DE GRUYTER
OPEN

10.2478/regd-2014-0003

Measuring creative capacity of Visegrad Four countries' economies

Martin Alexy, Marek Káčer

University of Economics in Bratislava
Faculty of National Economy
Department of Finance

Dolnozemská cesta 1
852 35 Bratislava
Slovak Republic

e-mail: martin.alexy@euba.sk
marek.kacer@euba.sk

Abstract

In this paper we study creative capacity of economies of Visegrad Four countries in the period 2000-2011. Creativity index is constructed based on the 3Ts concept of talent, technology and tolerance being the key components of the creativity. Creativity index is measured and calculated with both the cross-section and the time series dimensions. The paper provides index as an open source with the description of variables and their respective weights. Comparison of the creative capacity of economies is based on the empirical results of the Creativity index and its components. Czech Republic is the first and Hungary is the second in the ranking continuously during the examined period. Talent and technology areas are the main reasons for differences between the two leading countries and the rest.

JEL classification: O10, O30, O34, C10
Key words: *creativity index, Visegrad four, 3Ts concept*

Introduction

In economic and also other theories the creativity is defined as specific human activity, which brings results in some innovation, novelty, or something unusual and interesting. Defining the creative activities or the creativity was derived from psychology and then further developed through analysing human activities in arts, culture, education and also in the economy. Grasping the process of creativity and measuring the creativity by economic indicators has developed through various concepts and approaches. Some of them are derived from elaborate theoretical basis; some are determined by availability of economic indicators and others are based on the combination of indicators accessible from the statistic resources and from the expertise. Empirical studies provide several creativity indices as proxy variables for the creative capacity of the respective economies. This paper focuses on these creativity indices. In the existing literature they are constructed in the form of cross-section data. We compose the creativity index in the form of panel data, i.e. with the cross-section and time series dimensions.

A group of countries from the same geographic region with several common features including the level of economic development is researched in this paper. Four Central European countries called Visegrad Four group (V4) were selected. In the last 25 years each of them went through large economic and political transformation. Politically the system of one ruling party changed into the democracy. Market economy was introduced instead of centrally planned economy. They used to be members of Council for Mutual Economic Assistance and Warsaw treaty. Following the change they became NATO members and later they all joined European Union, one of them also Eurozone.

The contribution of our paper to the existing literature can be seen in the three areas. First we construct creativity index with both the cross-section and the time series dimensions. Second we provide open source creativity index, describing variables with their source and also how the weights of respective variables were determined. Third we analyse creative capacity of consistent group of developing and at the same time

transitional economies of Central Europe.

The paper is structured as follows. First part presents an overview of the existing literature. Second part describes a methodology including the selection of the variables, their normalization and also the determination of the weights. Third part provides empirical results of measuring the creative capacity of the V4 economies. The last part of the paper gives conclusions.

Overview of the literature

Schumpeter (1911) defines the creativity as "dynamic process of innovations, which is endogenous in relation to economy." He is one of the first researchers who acknowledge the economic dimension of the creativity. Creativity in connection to economics can be generally defined as human activity focused on the creation of an intangible asset. Such asset has characteristics of novelty, innovativeness or rareness. Amabile (1983), and Weisnberg (1988) broaden the economic understanding of the creativity as the part of production of ideas and inventions, which are new and useful for solving the economic issues.

Lundvall and Johnson (1994) attempted to define the relation between formation of creative ideas of individuals and ways of their absorption or their support in private and public sectors. Not only creation of ideas, but also the speed and the ability of their absorption play an important role. According to the authors it is in the interests of both private and public sector to not only maximize the process of creating the inventions by individuals, but also to connect inventions with other processes, namely with knowledge, networks and technology.

Florida (2002, 2005) defines the "creative class" as a key driving force for economic development of post-industrial cities. Florida distinguished 3 groups of creative occupations: creative core, creative professionals and bohemians. He presents "The 3Ts theory" for economic growth: technology, talent and tolerance. According to Florida the job opportunities will follow creative people and not the other way around. He emphasizes the role of the creative individuals

who ensure knowledge and innovation spill-overs within a city or a region as opposed to the concept of spill-overs between companies and sectors. Knudsen, Florida, Gates and Stolarick (2007) connected this influence of creative class with endogenous growth theory.

According to Glaeser (2004) creative capital is strongly connected with human capital, which is traditionally measured by level of education. In his view the majority of creative class has achieved high level of education. Empirical studies of Marlet and van Woerkens (2004), McGranahan and Wojan (2007), Florida, Mellander and Stolarick (2008) confirmed that the indicators for the creative class and education are both good predictors of urban and regional growth and that the indicators for the creative class perform better than the indicators for education. Therefore both creative class and traditional educational attainment are proxies to measure human capital.

Measuring creativity through set of indices developed in the last decade. There is a strong inspiration from Florida's 3Ts theory; he is also one of the pioneers of creativity index as quantitative index suitable for comparison between countries. Set of sub-indices and detailed indicators was broadened by each model or index. Some of indices incorporated also factors of the social and cultural environment other indices added additional emphasis on arts and culture. Table 1 provides a basic overview of creativity indices.

Table 1: Overview of creativity indices

Index	Key concept	Specifics
Euro-Creativity Index	Defines 3 areas to measure creativity based on 3Ts' theory: Talent, Technology and Tolerance. Each area defined by 3 indicators totalling in 9 creativity indicators.	Contains 2 additional measures of short-term trend: Euro-Creative Trend Index and the Euro-Creativity Matrix
Hong Kong Creativity Index	It is built on 5Cs with over 100 indicators: 1.Structural/institutional Capital, 2.Human Capital, 3.Social Capital, 4.Cultural Capital, 5.Manifestations of Creativity.	It captures the characteristics of the socio-cultural parameters and illustrates the interactions of various creativity factors.
Composite Index of the Creative Economy	Creative capacity is defined in 3 dimensions: Innovation, Entrepreneurship and Openness. Each dimension offers 3 indicators thus 9 in total.	It introduces a novel method – endogenous weighting. Each entity has its own unique set of the most appropriate weights.

Index	Key concept	Specifics
European Creativity Index (only theoretical design)	It is composed of 32 indicators divided among 6 sub-indices: 1.Human capital, 2.Opennes and diversity, 3.Cultural environment, 4.Technology, 5.Regulatory incentives to create, 6.Outcomes of creativity.	Index aims to combine culture-based indicators in existing frameworks related to creativity, innovation and socioeconomic development.
Global Creativity Index (GCI)	Technology, Talent and Tolerance indices form overall index. Technology is constructed from 3 variables, Talent and Tolerance from 2 each. GCI is thus created from 7 variables.	The research uses comparison of GCI with 6 measures of economic and social progress (GDP per capita, Income Inequality, Global Competitiveness Index, Global Entrepreneurship Index, Human Development Index, Happiness/life satisfaction)

Euro-Creativity Index was introduced by Florida and Tinagli (2004). It is constructed from Technology Index, Talent Index and Tolerance Index. The Euro-Creativity Index has extended and adapted the Florida's concepts of the creative class and its indicators to the European context. This index was calculated for 14 European countries. Hui et al. (2004) introduced Hong Kong Creativity Index (HKCI). In this index the four forms of the capital (structural/institutional, human, social and cultural) are the determinants of the creativity growth. Accumulated effects of the interplay between these determinants are the manifestations of creativity in terms of outcomes or outputs. Manifestation of the creativity is measured through the economic contribution of creativity and the inventive activity of economic sector in total over 20 indicators. Each of the four forms of the capital is defined by 20-30 indicators. The four forms of the capital and the manifestation of the creativity together compose the creativity index for Hong Kong.

Composite Index of the Creative Economy (CICE) has been developed by Bowen, Sleuwaegen, Moesen (2006) to benchmark and evaluate creative capacity of the given regions. The endogenous weighting method has been introduced to determine the weight each sub-dimension should contribute to the total value of the CICE. This method isolates achievement on the underlying dimensions as the source of a higher or lower CICE score value. CICE measures creative capacity of nine regions of Europe and North America from among a network of creative regions named Districts of Creativity.

Kern and Runge (2009) proposed the design of the European Creativity Index as a part of study made for European Commission to evaluate and impact of the culture on the creativity. The concept was built upon indicators related to culture-based creativity and their inclusion into the existing socioeconomic indicator schemes (i.e. European Innovation Scoreboard). This index remained only as a theoretical concept.

Florida et al. (2011) broadened the previous work and created the Global Creativity Index (GCI). Similar to the Euro-Creativity Index the GCI is made of the Talent, Technology and Tolerance sub-indices. It

was constructed for 82 nations, however not including the time series dimension. The data used for its composition are from the period 2000-2009 although different years are used for the different variables.

Creativity index proposed and developed by Florida is the most suitable for a comparison of the creative dimension of the different countries. The HKCI is very detailed and it was elaborated in depth particularly for Hong Kong. Its usage for international comparison is limited because there is no source of coherent data necessary for index computation. The CICE has been constructed specifically for the comparison of the selected regions and cannot be used for countries' comparison either. The endogenous weighting method usage with the time series dimension is questionable because the weights themselves would generally have to change in time thus leading to very inconsistent and even arbitrary index. The work of Kern and Runge did not engage any data and even though their concept explains and justifies the selection of variables, its practical implication for constructing usable index is dubious.

Methodology

Selection of variables

The creativity index design proposed by Florida and Tinagli (2004) is adopted in this study. Thus our Creativity index consists of 3 indices – Talent, Technology and Tolerance, each composed of three sub-indices. In the table 2 the description of each sub-indices with corresponding indicators (variables) is presented. Creativity index is calculated for the time period 2000-2011 due to data availability.

Talent index is comprised of the creative class, human capital and scientific talent. Creative class consists of 3 groups of creative people: creative core, creative professionals and bohemians. Table 3 gives overview of the creative class composition according to ISCO-88 code within the 3 groups. Human capital is determined by labour force with

Table 2: Creativity index for V4 countries – indicators and their weights

W1	Index	W2	Sub-index	W3	Indicator	Source
1/3	Talent	1/3	Creative Class	1	Employed in creative occupations	Eurostat
		1/3	Human Capital	0.5	Labour force with tertiary education (% of total)	WDI
				0.1	Public spending on education, total (% of GDP)	WDI
				0.1	Total public expenditure on education, all levels combined	Eurostat
				0.1	Total public expenditure on education, tertiary level	Eurostat
				0.1	Annual expenditure on public and private educational institutions per pupil/student, tertiary level	Eurostat
				0.1	Annual expenditure on public and private educational institutions per pupil/student, all levels combined	Eurostat
		1/3	Scientific Talent	0.3	Researchers in R&D	WDI
				0.3	Human resources in science and technology	Eurostat
				0.4	Scientific and technical journal articles	WDI
1/3	Tech-nolo-gy	1/3	Innovation	0.5	Patent applications filed through the Patent Cooperation Treaty, residents	WDI
				0.5	Patent applications to the European Patent Office	Eurostat
		1/3	High Tech innovation	0.5	European high-technology patents	Eurostat
				0.1	Royalty and license fees, receipts (BoP, %GDP)	WDI

W1	Index	W2	Sub-index	W3	Indicator	Source
				0.1	International transactions in royalties and licence fees: export	Eurostat
				0.3	International transactions in royalties and licence fees: balance	Eurostat
		1/3	R&D	0.5	Research and development expenditure (% of GDP)	WDI
				0.5	Gross domestic expenditure on R&D (GERD) in % of GDP	Eurostat
1/3	Tole-rance	1/3	Attitudes index	1	Tolerance of homosexuality	EVS
		1/3	Values Index	1	Proportion of population with protestant denomination	EVS
		1/3	Self Expression Index	0.5	Voice and accountability	WGI
				0.5	Control over life and freedom of choice	EVS

Abbreviations: W1, W2, W3 are weights corresponding to index level (W1), sub-index level (W2) and indicator level (W3)

Sources of data: Eurostat, WDI (World Development Indicators), EVS (European Values Study), WGI (Worldwide Governance Indicators)

tertiary education and public spending on education. Public expenditure on education is measured by 5 variables: total public spending on education, total public expenditure on education (all levels combined), total public expenditure on education (tertiary level), annual expenditure on public and private educational institutions per pupil or student (tertiary level) and annual expenditure on public and private educational institutions per pupil or student (all levels combined). Scientific talent includes variables: researchers in R&D, human resources in science and technology and scientific and technical journal articles.

Table 3: Creative class composition according to ISCO-88 code

Creative core	211. Physicists, chemists and related professionals
	212. Mathematicians, statisticians and related professionals
	213. Computing professionals
	214. Architects, engineers and related professionals
	221. Life science professionals
	222. Health professionals (except nursing)
	231. College, university and higher education teaching professionals
	232. Secondary education teaching professionals
	233. Primary and pre-primary education teaching professionals
	234. Special education teaching professionals
	235. Other teaching professionals
	243. Archivists, librarians and related information professionals
	244. Social science and related professionals
Creative professionals	111. Legislators
	112. Senior government officials
	113. Traditional chiefs and heads of villages
	114. Senior officials of special-interest organisations
	121. Directors and chief executives
	122. Production and operations department managers
	123. Other department managers
	131. General managers
	223. Nursing and midwifery professionals
	241. Business professionals
	242. Legal professionals

	246. Religious professionals
	311. Physical and engineering science technicians
	312. Computer associate professionals
	313. Optical and electronic equipment operators
	314. Ship and aircraft controllers and technicians
	315. Safety and quality inspectors
	321. Life science technicians and related associate professionals
	322. Modern health associate professionals (except nursing)
	323. Nursing and midwifery associate professionals
	324. Traditional medicine practitioners and faith healers
	331. Primary education teaching associate professionals
	332. Pre-primary education teaching associate professionals
	333. Special education teaching associate professionals
	334. Other teaching associate professionals
	341. Finance and sales associate professionals
	342. Business services agents and trade brokers
	343. Administrative associate professionals
	344. Customs, tax and related government associate professionals
	345. Police inspectors and detectives
	346. Social work associate professionals
	348. Religious associate professionals
Bohemians	245. Writers and creative or performing artists
	347. Artistic, entertainment and sports associate professionals

Technology index contains innovation, high tech innovation and research and development sub-indices. Innovation is measured by number of patent applications (filed both through the Patent Cooperation Treaty and the European Patent Office). High tech innovation is determined by two measures: the European high-technology patents and the royalty and license fees. Royalty and license fees are calculated from 3 variables. The royalty and license fees receipts and the international transactions in royalties and license fees export carry the same information. Both of them are used in order to deal with the missing data issue. Third one is the balance of international transactions in royalties and license fees. Research and development is measured by research and development expenditure; both the World Bank and the Eurostat data are used to cope with the missing data issue.

Tolerance index is composed from attitudes index, value index and self-expression index. Attitudes index is measured with tolerance of homosexuality; value index with the proportion of population with the protestant denomination. Both measures come from European Values Study (EVS). The tolerance of homosexuality is a standard component of Florida's creativity index. The proportion of population with the protestant denomination was chosen based on the study of Weber-Parsons (2003) where they attribute the economic success of early USA to the protestant virtues.

Self-expression index uses 2 measures. One of them is "Voice and accountability score" from the Worldwide Governance Indicators (WGI). It captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media. The second one is "Control over life and freedom of choice" coming from the EVS. It measures the degree how much people perceive they have completely free choice and control over their lives. The Florida's self-expression index captures the degree to which a nation values individual rights and self-expression. It is based on questions covering attitudes toward self-expression, quality of life, democracy, leisure, the environment, trust

and more; it was derived from the World Values Survey in the period 1995-1998. The two measures used in this study are suitable proxies capturing the same dimension; these measures also express evolution in time.

Normalization of variables

Each variable is measured in different units of measurement and even though the "size" effect of the economy is eliminated (each variable is expressed either as a score or as a ratio) in order to construct the overall indicator as a linear combination of the variables each value needs to be transformed to the score between 0 and 10, 10 being the highest value, meaning the best impact on the creative capacity of the economy. Two points are necessary for the linear transformation to be performed. Instead of minimum corresponding to 0 and maximum corresponding to 10 (for certain variables where the high value suggests the low creative capacity it is vice-versa) we decided to take 5th percentile to be transformed to 0 and 95th percentile to 10 in order to eliminate the potential influence of outliers. Both 5th and 95th percentiles are determined from the database of 30 European countries. Technically the linear transformation is performed according to the following equation:

y is the value of the score, x is the value of the variable, a and b are the constants calculated for each indicator separately based on the following terms:

The only exception from this rule is the group of variables from the European Values Study – there was no danger of outliers here since the lowest and highest possible values were clearly given. Thus the values 0 and 10 of the newly formed transformed variables corresponded to the minimum and maximum values (or vice-versa) based on the questionnaire design. This way it is assured that each transformed variable takes on the value from 0 to 10 and so does the resulting index, 0 meaning the least creative capacity of the country and 10 the greatest one.

Coping with the missing data issue

Since our intention was to construct the creativity index for the group of the V4 countries in the form of panel data, there was a necessity to deal with the fact that not the all data for the desired variables were available. Two specific issues regarding this point had to addressed: firstly regarding the data from the European Values Study and secondly the missing data from the other sources.

The missing data problem from the European Values Study was specific in that there were only four waves of the study conducted within the span of nearly 30 years – the first study was undertaken in 1981 and the last in 2009, with three rather isolated observations per country in case of the countries under research. Moreover, the data were collected via extended surveys and thus there is possibility of biases. However, they gave a good measure regarding the trends in the shifts of preferences and ideas of the citizens of the individual countries. That is why to compensate for the years when no survey was conducted and at the same time to compensate for the possible selection bias the fitted values from simple logarithmic trend models instead were used.

The qualitatively different issue was the missing data from the other sources. Unlike the missing data from EVS here the problem lied not in isolated observation in time domain but in the fact that some of the time series were not long enough. To address this issue the following approach was taken: the observation for the given country and the year was used (in order to calculate the value of the creativity index) if there had been at least one variable with the valid value for each of the nine sub-sectors. However, the weights of the remaining variables in the sub-sector for the given observation had to be re-calculated. The re-calculation was performed in such a way that the ratios of the weights of the variables with non-missing data were retained. The similar approach was taken in construction of the Worldwide Governance Indicators by the World Bank.

Determination of weights

When forming any composite index the determination of weights is of the great importance. We use the three levels of weights (see table 2 for details) – the first level is the level of three indices, the second level refers to the nine sub-indices and the last one corresponds to individual indicators (or variables). In this stage of work the decision was made to use the equal weights on the first and the second levels. We consider this method to be the best first shot in the situation when there is no other information available. In the third level there are alternations from the equal weighting in some cases; it was exclusively in the situation when there were a few variables expressing the similar concept – in this case the weights were lowered, usually in such a way that the sum of the lowered weights equals to the weights of other indicators in the same sub-index.

Empirical results

Talent index

Talent index is determined by 3 factors: creative class, human capital and scientific talent. The creative class measures the percentage of the labour force employed in the creative occupations. Average share of the creative class in the time period 2000-2011 was 38.3% in Czech Republic, 35.1% in Slovakia, 33.6% in Hungary and 32.0% in Poland. In each country there is increasing trend until 2009, although increase is very slow, 0.25% yearly on average. In the years 2010 and 2011 a very small decreasing tendency is observed. The ranking is the same over the whole time period with Czech Republic leading and followed by Slovakia, Hungary and Poland.

Human capital combines 2 sub-factors – labour force with tertiary education and public expenditures on education. The highest proportion of labour force with tertiary education is since 2007 in Poland (27.2% in 2011), followed by Hungary (23.9% in 2011), Slovakia (19.7% in 2011)

and Czech Republic (19.0% in 2011). There is steady yearly increase in the examined time period, in case of Poland 1.4% on average, other countries 0.7-0.8% on average. In the ranking Hungary lost its leading position to Poland in 2007, while Slovakia being originally the last of the four countries overcame Czech Republic in 2005 and since then remained the third.

Public expenditures on education are measured by 5 variables combining overall public expenditures, expenditures in tertiary level and expenditures per pupil (or student) with total share on GDP and as a share on GDP per capita. When comparing total public expenditures on education as a percentage of GDP there is a very small yearly change on average. The most recent data is available for 2010, when the highest ratio was in Poland 5.2%, while in 2000 it was 5.0%. Second country is Hungary with 4.9% ratio, while in 2000 it was 5.0%. Both Czech Republic and Slovakia spent 4.2% of GDP on education in 2010, while in 2000 it was 3.8% and 3.9% respectively. When analyzing the ranking of countries over the time period Poland and Hungary exchanged leading position several times, while Czech Republic and Slovakia has exchanged the last position.

The third factor is the scientific talent. There are 3 variables included in this factor: the researchers in R&D, the human resources in science and technology and the scientific and technical journal articles. When looking at the most recent data of 2010 Czech Republic is the leading country with 2785.5 of researchers in R&D measured per 1 million inhabitants. Slovakia is the second with 2779.7 then Hungary is the third with 2137.7 and Poland last with the 1685.4 score. There is steady increase almost every year in all countries with Czech Republic at the double speed.

The highest proportion of the labour force working in science and technology is in Poland 37.0% and Czech Republic 36.0%; next is Hungary with 34.6% and Slovakia with 34.1% based on data from 2011. The differences among countries are rather small; small yearly increase over the time can be observed – in Poland at the highest speed.

Czech Republic and Hungary were leading in the ranking until 2007, since then Poland replaced Hungary. Slovakia always ranked as the 3rd or 4th country.

When analysing scientific talent with number of scientific and technical journal articles per thousand of labour force Czech Republic has the score of 0.80, Hungary 0.63, Poland 0.46 and Slovakia 0.42 for the latest data available in 2009. There is a yearly fluctuation observed over the time in all countries besides Czech Republic, where there is a steady yearly increase. When looking at the score in 2000 in Czech Republic it was 0.53, in Hungary 0.62, in Poland 0.38 and in Slovakia 0.47. Czech Republic and Hungary were leading the ranking, while Poland and Slovakia always at the last 2 positions.

When constructing the Talent index, transforming and combining all above mentioned factors and variables, one can see an increasing trend in each of the countries over the years. Ranking has been changing in the time period with Hungary leading in 2000 with the score 2.75, Czech Republic second with the score 2.55, Slovakia third with the score 2.30 and Poland the last with the score 1.79. In 2011 the first place was taken by Poland with the score 5.37, followed by Hungary with the score 4.87, Czech Republic with the score 4.55 and Slovakia with the score 4.28. Chart 1 displays Talent index development over the year in all countries. Appendix 1 provides detailed overview of the data.

Chart 1:
Talent index comparison of Visegrad four countries in time period 2000-2011

Year	Czech Republic	Hungary	Poland	Slovakia
2000	2.55	2.75	1.79	2.30
2001	2.91	2.65	1.87	2.37
2002	2.85	2.76	2.05	2.32
2003	3.06	3.23	2.51	2.53
2004	3.35	3.69	2.87	3.02
2005	3.71	3.73	3.28	2.97
2006	4.21	3.75	3.19	3.01
2007	4.15	3.61	3.20	2.81
2008	4.29	3.97	3.50	2.85
2009	4.69	4.14	3.91	3.26
2010	4.73	4.07	4.55	4.04
2011	4.55	4.87	5.37	4.28

Technology index

Technology index is measured by 3 factors: the innovation, the high tech innovation and the research and development. Innovation is measured with number of patent applications (combining both European Patent registry and Patent Cooperation Treaty). When comparing number of patent applications filed through Patent Cooperation Treaty (calculated per million of labour force) Poland is first with 249, Hungary second with 174, Czech Republic third with 161 and Slovakia last with 97 according to data in 2011. There is growing trend in Poland and Czech Republic, while in Hungary and Slovakia there is decreasing tendency over the years. Ranking of the countries changes.

In similar comparison regarding the number of patent applications filed through European Patent registry (calculated per million of

inhabitants) Hungary leads with 18.3, followed by Czech Republic with 17.3, Poland with 9.9 and Slovakia with 4.3 in 2011. Besides Slovakia there is a growing trend in all other countries. In the ranking Hungary is in leading position over the years and Czech Republic ranking is the second. Poland and Slovakia exchanged their positions in 2009, since then Slovakia is the last.

High tech innovation is measured by 2 factors – the European high-technology patents and the royalty and license fees. Hungary has the 1.64 The European high-technology patents (calculated per million of inhabitants) Czech Republic has 1.61, Slovakia 0.79 and Poland 0.72 in the year 2011. Hungary has been ranking first over the time, while remaining countries has been exchanging their position. There is no trend observed in any of the countries in the examined time period.

Royalty and license fees are determined by 2 components (the royalty and license fees receipts and the international transactions in royalties and license fees export measure the same thing). When comparing Royalty and license fees receipts, Hungary is the first in the ranking with 0.8% of GDP, next is Poland and Czech Republic with 0.05% of GDP and Slovakia is the last with less then 0.001% of GDP in 2011. There is no trend observed over the time in any of the countries. Balance of international transactions in royalties and license fees is negative in all countries. Comparing the most recent data of 2011 Slovakia has the smallest deficit 0.14% of GDP, Hungary 0.30%, Czech Republic 0.39% and Poland 0.40% of GDP. This variable is available since 2004 except for Slovakia (available since 2010). In the given time period no trend is observed, values are fluctuating.

Research and development factor is determined by the research and development expenditure (calculated as % of GDP). In 2011 Czech Republic spent 1.64% of its GDP for R&D (compared to 1.17% in 2000), Hungary 1.22% (0.81% in 2000), Poland 0.76% (0.64% in 2000) and Slovakia 0.68% (0.65% in 2000). There is an increasing trend in Czech Republic and Hungary, but in case of Poland and Slovakia there is a slight fluctuation with no trend observed in the time period. Czech

Republic remained first and Hungary second in the ranking over the time. Poland was the last until 2004, when it was replaced by Slovakia.

When analysing Technology index constructed by previously described factors and variables, and increasing trend can be seen in each of the countries over the years. Czech Republic and Hungary kept exchanging leading position among the four. On the other hand Poland and Slovakia replaced one another on the last position few times. Czech Republic and Hungary score in Technology Index is twice higher than the other two countries. Comparing the index in 2011 to initial state, Czech Republic scored 2.09 (compared to 1.01 in 2000), Hungary scored 2.04 (0.94 in 2000), Poland scored 1.17 (0.47 in 2000) and Slovakia scored 0.94 (0.40 in 2000). Chart 2 presents Technology index development over the year in all countries. Appendix 2 gives detailed overview of data.

Chart 2: Technology index comparison of Visegrad four countries in time period 2000-2011

Year	Czech Republic	Hungary	Poland	Slovakia
2000	1.01	0.94	0.47	0.40
2001	1.03	1.08	0.43	0.41
2002	1.01	1.08	0.39	0.40
2003	1.14	1.02	0.37	0.33
2004	1.72	1.33	0.83	0.91
2005	1.57	1.79	0.77	0.88
2006	1.76	1.56	0.73	0.91
2007	1.81	1.60	0.80	0.90
2008	1.79	1.48	0.90	0.86
2009	1.84	1.94	0.99	0.83
2010	1.97	2.12	1.07	0.90
2011	2.09	2.04	1.17	0.94

Tolerance index

Tolerance index is measured by the attitudes index, the value index and the self-expression index. The attitudes index is derived from tolerance of homosexuality. Data source is the EVS and as it was already mentioned, there were 4 time periods when the survey was made, however, for each of the countries under research there were only 3 observations. In all countries except Hungary there was a sharp increase in the tolerance to homosexuality between the first wave in 1990-1991 and the second one in 1999, whereas in 2008 the tolerance remained on the same level as 1999 or even decreased. In Hungary the tolerance towards homosexuality decreased in 1999 comparing to 1991 and in 2008 increased when compared to 1999. In 2008, Czech Republic had a score of tolerance 4.85, Slovakia 4.79, Hungary 3.26 and Poland 2.86. To be able to calculate the creativity index we used the fitted values from simple logarithmic trend models to deal with missing data.

The value index is derived from the proportion of population with protestant denomination. This also comes from EVS survey and similarly one can compare the last results from 2008. There percentage of respondents with protestant denomination belief was highest in Hungary 12.4%, followed by Slovakia 8.3%, Czech Republic 1.9% and Poland 0.3%. Generally one can say that the proportion of population with the protestant denomination fluctuated around these values in all four countries. Similar to the attitude index the missing data were imputed using the simple logarithmic trend.

The self-expression index uses 2 measures: the Voice and accountability and the control over life and freedom of choice. When comparing score of voice and accountability data in 2011 Poland has the highest score 1.03, next is Czech Republic 0.99, Slovakia 0.97 and Hungary 0.82. Increasing trend is observed in Czech Republic, while in Hungary the score decreases over time. Both in Poland and Slovakia a fluctuation without any trend can be seen. Hungary had the highest score back in 2000, since then it was regularly stepping down in ranking. All other countries have exchanged their ranking positions over the time.

Control over life and freedom of choice comes from EVS survey. In the last survey results in 2008, the highest score was in Slovakia 6.75, followed by Czech Republic 6.63, Poland 6.62 and Hungary 6.48. Results in this score are very similar in all surveys for V4 countries; citizens' perception of their freedom and control over their life is nearly the same and did not change much within the period from 1990 to 2008.

Transforming and combining all previously mentioned factors and variables the tolerance index is created. When observing data over the time one can see slowly increasing trend in Slovakia, Czech Republic and Poland, but very slow decline in Hungary. Ranking has been stable in all time periods with Slovakia leading, Czech Republic, Hungary and Poland being the next in order. Tolerance index score in 2011 was 4.09 in Slovakia, 3.92 in Czech Republic, 3.18 in Hungary and 3.00 in Poland. Chart 3 displays Tolerance index development over the year in all countries. Appendix 3 provides detailed overview of data.

Chart 3: Tolerance index comparison of Visegrad four countries in time period 2000-2011

Year	Czech Republic	Hungary	Poland	Slovakia
2000	3.65	3.23	2.80	3.74
2001	3.67	3.24	2.82	3.77
2002	3.79	3.25	2.85	3.86
2003	3.80	3.24	2.84	3.87
2004	3.81	3.25	2.87	3.91
2005	3.80	3.26	2.86	3.93
2006	3.83	3.22	2.83	3.95
2007	3.86	3.23	2.87	3.98
2008	3.88	3.21	2.92	4.00
2009	3.90	3.20	2.96	4.01
2010	3.91	3.20	2.98	4.04
2011	3.92	3.18	3.00	4.09

Creativity index

When putting together the indices measuring 3Ts and comparing the V4 countries, Czech Republic was the first in the ranking in all examined period. In 2011 Czech Creativity index was 3.52 compared to 2.40 in 2000. Second in the ranking was Hungary with score of 3.36 in 2011 compared to 2.31 in 2000. When comparing data of 2011 the third position belongs to Poland with Creativity index 3.18. Until 2011 Poland was always the last of the four, this time it went ahead Slovakia. Polish Creativity index in 2000 was 1.69. Comparison of 2011 leaves the last position to Slovakia with score 3.10. In the previous years Slovakia always took the third position in the ranking. In 2000 Slovak Creativity index was 2.14. Chart 4 shows Creativity index development in all countries in the time period 2000-2011. Appendix 4 provides detailed overview of data.

Chart 4: Creativity index comparison of Visegrad four countries in time period 2000-2011

Year	Czech Republic	Hungary	Poland	Slovakia
2000	2.40	2.31	1.69	2.14
2001	2.53	2.32	1.71	2.18
2002	2.55	2.36	1.76	2.19
2003	2.67	2.50	1.91	2.25
2004	2.96	2.76	2.19	2.62
2005	3.03	2.93	2.30	2.59
2006	3.27	2.84	2.25	2.62
2007	3.27	2.81	2.29	2.56
2008	3.32	2.89	2.44	2.57
2009	3.48	3.09	2.62	2.70
2010	3.53	3.13	2.87	2.99
2011	3.52	3.36	3.18	3.10

When analysing the proportion of each Talent, Technology and Tolerance in the overall Creativity index, one can find out that Talent and Tolerance have much higher share than Technology index. This is the case in all countries.

Conclusion

In this paper creative capacity of economies of a particular group of V4 countries in the period 2000-2011 were studied. We constructed Creativity index based on Florida's 3Ts concept and calculated the index in the format of panel data. Talent, technology and tolerance indices were also calculated individually. The paper provides open source creativity index, describing variables with their source and also disclosed the weights of respective variables and how they were determined.

When comparing the countries based on Creativity index, Czech Republic is the first and Hungary is the second in the ranking and they both have been in those positions in the examined period. Slovakia has been the third and Poland the fourth until 2011 when they exchanged their positions. Talent and Technology areas are the main reasons for differences between the two leading countries and the rest. Czech Republic has the highest proportion of researchers in the R&D and also the highest proportion of labour force in the science and technology. Together with Hungary they lead in number of the scientific journals and number of the registered patents, significantly exceeding the other 2 countries. Czech Republic expenditures in the R&D are the highest, notably exceeding Hungary and leaving Slovakia and Poland behind with a big gap. Hungary and Poland are leading countries with the public expenditures on education. Even though Slovakia has the second highest proportion of researchers in R&D, the resources allocated to this area are very modest compared to other countries. Both Czech Republic and Slovakia surpass the other countries in Tolerance index mostly due to the attitudes towards homosexuals.

Public expenditures on R&D are a part of the technology index, their volume can be increased based on governmental policies. Other components of the technology index, namely the number of patent applications and the royalty and licence fees cannot be changed by any policy alone. However they can result from sound policies and appropriate investments into the R&D.

When evaluating time dimension there is a stagnating trend in governmental spending on education in all countries; the positive sign is the steady growth of expenditures in the tertiary education in line with Europe 2020 strategy. Another of the objectives of the Europe 2020 strategy related to the analysed factors is the increase in expenditures to the R&D; there is a very slow increase in all countries with certain phases of stagnation in Poland and Slovakia. The proportion of employment in the creative occupations did not significantly change over time, although there is increasing trend in the human resources employed in the science and technology. Tolerance index seems to capture general climate on the country and as such does not exhibit noteworthy time variation in the examined period 2000-2011. There was a sharp increase in the tolerance to homosexuality between the first wave in 1990-1991 and the second one in 1999 in all countries except for Hungary, but then no change in 2008. In this respect attitudes and values of the population do not change and self-expression of citizens doesn't change either in the examined period. Differences in overall Creativity index score between the countries are rather small and there is a growing trend in the examined time period. It can be only recommended and hoped for that increasing trend in creative capacities of these economies will continue.

Since there are two vital parts of any index, namely the datasets and the determination of the weights, we see the two lines of possible future development and improvement of the index. The first one refers to the data availability. Since the common goal of the researchers and the policy-makers striving to capture and enhance the creative capacity of the economy is to observe the development of the creative capacity in time, the reliable source of periodically collected and well-defined data

is necessary. Especially the tolerance dimension of the country would require the proxies that are more often measured and less burdened by the selection bias. And at the same time but to lesser extent the creative class representation would benefit from more detailed data. The second possible line of improvement lies in more sophisticated weights determination. As written in sub-section 2.4, the equal weights are appropriate when there is no additional information at hand. For example, if proper dependant variable is chosen the weights can be estimated using econometric approach. Needless to say, both suggested ways of index improvement are the objects of our further research.

References

[1] AMABILE, T., M. (1983). The social Psychology of Creativity. New York: Springer Verlag.

[2] BOWEN, H.P. - SLEUWAEGEN, L. - MOESEN, W. (2006). A composite index of the creative economy with application to regional best practices. Leuven: Vlerick Leuven Gent Management School Working Paper Series.

[3] FLORIDA R. – TINAGLI I. (2004). Europe in the Creative Age. Demos, February 2004.

[4] FLORIDA R. (2005). The Flight of the Creative Class: The New Global Competition for Talent. New York, Harper Business.

[5] FLORIDA, R. – MELLANDER, C. – STOLARICK, K. – SILK, K. – MATHESON, Z. – HOPGOOD, M. (2011). Creativity and Prosperity: The Global Creativity Index. Martin Prosperity Institute, Toronto.

[6] FLORIDA, R. (2002). The Rise of the Creative Class: And How Its Transforming Work, Leisure, Community and Everyday Life, New York: Basic Books.

[7] FLORIDA, R. - MELLANDER, C. - STOLARICK, K. (2008). Inside the black box of regional development: Human capital, the creative class and tolerance. Journal of Economic Geography 8:615–49.

[8] GLAESER, E. L. (2004). Review of Richard Florida's The rise of the creative class. Regional Science and Urban Economics 35:593–96.

[9] HUI, D. – NG, C. – MOK, P. – FONG, N. – CHIN, W. – YUEN, C. (2004). A study on Hong Kong Creativity Index. Commissioned by the Home Affairs Bureau, The Government of Hong Kong Special Administrative Region.

[10] KERN, P. – RUNGE, J. (2009). KEA briefing: towards a European creativity index. Part of the KEA's report 'The contribution of culture to creativity', conducted for the European Commission in 2008-2009.

[11] KNUDSEN, B. - FLORIDA, R. L. - GATES, G. - STOLARICK, K. (2007). Urban density, creativity, and innovation. Working paper, The Martin Prosperity Institute, University of Toronto

[12] LUNDVALL, B.A. - JOHNSON, B. (1994). The learning economy. Journal of Industry Studies, Vol. 1, No. 2, December 1994, pp. 23-42.

[13] MARLET, G. - VANWOERKENS, C. (2004). Skills and creativity in a cross-section of Dutch cities. Discussion Paper Series 04-29. Koopmans Research Institute, Utrecht.

[14] MCGRANAHAN, D. - WOJAN, T. (2007). Recasting the creative class to examine growth: Processes in rural and urban counties. Regional Studies 41:197–216.

[15] SCHUMPETER, J., A. (1911). Economic development. Translated edition by Opies, R., Elliot, J., E., Transaction publishers 1983.

[16] WEBER, M. AND T. PARSONS (2003). The Protestant Ethic and the Spirit of Capitalism, Dover Publications.

[17] WEISNBERG, R.,W. (1988). Problem solving and creativity. In Stemberg, R.,J.: The nature of Creativity. Cambridge University Press, Cambridge.