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MEASURING ROMANIAN DEVELOPMENT

Alexandru BOCIU
alex_bociu@yahoo.com
Nicoleta-Claudia MOLDOVAN
nicoleta.moldovan@e-uvt.ro
Iulia PARA
iulia.para@e-uvt.ro

Abstract
The present paper analyses the evolution of the degree of development in Romania, between 1991 and 2014, using composite indices and taking into account 16 sub-indicators. Identifying suitable methodologies for measuring development is an important empirical issue. In order to perform a more complex analysis of development, we use the aggregation process through Principal Component Analysis, being the most advanced and used methodology for composite index determination. The result of the empirical analysis reveals an involution of the degree of development in Romania.

Key words: *Composite indices; Development; Performance; Principal Component Analysis; Romania*

JEL Classification: *C38, H11, O52*

I. INTRODUCTION

This paper analyses the evolution of the level of development in Romania during the period 1991-2014. The ability to measure development more objectively and comprehensively is a significant concern for any modern state. The level of development influences a number of factors that have a direct impact on a country and its inhabitants.

This paper complements the literature by a quantitative approach of measuring development, using the Principal Component Analysis methodology in order to determine a composite index. PCA is a widely used and efficient method of composite indicator construction. Mathematically speaking, the PCA is defined as an orthogonal-linear transformation that translates the data into a coordinate system so that the widest variation of some data projections becomes the first coordinate, that is, the first major component, the second largest variation becomes the second major component, etc.

The relevance and novelty of the approach lies in a large number of sub-indicators considered in the construction of the composite index, named the development barometer (DB). This approach reduces the degree of subjectivity that the development analysis involves and provides a realistic picture of the evolution of development degree.

The result of the empirical analysis shows an involution of the degree of development with a slight stagnation and a slight increase during 2000-2002.

The paper is structured as follows: Section II presents a study of the literature on the possibilities of measuring development using composite indices. In Section III we present the empirical analysis on the basis of the set of data considered for Romania. Section IV presents the results of the empirical analysis, and the conclusions are presented in the last part of the paper.

II. LITERATURE REVIEW

Development is an important goal for all modern states, being a major objective in today's government programs. In our approach we consider development and the process of sustainable development of a state as being conditioned by the achievement of performance in the public sector. State-level development includes the recording of notable progress at many levels, from the state's economic situation, to the quality of public goods and services, the level of democracy recorded and much more.This concept of development applies to Romania as well as to any modern democratic state. Thus, we identify a high level of interest coming from the people who monitor the conditions and the assessment of prospects for various developed countries regarding local policy stability, a favourable environment for investors, economic growth or size of the effective market, poverty reduction, respect for human rights and long-term development. This increase of the interest has led to an increase in the use of quantitative government indices in developed countries. (Kaplan and Norton,1992) developed a public sector performance measurement tool called Balanced Scorecard. The tool uses four

dimensions to analyze public sector performance: (i) citizens 'opinion, (ii) financial dimensions, (iii) the internal product of the processes, and (iv) the employees' outlook and institutional capacity.

Identifying effective methodologies for assessing state development is a concern both for the academic environment and for a number of international institutions. Thus, we identify a series of composite indicators used to measure public sector performance and state development. The high interest in the exhaustive measurement of development has prompted a number of international bodies to base the measurement possibilities, using various indices, mostly composite indicators . These include the Political Instability Task Force, which uses the Polity IV index. Polity IV provides two aggregates, Democracy (DEMOC) and Autocracy (AUTOC), which are measured on a scale using five different indicators: i) The first indicator measures the extent to which a country has institutionalized measures for the transfer of executive power, so this indicator (XRREG) is based on the manner in which the head of state is elected; ii) The second indicator is the competitiveness of executive selection; iii) The honesty of executive recruitment (XROPEN); iv) the degree of constraints on the decision-making power of the leaders; v) regulating the electoral participation.

In Transparency International's realistic studies, (Lambsdorff, 2005) determines the Corruption Perceptions Index. This index uses two components of research and analysis: (i) corruption and (ii) the quality of the government act. In order to analyze governance, (Kaufmann et al ,1999a) uses three key components, in particular: (i) the rule of law, (ii) the level of bureaucracy, and (iii) political corruption. An (OECD,2007) analysis reveals the use of 4 research directions in development analysis: (i) inputs, (ii) processes, (iii) outputs and (iv) results. This provides an analysis of the entire process of production of public goods and public service provision. Moreover, this concept also includes a treatment of country policies and programs.

In order to highlight a country's overall performance from a sustainable economic growth perspective, the Institute for Management Development (IMD) has developed the World Competitiveness Yearbook (WCY). This indicator is obtained by aggregating twenty sub-indicators through four important areas, namely: i) economic performance, ii) efficiency of governance, ii) business environment efficiency, and iv) infrastructure. The World Bank uses the Country Policy Index and the Institutional Index to assess the qualitative level of public policies geared towards economic growth and poverty reduction.

(Lobonț et. ,2018) performs a study regarding the level of development of the European states over the period 1995-2014 using the Principal Component Analysis methodology. In order to determine the composite index used, the authors use 7 basic public domain areas: (i) administration, (ii) health, (iii) education, (iv) infrastructure, (v) income distribution, (vi) economic stability and (vii) economic performance. The results indicate that the most developed and performant European states are the old European states.

We note that development analysis requires several variables or sub-indicators to be considered. Thus, it is necessary to aggregate all sub-indicators that influence the degree of development. The most advanced and most commonly used composite indicator construction methodology is the Principal Component Analysis. Discovered by (Pearson ,1901), this methodology involves grouping individual indicators to form composite indicators, capable of exploiting a more complex set of information. PCA binds a set of variables with a small number of latent dimensions and allows the use of multiple variables for analysing a phenomenon. Mathematically speaking, the PCA is defined as an orthogonally-linear transformation that translates the data into a coordinate system so that the largest variance of some data projections becomes the first coordinate, that is, the first major component, the second largest variance becomes the second main component, etc.

III. METHODOLOGY AND DATA

The proposed empirical analysis is based on the research method known as the Principal Component Analysis (PCA). The purpose of this analysis is to transform some possible variables into a new set of unrelated variables called "main components". The number of these components is equal to, or less than the number of original variables or observations. This transformation is performed in such a way that the first component holds the maximum of the variance in the dataset, the second component holds the maximum of the remaining variance, and so on.

The data used in this work come entirely from the World Bank databases. These data were selected over a period of 24 years from 1991 to 2014. The categories of variables selected for the construction of the final index are diverse, ranging from social protection to economic growth. Due to the subjective character of the index and the flexible nature of the development, the variables studied are diverse and interconnected. The analysis of development also involves a social and economic character. The main purpose is to combine as diverse variables as individually expressing the quality of development, resulting in a more realistic barometer and as close as possible to reality. After identifying the variables and the time period studied, we encountered some difficulties as well as the lack of data for some years. Following the elimination of these data series we managed to structure them by categories and years, followed by the methodology applied in this case study.

The empirical analysis follows the evolution of the development over a period of 24 years, on the territory of Romania. An in-depth study can be based on the evolution of development in Romania and other countries in

Europe, and a comparative study is carried out between the barometers of the European countries. In this paper, we will focus on the particular case of post-December 1989 Romania and the evolution over time of its defining features.

The variables considered in the development barometer construction are: total labour force, employment rate, life expectancy at birth, railways, military expenditures, commodity trade, total reserves, arable land, CO2 emissions, forest areas, electricity, energy obtained from fossil fuels, urban population, GDP / capita, gross saving, GDP growth.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
A	1.00	0.97	-0.81	0.85	0.59	-0.55	-0.84	0.77	0.51	-0.67	-0.55	0.60	-0.39	-0.82	-0.60	-0.11
B	0.97	1.00	-0.76	0.84	0.57	-0.61	-0.77	0.72	0.49	-0.55	-0.42	0.56	-0.21	-0.74	-0.48	-0.18
C	-0.81	-0.76	1.00	-0.86	-0.80	0.78	0.93	-0.82	-0.87	0.88	0.34	-0.93	0.29	0.92	0.38	0.19
D	0.85	0.84	-0.86	1.00	0.80	-0.72	-0.92	0.93	0.67	-0.66	-0.40	0.76	-0.19	-0.91	-0.23	-0.30
E	0.59	0.57	-0.80	0.80	1.00	-0.83	-0.82	0.76	0.80	-0.63	0.02	0.83	0.00	-0.81	-0.05	-0.56
F	-0.55	-0.61	0.78	-0.72	-0.83	1.00	0.67	-0.62	-0.79	0.58	-0.13	-0.81	-0.21	0.66	-0.06	0.56
G	-0.84	-0.77	0.93	-0.92	-0.82	0.67	1.00	-0.89	-0.74	0.81	0.50	-0.85	0.38	0.98	0.41	0.15
H	0.77	0.72	-0.82	0.93	0.76	-0.62	-0.89	1.00	0.63	-0.70	-0.46	0.69	-0.28	-0.91	-0.27	-0.30
I	0.51	0.49	-0.87	0.67	0.80	-0.79	-0.74	0.63	1.00	-0.72	0.04	0.95	-0.01	-0.73	-0.05	-0.23
J	-0.67	-0.55	0.88	-0.66	-0.63	0.58	0.81	-0.70	-0.72	1.00	0.48	-0.79	0.60	0.83	0.53	0.05
K	-0.55	-0.42	0.34	-0.40	0.02	-0.13	0.50	-0.46	0.04	0.48	1.00	-0.13	0.74	0.49	0.64	-0.52
L	0.60	0.56	-0.93	0.76	0.83	-0.81	-0.85	0.69	0.95	-0.79	-0.13	1.00	-0.11	-0.84	-0.12	-0.19
M	-0.39	-0.21	0.29	-0.19	0.00	-0.21	0.38	-0.28	-0.01	0.60	0.74	-0.11	1.00	0.38	0.77	-0.38
N	-0.82	-0.74	0.92	-0.91	-0.81	0.66	0.98	-0.91	-0.73	0.83	0.49	-0.84	0.38	1.00	0.40	0.20
O	-0.60	-0.48	0.38	-0.23	-0.05	-0.06	0.41	-0.27	-0.05	0.53	0.64	-0.12	0.77	0.40	1.00	-0.26
P	-0.11	-0.18	0.19	-0.30	-0.56	0.56	0.15	-0.30	-0.23	0.05	-0.52	-0.19	-0.38	0.20	-0.26	1.00

Figure 1- Matrix of correlation of variables

We can observe the significant correlations between variables, both positive and negative. Of all the correlations present, the most significant are the correlations between the total labour force and the employment rate (r = 0.97), and the total reserves and GDP / capita (r = 0.98).

Moreover, the PCA method also involves determining the own values (represented in Table 1) that make up the Development Barometer. At this stage, we will select the components that hold the highest cumulative value of the variance in the original dataset. We can see that the sum of these eigenvalues is equal to the number of individual indicators.

Table 1- The variance of the eigenvalues

Components	Initial values		
	Total	% of variance	Cumulative %
1	9.870	61.687	61.687
2	3.216	20.100	81.788
3	1.042	6.512	88.300
4	.695	4.343	92.643
5	.572	3.574	96.217
6	.199	1.246	97.463
7	.129	.806	98.269
8	.112	.699	98.967
9	.062	.386	99.353
10	.038	.235	99.588
11	.022	.136	99.724
12	.016	.103	99.827
13	.013	.084	99.911
14	.007	.046	99.957
15	.004	.027	99.984
16	.003	.016	100.000

We can see that the first component has a variance of 9.87 and explains the most significant variance of all indicators (61.7%). The second component represents the maximum value of the remaining variance (20.1%) with a variance of 3.22% of the total. The third component has a value of 1.04 and a variance of 6.5%, so the first three components are responsible for a total variance of 88.3%, the remaining 13 components reflecting the remainder of the variance of 11.7%. According to Kaiser's principle, the initial values of the components that are < 1 will not be included. We can see that starting with component number 4 having a value of 0.69, and a maximum variance of 4.3% of the total remaining variance, the total values of the main components are subunit, reflecting only a minuscule value of variance in the dataset. These eigenvalues show exactly the number of main components that justify most of the variance in the dataset, this reduced number of components being sufficient to express a phenomenon.

Table 2 shows the loadings of components contained within a range [-1,1] where we can see the average and strong loads and how they affect the relationships between the individual indicators and the main components.

Table 2- The loadings of the main components

The loadings of the main components			
	The main component		
	1	2	3
Energy obtained from fossil fuel	.960		
CO2 emmissions	.951		
Life expectancy at birth	-.847		
Forested areas	-.792		
Military expenses	.780		
Total reserves	-.743	-.569	
Commodity trade	-.742		
GDP/ capita	-.740	-.570	
Employment rate		.849	
Total labour force		.810	
Railroads	.614	.735	
Arable land	.600	.672	
Urban population			.891
Electricity			.862
Gross savings			.778
GDP growth			-.702

We can see that the first eight indicators are responsible for the first component, the next four form the second component, and the last four form the third major component. In the case of total reserves, GDP / capita, railways and arable land, the values are attributed to several major components, this being eliminated by choosing higher values between components.

Applying the PCA method, we can see how individual indicators are grouped together, forming a composite index that renders in their simplistic manner the most common feature of them. The idea of this methodology is to identify the maximum variance of each indicator using as few factors as possible, so the final index does not necessarily depend on the size of the dataset, but rather on its "statistical" size. Because we selected 3 main components, the Development Barometer will be built on 3 sub-indicators. As we have seen in Table 1, the first component has a variance of 61.687%, the second component has a variance of 20.100%, and the third component has a variance of 6.512, summing up a total of 88.300%. So because the amount of the final weights is 100%, we will convert the weight of the components.

Table 3- Barometer Development

Year	B.D.
1991	1.534511
1992	1.165729
1993	0.941684
1994	0.871295
1995	0.790038
1996	0.683873
1997	0.541887
1998	0.250457
1999	0.005304
2000	-0.10665
2001	-0.04416
2002	0.091981
2003	0.008468
2004	-0.1364
2005	-0.18359
2006	-0.20615
2007	-0.32714
2008	-0.38447
2009	-0.53754
2010	-0.76845
2011	-0.8915
2012	-0.91846
2013	-1.11532
2014	-1.26534

X+Y+Z=100%

X=61.687**, Y**=20.100, **Z**=6.512

$$X = \frac{100\% * 61.687}{88.300} = 69.8607$$

$$Y = \frac{100\% * 20.100}{88.300} = 22.76331$$

$$Z = \frac{100\% * 6.512}{88.300} = 7.374858$$

=>B.D=X+Y+Z= 99.99887=100%

Thus, the calculated weights will continue to be used to calculate the Development Barometer. The additive aggregation method will continue to be used to determine the index.

D.B.=$\sum_{q-1}^{Q} w_q I_{qc}$ where w_q represent the weight of the indicator, and I_{qc} represents the value of the factors extracted from the analysis.

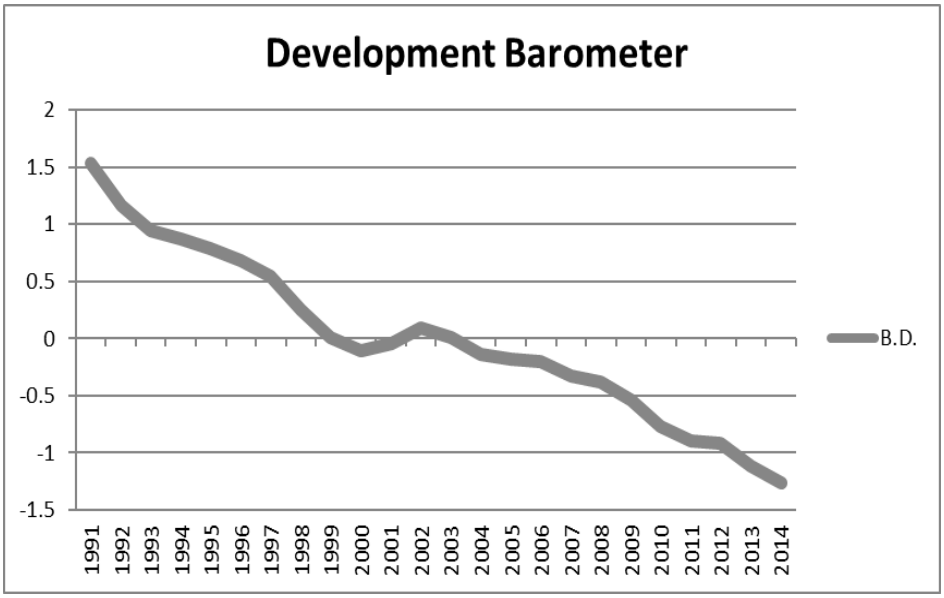

Figure 2- Index Evolution

As we can see in Figure 2, our index shows a downward trend as the years go by. Between 1999-2003 the level of development in Romania stagnated, registering a slight increase at the end of 2003.

IV. RESULTS AND DISCUSSION

The results of the empirical analysis indicate negative values of the Development Barometer. This can be justified by the negative trend of some variables that contribute individually to the formation of the index. Exactly 9 of the 16 variables record a downward trend, which can also be seen in our final D.B..

The results determined by composite indices will reflect to a greater or lesser extent the impact of each sub-indicator considered. This presents a degree of subjectivism in the evaluation of development, and a possibility of resolving subjectivism is the consideration of as many sub-indicators that have an impact on the phenomenon.

V. CONCLUSIONS

This paper has determined the evolution of the degree of development in Romania through the construction and use of a composite index named the Development Barometer. The identification of certain defining features of development is the basis for building an instrument capable of measuring these characteristics in a more accurate and current manner. The specialised literature, supporting the theoretical framework of this paper and the methodologies related to the composing of composite indices are vast. Development has been studied and analysed on a number of occasions by various national and international specialists and institutions, resulting in the fact that such an index, capable of measuring it, behaves a certain degree of subjectivism.

We consider the various methodologies used by numerous institutions such as the World Bank, OECD, Transparency International etc. as long-term projects with improvements over the years, pursuing different interests. So we cannot assume that developing a Barometer of Development is an easy task that immediately meets all the requirements imposed by the theoretical framework. One of the key issues was the subjectivity of the variables. These have been selected in a variety of ways, summing up a common feature. Of course, these variables could have been different or based on a single area of interest, such as finance, infrastructure or education, but this Barometer sums up all these areas for a common purpose. By studying other similar indices, we noticed a particularity. Most of the indices are based mainly on the basic characteristics of development, such as the rule of law, the right to vote, equality of citizens, etc. Only a limited number of indices address non-political dimensions such as gender, economy, science or health, so we considered the need for such an index. After identifying and selecting variables we noticed their diversity and multitude. Accessibility of variables can lead to the creation of much larger and even structured instruments on different areas of interest, the only impediment being the existence of data over certain time periods.

The use of PCA to determine the composite index allows for a complex analysis of development, and the results indicate a sustained decrease in development over the analysis period considered with a small exception

at 2000-2002. An explanation may be that the largest and fastest development of a former communist state takes place in the first years after the fall of the communist regime

This paper complements the literature with a quantitative approach to determining a composite measure of the degree of development, which is of interest to both policy-makers and academics but also to citizens.

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