European "cultural models" in statistical perspective: A high-dimensionally adjusted cultural index for the EU countries, 2005–2009

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Abstract

In the article, we present the construction of a cultural index using datasets of Eurostat's Cultural Statistics Pocketbooks 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 for the EU-27 member states. Using high-dimensionally adjusted factor analysis (Metropolis-Hastings Robbins-Monro algorithm), we construct a cultural index and determine a set of several cultural dimensions (as seen from the cultural statistics viewpoint). Using clustering analysis, we determine the general similarities and differences of observed cultural models and show several broadly different groupings that roughly, but not exclusively follow the divide speculated in some previous studies. The analysis therefore brings a novel and first statistically developed tool to empirically follow the changes in the condition of culture from the viewpoint of cultural statistics, while the clustering of models has important consequences for empirical cultural policy and has to be verified in future studies.

Keywords: cultural statistics, European cultural models, Eurostat, composite indicators, multivariate analysis, Metropolis-Hastings Robbins-Monro algorithm

JEL classification: C38, Z11, Z18

1. Introduction

Composite indicators are a field receiving 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." 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), and corruption and economic freedom (see e.g. Kešeljević & Spruk 2013), the need for a developed methodology of constructing composite indicators is dire.

In culture, the haze of making cultural indexes is on the rise. Endeavours such as National Arts Index (presented by the American organisation Americans for the Arts), Dutch Arts Index, European Cultural Vitality Index, draft indicator framework on culture and democracy, several efforts to construct a European Cultural Index, British NCA Arts 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 all of those indexes. 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 indexes to date: the insufficient units of observation as compared to the number of variables, i.e. high-dimensionality of the dataset.

In the article, we present the construction of a cultural index 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. Using multiple imputation and exploratory factor analysis (following e.g. Li 2010), we construct a cultural index showing the level of the quality 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 cultural dimensions, as viewed from the point of cultural statistics. Using clustering analysis, we are also able to determine the broader similarities and differences among cultural policy models in Europe. We are able to confirm the existence of three broadly different groups of countries: Western European, Eastern European, and Mediterranean countries.

Composite indicators that compare country performance are increasingly recognised as a useful tool in policy analysis and public communication. The number of composite indicators in existence around the world is growing year after year (Bandura 2008, e.g., cites more than 160 composite indicators). Such composite indicators provide simple comparisons of countries that can be used to illustrate complex and sometimes elusive issues in wide-ranging fields, such as environment, economy, society or technological development (Nardo et al., 2008).

The analysis in our article and construction of an own cultural index will allow us to test several main hypotheses. First, that the condition of culture can be separated into several key dimensions, as measured by our dataset. Second, that separate dimensions to include in the model consist of financing of culture, employment in culture, education in culture, cultural industries, and cultural heritage. Third, that including participation in culture changes the set of main dimensions of our latent construct. Fourth, that the classification of individual countries follows the Esping-Andersen's welfare regimes typology (Esping-Andersen 1990), yet with some apparent outliers. Fifth, that another difference to the Esping-Andersen's typology is the joint category for all Western European regimes: liberal, continental and social democratic. And sixth, that the financial crisis, which should show its effects in 2009, did not affect significantly the positions of individual countries.

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 indexes. In Section 6, we outline the results of the confirmatory factor analysis. 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 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. Their Section 4 examines four main standardisation methods. Standardising the basic indicators helps to eliminate the influence of the unit of measure, making them more comparable. Main standardisation methods they evaluate are the ratio between the indicators and the mean of the series; the ratio between the indicators and the maximum of the series; the ratio between the differences of the indicators with respect to the average of the distribution and the standard deviation; the ratio between the indicators with respect to the minimum of the distribution and its range. 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. The paper also states that when using a linear aggregation rule, the only method which computes weights as scaling constants, with no ambiguous interpretation, is the trade-off method. Nardo, Saisana, Saltelli, Tarantola, Hoffman and Giovannini (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 b 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 also examines the methods used for synthesising the basic indicators in more detail than in Cecconi et al (2004) and also provides notation and formulas. Finally, 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 paper focuses on the use of principal components analysis to find the measures which best capture the underlying variation in the data quality measures. The analysis is used to try and obtain a small number of indicators which provide the most data quality information, in order to make the assessment of data quality more straight forward.

Cultural indexes 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" (Kushner & Cohen, 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.

Basic statistical data in the NAI are identified based on the following eight criteria: (1) the indicator has at its core a meaningful measurement of arts and culture activity; (2) the data is national in scope; (3) the data are produced annually by a reputable organization; (4) seven years of data are available, beginning no later than 2003 and available at least through 2009; (5) the data are measured at a ratio level (not just on rankings or ratings); (6) the data series is statistically valid, even if based on sample; (7) the data are expected to be available for use in the Index in future years, and (8) the data is affordable within project budget constraints. On a broader 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 indexes 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 Dutch Cultural Index 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/indexes 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 several 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. The use of proxy variables should be considered when data are scarce. 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. Fourth, 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. Skewed data should also be identified and accounted for.

Fifth, indicators should be aggregated and weighted according to the underlying theoretical framework. Correlation and compensability issues among indicators need to considered and either be corrected for or treated as features of the phenomenon that need to retained in the analysis. Sixth, 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. Seventh, composite indicators should be transparent and fit to be decomposed into their underlying indicators or values. Eighth, attempts should be made to correlate the composite indicator with other published indicators, as well as to identify linkages through regressions. And ninth, composite indicators can be visualised or presented in a number of different ways, which can influence their interpretation.

An update to the survey by Bandura (2008) names 178 existing indexes by 2008. Organizations and academics elaborate composite indices, based on several indicators or sub-indices. These indicators and sub-indices are aggregated following some methodology to give an overall score for the country. The country scores are used to either create a ranking to show progress (or setbacks) or to simply present the data; without necessarily ranking the countries.

Rankings and assessments are also elaborated using a single indicator. In general, rankings are elaborated under these methods: (1) an elaborate index is prepared, composed of sub-indices (e.g. the Commitment to Development Index or the Environmental Sustainability Index), which are weighted to give an overall score; (2) a simple index is constructed based on a subset of indicators (e.g. the Human Development Index); (3) a single indicator is used to rank the country (e.g. Under Five Mortality Rank or Ranking on Major Military Spenders).

Frequently, the way to present the country rankings is through a "League Table", presenting the country index scores in descending order. An alternative form of presentation is categorical classifications based on a range of the numerical value of these indices (e.g., Freedom House classifies the countries into "Free", "Partially free" and "Not free"). Yet another form is to show – through coloured bars or arrows – the progress or setbacks in a specific policy area (e.g., Social Watch thematic assessments).

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 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 14 variables from the

dataset of 2005 and 18 variables from the dataset of 2009, which are listed and described in Table 1. 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. Below we present some descriptive statistics of the included variables, while not going into much deepness due to limited space and other existing studies on this topic.

Table 1: Definitions of included variables

2005	2005	2009	2009
name of variable	**description**	**name of variable**	**description**
gdppcppp	GDP p.c. purchasing power parity	**gdppcppp**	GDP p.c. purchasing power parity
educ2539high	% highly educated of age 25-39	**educ2539high**	% highly educated of age 25-39
educ4064high	% highly educated of age 40-64	**educ4064high**	% highly educated of age 40-64
activityrate	Activity rate in %	**activityrate**	Activity rate in %
unemprate	Unemployment rate in %	**unemprate**	Unemployment rate in %
cultherpc	Cultural heritage objects per mill capita	**cultherpc**	Cultural heritage objects per mill capita
artstertstudperc	Arts tertiary students %	**artstertstudperc**	Arts tertiary students %
emplcultpercintotecon	Employment in culture in total economy %	**emplcultpercintotecon**	Employment in culture in total economy %
valaddpublishpc	Value Added in Publishing Sector per 1000 capita	**valaddpublishpc**	Value Added in Publishing Sector per 1000 capita
valaddsoundrpc	Value Added in Sound Recording Sector per 1000 capita	**valaddsoundrpc**	Value Added in Sound Recording Sector per 1000 capita
		attliveperfperc	% have attend. live perform. at least 1, last 12 months
		viscultsiteperc	% visited a cultural site at least 1, last 12 months
		takpartpubperfperc	% taken part in a public performance, last 12 months
		takpartartactperc	% taken part in arts activities, last 12 months
cultconsumexphh	Expenditure for the consumption of culture per household	**cultconsumexphh**	Expenditure for the consumption of culture per household
gengovtcultpc	General government expenditure for culture per capita	**gengovtcultpc**	General government expenditure for culture per capita
centgovtcultpc	Central government expenditure for culture per capita	**centgovtcultpc**	Central government expenditure for culture per capita
locgovtcultpc	Local government expenditure for culture per capita	**locgovtcultpc**	Local government expenditure for culture per capita

Source: Eurostat.

As can be seen from Table 2, the top country in terms of GDP per capita (purchasing power parity) in both 2005 and 2009 was Luxembourg with Ireland on the second place, despite a drop in 2009 due to financial crisis. The bottom two countries in 2009 were Bulgaria and Romania with both raising their GDP relative to 2005. Most highly educated people among the population 25-39 years in 2009 lived in Ireland, Cyprus and Denmark, while the least such people lived in 2009 in Romania. The same percentages for the population 40-64 years in 2009 were the highest in Finland and Estonia, while the lowest were in Malta and Portugal. An apparent counteracting trend is visible in the rise in the percentage of highly educated in population 25-39 and drop in the percentage of highly educated in population 40-64 between years 2005 and 2009; a trend, visible in almost any country in the sample.

The highest activity rate was in both 2005 and 2009 in the Scandinavian countries, while the lowest was in Malta. An apparent trend is raise in the level of activity between 2005 and 2009. It is of no surprise that the level of unemployment is not following this trend: unemployment rates in some of the countries (e.g. Baltic countries, Ireland, Spain) have been significantly raised in the period 2005–2009.

Table 2: Descriptive statistics – general development

code	country	gdppc (in EUR)		educ2539high (in %)		educ4064high (in %)		activityrate (in %)		unemployrate (in %)	
		2005	*2009*	*2005*	*2009*	*2005*	*2009*	*2005*	*2009*	*2005*	*2009*
BE	Belgium	28,700.00	27,200.00	26.7	41.4	40.1	28.8	66.5	74.7	8.3	6.6
BG	Bulgaria	8,700.00	10,400.00	20.7	25.9	24.0	21.4	64.5	76.0	9.0	6.0
CZ	Czech Rep	18,600.00	19,000.00	12.6	18.3	14.9	13.6	70.3	78.4	7.2	5.9
DK	Denmark	29,700.00	27,700.00	31.7	44.0	39.9	29.0	80.6	82.7	4.0	5.1
DE	Germany	26,700.00	27,400.00	24.2	26.5	23.5	26.3	75.6	82.1	10.2	7.3
EE	Estonia	15,700.00	14,600.00	32.8	37.0	34.2	35.3	72.4	83.2	6.0	12.3
IE	Ireland	33,700.00	30,900.00	23.0	46.1	40.3	27.2	71.8	75.9	4.4	10.2
EL	Greece	20,800.00	22,300.00	18.2	27.4	26.3	19.8	67.0	74.5	9.0	8.4
ES	Spain	23,900.00	24,500.00	21.5	37.4	37.2	23.8	70.8	78.2	8.6	16.0
FR	France	26,500.00	25,300.00	18.5	41.0	36.7	21.4	69.4	77.6	9.1	7.5
IT	Italy	24,300.00	24,000.00	10.5	19.1	16.4	11.7	62.7	68.5	6.9	6.5
CY	Cyprus	21,900.00	23,200.00	22.7	45.4	41.5	25.8	73.0	81.0	4.7	4.5
LV	Latvia	13,100.00	11,400.00	20.4	29.6	22.1	23.8	71.3	82.9	7.0	15.3
LT	Lithuania	13,600.00	12,500.00	21.9	40.5	34.1	24.8	67.4	81.5	5.7	12.2
LU	Luxembourg	65,300.00	63,000.00	19.6	43.3	30.9	29.2	66.7	76.3	4.8	4.2
HU	Hungary	15,300.00	14,900.00	16.3	23.2	19.7	17.5	62.0	69.7	7.5	8.8
MT	Malta	18,000.00	18,300.00	8.1	20.0	19.0	9.0	59.2	61.0	7.3	5.5
NL	Netherlands	31,000.00	30,700.00	27.6	38.2	34.5	29.9	77.1	81.2	4.5	2.8
AT	Austria	30,200.00	28,800.00	16.4	21.1	19.5	17.8	73.7	78.5	4.8	4.0
PL	Poland	12,400.00	14,300.00	13.1	31.9	25.2	13.8	63.4	72.3	14.0	6.8
PT	Portugal	17,500.00	18,500.00	9.9	21.4	18.5	10.0	73.9	80.6	8.1	9.0
RO	Romania	8,800.00	10,400.00	10.4	17.4	13.3	10.2	63.6	71.4	7.6	5.7
SI	Slovenia	20,400.00	20,300.00	18.7	30.1	25.6	19.1	70.9	78.4	6.1	5.2
SK	Slovakia	14,700.00	16,900.00	13.5	19.0	16.0	13.4	68.6	78.2	13.4	10.5
FI	Finland	27,300.00	26,100.00	32.6	41.4	39.9	35.1	75.2	80.4	7.8	6.5
SE	Sweden	28,200.00	28,400.00	27.2	41.0	36.1	28.5	78.8	86.0	7.1	6.0
UK	United Kingdom	27,900.00	27,400.00	28.1	39.2	34.7	29.9	75.5	79.6	5.4	5.6

Source: Eurostat, own calculations.

From Table 3 we can see that the number of heritage objects per capita is largest in small countries[1]: Cyprus, Malta and Luxembourg are the forerunners. The lowest number of heritage objects per capita can be found in some Mediterranean and Eastern European countries such as Slovenia, Romania and Poland. As 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 industries (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 3: Descriptive statistics – heritage, education, private expenditure for culture and cultural industries' value added

[1] This probably raises the issue of the appropriateness of a variable, constructed in this manner. Perhaps some other form of weighting scheme per capita would be more appropriate.

code	country	cultherpc		artstertstud (in %)		cultconsumexphh (in EUR)		valaddpublishpc (in EUR)		valaddsoundrpc (in EUR)	
		2005	*2009*	*2005*	*2009*	*2005*	*2009*	*2005*	*2009*	*2005*	*2009*
BE	Belgium	0.8562	1.0312	4.5	5.1	1,236.00	1,316.00	0.0777	0.0901	0.0005	0.0008
BG	Bulgaria	0.9069	0.9203	2.6	2.4	467.80*	144.00	0.0201*	0.0087	0.0004*	0.0000
CZ	Czech Rep	1.1706	1.1464	2.6	1.9	578.00	607.00	0.0241	0.0323	0.0003*	0.0002
DK	Denmark	0.5528	0.5443	3.4	3.6	1,358.00	1,338.00	0.1809	0.1952	0.0022	0.0035
DE	Germany	0.3760	0.3902	3.7	3.6	1,284.00	1,334.00	0.1125	0.1204	0.0016	0.0024
EE	Estonia	1.4870	1.4921	4.4	5.1	336.00	376.00	0.0327	0.0455	0.0001	0.0011*
IE	Ireland	0.4752	0.4494	10.2	6.6	1,197.00	1,690.00	0.1055	0.1146	0.0012*	0.0004
EL	Greece	1.5281	1.5097	1.7	2.1	623.00	740.00	0.0660*	0.0711	0.0003*	0.0017
ES	Spain	0.8456	0.8292	4.6	4.7	666.00	794.00	0.0641	0.0764	0.0005	0.0008
FR	France	0.4914	0.4973	5.0*	4.2	1,025.00	945.00	0.0919	0.0892	0.0093	0.0046
IT	Italy	0.6808	0.6995	5.6	4.0	659.00	833.00	0.0670	0.0644	0.0010	0.0011
CY	Cyprus	3.9164	3.7647	3.8	5.5	689.00	932.00	0.0620*	0.0427	0.0000	0.0000
LV	Latvia	0.8715	0.8844	2.3	3.3	427.00	399.00	0.0240	0.0301	0.0008*	0.0005
LT	Lithuania	1.1754	1.1941	2.7	3.2	271.00	256.00	0.0168	0.0185	0.0003	0.0001
LU	Luxembourg	2.1739	2.0263	7.6*	3.5*	1,530.00	1,406.00	0.2806*	0.3178*	0.0029*	0.0010
HU	Hungary	0.6947	0.6978	1.3	1.7	507.00	493.00	0.0221	0.0312	0.0006	0.0008
MT	Malta	7.4257	7.2532	10.9	2.8	495.00*	1,088.00	0.0762*	0.0376*	0.0040*	0.0007*
NL	Netherlands	0.4286	0.4853	4.4	4.4	1,324.00	1,378.00	0.1557	0.1773	0.0014	0.0024
AT	Austria	0.9678	0.9575	4.1	5.2	1,175.00	1,415.00	0.0777	0.0861	0.0005	0.0018
PL	Poland	0.3145	0.3147	1.0	1.1	461.00	415.00	0.0200	0.0292	0.0001	0.0004
PT	Portugal	1.1353	1.1292	4.2	5.2	554.00	646.00	0.0395	0.0378	0.0004	0.0012*
RO	Romania	0.2776	0.2791	1.4	1.2	670.80*	155.00	0.0041	0.0065	0.0000	0.0002
SI	Slovenia	0.0000	0.0000	1.5	1.9	884.00	884.00	0.1081*	0.0546	0.0016	0.0028
SK	Slovakia	0.7423	0.9238	1.8	1.7	431.60*	390.00	0.0124	0.0190	0.0000	0.0001
FI	Finland	1.1416	1.1265	5.3	5.6	934.00	1,234.00	0.1979	0.1930	0.0049	0.0058
SE	Sweden	1.4368	1.4044	3.4	4.4	1,207.00	1,275.00	0.1358	0.1479	0.0080	0.0064
UK	United Kingdom	0.3808	0.3923	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 4 shows the level of employment in culture 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 4: Descriptive statistics – employment and participation in culture

code	country	emplcultpercintotecon (in %)		attliveperfperc (in %)	viscultsiteperc (in %)	takpartpubperfperc (in %)	takpartartactivperc (in %)
		2005	*2009*	*2009*	*2009*	*2009*	*2009*
BE	Belgium	2.1	1.4	48	45	8	14
BG	Bulgaria	1.8	1.5	15	12	4	3
CZ	Czech Rep	2.0	1.7	37	46	7*	8*
DK	Denmark	3.0	2.3	61	61	13*	20*
DE	Germany	2.8	2.2	52	58	11	14
EE	Estonia	3.2	1.8	57	35	40	11
IE	Ireland	2.5	1.5	50	40	11*	18*
EL	Greece	2.1	1.2	34	15	13	8
ES	Spain	2.1	1.3	38	47	8	13
FR	France	2.0	1.7	50	49	15*	13*
IT	Italy	2.1	1.1	30	27	24	10
CY	Cyprus	2.2	1.2	42	27	4	9
LV	Latvia	2.7	2.3	45	39	9	8
LT	Lithuania	2.5	2.0	47	30	8	14
LU	Luxembourg	1.8	1.3	54	55	9*	19*
HU	Hungary	2.1	1.8	34	42	2	2
MT	Malta	2.3	1.7	19	16	6*	4*
NL	Netherlands	3.8	2.0	55	51	6*	19*
AT	Austria	2.4	1.6	57	44	8	23
PL	Poland	1.7	1.4	22	31	3	8
PT	Portugal	1.4	0.9	47	32	6	7
RO	Romania	1.1	0.8	46*	36*	9*	9*
SI	Slovenia	2.3	2.0	42	43	12	10
SK	Slovakia	1.8	1.1	52	45	12	15
FI	Finland	3.3	2.3	64	66	11	22
SE	Sweden	3.5	2.3	62	63	7*	19*
UK	United Kingdom	3.1	2.1	54	57	9*	21*

Notes: * – imputed value.
Source: Eurostat, own calculations and imputations.

Table 5 shows the data on public financing of the arts. 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. Compendium of Cultural Policies and Trends 2014).

Table 5: Descriptive statistics – public funding of culture

code	country	gengovttotpc (in EUR)		centgovttotpc (in EUR)		locgovttotpc (in EUR)		gengovtcultpc (in EUR)		centgovtcultpc (in EUR)		locgovtcultpc (in EUR)	
		2005	*2009*	*2005*	*2009*	*2005*	*2009*	*2005*	*2009*	*2005*	*2009*	*2005*	*2009*
BE	Belgium	14,974.70	17,162.60	8,755.30	9,545.12	1,939.80	2,264.30	139.50*	181.59*	60.60*	97.61*	94.50*	90.63*
BG	Bulgaria	1,123.00	1,903.30	718.70	1,408.77	212.50	394.91	19.30	26.50	23.16*	42.85*	12.76*	36.94*
CZ	Czech Rep	4,389.60	6,069.70	3,093.00	4,172.28	1,158.40	1,635.74	63.10	96.01	18.00	35.84	46.80	61.16
DK	Denmark	20,170.60	23,565.10	12,303.40	16,842.40	12,829.00	15,129.70	253.80	286.60	67.30*	107.84*	156.00*	177.15*
DE	Germany	12,657.40	13,414.20	3,854.50	4,351.46	1,998.60	2,332.98	111.00	124.63	39.64*	46.48*	95.94*	83.25*
EE	Estonia	2,793.40	4,663.80	2,083.70	3,374.63	787.10	1,179.41	129.20	158.24	86.40	95.42	48.80	67.96
IE	Ireland	13,139.10	17,556.80	10,752.60	14,328.10	2,490.40	2,575.15	142.10	251.32	68.20	165.71	76.60	87.93
EL	Greece	7,739.10	11,077.40	5,642.90	8,486.82	451.50	679.46	14.30	57.28	14.30	57.28	0.00	0.00
ES	Spain	7,987.10	10,553.30	3,044.40	4,557.15	1,249.40	1,665.37	186.50	227.87	46.60	53.68	69.60	86.67
FR	France	15,076.60	17,093.80	6,569.60	6,772.90	3,065.70	3,571.44	214.10	256.49	81.80	105.31	148.00	170.08
IT	Italy	11,714.50	13,129.50	6,515.60	7,629.60	3,769.70	4,218.00	113.40	124.32	48.00	55.44	73.10	78.14
CY	Cyprus	7,655.00	9,781.10	6,526.10	8,296.41	394.50	456.03	96.90	154.86	76.00	130.64	20.80	24.22
LV	Latvia	2,018.60	3,579.90	1,217.90	1,995.45	535.90	1,048.34	63.36*	106.40	42.68*	61.68*	44.08*	34.02*
LT	Lithuania	2,096.20	3,570.90	1,268.70	2,017.48	497.40	858.99	36.60	73.17	19.60	44.60	17.00	28.57
LU	Luxembourg	27,333.00	32,571.80	19,331.70	23,173.90	3,491.50	4,206.28	683.50	538.80	595.90	395.75	129.80	190.88
HU	Hungary	4,413.50	4,688.60	2,870.90	3,106.00	1,141.20	1,119.20	98.20	99.13	63.30	70.19	41.00	42.20
MT	Malta	5,317.30	6,116.60	5,302.70	6,093.44	73.80	93.57	58.20	81.24	55.00	76.88	18.08*	0.00*
NL	Netherlands	14,078.90	17,881.00	8,289.00	10,658.00	4,961.50	6,088.40	240.30	260.10	99.10	106.88	165.50	178.21
AT	Austria	14,830.10	17,394.20	8,181.80	8,916.23	2,268.90	2,699.60	180.90	218.67	87.54*	116.16*	110.08*	124.15*
PL	Poland	2,782.60	3,636.80	1,567.30	2,041.83	846.00	1,203.30	45.40	62.91	71.54*	50.09*	13.52*	42.24*
PT	Portugal	6,795.70	7,892.40	5,135.50	5,817.46	929.50	1,182.00	90.40	98.98	54.70	61.83	35.70	37.07
RO	Romania	1,240.50	2,261.10	914.70	1,627.09	260.90	552.72	53.42*	83.83*	42.04*	74.08*	42.00*	52.89*
SI	Slovenia	6,466.20	8,480.50	4,224.40	5,297.04	1,237.10	1,750.28	122.40	224.32	75.40	154.84	61.00	86.06
SK	Slovakia	2,712.70	4,821.80	1,506.40	2,747.15	478.30	836.71	81.70*	110.04*	78.64*	68.57*	23.28*	40.44*
FI	Finland	15,080.30	18,156.60	7,708.10	9,077.38	5,889.10	7,373.20	150.10	183.99	74.60	100.07	113.00*	135.03*
SE	Sweden	17,757.60	17,359.80	10,630.50	9,760.65	7,970.30	8,310.97	201.30	209.04	86.90	88.80	135.50	134.91
UK	United Kingdom	13,410.80	13,221.70	12,256.40	12,101.00	3,929.90	3,723.01	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 seriously 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), 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 indexes 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, which includes approximately half as many 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.

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 (Li, 2010):

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

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:

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

The Metropolis-Hastings Robbins-Monro (MH-RM) 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 $(\theta^{(0)}, \mathbf{\Gamma}_0)$, where $\mathbf{\Gamma}_0$ 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 MH-RM algorithm consists of (Li, 2010):

– *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 $\{\mathbf{Z}_j{}^{(k+1)} = \left(Y, \mathbf{X}_j{}^{(k+1)}\right);\ j = 1, \dots, m_k\}$.

– *Stochastic Approximation*: compute an approximation of the gradient of the observed data log-likelihood $\nabla_\theta l\left(\theta^{(k)}|\mathbf{Y}\right)$ 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:

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

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

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

The iterations are terminated when the estimates converge. 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 MH-RM 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 MH-RM algorithm (see e.g. Li 2010; Asparouhov & 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 perform a confirmatory factor analysis validating our set of constructed factors/dimensions of the problem. We use standard tools from structural equations modelling and goodness of fit indices: value of chi square test, comparative fit index (CFI), Tucker-Lewis index (TLI), root mean squared error of approximation (RMSEA), and standardised root mean square residuals (SRMR).

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.

5. Exploratory factor analysis and construction of the indexes

We firstly construct our indices for years 2005 and 2009. In Table 6 are the results of MH-RM factor analysis for year 2005 with oblique rotation (correlations of factors suggest opting for a non-orthogonal solution): oblimin with gamma factor 0. Based on results of regular factor analysis (eigenvalues and scree plot tests), we decided for an optimal number of factors of five. From Table 6 we can elaborate our set of five factors for year 2005 as: Factor 1 – financing (public and private) of culture; Factor 2 – cultural industries (reversely signed[2]); Factor 3 – cultural heritage (reversely signed); Factor 4 – employment in culture (reversely signed); and Factor 5 – education in culture (reversely signed).

Table 6: Factor analysis, oblimin-rotated loadings, year 2005

	Factors				
	1	**2**	**3**	**4**	**5**
GDP p.c.	0.6930				
Highly educated 25-39					-0.8630
Highly educated 40-64					-0.9790
Activity rate	0.7180			-0.5410	
Unemployment rate	-0.7040				
Number of heritage objects			-0.9600		
Tertiary students of arts		-0.5940			
Employed in culture				-0.8190	
Value added publishing	0.5460	-0.4420			
Value added sound recording		-0.9250			
Consumption of culture	0.6070				
General cultural budget	0.8080				
Central cultural budget	0.7510				
Local cultural budget	0.5690	-0.4740			

Method used: Metropolis-Hastings Robbins-Monro algorithm

Rotation: Oblimin, Gamma=0

[2] 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.

Note: All loadings lower than 0.40 are left blank.
Source: Own calculations.

Following the methodology in Section 4, we construct five indices out of our factorial model and present them in Tables 7 and 8. Firstly, the results of the first index are hardly surprising; on the top are countries of liberal and social democratic regimes: Denmark, United Kingdom, Sweden, Ireland, including also Luxembourg and the Netherlands. Of the Eastern-European and Mediterranean countries, Estonia and Slovenia score well, while at the bottom are Lithuania, Romania, Bulgaria and Poland.

In cultural industries, the best scoring are almost the same countries, including also France and Malta, the latter being known for its pronunciation to the private sector in culture. The bottom countries are again from the Eastern-European part: Estonia, Bulgaria, Cyprus, Poland, Lithuania, and Slovakia. In cultural heritage, the best scoring are Malta, Cyprus, and Luxembourg (for reasons noted in Section 3), the top scorer is also Greece due to its rich historical tradition. The bottom scorers are Ireland, Netherlands, Germany, United Kingdom and Romania.

Table 7: Indexes and ranks, factors 1–3, year 2005

financing			
code	country	index	rank
NL	Netherlands	84.1510	1
DK	Denmark	83.3720	2
UK	United Kingdom	83.3341	3
LU	Luxembourg	83.3333	4
SE	Sweden	83.0371	5
IE	Ireland	76.1311	6
AT	Austria	75.2012	7
FR	France	58.5388	8
FI	Finland	50.1264	9
DE	Germany	50.0029	10
SI	Slovenia	50.0000	11
BE	Belgium	50.0000	12
EE	Estonia	50.0000	14.5
ES	Spain	50.0000	14.5
CY	Cyprus	50.0000	14.5
PT	Portugal	50.0000	14.5
LV	Latvia	50.0000	17
CZ	Czech Rep	49.9999	18
IT	Italy	49.9919	19
EL	Greece	24.9687	20
SK	Slovakia	20.1499	21
HU	Hungary	16.8570	22
MT	Malta	16.6670	23
LT	Lithuania	16.6667	24
RO	Romania	16.6666	25
BG	Bulgaria	16.6545	26
PL	Poland	16.6137	27

cultural industries			
code	country	index	rank
LU	Luxembourg	103.9979	1
FI	Finland	83.3865	2
UK	United Kingdom	83.3747	3
FR	France	83.3616	4
MT	Malta	83.3061	5
DK	Denmark	83.2316	6
NL	Netherlands	82.8470	7
IE	Ireland	72.2035	8
SE	Sweden	62.9298	9
IT	Italy	60.8440	10
AT	Austria	54.0272	11
BE	Belgium	52.2320	12
SI	Slovenia	50.2704	13
DE	Germany	50.2665	14
ES	Spain	50.0006	15
HU	Hungary	49.9530	16
PT	Portugal	49.8814	17
LV	Latvia	49.6437	18
CZ	Czech Rep	48.1865	19
EL	Greece	40.7810	20
RO	Romania	25.9217	21
EE	Estonia	17.1421	22
BG	Bulgaria	16.8579	23
CY	Cyprus	16.8556	24
PL	Poland	16.6594	25
LT	Lithuania	16.6261	26
SK	Slovakia	16.2069	27

cultural heritage			
code	country	index	rank
MT	Malta	83.5732	1
CY	Cyprus	83.2731	2
EE	Estonia	83.1121	3
EL	Greece	81.6069	4
LU	Luxembourg	74.5935	5
SE	Sweden	60.8257	6
LT	Lithuania	50.9484	7
BG	Bulgaria	50.2194	8
FI	Finland	50.0628	9
CZ	Czech Rep	50.0335	10
AT	Austria	50.0234	11
PT	Portugal	50.0126	12
LV	Latvia	50.0031	13
SK	Slovakia	49.9961	14
HU	Hungary	49.8512	15
BE	Belgium	49.8262	16
ES	Spain	49.7365	17
IT	Italy	49.2341	18
DK	Denmark	48.2177	19
FR	France	47.7291	20
PL	Poland	22.8026	21
SI	Slovenia	20.1289	22
IE	Ireland	19.1205	23
NL	Netherlands	16.8767	24
DE	Germany	16.8028	25
UK	United Kingdom	16.7437	26
RO	Romania	16.7263	27

Source: Own calculations.

In employment in culture, Germany is at the top, followed by the Nordic countries, the United Kingdom, the Netherlands, and also Baltic countries and Slovenia. At the bottom, we find exclusively Eastern European countries: Hungary, Romania, Poland and Czech Republic, while, interestingly, also Luxembourg, which indeed has one of the lowest *rates* of employment in culture (see Table 4).

In education, Scandinavian countries, United Kingdom and Netherlands again come at the top, followed by the Estonia and Belgium, the latter due to its high level of tertiary educated people in general, particularly among 40-64 years old, and the level of highly educated people among employees in culture. The high position of Spain can be attributed (similarly to Belgium) to a very high level of highly educated people among employees in culture. At the

bottom are Czech Republic, Italy, Malta, Slovakia, and Romania. The relatively low position of Austria is clearly due to its extremely low level of highly educated people in general population as well as among cultural employees.

Table 8: Indexes and ranks, factors 4–5, year 2005

employment			
code	country	index	rank
DE	Germany	83.7283	1
UK	United Kingdom	83.2679	2
FI	Finland	82.8285	3
NL	Netherlands	81.0760	4
DK	Denmark	80.4923	5
SE	Sweden	68.5570	6
EE	Estonia	50.7129	7
LT	Lithuania	50.0246	8
LV	Latvia	50.0125	9
SI	Slovenia	50.0017	10
CY	Cyprus	49.9999	11
PT	Portugal	49.9998	12
MT	Malta	49.9571	13
ES	Spain	49.8644	14
BG	Bulgaria	49.4415	15
IE	Ireland	49.2539	16
SK	Slovakia	46.5187	17
EL	Greece	41.6992	18
BE	Belgium	35.9655	19
FR	France	32.8857	20
AT	Austria	27.9082	21
HU	Hungary	23.8480	22
RO	Romania	21.3283	23
PL	Poland	20.6865	24
CZ	Czech Rep	17.4582	25
IT	Italy	16.6586	26
LU	Luxembourg	16.5815	27

education			
code	country	index	rank
DK	Denmark	83.3822	1
FI	Finland	83.3369	2
NL	Netherlands	83.3334	3
UK	United Kingdom	83.3333	4
EE	Estonia	83.3333	5
BE	Belgium	64.0351	6
IE	Ireland	51.2973	7
ES	Spain	50.0363	8
CY	Cyprus	50.0001	9
SE	Sweden	50.0000	10
BG	Bulgaria	50.0000	13.5
DE	Germany	50.0000	13.5
FR	France	50.0000	13.5
LT	Lithuania	50.0000	13.5
LU	Luxembourg	50.0000	13.5
HU	Hungary	50.0000	13.5
EL	Greece	49.9994	17
AT	Austria	49.9989	18
SI	Slovenia	49.9989	19
LV	Latvia	49.9874	20
PL	Poland	16.6666	21
PT	Portugal	16.6663	22
CZ	Czech Rep	16.6660	23
IT	Italy	16.6658	24
MT	Malta	16.6655	25
SK	Slovakia	16.6608	26
RO	Romania	16.5299	27

Source: Own calculations.

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. Table 9 shows the interpretation of our five factors: Factor 1 – public financing and participation; Factor 2 – private expenditure for culture (reversely signed); Factor 3 – education in culture and cultural heritage; Factor 4 – employment in culture (reversely signed); and Factor 5 – cultural industries.

Table 9: Factor analysis, MHRM algorithm, oblimin-rotated loadings, year 2009

	Factors				
	1	**2**	**3**	**4**	**5**
GDP p.c.	0.4040	-0.5690			
Highly educated 25-39			0.7230		
Highly educated 40-64			0.8590		
Activity rate	0.4010		0.5000		
Unemployment rate		0.7790			
Number of heritage objects			0.6700		
Tertiary students of arts			0.6290		
Employed in culture				-0.9370	
Value added publishing		-0.4630	0.5350		
Value added sound recording					0.9850
Attend. live performances	0.8670				
Visiting cultural sites	0.6610				

Taking part public perform.					0.5570
Taking part art activities	0.9010				
Consumption of culture		-0.9300			
General cultural budget	0.7350				
Central cultural budget	0.5210				
Local cultural budget	0.8420				

Method used: Metropolis-Hastings Robbins-Monro algorithm

Rotation: Oblimin, Gamma=0

Note: All loadings lower than 0.40 are left blank.
Source: Own calculations.

In Tables 10 and 11, we show the results of index calculation. In public financing and participation the Nordic countries, Luxembourg, Austria, United Kingdom and Netherlands unsurprisingly score the best. The Nordic cultural model (see Duelund 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, Hungary, Malta, Poland, and Bulgaria.

In private financing of culture, Luxembourg, Netherlands, UK and Ireland, and also Germany and Austria are the top scorers. They are followed by the Nordic countries, but they mostly score significantly worse. The bottom countries are the Baltic countries and some other countries of the Eastern part of Europe.

In the joint dimension of the education and cultural heritage, again the Nordic countries score the best, accompanied by (some) Baltic countries, the Netherlands, Belgium, Luxembourg, the United Kingdom, and Ireland. Apparently, the educational part of this dimension has stronger influence on the value of the index, which can be seen from Table 9, as well as from the low position of Malta, which was the leader in all separate subindices of cultural heritage we calculated during our research analysis. The worst scoring are again the Eastern European and Mediterranean countries: Slovenia, Italy, Hungary, Poland, and Romania.

Table 10: Indexes and ranks, factors 1–3, year 2009

public financing and participation			
code	country	index	rank
DK	Denmark	83.5239	1
SE	Sweden	83.3828	2
FI	Finland	83.3369	3
LU	Luxembourg	83.3299	4
AT	Austria	83.1937	5
UK	United Kingdom	81.8003	6
NL	Netherlands	78.7993	7
IE	Ireland	53.4871	8
FR	France	51.9178	9
BE	Belgium	50.3380	10
DE	Germany	50.2285	11
ES	Spain	50.0000	12
EE	Estonia	50.0000	13
SI	Slovenia	49.9996	14
SK	Slovakia	49.9985	15
CY	Cyprus	38.4102	16
RO	Romania	24.7784	17
LT	Lithuania	23.1319	18
IT	Italy	20.5645	19
LV	Latvia	18.6934	20
PT	Portugal	16.7430	21
CZ	Czech Rep	16.6943	22
EL	Greece	16.6757	23
HU	Hungary	16.6656	24
MT	Malta	16.6643	25
PL	Poland	16.6224	26
BG	Bulgaria	16.5306	27

private financing			
code	country	index	rank
LU	Luxembourg	92.8974	1
NL	Netherlands	85.4734	2
IE	Ireland	83.3376	3
DE	Germany	83.3326	4
AT	Austria	83.3318	5
DK	Denmark	83.3312	6
UK	United Kingdom	82.8979	7
MT	Malta	51.2058	8
SE	Sweden	50.1431	9
BE	Belgium	50.0259	10
CY	Cyprus	50.0039	11
CZ	Czech Rep	50.0015	12
IT	Italy	50.0001	13
FI	Finland	50.0000	14
EL	Greece	50.0000	15
FR	France	50.0000	16
ES	Spain	50.0000	17.5
SI	Slovenia	50.0000	17.5
PT	Portugal	49.9998	19
HU	Hungary	49.9693	20
RO	Romania	16.8019	21
PL	Poland	16.7722	22
BG	Bulgaria	16.6651	23
SK	Slovakia	16.6640	24
EE	Estonia	16.5648	25
LT	Lithuania	16.2873	26
LV	Latvia	15.4470	27

education and cultural heritage			
code	country	index	rank
FI	Finland	83.3442	1
LU	Luxembourg	83.3402	2
EE	Estonia	83.3256	3
NL	Netherlands	83.2995	4
BE	Belgium	82.8782	5
SE	Sweden	82.5148	6
CY	Cyprus	79.1300	7
UK	United Kingdom	77.8650	8
IE	Ireland	51.6642	9
DK	Denmark	50.0679	10
LT	Lithuania	50.0104	11
DE	Germany	50.0006	12
EL	Greece	50.0000	13.5
ES	Spain	50.0000	13.5
FR	France	50.0000	15
AT	Austria	50.0000	16
CZ	Czech Rep	49.9970	17
BG	Bulgaria	49.9850	18
LV	Latvia	49.9706	19
PT	Portugal	30.7295	20
SK	Slovakia	21.4666	21
MT	Malta	17.8074	22
SI	Slovenia	16.7326	23
IT	Italy	16.7068	24
HU	Hungary	16.6969	25
PL	Poland	16.6158	26
RO	Romania	16.4400	27

Source: Own calculations.

In employment in culture, again Germany is very strong, accompanied by all the Baltic and Scandinavian countries. The bottom scorers are Slovakia, Luxembourg, Spain, Italy and Greece, the results that mainly concur with observations for 2005. In cultural industries, again, Scandinavian countries and the UK perform best. Again, France scores very well in this criterion, accompanied by Slovenia. The worst scoring are Poland, Bulgaria, Lithuania and Cyprus, which is almost a repetition of the situation in 2005.

Table 11: Indexes and ranks, factors 4–5, year 2009

employment			
code	country	index	rank
DK	Denmark	83.3691	1
DE	Germany	83.3425	2
LV	Latvia	83.3391	3
FI	Finland	83.3175	4
UK	United Kingdom	83.2596	5
SE	Sweden	78.9635	6
LT	Lithuania	69.8663	7
EE	Estonia	51.6888	8
SI	Slovenia	50.0865	9
HU	Hungary	50.0784	10
NL	Netherlands	50.0009	11
PL	Poland	50.0000	12
BG	Bulgaria	50.0000	13
AT	Austria	49.9999	14
IE	Ireland	49.9999	15
CZ	Czech Rep	49.9969	16
FR	France	49.9776	17
MT	Malta	49.9480	18
BE	Belgium	49.9336	19
CY	Cyprus	17.9156	20
RO	Romania	17.3324	21
PT	Portugal	16.8407	22
SK	Slovakia	16.7713	23
LU	Luxembourg	16.6641	24
ES	Spain	16.6573	25
IT	Italy	16.6512	26
EL	Greece	16.5192	27

cultural industries			
code	country	index	rank
SE	Sweden	84.1263	1
DK	Denmark	83.5487	2
UK	United Kingdom	83.3914	3
FI	Finland	83.3756	4
FR	France	83.3408	5
SI	Slovenia	83.3349	6
EL	Greece	50.0203	7
IT	Italy	50.0000	8
BE	Belgium	50.0000	13
DE	Germany	50.0000	13
EE	Estonia	50.0000	13
ES	Spain	50.0000	13
LU	Luxembourg	50.0000	13
MT	Malta	50.0000	13
NL	Netherlands	50.0000	13
AT	Austria	50.0000	13
PT	Portugal	50.0000	13
HU	Hungary	49.9986	18
CZ	Czech Rep	16.6666	19
IE	Ireland	16.6664	20
SK	Slovakia	16.6657	21
RO	Romania	16.6475	22
LV	Latvia	16.6372	23
PL	Poland	16.4257	24
BG	Bulgaria	16.1340	25
LT	Lithuania	15.9316	26
CY	Cyprus	-9.4259	27

Source: Own calculations.

6. Confirmatory factor analysis

In this section, we present results of validation of our factorial model. The basic model is second-order and assumes an underlying latent construct, which we call "condition of culture" due to the lack of a better expression. Figure 1 shows the structure of the model that we are testing, which in both 2005 and 2009 depends on five main dimensions/factors. We will test the fit of this model as compared to the first-order model, where the five factors have a correlated structure with no underlying latent construct.

Figure 1: Our estimated second-order and first-order factor models

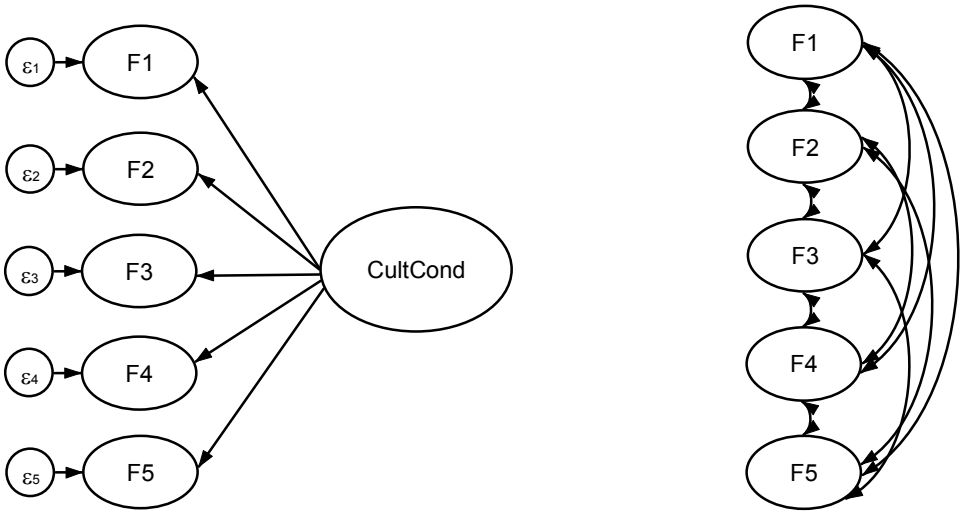

Table 12 shows the results of the goodness-of-fit statistics for all the models. The second-order models have a relatively good chi-square test results, particularly the 2009 model has also a reasonable good fit as shown by CFI and TLI indexes, which are higher that 0.90 (the usually specified threshold). The RMSEA criterion is not that good in both models, while the standardised root mean squared residual is in the limits of required fit. We can therefore say that the second-order models have a reasonable data fit with a still significant space for improvement. It is also clearly visible that second-order models for both 2005 and 2009 have a better fit than the respective first-order models in almost all criteria.

Table 12: Goodness of fit statistics, 2005 and 2009 models

	Chi Square [p value]	CFI	TLI	RMSEA	SRMR
2005 model, second order	169.096 [0.000]	0.799	0.598	0.219	0.091
2005 model, first order	151.212 [0.000]	0.728	0.652	0.205	0.144
2009 model, second order	363.718 [0.000]	0.952	0.903	0.116	0.063
2009 model, first order	159.157 [0.000]	0.632	0.521	0.209	0.153

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 (and "cultural models") based on the results of Section 5. Table 13 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 factors is 3, as pseudo-T square is among the lowest, whereas Je(2)/Je(1) statistic is actually 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 ranks is four.

Table 13: Duda-Hart and Calinski-Harabasz statistics, clustering of factors and ranks, year 2005

	FACTORS			RANKS		
Number of clusters	Duda/Hart		Calinski/Harabasz	Duda/Hart		Calinski/Harabasz
	Je(2)/Je(1)	pseudo T-squared	pseudo-F	Je(2)/Je(1)	pseudo T-squared	pseudo-F
1	0.6486	13.55		0.6892	11.28	
2	0.6213	7.31	13.55	0.6803	6.58	11.28
3	0.7269	4.13	10.73	0.5034	8.88	9.93
4	0.5472	4.97	9.84	0.6967	3.92	10.35
5	0.6328	4.64	10.14	0.5710	3.76	10.16
6	0.2348	9.78	10.33	0.2849	7.53	10.12
7	0.5460	3.33	9.95	0.6155	3.12	9.88
8	0.6778	3.33	10.38	0.2576	2.88	9.96
9	0.6638	2.53	10.80	0.2997	4.67	10.63
10	0.2582	2.87	10.66	0.5342	2.62	10.70
11	0.2956	4.77	11.71	0.2382	6.40	11.28
12	0.5349	1.74	12.11	0.3413	3.86	11.55
13	0.0006	1634.84	12.91	0.0000	.	11.83
14	0.3952	1.53	12.87	0.3874	1.58	12.15
15	0.0986	9.14	13.59	0.0000	.	12.55

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 14. They show that two broad groupings appear to show in the clusters: a) Nordic, Liberal/Anglo-Saxon and Continental countries, which are clustered in clusters 2 and 3 (factors) and 3 and 4 (ranks); b) Eastern European and Mediterranean countries, which are clustered in cluster 1 (factors) and 1 and 2 (ranks). These observations are confirmed in the analysis of year 2009, where we observe that the second group is composed of two distinct groups of countries. We can also observe that some countries, particularly Malta, change their position and it is hard to determine their fixed position in one cluster exactly.

Table 14: Final groupings, clustering of factors and ranks, year 2005

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

Final groupings - ranks:	
Cluster 1	Cyprus, Estonia, Lithuania, Bulgaria
Cluster 2	Hungary, Greece, Italy, Czech Republic, Romania, Poland, Slovakia
Cluster 3	United Kingdom, Netherlands, Finland, Denmark, Sweden
Cluster 4	Luxembourg, Slovenia, Germany, Austria, France, Ireland, Latvia, Spain, Belgium, Malta, Portugal

Source: Own calculations.

Table 15 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 factors and ranks are included in the analysis.

Table 15: Duda-Hart and Calinski-Harabasz statistics, clustering of factors and ranks, year 2009

	FACTORS			RANKS		
Number of clusters	Duda/Hart Je(2)/Je(1)	Duda/Hart pseudo T-squared	Calinski/Harabasz pseudo-F	Duda/Hart Je(2)/Je(1)	Duda/Hart pseudo T-squared	Calinski/Harabasz pseudo-F
1	0.6346	14.39		0.6061	16.25	
2	0.5841	9.26	14.39	0.6592	7.24	16.25
3	0.6326	5.81	11.64	0.5107	8.62	13.18
4	0.6017	3.97	12.16	0.5296	5.33	13.28
5	0.4189	6.93	12.11	0.6486	3.25	12.90
6	0.5402	5.11	11.79	0.3069	6.77	11.89
7	0.1430	5.99	11.82	0.6466	2.73	11.09
8	0.4262	5.38	12.34	0.1789	4.59	11.18
9	0.4786	3.27	12.24	0.2603	2.84	11.08
10	0.2146	7.32	13.72	0.4712	3.37	11.38
11	0.3472	3.76	13.82	0.3033	2.30	11.65
12	0.0000	.	13.66	0.5091	1.93	12.21
13	0.3629	3.51	13.88	0.3730	1.68	12.42
14	0.2458	3.07	14.21	0.3686	3.43	12.10
15	0.3667	1.73	15.09	0.0000	.	11.87

Source: Own calculations.

Results of the K-means strengthening are shown in Table 16. 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 Slovenia is a clear outlier and clusters in the first group. Secondly, we can observe the presence of diversification of the second group into Mediterranean group (Greece, Italy, Spain, Portugal, probably also Malta) that clusters in cluster 2, and Eastern European countries that cluster in cluster 1. Finally, cluster 4 appears to join some outliers like Cyprus and Luxembourg, the position of which is again difficult to determine.

Table 16: Final groupings, clustering of factors and ranks, year 2009

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

Final groupings - ranks:	
Cluster 1	Bulgaria, Latvia, Lithuania, Poland, Hungary, Estonia
Cluster 2	Greece, Italy, Malta, Portugal, France, Slovenia
Cluster 3	Belgium, Denmark, Germany, Netherlands, Austria, Finland, Sweden, United Kingdom, Ireland, Luxembourg
Cluster 4	Cyprus, Czech Republic, Romania, Slovakia, Spain

Source: Own calculations.

Our final proposed clustering of cultural models based on cultural statistics would therefore be: (1) Eastern European model: Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia, most of the times also Latvia, Lithuania and Estonia; (2) Mediterranean model: Greece, Spain, Italy, Portugal, most of the times also Malta and Cyprus; and (3) Liberal/Nordic/Continental model: Denmark, Finland, Sweden, the United Kingdom, Ireland, Germany, Austria, France, the Netherlands, Belgium, most of the times also Luxembourg and Slovenia.

There are some additional observations to make. Firstly, Estonia, Latvia and Lithuania have very similar results in all scores and sometimes (e.g. Latvia in 2005) cluster in the "Western" model. It is possible to speculate that there is a special, Baltic cultural model, which would exhibit different characteristics than both Western and Eastern European countries. This remains another (hypo)thesis to test in future research.

Secondly, Slovenia is an apparent outlier. This country has a special position of culture throughout its history and also particular pronunciation to this sector in contemporary situation (as exhibited by it being constantly among the top scorers in the share of public budget dedicated to culture, see Compendium 2014). Although reports from this country suggest that the position of Slovenia in cultural sector has deteriorated in the past years (see e.g. Slovenian Cultural Index, Asociacija 2014) its position appears to lie close to the "bottom" countries of the Western European model (i.e. the countries in cluster 4 in year 2005). It also has to be said that in Slovenia in 2009 most of the parameters in culture (particularly public financing) have risen due to political reasons (the minister at that time, Majda Širca Ravnikar was a powerful political figure and ensured a stronger financial support for this sector). This also partly explains its strong position among Western European countries in the year of 2009.

Thirdly, it is interesting that all of the Western European countries cluster in a common model. Although e.g. Nordic countries appear strongly similar in most of the indicators and indexes, 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.

Finally, there are at least three additional separate cases, outliers. All three are small countries but very distinct from other countries: Luxembourg with its high financial performance, Malta with its pronouncement on cultural industries and heritage, and Cyprus, again, with pronouncement on cultural heritage. It also remains somewhat dubious where to locate Belgium and Spain. In some clusters, it is apparent that the two are outliers and their position has to be estimated in future empirical analysis.

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 indexes 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. And fourth, a significant step made in the analysis of cultural models in European Union, where to our knowledge no other statistically based analysis of existing indicators and their relationships to determine the similarities and differences between countries and models exists so far. 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 six hypotheses. Firstly, the condition of culture was shown to be separated into five key dimensions – although the fit is not optimal, the results of confirmatory factor analysis as well as statistics from the exploratory factor analysis clearly show that we can confirm the hypothesis. Secondly, separate dimensions of our latent construct consisted of financing of culture, employment in culture, education in culture, cultural industries, and cultural heritage, as stated in the hypothesis. It is interesting that general factors such as GDP per capita, unemployment rate etc. do not have a special role (special dimension) but nicely cluster into the set of our five dimensions. Thirdly, including participation in culture *did not* significantly change the set of main dimensions of our latent construct – when including it in 2009 we did not get a special dimension, only a modification of our initial set of five dimensions. Fourthly, the classification of individual countries followed the Esping-Andersen's welfare regimes typology very roughly with some apparent outliers which were noted in the text. Fifthly, a significant difference to the Esping-Andersen's typology was the joint category for all Western European regimes: liberal, continental and social democratic, which clearly have a different condition of culture as judged from the viewpoint of cultural statistics than the remaining groups of countries: Eastern European and Mediterranean countries. And, finally, financial crisis (which should show its effects in 2009), did slightly affect the positions of individual countries (e.g. Luxembourg, France, Ireland, Cyprus), but mainly had no significant effects on the classification of our models nor on the positions of individual countries in our set of indices.

There are still several issues open for further research, though. 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 finally, the analysis should be broader in terms of time dimension and accuracy of data, but we were unfortunately limited in this aspect with existing cultural statistical data. 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.

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