectively facing a significant obstacle to their own development [1]. Restrictions on economic performance is then also, of course, reflected in other related, and for society, highly sensitive areas, one of which the level of living standards of the population may be mentioned in particular [15]. In this context, however, we cannot completely forget some positive effects generated by disparities - but just because of the existence of certain, however "reasonable" differences, can be regarded as a stimulus and factual condition for progress [6]. In other words, socio-economic disparities should only be regulated, not entirely eliminated in order to the growth and development of any territorial unit burdened with them. Knowledge of the extent and development of disparities can literally be described in the best way as a cardinal prerequisite for development, as the realization of any activity with the aim of their influencing may not be desirable for growth and development, and moreover these activities are usually associated with spending a considerable amount of economic resources, whose economic efficiency and effectiveness is necessary to systematically evaluate [9].

1 Statement of a problem

Although the issue of disparities is a long-term and global problem at the general level, an important impulse, which in the development of their studies in the last decades has significantly been contributing, is the effort to achieve solidarity across EU countries and regions. The availability of a sophisticated analytical apparatus for estimating regional disparities is an essential prerequisite for the formulation of successful regional policy, as well as an evaluation of its application capabilities, and necessary continuous correction. Within the theoretical and practical applications, and over time, some basic directions came into existence, through which we can approach regional disparities for evaluation. Although the methods used under these directions are generally oriented towards a single goal – to quantify the disparities development – followed on from the same neoclassical postulates – particularly the natural tendency of economies to a state of their long-term equilibrium – and generally they very often agree in results, it being necessary to remark the ways their implementation substantially differ. In terms of the most common approaches to economic disparities evaluation it would probably be possible to indicate the following directions:

- β -convergence, which is based on the assumption of the inverse relationship between the level of production and long-term growth, while generally using estimations through various forms of linear, or linearized, regression models [11, 3, 2];
- σ -convergence, which is also based on the assumption of the neoclassical natural tendency of economies to a common long-term equilibrium, while generally lying in the evaluation of dispersion or variability across a reference sample [2, 3];
- data distribution analysis by means of using non-parametric estimations of the shape of density function, usually based on the description of Markov chains, or transition probability matrix [14];
- econometric approaches based on the analysis of deterministic and stochastic trends' components of time series through cointegration analysis [4, 13].

Methodological variability, on the one hand, allows selection procedures due to a different extent of the accentuation of relevant variables more suitable to the specific objective evaluation; on the other hand, this freedom attributes a certain degree of entropy to the results of the evaluation, because the choice of specific methods is subjective to a large extent, while the analogy of their results is not universal. Concerning the abovementioned theoretical measurement directions of disparities development, it can be generally stated that, in principle, it is not about the approaches that would have mutually substituted, but it is rather about the complements, since the advantages of one group of methods can be generally considered as the disadvantages of another one, and vice versa. For example, in β -convergence and σ -convergence concepts, we may mark as crucial advantages the lower knowledge requirements of mathematical and statistical apparatus, the calculation (un)demanding and easy interpretation of results. On the other hand, the results of these methods are basically just summary characteristics describing a given territorial unit, which completely abandons the provision of detailed information about their own composition, and thus about causes of the development in terms of changes within the sample regions. Analogously opposite conclusions can then be developed towards methods for

disparities evaluation by means of analyzing the data distribution and econometric models, which usually provide “complete” information that is possible to de-compose to the level of individual regions, or pairs, and therefore identify the partial causes of development tendencies. These methods are then logically more demanding, particularly when their interpretation requires a deeper methodological knowledge of both the presenter and the recipient’s side.

Given approaches may also be considered in certain exaggeration as opposite poles however, lacking the “middle way” between them, which would offer simplicity and easy interpretation, yet maintain sufficient information for a basic partial analysis. The method, which would have offered the usability potential not only in the context of empirical studies, but the results would have been, without necessity of more detailed study of partial steps, clear enough also for inexpert audiences from other fields, like the political-bureaucratic apparatus, but also the wider public. The authors of this paper assume that the so-called “Pareto analysis” or “the Pareto chart” could be an instrument suitable for the number of the abovementioned points, as well as serving as a suitable form of evaluation of the development of regional disparities.

In connection to the abovementioned, the aim of this paper is to demonstrate the usability of an alternative approach to the evaluation of the development of regional disparities, specifically of the application of the Pareto chart, and assess its usefulness as a tool which through graphic expression to some extent is able to combine the advantages of the undemanding and simple interpretability, as well as preserving information useful for a more detailed evaluation of specific causes of development for the disparities of the whole unit.

2 Methodical

As already indicated, this paper orients its focus on the evaluation of the advantages of regional disparities by using the Pareto chart, so it is certainly quite appropriate to specify this tool. Generally, the Pareto chart is designed as one of the seven basic tools of quality improvement defined by Kaoru Ishikawa [7]. In the Juran defined concepts [8] Ishikawa used, a diagram is essentially an application of the famous Pareto 80/20 rule, which has been interpreted by using a combination of column and line graphs simultaneously capturing the sequence, frequency and cumulative relative frequency within a given sample. In the field of quality management, this diagram is often used as a tool for simple error analysis. Its application, however, downright offers itself in the regional disparities evaluation since the used cumulative relative frequency (line graph) is nothing else than the inverse expression of the notoriously known Lorenz curve [10], commonly used in economics to demonstrate wealth distribution in society. In combination with a (column) graph of aligned absolute frequencies, or when applying weighted values in the field of regional development (e.g. per capita), it can then be easily read from the graph how individual parts of the sample, or even specific regions, diverge from one another.

The disparities development evaluation through the Pareto diagram then lies in the visual comparison of two or more periods. This crucial advantage of the approach is, however, its most significant drawback to some extent. Although the Pareto chart can be described as clear for comparing a single, two or three periods, its clarity undoubtedly decreases with a growing number of the compared periods within a single

field of the graph. Other apparent disadvantages arising from the principle of visual comparison is a limited ability to estimate the extent of disparities, as well as the evaluation of their development in the case that in terms of the partial convergence and divergence tendencies, the individual parts of the sample are fundamentally differentiated. On the contrary, a great advantage of diagram application while comparing can undoubtedly mark the information content not only concerning the changes in disparities, but also the values of the monitored indicator and their changes, or extreme values, growth, etc., which other methods of disparities evaluation usually do not provide directly.

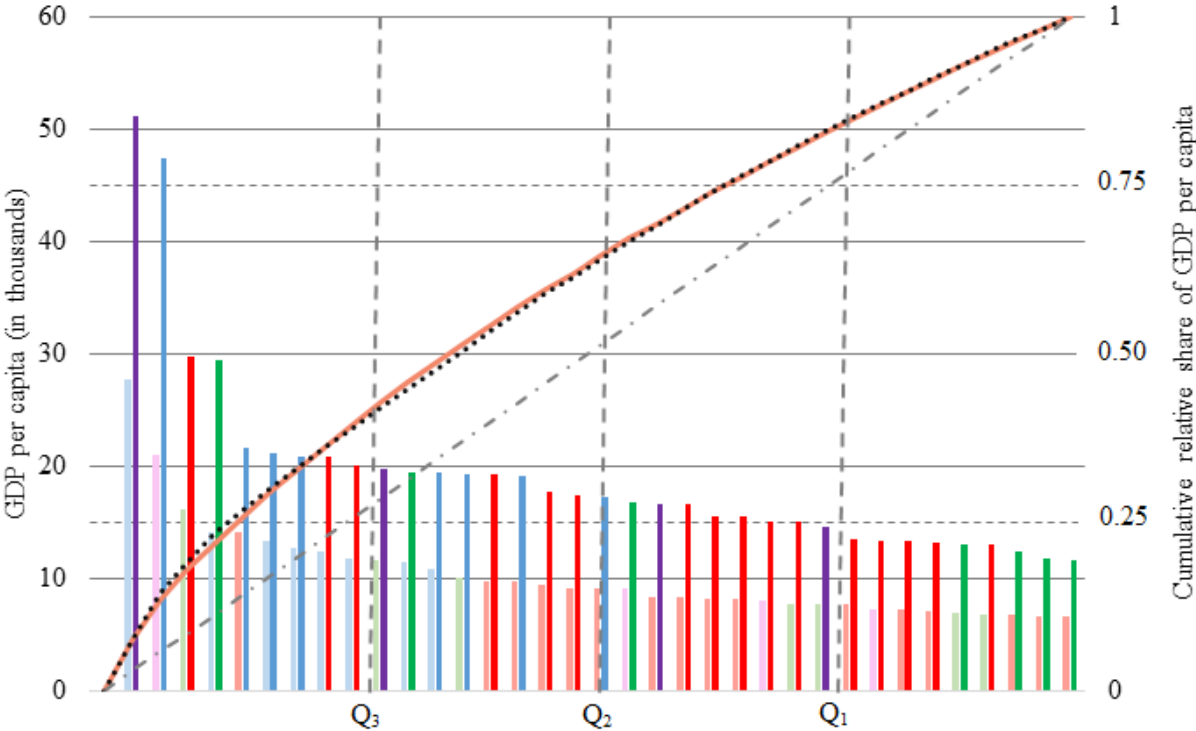
For the purposes of achieving the defined targets, the usability of the Pareto chart will be demonstrated on the disparities development indicator of GDP per capita (in purchasing power parity) between the NUTS II regions of the Visegrad Group countries, a total of 35 regions, of which 8 are Czech, 7 Hungarian, 16 Polish and 4 Slovak. The development was evaluated between 2000 and 2014, using source data from the Eurostat database [5]. In order to evaluate the usability of the Pareto chart method for evaluating the development of regional disparities, the findings will be confronted with the results of the disparities measurement through σ -convergence, namely by monitoring the development of the coefficient of variation. For the purposes of this paper there appears from the four abovementioned directions, the use of σ -convergence, as the “benchmark” method, seeming the most suitable because β -convergence is a formally necessary, but not sufficient, condition for σ -convergence [12], while in comparison to the analysis of the distribution by using non-parametric estimates and econometric methods, it is a very simple and easily interpretable method, not necessary to extensively delimit now. The coefficient of variation is then chosen because of its good information value, comparability and customary use in solving disparities development by using the variability in many relevant studies [16, 12].

3 Results and discussion

Disparities development in GDP per capita of regions in the Visegrad group countries in the period 2000-2014 is shown in Fig. 1. Already at first sight it is clear, that thanks to the lines expressing distribution through the cumulative relative GDP per capita, the extent of regional disparities when comparing the years 2000 and 2014 has not change so much, when their deviation from the line of equal (uniform) distribution (gray-dashed) remained approximately at the same level. The area between the lines of equal distribution and real distribution can be marked as the range of disparities, or it is equal to the Gini coefficient, which can also be used as one of the methods of evaluating disparities in terms of σ -convergence approaches. The differences in regions disparities located between individual quartiles (Q) can be easily read from the curves and these differences are mostly very similar in both years being compared. There is a higher deflection of the curves between the most developed region and Q₃, as well as clear evidence of a relatively higher range of disparities among the regions with higher GDP per capita between Q₃ and Q₂. Furthermore, there is a convergence of both lines to the line of equal distribution in the Q₂ and Q₁ range, as well as in the bottom quartile (between Q₁ and the least developed region) which is the sign of a relatively lower range of disparities between the less developed regions.

From the comparison of lines in the real distribution of GDP per capita, it can then be easily deduced that while the disparities ranging in the bottom half of the sample remains unchanged because of the practically identical shape of the curves in both reference years, there were some changes in half of the developed regions (between the most developed region and Q_2) that are rather obvious even though they are based on visual inspection. Specifically, due to higher deflection (black dotted) line, which expresses disparity in 2014, it being clear that the disparities range between the most developed regions is higher in comparison with 2000 (solid orange line). Likewise, it is obvious that this trend is then reversed when the curve of the year 2014 converges to the curve of the equal distribution and is closer than the curve of the year 2000, while this reduction in the range of disparities is most noticeable between Q_3 and Q_2 .

Fig. 1: The Pareto chart of disparities in GDP of the Visegrad Group regions (2000 and 2014)



Legend: lighter colors in the columns express the GDP per capita in 2000 (blue – Czech, green – Hungarian, red - Polish, purple - Slovak regions; deeper colors represent the situation in 2014 (shades analogically), full (orange) line indicates the cumulative relative share of GDP per capita in 2000; (black) dotted line analogically for 2014; (grayed out) dot-dashed line represents the situation of an equal distribution of GDP per capita among all regions; Q_1 , Q_2 and Q_3 indicate quartiles.

Source: own calculations based on [5]

The absolute values of regional GDP per capita, shown in the diagram in columns, confirm these findings. The differences between the values of (deeper) columns that represent 2014 as compared to the (lighter) columns in 2000 are more pronounced at first glance among the most advanced regions. Likewise, it can be concluded that disparities among regions in the Q_3 and Q_2 range relatively decreased due to GDP growth while the distribution changes are barely visible in the regions located between the median (Q_2) and the least developed region. Although it is possible to assume from visual comparison in this case that the absolute differences are slightly higher, when considering the growth factor, which is also evident from the diagram, it is obvious that the change of the disparities range will be practically minimal in a relative

statement. Just the information about changes in the GDP per capita values is such a major benefit, which allows the inferring of more complex conclusions from a Pareto chart about regional development, not only of changes in disparities, but also in terms of changes in economic performance, or lost growth. The diagram also shows that the deviation of the four most developed (metropolitan) regions significantly grew from other ones.

As shown in Fig. 1, it is clear when evaluating a lower number of regions, that it is possible to monitor changes in disparities within the partial groups to a certain extent thanks to the color resolution of columns. In terms of the development of regional disparities within each country, it is then possible, due to significantly diversified growth, to quite safely state that between 2000 and 2014 there was a divergence between the regions of Slovakia (purple). The changes in position within the sample and acquisitions of different size are less obvious for other countries, and therefore it is not possible to derive reliable conclusions for the development of their internal disparities. Furthermore, it is possible to see that Slovak regions are associated more with higher growth, causing their movement to the left in the diagram, or towards the developed regions. Similar tendencies are also evident with Polish regions (red). The opposite tendencies, or the fall in ranking, are again visible in Hungarian regions (green), four of them located among five of the least developed regions in 2014. Downward tendencies are also visible in some Czech regions (blue), even though they all were located in the middle of more developed regions in 2014.

3.1 Validation of results through σ -convergence

As mentioned, to evaluate the relevance of the conclusions arising from the visual evaluation of the disparities development through the Pareto chart, the coefficient of variation is used, which falls within the so-called σ -convergence approaches. The results of the analysis of the regional disparities development of the Visegrad Group (V4) through this approach are presented in Tab. 1.

Tab. 1: Disparities in GDP of the Visegrad Group regions based on σ -convergence (2000 and 2014)

	2000	2014		2000	2014
V4	41.42%	44.36%	V4	41.42%	44.36%
Q4 to Q3	31.00%	39.01%	CZ	36.28%	39.71%
Q3 to Q2	8.93%	5.10%	HU	32.85%	36.73%
Q2 to Q1	5.51%	5.52%	PL	20.87%	24.58%
Q1 to Q0	4.68%	5.17%	SK	49.41%	58.30%

Source: own calculations based on [5]

Within all regions of the Visegrad Group it is noticeable that actually there is only little change in the range of disparities (from 41.42% to 44.36%). In terms of development within individual sections bordered by quartiles it is then confirmed that indeed there was the most dramatic increase in disparities (8 percentage points) among the most developed regions, while there was some decrease (by about 3.8 pp) in the regions between Q₃ to Q₂ on the contrary. At the same time, the conclusion to the same extent of disparities in half of the less developed regions confirms, while in the Q₃ to Q₂ range there was virtually no change recorded, and the change among the least developed regions reached only 0.5 pp. In the context of countries it is obvious that the confirmation of the conclusion on a change of range of regional disparities among Slovak regions, as based on analyzes using the σ -convergence, it is evident that the

value of the variation coefficient increased from 49.41% to 58.30%. Changes in other countries are then indeed minimal, or up to 4 pp among regions of the Czech Republic, Hungary and Poland, which further confirms the presentation of the visual evaluation of disparities based on the Pareto chart.

Conclusion

The intention of this article was to show the possibilities of the alternative evaluation of the development of regional disparities, whose credible quantification is the alpha and omega of every modern regional policy. As a possible contribution to the filling of a certain “vacuum” between nowadays conventionally used trivialities, but information-sparse attitudes, and vice versa highly sophisticated, but also demanding and more difficult to interpret approaches for measuring disparities, there was introduced the method called Pareto chart. The aim of the paper was to demonstrate and assess its usefulness for the evaluation of the development of regional disparities.

Due to the above-discussed facts it can probably be said that the comparison of the conclusions about the development of disparities based on the Pareto chart analysis and the results of the disparities analysis made with σ -convergence access clearly confirmed that a Pareto chart can be used as a sufficiently qualified tool to evaluate the development of regional disparities, which joins the advantages of simplicity and ease of interpretability, while retaining information useful for sub-base analysis of the causes of the development of these disparities in terms of changes within the sample of regions. The developed conclusions based on the Pareto chart was not in any way inconsistent with the results obtained through the σ -convergence access, moreover, the diagram displays other useful information such as growth, extreme values, and even changes in the positions of specific regions. Thanks to these parameters, it is possible on the base of this chart to attain a more comprehensive view of regional development within a particular territorial unit.

However, it must also be noted that the assessment of regional disparities using Pareto chart could mean certain difficulties arising from visual assessment. There can be designated opacity that is predictable while assessing multiple periods within a single field of the graph. Another limitation of interpretation, closely related to the imperfections of the human eye, is the very difficult identifiability, or non-identifiability, of very small changes. Within this study, based on the comparison of interpretation of the Pareto chart with the σ -convergence results, it can be said that the boundaries of differentiability was around 4 pp. The question is how important is such a relatively small change when drawing conclusions about the development of disparities, but it can be assumed that the differentiability border will vary according to the particular sample regions. It should also be noted that it is a tool for assessing the development of disparities, but not a tool to quantify its extent. In more complex analyses it would undoubtedly be appropriate to add one of the other methods, whose ambitions lie precisely in estimating values.

To conclude, it is a very interesting alternative assessment of regional disparities, which undoubtedly has, either individually or as a suitable complement to another technique, a potential usefulness not only in professional scientific studies, but may with clarity via graphical interpretation be understandable enough to inexpert audiences from different disciplines, decision makers from within the political-bureaucratic apparatus, and also the broad professional and unprofessional public.

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