Balcerzak, Adam P.; Pietrzak, Michal Bernad

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TOPSIS Analysis of Changes of Quality of Human Capital in European Union Countries

Adam P. Balcerzak[a], Michał Bernard Pietrzak[b]*

[a]*Nicolaus Copernicus University, ul. Gagarina 13a, 87-100 Toruń, Poland*
[b]*Nicolaus Copernicus University, ul. Gagarina 13a, 87-100 Toruń, Poland*

Abstract

Purpose of the article In the case of highly developed countries quality of human capital (QHC) is currently considered as one of the most important factors determining international competitiveness and growth of economies. The fundamental role of the QHC can be seen in the EU policy documents such as Europe 2020 strategy. In this context the main purpose of the article is to evaluate the QHC in the EU countries at the macroeconomic level and to make comparison between so called "new" member states that joined the EU after the year 2004 and the "old" EU countries.

Methodology/methods QHC is considered as a multidimensional phenomenon. As a result, in the research Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) was applied. The method enables to evaluate the objects in terms of economic phenomena that have multidimensional character based on the set of detailed economic attributes (variables). In the research eight diagnostic variables were used. The synthetic index describing the relative level of QHC in the analysed economies was estimated, which enabled to propose a rating of the countries and group them into homogenous subsets.

Scientific aim The scientific aim of the article was to evaluate the progress obtained by the "new" member states after joining the EU. As a result, two ratings grouping the EU countries from the once with the highest level of QHC to the once with its lowest level in the year 2004 and 2012 were determined.

Findings The comparison of the ratings in the year 2004 and 2012 shows that most of the "new" member states have made a significant progress in the analysed period.

Conclusions The conducted multidimensional research enabled to quantify QHC in the EU countries in the year 2004 and 2012 with application of multidimensional perspective. As a result it enabled to evaluate the changes of that phenomenon in the period and to point the countries that are the leaders in the field.

Keywords: Quality of Human Capital, macroeconomic perspective, TOPSIS method, European Union countries

JEL Classification: C38, E24

Introduction

Quality of human capital (QHC) makes currently one of the most important factor influencing growth in the-case of developed economies. It is treated as one of pillars of knowledge-based economy (KBE) (Madrak-Grochowska, 2015; World Bank, 2007). Effective utilisation of potential of the KBE is considered as a *conditio sine qua non* for quick and sustainable growth in the case of highly developed economies and countries that want to avoid middle income trap (Wronowska, 2015; Balcerzak *et al*., 2016). In this context, the role of QHC has been also stressed by European Commission in the main European Union long term policy guidelines such as Europe 2020 strategy (Balcerzak, 2015; Baležentis *et al*., 2011; European Commission, 2010; Hobza & Mourre, 2010). As a result, the aim of the research is to evaluate the QHC in the EU countries at the macroeconomic level. The additional purpose of the paper is to make comparison between "new" member states that joined EU after the year 2004 and the "old" EU economies, and to evaluate the progress obtained by the "new" member states after joining the EU.

* Corresponding author. Tel.: +48 793 370 619
E-mail address: adam.balcerzak@umk.pl.

The QHC is usually treated as a multivariate phenomenon regardless of whether it is examined from micro or macro perspective (Balcerzak, 2016, Jantoń-Drozdowska & Majewska, 2015; Stankiewicz and Moczulska, 2015; Bieszk-Stolorz and Markowicz, 2015; Dominiak *et al*. 2015; Richert-Kaźmierska, 2015; Woźniak-Jęchorek, 2015). Thus, in the case of quantitative research, it should be analysed with application of multivariate analysis and taxonomic tools (see Balcerzak and Pietrzak 2016a, 2016b, 2016c, 2016d). In the current research TOPSIS method was applied. The research was conducted for the years 2004 and 2012 based on Eurostat data.

1 Short outline of TOPSIS method as a tool of multiple-criteria analysis

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is a method commonly used in current economic research (Yoon and Hwang, 1995). The most often application of the method relates to a multiple criteria decision making problems (MADM). However, it can be also used for evaluation and description of complex multivariate economic objects. It enables synthetic quantification of multidimensional economic phenomena with a taxonomic measure of development (TMD). In that case TMD is described as a similarity to the ideal solution, which is obtained by estimating a proximity of a given phenomenon to a positive ideal solution and its distance from a negative ideal solution.

The measurement of the objects in terms of complex multivariate economic phenomenon is based on a set of detailed economic attributes (variables) that can describe singe feature of complex phenomenon. On the basis of the used variables after evaluation of separation measure from the positive ideal solution and separation measure from negative ideal solution a TMD is calculated, where separation measure form negative ideal solution is divided by the sum of separation measures from the positive and negative ideal solutions. Thus, TMD takes into account all the determinants of analysed phenomenon.

2 Application of TOPSIS method to measuring quality of human capital in Europe

The current analysis was done for 24 European Union countries in the years 2004 and 2012. Luxemburg, Malta and Cyprus were eliminated from the research due to unavailability of data. The Croatia was not taken into consideration as it has been a member of UE only since 2013. Quality of human capital at macroeconomic level was analysed here from the perspective of conditions that must be fulfilled by given economies to be able to compete effectively in global knowledge-based economy (KBE) (Balcerzak, 2009; Balcerzak & Pietrzak, 2016c, Pietrzak & Balcerzak 2016). A set of eight diagnostic variables related to QHC, which are crucial for exploiting the potential of KBE, is given in Table 1. The eight variables were used for calculation of TMD.

Table 1 Diagnostic variables used for evaluation of quality of human capital in EU countries

Macroeconomic and labour market effectiveness
X_1^1 – Labour productivity (percentage of EU28 total based on PPS per employed person)
X_2^1 – Employment rate (20 to 65) (percentage of total population)
Quality of education
X_1^2 – Lifelong learning - participation rate in education and training (last 4 weeks) (% of population 25 to 64)
X_2^2 – Science and technology graduates (tertiary graduates in science and technology per 1 000 inhabitants aged 20-29 years)
National innovation system
X_1^3 – Exports of high technology products as a share of total exports
X_2^3 – Total intramural R&D expenditure (GERD) (percentage of GDP)
Health and social cohesion
X_1^4 – People at risk of poverty or social exclusion (percentage of total population)
X_2^4 – Material deprivation rate (percentage of total population)

Source: own work.

In the first stage last two diagnostic variables X_1^4 and X_2^4, which were dis-stimulant were transferred into stimulants. Then, all eight variables were normalized with classic standardization formula. In the next stage a positive ideal solution and negative ideal solution with maximum and minimum values respectively for all variables for the years 2004 and 2012 were pointed. Thus, a constant ideal solutions for both years were calculated, which enabled to make comparisons between the year 2004 and 2012. With application of the Euclidean metric a distance from positive and negative ideal solutions for all diagnostic variables were obtained. Finally, the value of TMD for all the variables was obtained by combining the proximity to the positive ideal solution and the remoteness from the negative ideal solution, where separation measures from negative ideal solution is divided by the sum of separation measures from the positive and negative ideal solutions. Two rankings of countries for the year 2004 and 2012 were obtained. In the last stage, based on the ranking a natural breaks method was used to group the countries into four homogenous sub-stets, where fourth class was grouping countries characterized with the highest level of quality of human capital and first class was grouping countries with its lowest level. The results are given in Table 2.

Table 2 Results of TOPSIS analysis of quality of human capital for the years 2004 and 2012

2004				2012			
Country	**TMD**	**Ranking**	**Class**	**Country**	**TMD**	**Ranking**	**Class**
Sweden	0,69	1	4	Sweden	0,72	1	4
Finland	0,69	2	4	Denmark	0,63	2	4
Denmark	0,67	3	4	Finland	0,63	3	4
United Kingdom	0,61	4	4	Netherlands	0,57	4	4
Netherlands	0,60	5	4	Austria	0,55	5	3
Ireland	0,58	6	3	France	0,55	6	3
France	0,56	7	3	Germany	0,52	7	3
Austria	0,53	8	3	United Kingdom	0,50	8	3
Germany	0,49	9	3	Ireland	0,49	9	3
Belgium	0,45	10	3	Czech Republic	0,47	10	3
Slovenia	0,43	11	3	Slovenia	0,44	11	3
Spain	0,38	12	2	Belgium	0,42	12	3
Czech Republic	0,37	13	2	Estonia	0,40	13	2
Italy	0,35	14	2	Lithuania	0,35	14	2
Portugal	0,33	15	2	Portugal	0,35	15	2
Estonia	0,33	16	2	Slovakia	0,33	16	2
Lithuania	0,33	17	2	Spain	0,33	17	2
Hungary	0,28	18	2	Poland	0,29	18	2
Greece	0,27	19	2	Italy	0,29	19	2
Latvia	0,24	20	1	Hungary	0,26	20	1
Slovakia	0,22	21	1	Romania	0,24	21	1
Romania	0,18	22	1	Latvia	0,24	22	1
Poland	0,17	23	1	Greece	0,20	23	1
Bulgaria	0,12	24	1	Bulgaria	0,14	24	1

Source: own estimation based on Eurostat data.

The results show that the EU countries can be divided into two heterogonous groups in terms of the level of the QHC. The “old” EU member states, with the exception of the southern countries, can be categorized as the economies with high level of the QHC. The southern European countries and the “new” member states form a sub-set with relatively lower level of the QHC form the perspective of requirements of knowledge-based economy. The economies from the first group were assigned to the fourth and third class. The economies with lower level of the QHC are found in the second and first class.

In the year 2004, in the fourth class with the highest level of the QHC one could find Scandinavian countries, Netherlands and United Kingdom. In the years 2004 and 2012 the group of leaders was quite stable. Only United Kingdom was classified in the third class in the last year of the research. In the third class in both years one could find Germany, Belgium, France, Austria and Ireland. Except Ireland these countries can be characterized with many institutional similarities and quite close macroeconomic conditions. In the year 2004 in this group one could also find Slovenia and additionally Czech Republic in the year 2012. It means that these two "new" members states were able to join the group of European economies that are characterised with high level of quality of human capital from the perspective of knowledge based economy.

In spite of the fact that southern European economies such as Spain, Italy, Portugal and Greece joined the EU before the year 2004, they are still characterized with relatively low level of the QHC from the macroeconomic perspective. Additionally, in the year 2012 Greece was classified in the first class that groups the economies with the lowest level of the QHC, which indicates a negative direction of changes in the country.

Such "new" member states as Estonia, Lithuania, Czech Republic, and Hungary were grouped in the second class in the year 2004. In the year 2012 also Poland joined this sub-set. Latvia, Romania and Bulgaria were assigned to the first class in both years. This group can be characterized with relatively lowest level of the QHC at macroeconomic level.

In the last stage of the analysis a percentage changes of the values of TMD for the QHC in the years 2004-2012 were calculated. Based on the results, also in this case the countries were grouped into four homogenous sub-sets with application of natural breaks method. The results are presented in table 3.

Table 3 Percentage difference of values of TMD for quality of human capital in the years 2004-2012

2004-2012							
Countries	**Percentage difference**	**Ranking**	**Class**	**Countries**	**Percentage difference**	**Ranking**	**Class**
Poland	73,02%	1	4	Latvia	-0,83%	13	2
Slovakia	50,82%	2	4	France	-1,34%	14	2
Romania	33,43%	3	4	Netherlands	-5,58%	15	2
Czech Republic	26,32%	4	3	Denmark	-5,84%	16	2
Estonia	21,29%	5	3	Belgium	-7,17%	17	2
Bulgaria	16,71%	6	3	Finland	-7,61%	18	2
Lithuania	8,38%	7	3	Hungary	-9,32%	19	2
Germany	5,87%	8	3	Spain	-12,47%	20	2
Portugal	3,96%	9	2	Ireland	-15,42%	21	2
Sweden	3,93%	10	2	Italy	-17,60%	22	2
Austria	3,48%	11	2	United Kingdom	-18,06%	23	1
Slovenia	1,84%	12	2	Greece	-26,57%	24	1

Source: own estimation based on Eurostat data.

By analogy, in regard to assessment of dynamics of the measure of the QHC all analysed countries have been assigned to four classes. Countries assigned to fourth and third classes are characterized by relatively high positive growth rates of value of the QHC in the analised period. The largest improvement in that field was obtained by Poland and Slovakia with positive change of more than 70 and 50% respectively in regard to the value of measure of the QHC. Additionally, the increase of more than 20% was obtained by Romania, Czech Republic and Estonia. In the third class with positive dynamics of the value of the measure one could also find Bulgaria, Lithuania and Germany.

However, what is especially important from the perspective of contribution of this research, based on the obtained results it can be seen that the positive changes obtained by the "new" member states cannot be treated only as the consequence of low starting point and simple abilities to take advantage of the "convergence" process. Relatively bad results obtained by "southern old" EU member states, which to some extent were also influenced by the severe consequences of the last global financial crisis, show that the changes in the QHC are influenced by many institutional and policy factors. These factors should be the subject of special interests of all policy makers. Thus, they should be also the subject of profound research.

Conclusion

The article concentrated on the problem of measurement of QHC at macroeconomic level in European Union countries. The additional purpose of the article was to conduct comparison between "new" and "old" member of the EU and to assess the progress obtained by the "new" member states. Due to multivariate character of the analysed phenomenon the research was done with application of TOPSIS method. The method enabled to make rankings of the countries and to verify their relative progress in the analysed period. The conducted research confirmed a meaning progress obtained by Central European economies.

The divergence between the "new" member states and "southern" European countries in relation to the QHC shows that the dynamics of changes of the level of the QHC at macroeconomic level is not only the result of simple "caching up" process, but it is influenced by many determinants, which can be modified by government's policy.

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