

European cultural statistics in a comparative perspective: A high-dimensionally adjusted cultural index for EU countries¹

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Abstract

In this article, we present the construction of a cultural index by means of using datasets from the 2007 and 2011 editions of Eurostat's Cultural statistics pocketbook, as well as Eurostat's COFOG data. The datasets allow for a broad perspective that encompasses a set of more than 200 variables for the EU-27 member states. By applying a high-dimensionally adjusted factor analysis to the datasets, we were able to construct a cultural index as well as identify a set of several cultural dimensions (as looked at from a cultural statistics viewpoint). By performing a clustering analysis, we could then determine general similarities and differences among countries and lay out several different groupings that roughly (albeit not exclusively) fall in line with observed results from previous studies. The analysis therefore provides a novel – as well as the first statistically developed – tool with which to empirically track changes, in terms of cultural statistics, in the social and economic situation in culture, while the clustering of models, moreover, has important consequences for empirical cultural policy and calls for further verification in future studies.

JEL classification: C38, C43, Z11, Z18, H80

Keywords: cultural statistics, comparative analysis, Eurostat, composite indicators, weighting schemes, Metropolis-Hastings Robbins-Monro algorithm

¹ For the comments we kindly thank Marilena Vecco, Marc Verboord, Tjaša Bartolj, and the participants at conferences and symposiums of Eurasian Business and Economic Society (EBES) Istanbul 2014, EBES Barcelona 2014, Association for Cultural Economics International (ACEI) Montreal 2014, International Conference on Cultural Policy Research (ICCPR) Hildesheim 2014, European Workshop on Applied Cultural Economics (EWACE) Vienna 2015, and Economic and Business Review (EBR) Ljubljana 2015. All remaining errors are our own.

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1. Introduction

Composite indicators are a field receiving an ever-wider attention. According to the OECD glossary, “a composite indicator is formed when individual indicators are compiled into a single index on the basis of an underlying model of the multi-dimensional concept that is being measured” (OECD 2016). In the presence of an ever wider need for measurement of composite and multidimensional concepts, such as active ageing (UNECE Active Ageing Index, see Zaidi et al. 2012), social exclusion (SHARE index of social exclusion, see Myck et al., 2015), corruption and economic freedom (see e.g. Kešeljević and Spruk 2013), creativity (see e.g. Correia and Costa 2014) and many others, the need for a developed methodology of constructing composite indicators is dire.

In culture, the haze of making cultural indices is on the rise. Endeavours such as National Arts Index (presented by the American organisation Americans for the Arts), Arts Index Netherlands, European Cultural Vitality Index, draft indicator framework on culture and democracy, several efforts to construct a European Cultural Index, British NCA Arts Index, ARC Creative City Index, Creative Community Index, Florida’s Creative Cities Index, Euro-Creativity Index, Cultural Life Index, Creative Vitality Index, Intercultural Cities Index, Slovenian Asociacija’s Cultural Index, and several other efforts show the intense efforts into construction of an appropriate composite indicator to measure the condition of culture. Yet, even the most basic methodological principles of constructing composite indicators, such as appropriate considerations of weighting, multivariate analysis and sensitivity analysis, are largely absent from most of those indices. It is thus the purpose of this article to present a new, statistically better grounded index that closely follows the rules of constructing composite indicators of the OECD (see Nardo et al. 2008), while also solving an important problem, to our knowledge rarely addressed in any of the existing indices in general to date: the insufficient units of observation as compared to the number of variables, i.e. high-dimensionality of the dataset. The only exception is the working paper, on which this work is based (Srakar, Verbič and Čopič 2015).

In the article, we present the construction of an index of economic and social condition of culture using datasets of Eurostat’s Cultural Statistics Pocketbooks (ECSP) from 2007 and 2011 and Eurostat’s COFOG data. The datasets allow us a broad perspective over a set of more than 200 variables in 12 domains: general development, cultural heritage, education in culture, cultural employment, share of artists in the general population, ratios of certain employment groups (ratios of women among artists, ratios of part-time jobs, etc.), cultural industries/enterprises in cultural sectors, foreign trade, participation in culture, internet habits, private expenditure, and public funding. Of those we select a slightly smaller group of indicators based on the theoretical construction of a composite indicator, measuring economic and social condition of culture, and use multiple imputation and exploratory factor analysis (following e.g. Cai 2010) to construct the index showing the “condition” of culture as viewed from the point of cultural statistics for the observed EU-27 member states for the years 2005 (the base for results of ECSP for year 2007) and 2009 (the base for results of ECSP for year 2011). Based on high-dimensionally adjusted exploratory factor analysis (using Metropolis-Hastings Robbins-Monro algorithm), we are able to determine a set of several dimensions, as viewed from the point of cultural statistics (bringing an interesting result that some commonly used dimensions, such as cultural participation, do not present a separate dimension in the analysis). Using clustering analysis, we are also able to determine the broader similarities and differences among European countries. We are able to confirm the existence of four broadly

different groups of countries: Western European, Mediterranean, Eastern European, and “outlier” countries.

The analysis in our article and construction of an own cultural index will allow us to test several main hypotheses:

H1: Using the dataset in our study, including participation in culture significantly changes the set of main dimensions of our latent construct.

H2: Using the dataset in our study, the start of the financial crisis did significantly affect the positions of individual countries in the cultural index.

H3: The constructed index is strongly positively correlated to the economic and social welfare of the included countries.

H4: Using the dataset in our study, classification of individual countries follows the Esping-Andersen’s welfare regimes typology.

The structure of the article is as follows. In Section 2, we give an overview of the literature. In Section 3, we present our dataset and some basic descriptive statistics. In Section 4, we describe the methods used. In Section 5, we present the results of the exploratory factor analysis and construction of our indices. In Section 6, we present the calculation of the final index. In Section 7, we present the clustering of countries into main groupings and the resulting typology of models. In the final section, we conclude with the main findings and some recommendations for future research.

2. Literature review

The literature in composite indicators formation is growing, but let’s briefly mention just few influential studies. Brancato and Simeoni (2008) investigate the capacity of standard quality indicators to reflect quality components and overall quality, using structural equation models. The paper applies confirmatory factor analysis first-order and second-order models. Structural equation models provide measures of the impact of each manifest variable (e.g. quality indicators) on the relative latent factor (e.g. quality or quality components) as well as measures of reliability, such as the Squared Multiple Correlation. Cecconi, Polidoro and Ricci (2004) detail a methodological approach to synthesising basic indicators in order to compare territorial data collection quality, for the Italian consumer price survey. Munda and Nardo (2006) evaluate the consistency between the mathematical aggregation rule, used to construct composite indicators and the meaning of weights. They formally prove that equal importance is incompatible with linear aggregation; since in a linear aggregation weights have the meaning of a trade-off ratio. Nardo et al. (2008) provide a handbook i.e. a guide on constructing and using composite indicators, with a focus on composite indicators which compare and rank countries’ performances. This handbook, published by the OECD will be discussed in more detail below. Polidoro, Ricci and Sgamba (2006) provide a novel methodology that expands on the methods detailed in Cecconi et al. (2004). The paper details the methodology used to synthesise the indicators for sample coverage, data collection infrastructure and micro data accuracy as well as creating an overall synthetic indicator. The paper of Smith and Weir (2000) describes how to obtain some overall measure of quality by considering quality as a multivariate measure for any dataset, where each quality indicator represents one dimension of quality. This is an alternative approach to evaluating the total survey error, since total survey error evaluates quality in terms of overall accuracy but is very costly. The papers of Cherchye and colleagues (2008; 2009) propose developments of composite indicators with imprecise data and using DEA analysis. Also, Saisana (2011) proposes different methods for usage of weighting in the construction of composite indicators.

There exist also very comprehensive overviews of the existing indices to date: in two studies, Bandura (2008; 2011) provides an inventory of over four hundred country-level indices, spanning over topics from economic progress to educational quality. Furthermore, Rotberg et al. (2013) identify over a hundred country-level indices that aim at measuring (broadly defined) governance or some of its inherent components. Finally, as related to the field of cultural indices, Stano, Weziak-Bialowolska and Saisana (2015) present a theoretical overview on the problems and challenges for the cultural indices to date.

Cultural indices are defined by Kushner and Cohen as “tools to stimulate public dialogue about the value of the arts, as well as to improve policy and decision-making” (Americans for the Arts 2012). They usually include a wide range of indicators that reflect a full picture of arts and culture (public, non-profit, business organisations, individual artists etc.). The cultural and socio-economic contexts in Europe differ a lot from country to country, as well as their approaches to collecting data and measuring their cultural sectors. As stated by Inkei (2013a), “the attempts for synergising and harmonizing statistics at the EU level progressed, but little is done for an integrated indicators’ tool that could shed light on the vitality of arts and culture in Europe over a reasonable time span”. Inkei precedes his article by answering what tool, or index, could address the European cultural sector and provide explicit, but also realistic information on at least these four dimensions, borrowed by the National Arts Index (NAI) of the USA: financing, capacities, participation, and competitiveness with other sectors.

The National Arts Index was developed by the Americans for the Arts organization. The index, composed of 83 indicators, embraces all sectors: non-profit organization, for-profit businesses, individual artists, as well as amateur levels of activity. Different aspects of culture are involved as various dimensions of culture and related domains of society. On a broad level, the 83 indicators are grouped into four dimensions: (1) financing, (2) capacities, (3) participation, and (4) the competitiveness with other sectors. Each dimension adds up to a respective index. The evolution of the four indices along the years portrays the trends that collectively determine the “health and vitality” of US culture.

As stated by Inkei (2013b) there are several attempts to also construct a European Arts Index, Inkei mentions the Arts Index Netherlands and attempts to construct a similar endeavour in France. In addition, in the UK in 2013 a NCA Arts Index has been published consisting of 20 indicators/indices combined together in a joint index. Finally, in Slovenia, in 2014 a paper called “Cultural Index: Case of Slovenia” has been presented (Društvo Asociacija 2014). The Asociacija’s Cultural Index is composed of number of indicators in 10 main domains and then composed in to a single national index, calculated for the years 2002-2012.

Despite several endeavours, very few efforts have been devoted to statistically better ground the formation of the index. OECD’s Handbook on Constructing Composite Indicators recommends ten main steps in the construction of composite indicators (see Nardo et al. 2008). First, a theoretical framework should be developed to provide the basis for the selection and combination of single indicators into a meaningful composite indicator under a fitness-for-purpose principle. Second, indicators should be selected based on their analytical soundness, measurability, country coverage, relevance to the phenomenon being measured and relationship to each other. Third, consideration should be given to different approaches for imputing missing values. Extreme values should be examined, as they can become unintended benchmarks. Fourth, an exploratory analysis should investigate the overall structure of the indicators, assess the suitability of the data set and explain the methodological choices, e.g. weighting, aggregation. Fifth, indicators should be normalised to render them

comparable. Attention needs to be paid to extreme values as they may influence subsequent steps in the process of building a composite indicator. Sixth, indicators should be aggregated and weighted according to the underlying theoretical framework. Correlation and compensability issues among indicators need to be considered. Seventh, analysis should be undertaken to assess the robustness of the composite indicator in terms of, *e.g.*, the mechanism for including or excluding single indicators, the normalisation scheme, imputation of missing data, the choice of weights and the aggregation method. Eighth, composite indicators should be transparent and fit to be decomposed into their underlying indicators or values. Ninth, attempts should be made to correlate the composite indicator with other published indicators, as well as to identify linkages through regressions. And, finally, tenth, composite indicators can be visualised or presented in a number of different ways, which can influence their interpretation.

In our analysis we will build on existing typology of indicators to measure economic and social “condition” of culture. Mainly we will refer to the reports of OECD (2006) and UNESCO (2009). In the former, the set of dimensions for the economic and social contribution of culture is defined and structured as follows:

Economic dimension:

- Output and Value Added: as stated in the report, “Clearly the main instrument of economic measurement for production is GDP. The contribution of culture to this global measure, *i.e.*, the value added of culture industries, is therefore our main economic indicator.” (OECD, 2006: 19) In our analysis we will use contribution of public funding of culture to GDP (for general, central and local funding) as the best measure we were able to obtain to measure this dimension. We also use several indicators measuring the economic contribution of cultural industries as the sector, best related to the economic dimension of culture (see KEA, 2006; Srakar, 2015).
- Employment: measuring culture-related employment requires modifications to the traditional approach used in most other areas of the economy, and the authors of the report recommend “an approach which uses combinations of industry and occupation to define the overall size and structure of the sector”. To this end we use multiple indicators of employment in culture related both to the general as well as sectorial ones.
- Export and Imports: the authors of the report recommend careful consideration of this dimension, as it “would clearly vary from country to country and arriving at meaningful comparisons will require careful considerations”. In our analysis, the indicators measuring this dimension were not well integrated into the results and didn’t provide meaningful interpretations. To this end, we avoid using this dimension although we allow possibility that in future analyses this would provide some additional dimension and possibility for further insights.
- Government Expenditures: at least for the European countries, the contribution of governments remains fundamental to a large part of the sector. To this end, we use indicators measuring the extent of general, central and local government spending for culture per capita.
- Private Sector Funding: although the report of OECD recommends taking into account the support from individuals, which also plays an important role in the funding of culture, due to lack of comparable data on this category (see *e.g.* Čopič et al., 2011), we do not include a special indicator (or indicators) measuring this dimension.
- Household Spending: spending by households or individuals on cultural goods and services provides an economic measure that can related to overall spending by

households. In our analysis we are able to include multiple measures (in particular for year 2009) to take into account this category, which also strongly related to the previous category (Private Sector Funding).

Social dimension:

- Participation/Consumption: this category borders between economic and social dimension. Many authors (see e.g. Inkei, 2013b) use it as an important and separate dimension in the construction of the cultural index. We, therefore, try to include multiple measures related to it in our construction of the index.
- Social Indicators: as stated in the OECD report, “although there is a considerable body of research on this area, definitive choices about what measures should be included are far from evident”. In our index, we follow the advice from the same report of “using some exposure to arts in the general education process” and include several indicators related to education in the arts related disciplines.

3. Data and basic descriptive statistics

The data we will use to construct a cultural index, valid for the EU-27 member states (Belgium, Bulgaria, Czech Republic, Denmark, Germany, Estonia, Ireland, Greece, Spain, France, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, Netherlands, Austria, Poland, Portugal, Romania, Slovenia, Slovakia, Finland, Sweden, and United Kingdom), are based on Eurostat’s Cultural Statistics Pocketbook 2007 (Eurostat 2007) and Eurostat’s Cultural Statistics Pocketbook 2011 (Eurostat 2011), whereas the data for the public funding of culture are taken from the COFOG Eurostat’s database (for years 2005 and 2009). We therefore have at our disposal a broad dataset of more than 200 variables in 12 domains: general development, cultural heritage, education in culture, cultural employment, share of artists in the general population, ratios of certain employment groups (ratios of women among artists, ratios of part-time jobs, etc.), industries/enterprises in cultural sectors, foreign trade, participation in culture, internet habits, private expenditure, and public funding.

From these variables, we selected a smaller group of variables that are mostly common to both datasets (for 2005 and 2009) and are assumed to contain most of the variability of a specific cultural domain contributing to condition of culture. We thus selected 33 variables from the dataset of 2005 and 63 variables from the dataset of 2009, which are listed and described in the Appendix (see Table A). The main difference between both sets of variables lies in the variables of participation in culture, which are not well represented in the Cultural Statistics Pocketbook of 2007, but are much more abundant in the pocketbook of 2011; similarly it holds for the variables of internet habits and private spending for culture.

It has to be noted that our choice of variables is constructed in the basis of available variables which are expected to be related to the underlying construct of “condition of culture”. Although we do not provide a theoretical background for this concept, it should be noted that it mainly derives from (existing and comparable) statistical measures to estimate such condition. It, therefore, includes mainly economically-related indicators, such as level of financing (public and private), employment, statistics on the performance of cultural industries and general development indicators. Furthermore, due its background in statistical indicators, it measures exclusively quantity of culture and not its quality. For future analysis it would be interesting to include in the analysis qualitative/dummy variables, measuring e.g.

existing legislation in culture in individual countries, its implementation and quality, results from surveys on culture from other sectors (not just economically related data), etc. Furthermore, cultural statistics suffers from many drawbacks, some of them surely being the absence of data in cultural fields and problems of reliability of existing data (see Bina et al. 2012), as well as definition of cultural and creative skills and occupations (see e.g. Bakhshi, Freeman and Higgs, 2013).

Finally, it has to be noted that we do not separate between inputs and outputs (see e.g. Kregzdaite et al. 2016), not to mention throughputs (see e.g. Hoelscher 2014) or outcomes (see e.g. Stano, Weziak-Bialowolska and Saisana 2015). Our choice of indicators is based on existing cultural statistics, used to estimate the “condition/state of culture” in a certain country, as measured by the Eurostat indicators. To this reason, we include as indicators all the variables that should a) contribute to the condition of culture in chosen 27 EU countries; and b) should have a clear sign of the effect on this conditions (either positive, such as public funding, or negative, such as level of unemployment). It could be wise to observe more disaggregated data, but the purpose of the analysis is to construct composite measures which would best encapsulate the variance and correlations between existing variables and to explore the relationships in such a set of measures.

Below we present some descriptive statistics of the included variables, while not going into much depth due to limited space and other existing studies on this topic.

From Table 1 we can see that for the percentage of arts students, the forerunners in 2005 were Ireland, Luxembourg (the value is imputed) and Malta, while in 2009 they were Ireland, United Kingdom and Finland. The worst countries in this aspect in 2005 and 2009 were South-Eastern and Eastern European countries: Greece, Slovenia, Slovakia and Poland.

As for the private expenditure for culture, unsurprisingly the top countries (in 2005 and 2009) come from Western European countries: Ireland, United Kingdom, Luxembourg and Austria. The worst scoring are the South-Eastern and Eastern European countries, particularly notable are the Baltic states. In the value added in cultural industries³ (among countries with no imputed values), the highest scoring are unsurprisingly United Kingdom, Ireland and Scandinavian countries. Quite notable are also Slovenia and Cyprus, the latter particularly in publishing. The worst scoring are most of the Eastern European countries.

Table 1: Descriptive statistics –education, private expenditure for culture and cultural industries’ value added

country	Arts tertiary students (in %)		Expenditure for the consumption of culture per household (in EUR)		Value Added in Publishing Sector per 1000 capita (in EUR)		Value Added in Sound Recording Sector per 1000 capita (in EUR)	
	2005	2009	2005	2009	2005	2009	2005	2009
Belgium	4.5	5.1	1 236.00	1 316.00	0.0777	0.0901	0.0005	0.0008
Bulgaria	2.6	2.4	467.80*	144.00	0.0201*	0.0087	0.0004*	0.0000
Czech Rep	2.6	1.9	578.00	607.00	0.0241	0.0323	0.0003*	0.0002

³ Economic indicators on cultural sectors can be found using harmonised SBS (Structural Business Statistics) data collected by Eurostat (see Eurostat, 2007; Eurostat, 2011). Among the included sectors for the cultural industries are: Publishing (for both 2005 and 2009); Motion picture, video and television programme production, sound recording and music publishing activities (for both 2005 and 2009); Programming and broadcasting activities (for 2009).

Denmark	3.4	3.6	1 358.00	1 338.00	0.1809	0.1952	0.0022	0.0035
Germany	3.7	3.6	1 284.00	1 334.00	0.1125	0.1204	0.0016	0.0024
Estonia	4.4	5.1	336.00	376.00	0.0327	0.0455	0.0001	0.0011*
Ireland	10.2	6.6	1 197.00	1 690.00	0.1055	0.1146	0.0012*	0.0004
Greece	1.7	2.1	623.00	740.00	0.0660*	0.0711	0.0003*	0.0017
Spain	4.6	4.7	666.00	794.00	0.0641	0.0764	0.0005	0.0008
France	5.0*	4.2	1 025.00	945.00	0.0919	0.0892	0.0093	0.0046
Italy	5.6	4.0	659.00	833.00	0.0670	0.0644	0.0010	0.0011
Cyprus	3.8	5.5	689.00	932.00	0.0620*	0.0427	0.0000	0.0000
Latvia	2.3	3.3	427.00	399.00	0.0240	0.0301	0.0008*	0.0005
Lithuania	2.7	3.2	271.00	256.00	0.0168	0.0185	0.0003	0.0001
Luxembourg	7.6*	3.5*	1 530.00	1 406.00	0.2806*	0.3178*	0.0029*	0.0010
Hungary	1.3	1.7	507.00	493.00	0.0221	0.0312	0.0006	0.0008
Malta	10.9	2.8	495.00*	1 088.00	0.0762*	0.0376*	0.0040*	0.0007*
Netherlands	4.4	4.4	1 324.00	1 378.00	0.1557	0.1773	0.0014	0.0024
Austria	4.1	5.2	1 175.00	1 415.00	0.0777	0.0861	0.0005	0.0018
Poland	1.0	1.1	461.00	415.00	0.0200	0.0292	0.0001	0.0004
Portugal	4.2	5.2	554.00	646.00	0.0395	0.0378	0.0004	0.0012*
Romania	1.4	1.2	670.80*	155.00	0.0041	0.0065	0.0000	0.0002
Slovenia	1.5	1.9	884.00	884.00	0.1081*	0.0546	0.0016	0.0028
Slovakia	1.8	1.7	431.60*	390.00	0.0124	0.0190	0.0000	0.0001
Finland	5.3	5.6	934.00	1 234.00	0.1979	0.1930	0.0049	0.0058
Sweden	3.4	4.4	1 207.00	1 275.00	0.1358	0.1479	0.0080	0.0064
United Kingdom	6.5	6.8	1 366.00	1 501.00	0.1975	0.1960	0.0036	0.0041

Note: * – imputed value.

Source: Eurostat, own calculations and imputations.

Table 3 shows the level of employment in culture⁴ and the levels of participation in culture. The highest scoring in the rate of cultural employment in total population are the Anglo-Saxon countries (UK, Ireland) and the Scandinavian countries, among others. Notable for high scores are also the Netherlands, Germany and Baltic countries. The worst scoring are the Eastern European countries and, perhaps surprisingly, also Luxembourg. The highest percentage of highly educated people employed in culture is recorded for Belgium, Lithuania and Estonia, whereas the lowest for Portugal, Malta, and the Czech Republic. The highest number of people employed in individual cultural sectors per capita is again recorded for Scandinavian, Anglo-Saxon and Baltic countries, while the lowest for Romania and Greece – countries of South-Eastern Europe.

As for the levels of cultural participation, we experienced problems with our dataset, as the year 2005 has almost no usable data for this purposes. We have therefore included only the variables for year 2009, where unsurprisingly, the highest level of cultural participation is to be found in Scandinavian (Denmark, Finland, Sweden) and Western European countries (Germany, Netherlands, France, United Kingdom). The worst scoring in this area were Bulgaria, Malta, Cyprus, Hungary, and Poland.

Table 2: Descriptive statistics – employment and participation in culture

country	Employment in culture in total economy (in %)		% have attend. live perform. at least 1, last 12 months	% visited a cultural site at least 1, last 12 months	% taken part in a public performance, last 12 months	% taken part in arts activities, last 12 months
	2005	2009	2009	2009	2009	2009
Belgium	2.1	1.4	48	45	8	14

⁴ Data on cultural employment based on the EU-LFS were calculated using a matrix crossing cultural economic activities ('sectors') with cultural occupations. This method counts all jobs in cultural activities (classified by NACE) and all cultural occupations (classified by ISCO) found in other (non-cultural) sectors. This matrix is based on the NACE Rev.1.1 and ISCO-88 classifications (Eurostat, 2011).

Bulgaria	1.8	1.5	15	12	4	3
Czech Rep	2.0	1.7	37	46	7*	8*
Denmark	3.0	2.3	61	61	13*	20*
Germany	2.8	2.2	52	58	11	14
Estonia	3.2	1.8	57	35	40	11
Ireland	2.5	1.5	50	40	11*	18*
Greece	2.1	1.2	34	15	13	8
Spain	2.1	1.3	38	47	8	13
France	2.0	1.7	50	49	15*	13*
Italy	2.1	1.1	30	27	24	10
Cyprus	2.2	1.2	42	27	4	9
Latvia	2.7	2.3	45	39	9	8
Lithuania	2.5	2.0	47	30	8	14
Luxembourg	1.8	1.3	54	55	9*	19*
Hungary	2.1	1.8	34	42	2	2
Malta	2.3	1.7	19	16	6*	4*
Netherlands	3.8	2.0	55	51	6*	19*
Austria	2.4	1.6	57	44	8	23
Poland	1.7	1.4	22	31	3	8
Portugal	1.4	0.9	47	32	6	7
Romania	1.1	0.8	46*	36*	9*	9*
Slovenia	2.3	2.0	42	43	12	10
Slovakia	1.8	1.1	52	45	12	15
Finland	3.3	2.3	64	66	11	22
Sweden	3.5	2.3	62	63	7*	19*
United Kingdom	3.1	2.1	54	57	9*	21*

Notes: * – imputed value.

Source: Eurostat, own calculations and imputations.

Table 4 shows the data on public financing of culture⁵. The best scoring countries on average in the level of public funding for culture (general, central and local level) are Denmark, France, Luxembourg, the Netherlands, and United Kingdom. The worst scoring are mainly countries of Eastern Europe (Bulgaria, Czech Republic, Lithuania, Latvia), while also including Greece. Notable exceptions among the Eastern European countries that score well are Estonia and Slovenia, which is also confirmed by the literature (see e.g. ERICarts and Council of Europe 2014).

Table 3: Descriptive statistics – public funding of culture

country	General government expenditure for culture per capita (in EUR)		Central government expenditure for culture per capita (in EUR)		Local government expenditure for culture per capita (in EUR)	
	2005	2009	2005	2009	2005	2009
Belgium	139.50*	181.59*	60.60*	97.61*	94.50*	90.63*
Bulgaria	19.30	26.50	23.16*	42.85*	12.76*	36.94*
Czech Rep	63.10	96.01	18.00	35.84	46.80	61.16
Denmark	253.80	286.60	67.30*	107.84*	156.00*	177.15*
Germany	111.00	124.63	39.64*	46.48*	95.94*	83.25*
Estonia	129.20	158.24	86.40	95.42	48.80	67.96
Ireland	142.10	251.32	68.20	165.71	76.60	87.93

⁵ For public financing in culture we use level of public budget per capita. This usage is justified by some previous analyses on international level (e.g. Čopič et al. 2013). The data for the public funding of culture are taken from the COFOG Eurostat's database which has also two additional measures of government funding for cultural services: Percentage of GDP and Percentage of Total Government Expenditur. As there is much less variation in these two variables among countries (cross-section dimension) we use only level of public budget per capita as a variable in our index. Most of the results have been tested also with the usage of two other measures and have been corroborated.

Greece	14.30	57.28	14.30	57.28	0.00	0.00
Spain	186.50	227.87	46.60	53.68	69.60	86.67
France	214.10	256.49	81.80	105.31	148.00	170.08
Italy	113.40	124.32	48.00	55.44	73.10	78.14
Cyprus	96.90	154.86	76.00	130.64	20.80	24.22
Latvia	63.36*	106.40	42.68*	61.68*	44.08*	34.02*
Lithuania	36.60	73.17	19.60	44.60	17.00	28.57
Luxembourg	683.50	538.80	595.90	395.75	129.80	190.88
Hungary	98.20	99.13	63.30	70.19	41.00	42.20
Malta	58.20	81.24	55.00	76.88	18.08*	0.00*
Netherlands	240.30	260.10	99.10	106.88	165.50	178.21
Austria	180.90	218.67	87.54*	116.16*	110.08*	124.15*
Poland	45.40	62.91	71.54*	50.09*	13.52*	42.24*
Portugal	90.40	98.98	54.70	61.83	35.70	37.07
Romania	53.42*	83.83*	42.04*	74.08*	42.00*	52.89*
Slovenia	122.40	224.32	75.40	154.84	61.00	86.06
Slovakia	81.70*	110.04*	78.64*	68.57*	23.28*	40.44*
Finland	150.10	183.99	74.60	100.07	113.00*	135.03*
Sweden	201.30	209.04	86.90	88.80	135.50	134.91
United Kingdom	220.90	175.63	110.74*	88.92*	131.46*	93.33*

Notes: * – imputed value.

Source: Eurostat, own calculations and imputations.

4. Methodology

Our methodology consists of five main steps. Firstly, we impute the values for the missing data as they might distort the results of multivariate analysis (see e.g. Koch 2013). We use multiple imputation, based on Fully Conditional Specification method (see e.g. van Buuren et al. 2006; van Buuren 2012), which allows simultaneous imputation of different related variables with missing values. We use five different generated values for the estimation of imputation values. For the variables with missing values in the domain of “general development” we use multiple imputations based on complete variables in this area. For variables in other domains, we use multiple imputations based on selected variables in the domain of general development including the multiple imputed ones, as well as the most significant variables in other domains that have already been imputed. Several imputation possibilities (with different variables used for imputation, different number of generated values, etc.) have been performed as well with no significant differences in results.

Secondly, we use factor analysis on our set of variables. We use transformation of each variable into its quartiles to standardise the variables and prevent the impact of different units of measurement. The results of factor analysis allow us to separate key decisive factors/dimensions and give them a stronger interpretation based on rotated (oblimin) factor loadings. This also provides information for other construction of cultural indices with respect to which dimensions to include as separate dimensions in the estimation of an index (provided that, so far, no attempt of constructing a cultural index uses multivariate analysis methodology).

A logical consideration is the high-dimensionality of the dataset (see e.g. Bai and Li 2012; Bai and Wang 2014), which includes more variables as there are units. Factor analysis commonly requires at least 10 times more units than variables (see e.g. Froman 2001). This condition is not satisfied in our analysis, which is the reason to use high-dimensional corrections. We chose to use Metropolis-Hastings adjustment of the original Robbins-Monro (1951) algorithm, which is a root-finding algorithm for noise-corrupted regression functions (see e.g.

Woods and Thissen 2001). The following mathematical explanation of the algorithm derives from Cai (2010a; 2010b).

Let $g(\cdot)$ be a real-valued function of the real variable θ . The Robbins–Monro method iteratively updates the approximation to the root according to the following recursive scheme (Cai 2010a):

$$\theta_{k+1} = \theta_k + \gamma_k R_{k+1}$$

where $R_{k+1} = g(\theta_k) + \zeta_{k+1}$ is an estimate of $g(\theta_k)$ and $\{\gamma_k; k \geq 1\}$ is a sequence of gain constants such that:

$$\gamma_k \in (0,1], \quad \sum_{k=1}^{\infty} \gamma_k = \infty, \quad \text{and} \quad \sum_{k=1}^{\infty} \gamma_k^2 < \infty$$

The Metropolis-Hastings Robbins-Monro (MHRM) algorithm is an extension of this basic algorithm to multi-parameter problems that involve stochastic augmentation of missing data. Let:

$$\mathbf{H}(\theta|\mathbf{Z}) = -\frac{\partial^2 l(\theta|\mathbf{Z})}{\partial \theta \partial \theta'}$$

be the $d \times d$ complete data information matrix, and let $\mathcal{K}(\cdot, A|\mathbf{Y}, \theta)$ be a Markov transition kernel such that for any $\theta \in \Theta$ and any measurable set $A \in \mathcal{E}$ it generates a uniformly ergodic chain having $\Pi(\mathbf{X}|\mathbf{Y}, \theta)$ as its invariant measure so that:

$$\int_A \Pi(d\mathbf{X}|\mathbf{Y}, \theta) = \int_{\mathcal{E}} \Pi(d\mathbf{X}|\mathbf{Y}, \theta) \mathcal{K}(\mathbf{X}, A|\mathbf{Y}, \theta)$$

Let initial values be $(\theta^{(0)}, \Gamma_0)$, where Γ_0 is a $d \times d$ symmetric positive definite matrix. Let $\theta^{(k)}$ be the parameter estimate at the end of the iteration k . The $(k+1)$ th iteration of the MHRM algorithm consists of (Cai 2010a):

- *Stochastic Imputation*: Draw m_k sets of missing data $\{\mathbf{X}_j^{(k+1)}; j = 1, \dots, m_k\}$ from $\mathcal{K}(\cdot, A|\mathbf{Y}, \theta^{(k)})$ to form m_k sets of complete data $\{\mathbf{Z}_j^{(k+1)} = (Y, \mathbf{X}_j^{(k+1)}); j = 1, \dots, m_k\}$.
- *Stochastic Approximation*: compute an approximation of the gradient of the observed data log-likelihood $\nabla_{\theta} l(\theta^{(k)}|\mathbf{Y})$ by the sample average of complete data gradients:

$$\tilde{\mathbf{s}}_{k+1} = \frac{1}{m_k} \sum_{j=1}^{m_k} \mathbf{s}(\theta^{(k)}|\mathbf{Z}_j^{(k+1)})$$

and a recursive approximation of the conditional expectation of the complete data information matrix:

$$\mathbf{\Gamma}_{k+1} = \mathbf{\Gamma}_k + \gamma_k \left\{ \frac{1}{m_k} \sum_{j=1}^{m_k} \mathbf{H}(\theta^{(k)} | \mathbf{Z}_j^{(k+1)}) - \mathbf{\Gamma}_k \right\}$$

– *Robbins-Monro update*: set the new parameter estimate to:

$$\theta^{(k+1)} = \theta^{(k)} + \gamma_k (\mathbf{\Gamma}_{k+1}^{-1} \tilde{\mathbf{s}}_{k+1}).$$

The iterations are terminated when the estimates converge. As stated by Cai (2010a), in practice, γ_k may be taken as $1/k$, in which case the choice of $\mathbf{\Gamma}_0$ becomes arbitrary. One can show that under certain regularity conditions the MHRM algorithm converges to a local maximum of $l(\theta | \mathbf{Y})$ with probability one. Though the simulation size m_k is allowed to depend on the iteration number k , it is by no means required. The convergence result shows that the algorithm converges with a fixed and relatively small simulation size, i.e. $m_k \equiv m$ for all k . Therefore, we use results from the oblimin-rotated version of high-dimensionally adjusted factor analysis using MHRM algorithm (see e.g. Cai 2010a; 2010b; Asparouhov and Muthén 2012).

Thirdly, we construct indices based on results from the factor analysis. The indices have been constructed by exploiting the nature of factors as standardised normal variables. We, therefore firstly transform the factors by adding 3 to each value (making them positive in approximately 99.86% cases), and then dividing their values by 6 (which is the range of the factor in 99.73% cases) and multiplying by 100 to get the conventional scales of the index values.

Fourthly, we construct a joint, single index for each of the considered years. To this end we use principal components analysis on the basis of constructed factors. We also test the resulting index to some of the macroeconomic indicators: GDP per capita, unemployment level and level of happiness.

Finally, and perhaps most important in terms of scientific contribution of the article, the resulting factors and indices allow us to perform a clustering analysis, being able to show the similarities and differences in analysed cultural characteristics of different countries. We use conventional hierarchical clustering with Wards linkage, strengthened by non-hierarchical K-means method (see e.g. Murtagh et al. 2008).

5. Exploratory factor analysis and construction of the indices

We firstly construct our indices for years 2005 and 2009. Based on results of regular factor analysis (eigenvalues and scree plot tests), we decided for an optimal number of factors of five. From the results of regular factor analysis (see Appendix, Table B) we can elaborate our set of five factors for year 2005 as: Factor 1 – general development and financing (public and private) of culture; Factor 2 – education in culture; Factor 3 – central-level public financing of culture; Factor 4 – cultural industries; Factor 5 – cultural heritage.

When using MHRM algorithm, our set of factors changes to: Factor 1 – employment and private financing of culture; Factor 2 – education and participation in culture (reversely signed⁶); Factor 3 – public funding of culture (reversely signed); Factor 4 – cultural

⁶ The notation »reversely signed« means that the best countries in this dimension score worst on the index and vice versa. The index was therefore transformed by subtracting all the estimated values from 100.

industries; and Factor 5 – cultural heritage (reversely signed). For the results see Appendix, Table B.

Following the methodology in Section 4, we construct five indices out of our MHRM factorial model and present them in Tables 5 and 6. Firstly, the results of the first index are hardly surprising; on the top are countries of liberal, social democratic and continental regimes: Denmark, Netherlands, Germany, Belgium, Finland, Sweden, Ireland, France and United Kingdom. Interestingly, Luxembourg scores rather poor on this criteria (following the results of Table 3), while the worst scoring are Romania, Cyprus, Portugal, Slovakia and Malta – mainly countries of the Mediterranean and Eastern European geographical origin.

In education and participation, the picture is slightly different, although still similar. Luxembourg, Belgium, Denmark, Germany, Ireland, Spain and France score the best, while Slovakia, Poland, Lithuania, Romania and Latvia score the worst, quite closely following the descriptive statistics of Tables 1 and 2.

In public funding, not surprisingly, Netherlands, Luxembourg, Austria, Estonia and Denmark lead the rankings. Perhaps it might come strange that Estonia scores so high, but also according to the data of ERICarts and Council of Europe (2016), Estonia is among countries with highest per capita public spending for culture, at least leading the Eastern and Mediterranean block (closely followed by Slovenia). Among the worst scoring countries are Bulgaria, Malta, Poland and Greece, being accompanied also by Germany with very low levels of central-level public spending on culture, particularly in 2005.

Table 4: Indices and ranks, MHRM algorithm, year 2005

Public funding for culture			Education and participation in culture			Private funding and employment in culture		
Country	Index	Rank	Country	Index	Rank	Country	Index	Rank
United Kingdom	108.09	1	Luxembourg	94.45	1	Denmark	118.48	1
Luxembourg	99.72	2	United Kingdom	93.54	2	Germany	112.73	2
Estonia	93.30	3	France	85.76	3	Netherlands	90.80	3
Sweden	83.62	4	Ireland	79.71	4	United Kingdom	79.23	4
Netherlands	76.72	5	Sweden	67.43	5	Luxembourg	77.77	5
Latvia	75.33	6	Spain	66.93	6	Latvia	76.60	6
Finland	71.96	7	Austria	66.35	7	Slovenia	69.12	7
Denmark	64.93	8	Italy	65.75	8	Cyprus	69.11	8
Austria	61.60	9	Malta	64.89	9	Ireland	63.09	9
Cyprus	58.92	10	Denmark	64.47	10	Spain	57.08	10
Slovenia	58.91	11	Belgium	59.41	11	France	56.56	11
Ireland	51.56	12	Germany	56.55	12	Poland	56.13	12
France	48.33	13	Finland	55.29	13	Belgium	53.17	13
Malta	45.47	14	Netherlands	49.67	14	Portugal	52.47	14
Italy	42.87	15	Hungary	42.61	15	Austria	50.78	15
Spain	42.08	16	Slovenia	36.72	16	Finland	50.37	16
Hungary	40.02	17	Cyprus	36.72	17	Czech Rep	47.83	17
Lithuania	33.31	18	Estonia	36.20	18	Hungary	46.02	18
Belgium	32.12	19	Greece	36.12	19	Bulgaria	45.82	19
Romania	30.68	20	Bulgaria	31.24	20	Estonia	40.25	20
Portugal	29.84	21	Portugal	31.07	21	Greece	38.23	21
Slovakia	29.28	22	Czech Rep	26.29	22	Sweden	36.20	22
Bulgaria	21.82	23	Poland	24.18	23	Romania	34.51	23
Germany	21.26	24	Latvia	18.01	24	Lithuania	33.20	24
Greece	19.72	25	Lithuania	16.71	25	Italy	32.20	25
Czech Rep	13.92	26	Slovakia	1.60	26	Slovakia	31.08	26
Poland	-6.50	27	Romania	-2.27	27	Malta	22.40	27

Source: Own calculations.

In cultural industries, it is Malta who leads the way, being followed by Germany, United Kingdom and Ireland. The countries of the liberal regime (see Esping-Andersen, 1990) score very well on this criteria which can be attributed to their policies of supporting cultural industries on the basis of economic effects of culture (see the debate following the study of Myerscough, 1988). The worst scoring countries are Romania, Poland, Hungary, Sweden, France and Italy.

In cultural heritage (the factor also includes several loadings from cultural industries), United Kingdom, Denmark, Luxembourg, France, Cyprus and Malta are the leaders, while countries of the Eastern Europe, Hungary, Czech Republic, Slovakia, Poland and Romania score the worst.

We now repeat the analysis for the dataset of 2009. Based on the eigenvalue and scree plot tests and rotated factor loadings, we decided to keep five factors. The interpretation of the factors from the regular factor analysis (see Appendix, Table C) is the following: Factor 1 – general development, public financing of culture and cultural participation; Factor 2 – private financing of culture; Factor 3 – employment in culture; Factor 4 – education in culture; Factor 5 – cultural industries.

When using MHRM algorithm, the set of factors changes to: Factor 1 – public funding for culture and cultural participation (reversely signed); Factor 2 – employment and education in culture; Factor 3 – private financing for culture and cultural participation (reversely signed); Factor 4 – cultural industries; Factor 5 – cultural heritage (for the results see Appendix, Table C).

In Tables 6 and 7, we show the results of index calculation for MHRM-algorithm-based factors for year 2009. In public financing and participation the Nordic countries, Luxembourg, Netherlands, Germany and France unsurprisingly score the best. The Nordic cultural model (see Duellund 2003) is known for its high level of participation in culture, while some other countries (particularly Luxembourg) enjoy high levels of public budget for culture. The worst scorers are again countries of the Eastern and Mediterranean part of Europe: Greece, Romania and Bulgaria, including also Lithuania and Latvia (Estonia also scores rather poor which could be a consequence of severe cuts in its public budget for culture in 2009, see e.g. Srakar 2015). The low position of Baltic countries can be also explained by their low levels of participation in culture, particularly in year 2009.

In employment and education in culture, again, unsurprisingly the Nordic and Baltic countries score the best, with United Kingdom, Germany, Netherlands and Austria being close followers. Interestingly, the Mediterranean countries are at the bottom positions which reflects the findings of the factor “Employment in culture” for the year 2005.

In private financing of culture and cultural participation (the latter, interestingly, spreads among two different factors), countries of the Nordic, Benelux and Liberal orientation score the best, including also Italy, Spain, and interestingly, Czech Republic (being relatively high in several participation criteria as well as private financing of culture, as compared to e.g. Eastern countries). The worst scoring are Eastern European countries: Romania, Bulgaria and Poland.

Table 5: Indices and ranks, factors 1–3, MHRM algorithm, year 2009

Public financing and participation in culture	Education in culture	Private financing of culture
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Country	Index	Rank	Country	Index	Rank	Country	Index	Rank
Denmark	117.35	1	Estonia	101.47	1	Ireland	88.36	1
Sweden	95.06	2	Austria	88.99	2	Denmark	85.86	2
Finland	93.49	3	Belgium	82.28	3	Belgium	85.77	3
Luxembourg	88.05	4	Portugal	80.87	4	Italy	80.72	4
Netherlands	83.50	5	Cyprus	80.10	5	Austria	78.95	5
Germany	76.32	6	Ireland	78.14	6	Czech Rep	73.40	6
France	73.88	7	United Kingdom	74.44	7	Hungary	71.59	7
United Kingdom	73.03	8	France	73.97	8	Slovenia	71.56	8
Austria	60.53	9	Finland	71.83	9	Finland	70.83	9
Belgium	54.33	10	Netherlands	70.48	10	United Kingdom	68.91	10
Slovakia	53.83	11	Sweden	69.10	11	Sweden	64.98	11
Spain	53.53	12	Spain	64.21	12	Netherlands	62.85	12
Ireland	49.61	13	Luxembourg	60.88	13	Germany	60.97	13
Estonia	36.50	14	Italy	54.79	14	France	57.03	14
Malta	36.19	15	Latvia	47.85	15	Portugal	42.30	15
Czech Rep	33.14	16	Denmark	47.84	16	Latvia	41.94	16
Slovenia	32.99	17	Malta	39.94	17	Poland	38.80	17
Hungary	32.98	18	Germany	38.95	18	Lithuania	38.53	18
Lithuania	27.17	19	Greece	34.48	19	Slovakia	35.68	19
Italy	20.11	20	Bulgaria	33.26	20	Spain	30.47	20
Romania	19.23	21	Lithuania	29.29	21	Romania	25.91	21
Portugal	18.52	22	Slovakia	25.83	22	Greece	25.79	22
Cyprus	17.90	23	Czech Rep	19.59	23	Bulgaria	23.63	23
Poland	10.07	24	Hungary	18.89	24	Luxembourg	20.67	24
Latvia	9.43	25	Slovenia	18.88	25	Cyprus	18.86	25
Greece	0.77	26	Romania	11.59	26	Estonia	18.40	26
Bulgaria	-10.50	27	Poland	-0.40	27	Malta	2.97	27

Source: Own calculations.

In cultural industries, unsurprisingly, United Kingdom, leads the way, followed by Denmark, Malta and Netherlands, which is in accordance with results for the year 2005. Interestingly, Greece scores very high, which is a consequence of additional included variables, such as turnover, employment and number of enterprises, in both publishing as well as sound recording industry. Clearly, the Eastern countries, such as Hungary, Romania, Bulgaria and Slovakia are the worst scorers, with Ireland significantly dropping its position of 2005, probably a consequence of the economic crisis severely affecting this country, and being reflected also in the results of Table 2, particularly for the sound recording sector.

Finally, in cultural heritage the best scoring countries are Cyprus, Greece, Malta, Spain and France, which is not surprising. Due to the construction of the variable (measuring number of objects per capita), it is not surprising that some smaller countries such as Luxembourg and Estonia score very well (reflected also in results of Tables 2 and 5). Slovenia, Germany and Hungary score worst, which is reflected in Table 2.

Table 6: Indices and ranks, factors 4–5, MHRM algorithm, year 2009

Cultural industries			Employment in culture		
Country	Index	Rank	Country	Index	Rank
United Kingdom	84.95	1	Finland	96.26	1
Denmark	83.62	2	Latvia	95.47	2
Greece	77.23	3	Sweden	86.16	3
Netherlands	74.92	4	Denmark	82.52	4
Malta	63.26	5	United Kingdom	76.90	5
France	63.18	6	Estonia	76.19	6
Latvia	61.25	7	Netherlands	74.10	7
Finland	60.56	8	Lithuania	66.87	8
Spain	58.99	9	Germany	60.85	9
Cyprus	53.67	10	Austria	58.68	10
Germany	53.49	11	Belgium	57.98	11
Italy	53.45	12	Czech Rep	57.31	12
Belgium	52.80	13	Hungary	56.66	13
Luxembourg	52.16	14	Slovenia	56.66	14

Sweden	50.09	15	Malta	52.53	15
Austria	48.43	16	Ireland	42.96	16
Estonia	47.33	17	Bulgaria	42.58	17
Poland	46.62	18	Poland	39.95	18
Hungary	45.70	19	Slovakia	36.68	19
Slovenia	45.69	20	Spain	35.00	20
Portugal	45.62	21	Cyprus	34.20	21
Czech Rep	44.77	22	France	33.17	22
Lithuania	43.88	23	Luxembourg	31.22	23
Ireland	37.51	24	Portugal	14.43	24
Bulgaria	24.99	25	Greece	6.71	25
Romania	15.84	26	Romania	4.77	26
Slovakia	-0.34	27	Italy	0.62	27

Source: Own calculations.

6. Construction of the final index

Our calculation of a single index is based on principal components analysis (PCA), following and modifying the method of Fernando, Samita and Abeynayake (2012). Similar as the authors there we use only the values of the first principal component of the PCA of five factors as the value of our final index.

In Table 8 are the results of the analysis for the regular factor analysis. In both 2005 and 2009, the leading country is Denmark, which could be related to its high level of financing of culture (see Tables 5 and 7 and ERICarts and Council of Europe 2016). As for 2005, the leading countries are also Netherlands, United Kingdom, Luxembourg and Finland, while for 2009 they are Finland (rising in position), Netherlands, Sweden and United Kingdom. Germany, Austria, Ireland, Estonia, Slovenia and France also score in the top part of the table in both years. Interestingly, there is no drop apparent for Ireland in 2009 (which we would expect due to severe effects of the financial crisis in this country). On the other hand, significant drops for Luxembourg and Cyprus can be noted. Also, Germany and Austria have improved their positions. In the bottom part, Greece, which is already not ranked well, significantly dropped in 2009, as would be expected, while no such drops can be noted for other countries of the so-called PIIGS cluster with severe sovereign debt problems (Portugal, Spain, Italy). Also, Czech Republic and Belgium have significantly improved their positions in 2009. Finally, the bottom countries are clearly Poland, Bulgaria and Romania.

In Table 10 we also show the results of MHRM-based analysis. As for the top countries, there are not much changes: Denmark is the clear leader for both 2005 and 2009, while United Kingdom, Netherlands, Sweden, Finland and Luxembourg are among the top five. Interestingly, Luxembourg does not drop in 2009 (the drop is not supported by descriptive data neither), as would be predicted by the results of the regular factor analysis. As for the other results there are even less changes visible in 2009 as compared to 2005 and the bottom countries clearly remain Poland and Romania (while Bulgaria scores slightly better than in Table 9).

Table 7: Final index, MHRM-based factor analysis, 2005 and 2009

2005			2009			
country	index	rank	country	index	rank	
United Kingdom	96.76	1	Denmark	99.11	1	↑
Luxembourg	93.59	2	Finland	89.35	2	↑
Denmark	83.00	3	United Kingdom	87.60	3	↓
Netherlands	71.83	4	Netherlands	83.25	4	=
Ireland	65.20	5	Sweden	80.60	5	↑
France	64.20	6	Austria	70.94	6	↑
Sweden	62.64	7	Belgium	70.93	7	↑

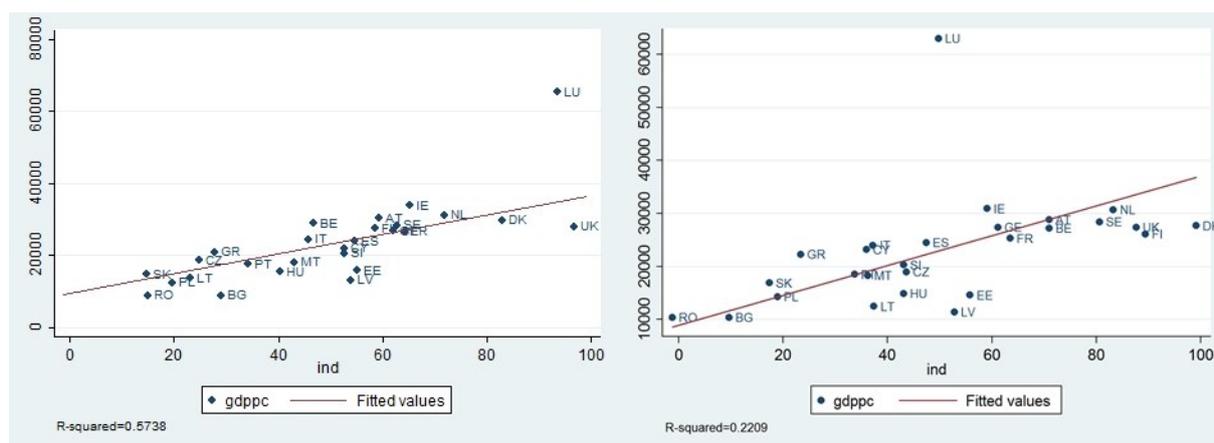
Germany	62.03	8	France	63.48	8	↓
Austria	59.25	9	Germany	61.17	9	↓
Finland	58.44	10	Ireland	59.09	10	↓
Estonia	55.05	11	Estonia	55.82	11	=
Spain	54.58	12	Latvia	52.85	12	↑
Latvia	53.77	13	Luxembourg	49.77	13	↓
Slovenia	52.73	14	Spain	47.40	14	↓
Cyprus	52.73	15	Czech Rep	43.60	15	↑
Belgium	46.62	16	Hungary	43.08	16	↑
Italy	45.83	17	Slovenia	43.07	17	↓
Malta	43.06	18	Lithuania	37.41	18	↑
Hungary	40.30	19	Italy	37.23	19	↓
Portugal	34.21	20	Malta	36.27	20	↓
Bulgaria	29.09	21	Cyprus	36.00	21	↓
Greece	27.67	22	Portugal	33.75	22	↓
Czech Rep	24.93	23	Greece	23.38	23	↓
Lithuania	23.09	24	Poland	18.96	24	↑
Poland	19.55	25	Slovakia	17.37	25	↑
Romania	15.00	26	Bulgaria	9.69	26	↓
Slovakia	14.86	27	Romania	-1.18	27	↓

Source: Own calculations.

We verify our index also in relationship to some main macroeconomic aggregates: GDP per capita, level of unemployment in the economy and level of happiness (for the latter we use Veenhoven's dataset, kindly provided by the author, see e.g. Veenhoven 2006).

The graphs in Figures 1-3 clearly confirm the validity of the index. Firstly, cultural index (based on MHRM algorithm) is clearly positively related to the level of GDP per capita with one clear outlier, Luxembourg, which has both an extremely high level of GDP per capita as well as public cultural spending (as demonstrated in Tables 1, 4, 5 and 7) but does not score so well on other culture-related criteria. Also, the relationship between the level of GDP per capita and cultural index is quite strong, as demonstrated by significant and high values of R-square statistic.

Figure 1: Relationship of MHRM-based cultural index to GDP per capita, 2005 (left) and 2009 (right)



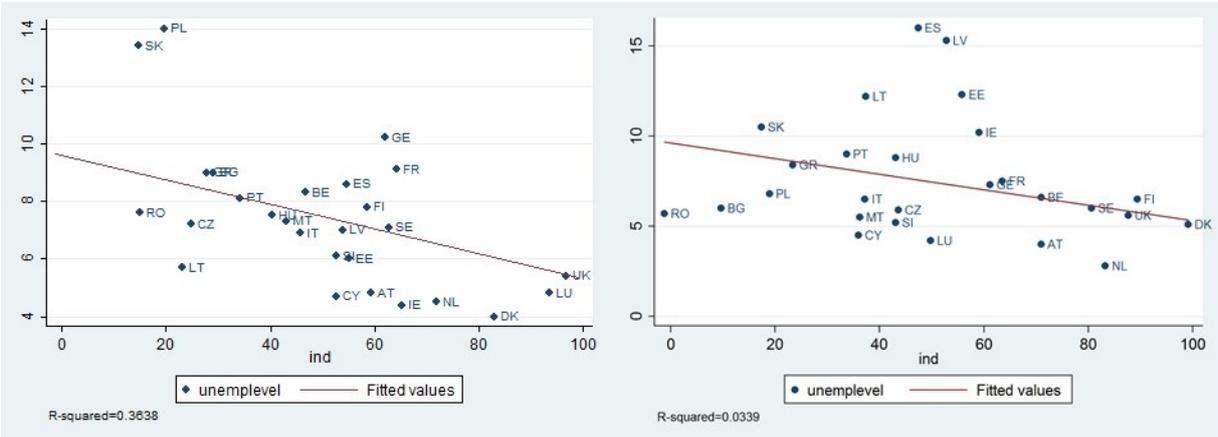
Source: Own calculations.

Also, Figure 2 shows a negative relationship of unemployment and cultural index as would be expected. Interestingly, here the relationship is stronger for year 2005. It has to be noted that of course GDP per capita and level of unemployment are correlated to the value of our index

by definition, as they were included among the indicators, but this relationship could be different due to the influence of other (numerous) indicators.

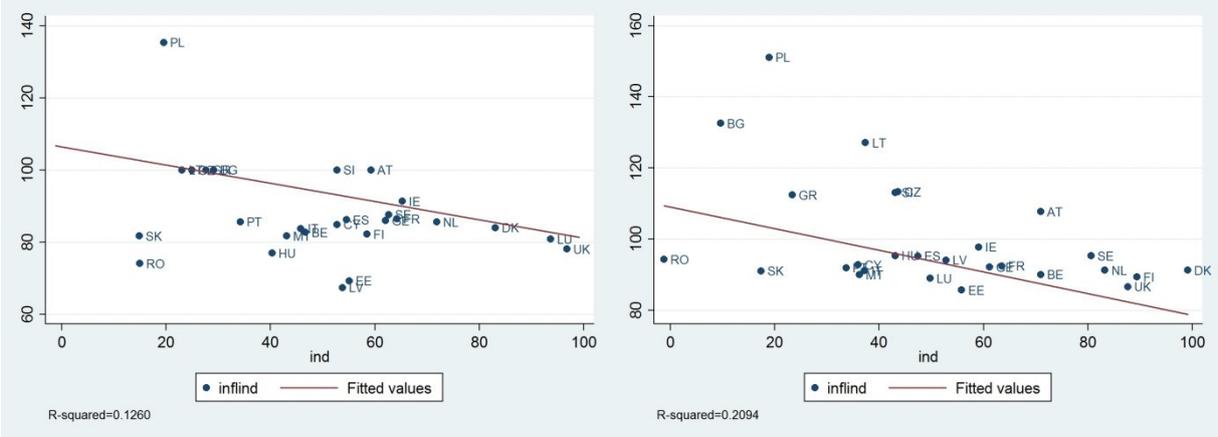
For this reason, we also observe the relationship to the level of happiness. From the findings of the literature (see e.g. Tepper, 2014; Wheatley and Bickerton, 2016; Wang and Wong, 2011; 2014) the positive relationship between subjective well-being and culture is confirmed. As stated by Tepper: “we find strong support that artistic practice is associated with higher levels of life satisfaction, a more positive self-image, less anxiety about change, a more tolerant and open approach to diverse others, and, in some cases, less focus on materialistic values and the acquisition of goods.” (Tepper, 2014: 6). From the results, the validity of our index is confirmed again: clearly, the countries with higher level of happiness have also a higher level of cultural index, as would be expected, and the relationship is slightly stronger for 2009 than for 2005 (which could be also a consequence of a much larger and better defined set of indicators).

Figure 2: Relationship of MHRM-based cultural index to the unemployment level, 2005 (left) and 2009 (right)



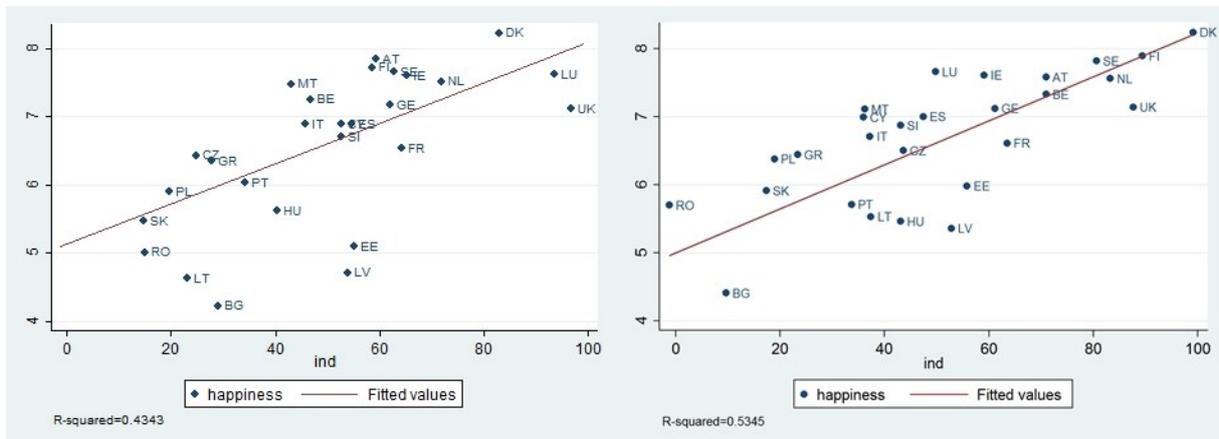
Source: Own calculations.

Figure 3: Relationship of MHRM-based cultural index to the level of inflation, 2005 (left) and 2009 (right)



Source: Own calculations.

Figure 4: Relationship of MHRM-based cultural index to the level of happiness, 2005 (left) and 2009 (right)



Source: Own calculations.

7. Clustering analysis and construction of “cultural model” typologies

In this section, we perform a clustering analysis to get the final groupings of countries based on the results of Section 5. Table 9 is the basis for decisions on our clustering for the year 2005. The table shows that optimal number of clusters for the clustering based on regular factor analysis is 4, as pseudo-T square is among the lowest, whereas $Je(2)/Je(1)$ statistic is among the highest, and Calinski-Harabasz statistic is also very high for this number of clusters. For similar reasons, the optimal number of clusters for the clustering based on MHRM is four as well.

Table 8: Duda-Hart and Calinski-Harabasz statistics, clustering of factors, years 2005 and 2009

Number of clusters	MHRM 2005			MHRM 2009		
	Duda/Hart		Calinski/Harabasz pseudo-F	Duda/Hart		Calinski/Harabasz pseudo-F
	$Je(2)/Je(1)$	pseudo T-squared		$Je(2)/Je(1)$	pseudo T-squared	
1	0.6049	16.33		0.6395	14.09	
2	0.6987	6.90	16.33	0.7382	4.61	14.09
3	0.4566	7.14	14.94	0.6059	6.50	10.73
4	0.5115	7.64	16.81	0.7472	2.71	9.60
5	0.4639	4.62	16.38	0.4133	7.10	8.47
6	0.4703	7.88	17.65	0.5750	3.70	8.23
7	0.3678	6.87	18.57	0.4893	3.13	8.81
8	0.2506	2.99	18.56	0.4955	2.04	9.88
9	0.4039	5.90	21.27	0.1725	4.80	9.77
10	0.3459	3.78	22.67	0.0000	.	9.87
11	0.1860	8.75	25.07	0.4462	3.72	10.14
12	0.0000	3180000.00	26.38	0.3367	1.97	10.26
13	0.0000	.	27.58	0.4735	2.22	10.76
14	0.4076	4.36	32.44	0.1906	8.49	11.54
15	0.2439	3.10	37.44	0.0000	.	11.86

Source: Own calculations.

After performing the K-means strengthening of clusters for factors and ranks (with the predetermined number of clusters), the final groupings are listed in Table 10. They show that two broad groupings appear to show in the clusters: a) Nordic, Liberal/Anglo-Saxon and Continental countries; b) Eastern European and Mediterranean countries. These observations are confirmed in the analysis of year 2009, where we observe that the second group is

composed of three distinct groups of countries. We can also observe that some countries (e.g. Malta, Luxembourg, Cyprus, Estonia, Slovenia) change their position and it is hard to determine their fixed position in one cluster exactly.

Table 9: Final groupings, clustering of factors, years 2005 and 2009

Final groupings – factors, MHRM, 2005:		Final groupings – factors, MHRM, 2009:	
Cluster 1	Belgium, Hungary, Italy, Malta, Spain	Cluster 1	Denmark, Finland, Germany, Netherlands, Sweden, United Kingdom
Cluster 2	Cyprus, Estonia, Finland, Latvia, Netherlands, Slovenia	Cluster 2	Cyprus, Estonia, Luxembourg, Malta, Portugal, Slovenia, Spain
Cluster 3	Austria, France, Ireland, Luxembourg, Sweden, United Kingdom	Cluster 3	Austria, Belgium, France, Ireland, Italy
Cluster 4	Bulgaria, Czech Rep, Greece, Lithuania, Poland, Portugal, Romania, Slovakia	Cluster 4	Bulgaria, Czech Rep, Greece, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia
Cluster 5	Denmark, Germany		

Source: Own calculations.

Table 11 serves as the basis for decision on the number of clusters for year 2009 to include in our final, K-means clustering. It is clear that four clusters for both types of factor analysis should be used.

Results of the K-means strengthening are shown in Table 12. They again broadly confirm the two main groups of countries we observed previously: Nordic, Liberal/Anglo-Saxon and Continental countries; and Eastern European and Mediterranean countries. It is apparent that there are some outliers: firstly, Luxembourg is sometimes located in the Western and sometimes in other clusters (similarly as for 2005). Secondly, the position of Malta is slightly unclear: although it appears closest to the Mediterranean cluster, it is sometimes also located in other clusters; the same holds for Cyprus. Estonia is located in the Western cluster for the regular factor analysis while falling in another cluster for the MHRM analysis. Interestingly, despite its high levels of single index, Slovenia is located clearly in the Eastern countries cluster. Also, France is sometimes located clearly in the Western cluster while sometimes also closer to the Mediterranean countries. Finally, particularly from the results of the MHRM analysis, we can observe the diversification of the second group into Mediterranean group (Greece, Italy, Spain, Portugal, probably also Malta and Cyprus) and Eastern European countries.

Our final proposed clustering of countries based on cultural statistics would therefore be: (1) Eastern European group: Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia, Latvia, Lithuania; (2) Mediterranean group: Greece, Spain, Italy, Cyprus, Portugal; (3) Western European (Liberal/Social-Democratic/Continental) group: Belgium, Netherlands, Germany, Austria, Ireland, United Kingdom, Denmark, Finland, Sweden; (4) Outliers: Malta, Cyprus, Luxembourg, Estonia, Slovenia, France.

There are some additional observations to make.

Firstly, among the outliers there are some several small countries with specific position of culture. In Malta, a high pronunciation on cultural industries and cultural heritage can be

found. In Luxembourg, a great disparity between indicators in financing and general development on one hand and employment on the other hand can be found. For Cyprus, it is unclear to which level it belongs to the Mediterranean and/or to other clusters (perhaps it could be located closest to Malta). For Estonia and Slovenia, culture has a special place in the nation history, which is reflected in high levels for public funding of culture for both countries (see e.g. ERICarts and Council of Europe 2016). Although reports for Slovenia suggest that the position in cultural sector has deteriorated in the past years (see e.g. Slovenian Cultural Index, see Društvo Asociacija 2014) its position appears to lie close to the “bottom” countries of the Western European group. Also, although not being a small country, culture has a special position for France, being sometimes labelled as cultural monarchy (see e.g. Burley, 1981), which partly explains its special positioning among the countries.

Finally, it is very interesting that most of the Western European countries cluster in a common group. Although e.g. Nordic countries appear strongly similar in most of the indicators and indices, one cannot clearly separate their cultural model from other Western European countries on the line of statistical parameters (at least the ones we included in our analysis) only. The same holds for other Western European countries as well. This shows that Esping-Andersen’s original model (see Esping-Andersen 1990) which separates liberal, socialdemocratic and continental countries is not fully applicable to the cultural sphere.

8. Concluding remarks

In the article, we presented construction and analysis of a cultural index for EU-27 member states in years 2005 and 2009, based on existing European cultural statistics. There are four apparent contributions of our analysis to the literature in the fields of cultural economics and cultural policy analysis. First, construction of a statistically developed cultural index that includes most of the considerations of widely referenced OECD Handbook on Construction of Composite Indicators from 2008, which are not even closely followed in any existing cultural index to date to our knowledge. Second, statistical elaboration of a set of separate dimensions of any cultural system in the EU that brings in our opinion a solid base for choice of dimensions of similar cultural indices in future. Third, a solution to the problem of high-dimensionality that can be present whenever one tries to estimate such an index based on country-level (and, therefore, not micro-level) data, using the Metropolis-Hastings Robbins-Monro algorithm as suggested by the literature. Although results in some dimensions are still not optimal and further solutions to this issue should be searched for, this nevertheless presents a viable methodology for future constructions of indices with similar problems in all areas of the economy and society. And fourth, a significant step made in the analysis of cultural groupings in European Union, where to our knowledge very few empirical literature exists so far (the studies that have to be noted, but are only related, are Hillman Chartrand and McCaughey, 1989; Ulldemolins and Arostegui, 2013; Zimmer and Toepler, 1996; Zimmer and Toepler, 1998). . This should bring sufficient support for the development of empirical and statistical cultural policy, which is to our opinion unfortunately still at its very beginnings.

Let’s summarise the relevance of the findings for the verification of our initial four hypotheses. Firstly, the high-dimensional methodology *did* enable a more diversified view on the factors with dimensions being more clearly divided and not grouped mainly in the first factor (as for the regular factor analysis). Also, the positions of some countries have changed and become more logical, as shown in section 6.

Including participation in culture for year 2009 *did not* significantly change the set of main dimensions of our latent construct. This finding was verified in numerous robustness tests (including correlations with a much larger number of variables, see Srakar and Vecco, 2016). Although it could be a consequence of a limited set of indicators it significantly opposes the methodology of existing cultural indices (e.g. US National Arts Index, Arts Index Netherlands) which take participation in culture as one of their main dimensions. To our opinion this indicates that participation of culture is strongly correlated to all/most of the included variables in the analysis and does not, therefore, form a separate, clearly distinguishable dimension. For future analysis, it would be, therefore, wise to exclude it as a separate dimension and correlate it more strongly with other cultural dimensions. On the other hand, it is also possible that the specific position of cultural participation in our analysis derives from the weak definition of the latent construct of “condition of culture” and choice of the indicators. To this end it would be necessary to test and validate the findings of the analysis in future research.

Furthermore, it is interesting that in the final, MHRM analysis the general development factors did also not have a special dimensions but nicely clustered into other factors/dimensions.

Thirdly, the financial crisis, which should show its effects in 2009, *did not* significantly affect the positions of individual countries in the cultural index, at least in most cases. Although there were some small changes, observed mainly in Section 6, no drastic change was visible. This could be a consequence of 2009 being only the starting year of the crisis when the latter implemented austerity measures did not yet show their temper. We could thus expect some changes, particularly for countries being most affected by the crisis (e.g. PIIGS countries, Cyprus, Slovenia), in the positions on our index.

As for the classification of individual countries, the Esping-Andersen’s welfare regimes typology *was not* followed completely. The main change was a unique cluster for Western countries which contradicts some of the Esping-Andersen’s claims. Clearly we cannot separate Western countries of the liberal, socialdemocratic and/or continental regime by the level of development of their cultural sphere, this was firmly showed in our analysis.

There are several issues open for further research. Firstly, some dimensions of culture that could be included are at present not included in the model, such as existing legislation in culture. Secondly, the index scores could be included in a regression analysis and by this additionally verified in their validity and sensitivity. Also, composite indicators may not be the best way to represent the “condition” of culture or its dimensions, to this end a more case-study and qualitative analysis’ based approach might be preferred. It was our task in the analysis to try to explore the novel approach to the subject and its results and consequences. Finally, the analysis should be broader in terms of time dimension and accuracy of data, but we are unfortunately limited in this aspect with existing cultural statistical data. With improved cultural statistics, also a more developed and theoretically better founded analysis would be possible. We therefore see our article primarily as a much-needed step towards developing statistical tools in empirical cultural policy on a consistent basis, hoping to stimulate research, including the verification of our findings.

9. References

- Americans for the Arts. (2012). *National Arts Index 2012: An Annual Measure of the Vitality of Arts and Culture in the United States: 1998-2010*. Washington, New York: Americans for the Arts.
- Asparouhov, T. & Muthén, B. (2012). *Comparison of computational methods for high dimensional item factor analysis*. <https://www.statmodel.com/download/HighDimension.pdf>. Accessed 12 March 2016.
- Bai, J. & Li, K. (2012). Statistical analysis of factor models of high dimension. *Annals of Statistics* 40(1), 436-465.
- Bai, J. & Wang, P. (2014). Identification theory for high dimensional static and dynamic factor models. *Journal of Econometrics*, 178(2), 794-804.
- Bakhshi, H., Freeman, A. & Higgs, P. (2013). *A Dynamic Mapping of the UK's Creative Industries*. London: NESTA.
- Bandura, R. (2008). *A Survey of Composite Indices Measuring Country Performance: 2008 Update*. New York: United Nations Development Programme.
- Bandura, R. (2011). Composite Indicators and Rankings: Inventory 2011. Unpublished, 2011.
- Bína, V., Chantepie, P., Deroin, V., Frank, G., Kommel, K., Kotýnek, J. & Robin, P. (2012). *ESSnet-Culture Final Report*. Luxembourg: European Commission, Eurostat (ESTAT).
- Brancato, G. & Simeoni, G. (2008). Modelling Survey Quality by Structural Equation Models. *Proceedings of Q2008 European Conference on Quality in Survey Statistics, Rome, July 2008*.
- Burley, P. (1981). *Louis XVI and a new monarchy: an institutional and political study of France 1768-1778*. Doctoral thesis, University of London.
- Cai, L. (2010a). Metropolis-Hastings Robbins-Monro algorithm for confirmatory item factor analysis. *Journal of Educational and Behavioral Statistics*, 35, 307-335.
- Cai, L. (2010b). High-dimensional exploratory item factor analysis by a Metropolis-Hastings Robbins-Monro algorithm. *Psychometrika*, 75, 33-57.
- Cecconi, C., Polidoro, F. & Ricci, R. (2004). Indicators to define a territorial quality profile for the Italian consumer price survey. *Proceedings of Q2004 European Conference on Quality in Survey Statistics, Mainz, May 2004*.
- Cherchye, L., Moesen, W., Rogge, N. & Van Puyenbroeck, T. (2009). *Constructing a Knowledge Economy Composite Indicator with Imprecise Data*. CES KU Leuven Discussion Paper Series 09.15.
- Cherchye, L., Moesen, W., Rogge, N., Van Puyenbroeck, T., Saisana, M., Saltelli, A., Liska, R. & Tarantola, S. (2008). Creating Composite Indicators with DEA and Robustness Analysis: the case of the Technology Achievement Index. *Journal of the Operational Research Society*, Vol. 59, 239-251.
- Correia, C. M. and Costa, J. S. (2014). Measuring Creativity in the EU Member States, *Investigaciones Regionales*, Vol.30, 7-26.
- Društvo Asociacija. (2014). *Kulturni indeks: Primer Slovenija*. Ljubljana: Društvo Asociacija.
- Duelund, P. (2003). *The Nordic Cultural Model*. Copenhagen: Nordic Cultural Institute.
- ERICarts and Council of Europe (2016). *Compendium of Cultural Policies and Trends in Europe*. <http://www.culturalpolicies.net/web/index.php>. Accessed 12 March 2016.
- Esping-Andersen, G. (1990). *The Three Worlds of Welfare Capitalism*. Princeton, NJ: Princeton University Press.
- Eurostat (2007). *Pocketbook Cultural Statistics. 2007 Edition*. Brussels: European Commission.
- Eurostat (2011). *Pocketbook Cultural Statistics. 2011 Edition*. Brussels: European Commission.

- Fernando, M.A.C.S.S., Samita, S. & Abeynayake, R. (2012). Modified Factor Analysis to construct Composite Indices: Illustration on Urbanization Index. *Tropical Agricultural Research*, 23 (4), pp. 327– 337.
- Froman, R. (2001). Elements to Consider in Planning the Use of Factor Analysis. *Southern Online Journal of Nursing Research*, Issue 5, Vol. 2, 2001.
- Hillman Chartrand, H. & McCaughey, C. (1989). The arm's length principle and the arts: and international perspective – past, present and future, In: M.C. Cummings Jr & J. Mark Davidson Schuster (eds.) *Who's to Pay? for the Arts: The International Search for Models of Support*, New York City: American Council for the Arts.
- Hoelscher, M. (2014). *Presentation of the draft Framework of Indicators on Culture's Contribution to Democracy (follow-up to the 2013 Council of Europe Conference of Ministers of Culture)*. Brussels: 13th Assembly of Experts of the Council of Europe / ERICarts.
- Inkei, P. (2013a). *Considerations about a European Cultural Index*. Amsterdam: European Cultural Foundation.
- Inkei, P. (2013b). *From indicators to cultural policies*. Budapest: Budapest Observatory.
- Kešeljević, A. & Spruk, R. (2013). Endogenous economic freedom and the wealth of nations: evidence from a panel of countries, 1996—2011. *Applied Economics*, Taylor & Francis Journals, vol. 45(28), 3952-3962.
- Koch, I. (2013). *Analysis of multivariate and high-dimensional data: theory and practice*. Cambridge: Cambridge University Press.
- Kregzdaite, R., Cernevičute, J., Strazdas, R. & Jancoras, Z. (2016). *Problems of evaluation impact of CCI: constructing indexes*. Valladolid: 19th International Conference on Cultural Economics, Accepted Abstract.
- Munda, G. & Nardo, M. (2006). Weighting and Aggregation for Composite Indicators: A Non-compensatory Approach. *Proceedings of Q2006 European Conference on Quality in Survey Statistics*, Cardiff.
- Murtagh, F., Downs, G. & Contreras, P. (2008). Hierarchical clustering of massive, high dimensional data sets by exploiting ultrametric embedding, *SIAM Journal on Scientific Computing*, 30(2), 707–730.
- Myck, M., Najsztab, M. & Oczkowska, M. (2015). Measuring social deprivation and social exclusion. In Börsch-Supan, A., Kneip, T., Litwin, H., Myck, M. & Weber, G. (Eds.), *SHARE Wave 5 data: a contribution to a better understanding of differences in material conditions in later life* (pp. 67-78). Berlin: De Gruyter.
- Myerscough, J. (1988). *The Economic Importance of the Arts in Britain*. London: Policy Studies Institute.
- Nardo, M., Saisana, M., Saltelli, A., Tarantola, S., Hoffman, A. & Giovannini, E. (2008). *Handbook on constructing composite indicators: methodology and user guide*, Paris: OECD.
- OECD (2007). Glossary of Statistical Terms. Composite indicator. <https://stats.oecd.org/glossary/detail.asp?ID=6278>. Accessed 12 March 2016.
- Polidoro, F., Ricci, R. & Sgamba, A.M. (2006). The relationship between Data Quality and Quality Profile of the Process of Territorial Data Collection in Italian Consumer Price Survey. *Proceedings of Q2006 European Conference on Quality in Survey Statistics*, Cardiff, October 2006.
- Robbins, H. & Monro, S. (1951). A stochastic approximation method. *The Annals of Mathematical Statistics*, 22, 400–407.
- Rotberg, R.I., Bhushan, A. & Gisselquist, R.M. (2013). The Indexes of Governance. *Measuring Governance Effectiveness: National and International Dimensions*, a

- conference sponsored by the Centre for International Governance Innovation and the North-South Institute. 2013.
- Saisana, M. (2011). *Weighting Methods II: Statistical Approaches*. Lecture at JRC Seminar on Composite Indicators and Rankings, Ispra Italy.
- Smith, P. & Weir, P. (2000). Characterisation of quality in sample surveys using principal components analysis. *Proceedings of UNECE Work session on Statistical Data Editing*, Cardiff, October 2000.
- Srakar, A. (2015). Financiranje kulture v Sloveniji in ekonomski učinki slovenske kulture v letih 1997-2014. *Likovne besede*, 2015, Special Edition, 5-25.
- Srakar, A., Verbič, M. & Čopič, V. (2015). *European Cultural Models in Statistical Perspective: A High-dimensionally Adjusted Cultural Index for the EU Countries, 2005–2009*. Oviedo: Association for Cultural Economics International, Working Paper, 6, 2015.
- Stano, P., Weziak-Bialowolska, D. & Saisana, M. (2015). *Monitoring cultural and creative activities and their impact in European cities' development: Challenges and the way forward*. ATINER's Conference Paper Series: PLA2015-1727. Athens: ATINER.
- Ulldemolins, J.R. & Arostegui, A.R. (2013) The governance of national cultural organisations: comparative study of performance contracts with the main cultural organisations in England, France and Catalonia (Spain). *International Journal of Cultural Policy*, 19, 2, 249-269.
- Van Buuren, S. (2012). *Flexible Imputation of Missing Data*. Boca Raton, FL: Chapman & Hall/CRC.
- Van Buuren, S., Brands, J.P.L., Groothuis-Oudshoorn, C.G.M. & Rubin, D.B. (2006). Fully conditional specification in multivariate imputation. *Journal of Statistical Computation and Simulation*, 76, 1049-1064.
- Veenhoven, R. (2006). *World Database of Happiness, continuous register of scientific research on subjective enjoyment of life*. Erasmus University Rotterdam, Netherlands. <http://worlddatabaseofhappiness.eur.nl>. Accessed 12 March 2016.
- Woods, C.M. & Thissen, D. (2006). Item response theory with estimation of the latent population distribution using spline-based densities. *Psychometrika*, 71, 281–301.
- Zaidi, A., K. Gasior, M.M. Hofmarcher, O. Lelkes, B. Marin, R. Rodrigues, A. Schmidt, P. Vanhuyse & E. Zolyomi (2012). *Towards An Active Ageing Index: Concept, Methodology and First Results*. EC/UNECE, Active Ageing Index Project, UNECE Grant ECE/GC/2012/003, European Centre for Social Welfare Policy and Research, Vienna, July 2012.
- Zimmer, A. & Toepler, S. (1996). Cultural policies and the welfare state: the cases of Sweden, Germany and the United States. *The journal of arts management, law and society*, 26 (3), 167-193.
- Zimmer, A. & Toepler, S. (1998). *The subsidized muse: government and the arts in Western Europe and the United States*. Paper given at the 10th international conference on cultural economics, Barcelona.