Entrepreneurial Business and Economics Review

OPEN ACCESS

2015, Vol. 3, No. 2 **DOI**: 10.15678/EBER.2015.030210

Assessment of a Country's Regional Economic Development on the Basis of Estimation of a Single Process (ESP) Method

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ABSTRACT

Objective: The objective of this article is to demonstrate an option of quantitative assessment of the status of an isolated complex target object.

Research Design & Methods: Review of scientific literature, an analysis of statistical data and methods applied in the theory of multiple criteria have been used for the purpose of this research.

Findings: The calculations have revealed that the proposed methodology is suitable for addressing real tasks. This methodology allowed the identification of unused potential of economic development in each region.

Implications & Recommendations: The proposed methodology can be applied to determine the current situation of regional economic development of a country. This could help plan the investment for country regional development .

Contribution & Value Added: Up to now the goal of multi-criteria valuation was to determine the priority of analysed variants. In order to determine the economic development of separate regions during the period in question, a different method of normalisation of values was employed than the one normally used in multi-criteria valuations. The originality of this work lies in the assessment of the status of an isolated process at a given moment of time.

Article type:	research article
Keywords:	multi-criteria valuation; regions; regional development; indicators; assessment; Lithuania
JEL codes:	Q01

Received: 11 January 2015 Revised: 1 June 2015 Accepted: 11 June 2015

Suggested citation:

Ginevičius, R., Gedvilaitė, D., & Bruzgė, Š. (2015). Assessment of a Country's Regional Economic Development on the Basis of Estimation of a Single Process (ESP) Method. *Entrepreneurial Business and Economics Review, 3*(2), 141-153. doi: 10.15678/EBER.2015.030210

INTRODUCTION

Up till now the goal of multi-criteria valuation was to determine the priority of analysed variants. In economic sciences it is much more difficult to determine the quantitative status of separate socio-economic systems. This task is being analysed on the basis of economic development of regions. For this purpose the hierarchically structured indicator system has been created. Based on this system the values and significance of the indicators have been determined. In order to determine the economic development of separate regions during the period in question the method of normalisation of values used was different than the one normally used in multi-criteria valuations. This allowed the determination of unused potential of economic development in each region.

Therefore the purpose of this article is to demonstrate an option of quantitative assessment of the status of an isolated complex target object. All the more that so far in practice not a single assessment has been completed on the basis of this method.

This article applies such research methods as (i) review of scientific literature, (ii) analysis of statistical data and (iii) the methods applied in the theory of multiple criteria.

LITERATURE REVIEW

The sustainability of a country's regional development like of any other social-economic system (SES) is usually analysed in terms of three aspects: economic, social and environmental (Rutkauskas *et al.,* 2014; Čiegis *et al*., 2014; Dudzevičiūtė *et al.,* 2014; Radosavljevic, 2014; Hay *et al.,* 2014; Stankevičienė *et al.,* 2014*;* Tvaronavičienė *et al.,* 2014; Tabara & Chabay, 2013; Dagiliūtė, 2012; Shneidewind & Augenstein, 2012; Kocmanova *et al.,* 2012; Bell & Morse, 2008). Each of these aspects can only be defined by multiple indicators since each aspect constitutes a complex and integrated process which in practice manifests multiple characteristics, features, etc.

The intensity of development of the above aspects differs, which has implications on the sustainability of regional development as a whole. There are two major issues. First, quantitative assessment of the development degree of individual regional aspects and, second, assessment of sustainability of the regional development as a whole.

Given that each of these aspects can only be reflected through multiple indicators, a successful assessment of the effective degree of development is based on multi-criteria methods which are multifunctional by nature, i.e. they can be used for the purposes of quantitative assessment of any complex process defined by multiple indicators (Ginevičius & Podvezko, 2012; Ginevičius *et al.,* 2011b,c; Ginevičius & Podvezko, 2008; Andriušaitienė *et al.,* 2008).

The adaptability of multi-criteria methods also results from the ability to sum up both maximising (where the growing value of an indicator refers to improvement of a situation) and minimising (where the growing value of an indicator refers to deterioration of a situation) indicators in a single generalising value. Summing up of all the indicators is made possible by normalisation which makes them dimensionless, i.e. comparable with each other.

Multi-criteria assessment theory and its mathematic apparatus were developed and revised with a single purpose – to prioritise the variables being analysed (Ginevičius &

Podvezko, 2012; Andriušaitienė *et al.,* 2008). The main facet that lies at the heart of this idea is the normalisation of multi-dimensional indicators. It means that for comparison purposes of the variables, the normalised value of the isolated indicator for a variable j derives from general context, i.e. this value is influenced by the values of the counterpart indicators of other variants. This can be seen from the formula which reflects the essence of such normalisation irrespective of its proposed variations (Ginevičius & Podvezko, 2012; Andriušaitienė *et al.,* 2008):

$$\tilde{q}_{ij} = \frac{q_{ij}}{\sum_{i=1}^{n} q_{ij}} \quad (1)$$

where:

$\tilde{q}_{ij}$ - the normalised value of the indicator *i* for the option *j*,
q_{ij} - the value of the indicator *i* for the option *j*,
n - the number of the indicators ($i = \overline{1,n}$).

The formula (1) shows that the normalised value of the indicator *i* for variable *j* is derived by dividing its value from the sum of indicator *j* values from all variables. This normalisation approach is of course logical where the purpose of multi-criteria assessment is, as it has been mentioned, prioritisation of the variables.

The tasks of the kind are relevant for solving all types of different problems: prioritising alternative options for construction projects, insulation of buildings, walls, other construction elements, rating higher education schools by quality of performance, regions of the country by their economic-social development, countries by their development degree (Andriušaitienė *et al.,* 2008; Ginevičius *et al.,* 2005; Brauers & Ginevičius, 2009; Ginevičius & Podvezko, 2009; Ginevičius *et al.,* 2008).

These and similar tasks can be assigned to a single class or a group of multi-criteria assessment tasks. In recent years, researchers have identified another class – quantitative assessment of an isolated object or the status of an isolated social-economic system (Ginevičius, 2008). While in the first case, the purpose of multi-criteria assessment was building a framework to support decision making function, i. e. to "help" the decision-maker chose the most suitable variables from a number of possible options, in the second case the multi-criteria assessment aims at building an efficient analysed phenomenon (AP) management tool. Why is it so? Constructive management of a system is possible only provided that there is a possibility of quantitative assessment of its status at a given point in time. Only when we know a system and we know its changes per respective period we can conclude to what extent management, organisational and other decisions have been efficient, i.e. whether positive changes of the situation matched the money invested into the improvement.

With this purpose in mind, i.e. a quantitative assessment of an isolated variant of AP on the basis of multi-criteria methods, it is clear that the existing methods for normalisation of the values of indicators are not suitable. Not suitable because in this case each of the indicators of the variable j expressed in different dimensions has to be converted into dimensionless indicators than have no links to the values of the counterpart indicators of other variables. To convert a number expressed in a certain dimension into a dimensionless value, it has to be divided from the number expressed in the same dimension. Since our purpose is to derive a normalised dimensionless value of

the indicator *i*, this value cannot be bigger than 1. It means that the sought value has to be a number equal or bigger than the maximum possible value of the indicator *i* (Ginevičius, 2008). The most suitable method to identify this value is expert interviews. Another solution is possible as well, for instance, where the maximum value of the indicator is taken (e. g. the maximum value of the indicator achieved in all regions of the country). This method has been called as ESP (Estimation of a Single Process) (Ginevičius *et al.,* 2011a). Therefore the purpose of this article is to demonstrate an option of quantitative assessment of the status of an isolated complex target object. Up till now not a single assessment has been completed on the basis of this method.

MATERIAL AND METHODS

A suitable means for evaluation and illustration of suitability of a method is the complex assessment of a region's economic development, the most essential feature of this development. As a general rule, the assessment has to be based on a framework of indicators defining regional economic development of a country. The analysis of reference sources reveals that there are different suggested options for what it should look like. The choice in each case is limited by three indicators which are generalising in themselves. These indicators are: regional gross domestic product (GDP) *per capita*, regional foreign direct investments (FDI) *per capita* and regional unemployment level (Čiegis *et al.*, 2010).

GDP *per capita* is considered a reliable indicator of a country's success and wealth reflecting the level of its economic development; FDI facilitate more rapid technological development and are an important source for building of fixed capital; unemployment level reflects participation of the people.

Table 1. Matrix for building the framework of economic development indicators of a region

Activities Aspects	1	2	3	...	i	...	n
1	r_{11}	r_{12}	r_{13}	...	r_{1i}	...	r_{1n}
2	r_{21}	r_{22}	r_{23}	...	r_{2i}	...	r_{2n}
3	r_{31}	r_{23}	r_{33}	...	r_{3i}	...	r_{3n}
⋮	⋮	⋮	⋮	...	⋮	...	⋮
j	r_{j1}	r_{j2}	r_{j3}	...	r_{ji}	...	r_{jn}
⋮	⋮	⋮	⋮	...	⋮	...	⋮
m	r_{m1}	r_{m2}	r_{m3}	...	r_{mi}	...	r_{mn}

Source: own elaboration.

A question is, whether these three indicators adequately reflect economic development of a country's region. The analysis of their dynamics has revealed that both FDI and the unemployment level are closely linked with GDP. This means that GDP in itself integrates both rapid technological progress of a region and positive impact on the economic development exerted by the fixed capital built with the help of foreign direct investments. In the same vein, GDP integrates the situation on the labour market – high indicator mirrors high participation of the people.

Consequently, the economic development of a region can be defined by generalising indicators only if in addition to GDP there are other, unrelated indicators. If there are no such indicators, a framework of primary and undividable indicators as its elements has to be built (Ginevičius *et al.*, 2014).

The information of the country's economic-social development has prompted a conclusion that there are two possible approaches towards building of a framework of indicators: first, based on development aspects and their defining indicators, and, second, based on activities (Table 1, Figure 1).

In the regions, economic activity reveal itself as development of its separate activities therefore further calculations will be based specifically on this type of a framework of indicators.

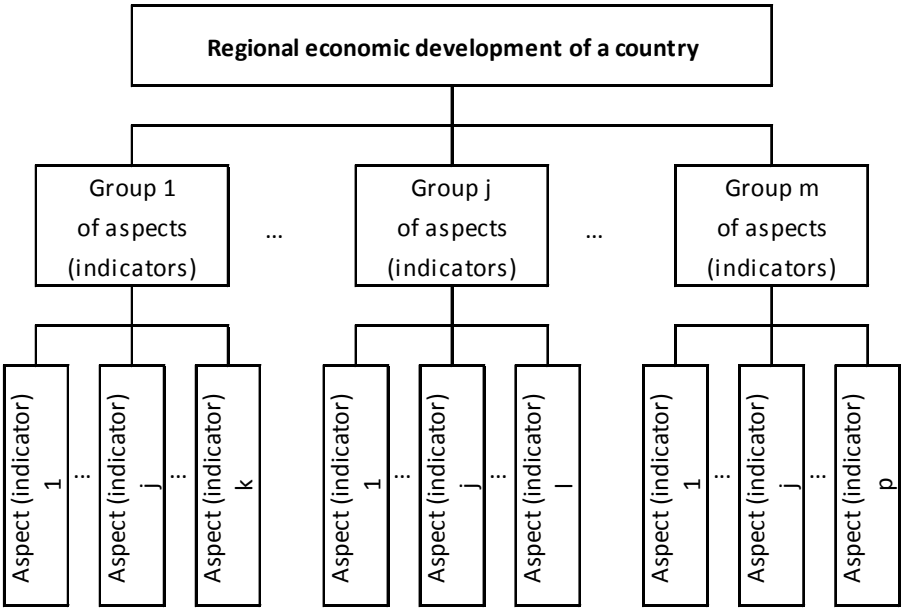

Figure 1. Hierarchic structured framework of economic development indicators of a country's region
Source: own elaboration.

RESULTS AND DISCUSSION

Referring to the basic publication of *Statistics Lithuania* on the regional development of the country (Lietuvos apskritys 2010, 2011, 2012) the following framework of economic development indicators of the regions has been built (Figure 2).

In the context of building this framework of indicators a question emerged as to what criterion should determine whether a specific activity is a part of economic development. The activities which produce material products have been categorised as economic activities. On that basis for example foreign and domestic trade has been excluded realising products resulting from economic activities.

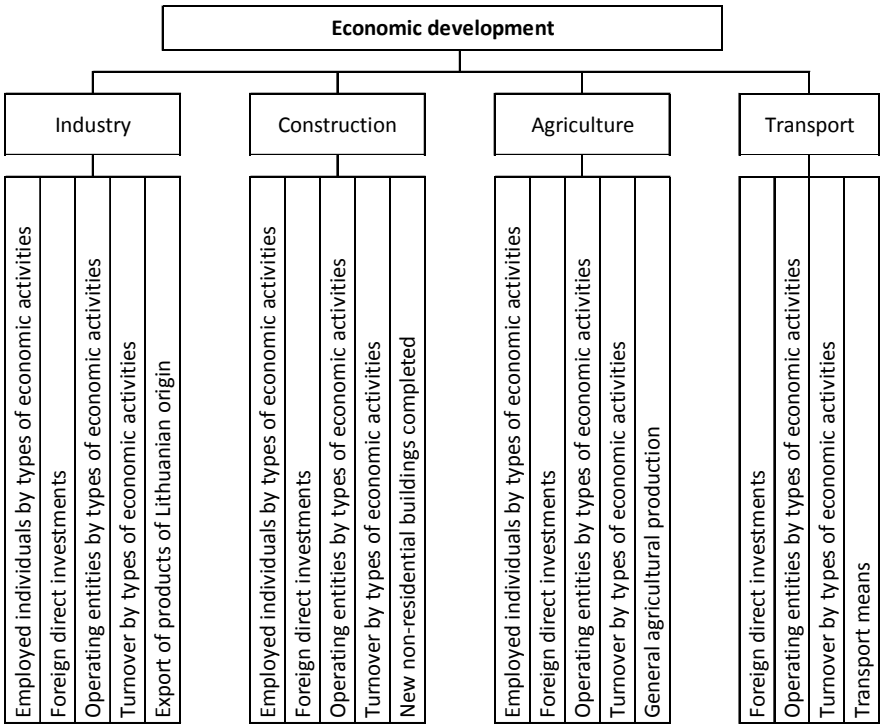

Figure 2. A framework of economic development indicators of Lithuanian regions
Source: own elaboration.

Multi-criteria assessment of any complex process shall be performed in certain phases: building of a framework of indicators; normalisation of the values; identification of the values and weights of the indicators; deciding on a method to be used for multi-criteria assessment of the indicators; multi-criteria assessment and deployment of its results for improvement purposes.

Multi-criteria assessment of the regional economic development of the country is based on Figure 2 showing hierarchic framework of indicators. This means that first of all, the quantitative assessment of all four activities, namely industry, construction, agriculture and transport, has to be conducted. It can be achieved by using the Simple Additive Weighting SAW multi-criteria assessment method (Hwang & Yoon, 1981):

$$K_j = \sum_{i=1}^{n} w_{ij}\tilde{q}_{ij} \tag{2}$$

where:

K_j - value of the activity j assessed on the basis of SAW multi-criteria assessment method,

w_{ij} - the weight of the indicator i for the activity j; number of the indicator i for the activity j,

$\tilde{q}_{ij}$ - the normalised value of the indicator i for the activity j,

n- number of the indicators i ($i = \overline{1,n}$).

Once K_j values are identified similar method can be used to establish the degree of economic development as a whole:

$$K_k = \sum_{j=1}^{m} w_j K_j \tag{3}$$

where:

K_k - the value of economic development of the region k based on SAW multi-criteria assessment method,

w_j - the weight of the activity j,

K_j - value of the activity j assessed on the basis of SAW multi-criteria assessment method,

m - number of the activities ($j = \overline{1,m}$).

According to the framework of indicators indicated in Figure 1, the values of the indicators for all regions of Lithuania have been retrieved from the *Statistical Yearbook of Lithuania* (2012) (Table 2). It appears that all the indicators are maximising, i.e. in all instances the increase of their values reflects improvement of the situation therefore there is no need for reorganisation of the initial data.

Another phase of a multi-criteria assessment is the normalisation of the values of the indicators. Following the given task, integrated assessment of the economic development of an isolated region, to derive a dimensionless value of an isolated indicator a value higher than or equal to the maximum existing value of the particular indicator has to be chosen for each indicator. Here the normalisation will be as follows:

$$\tilde{\tilde{q}}_i = \frac{q_i}{q_{max\,i}} \tag{4}$$

where:

$\tilde{\tilde{q}}_i$ - the normalised value of the indicator i,

q_i- the value of the indicator i,

$q_{max\,i}$ - the maximum value of the indicator i.

In our case, the maximum value chosen among all regions of the country being analysed in the reference period should be taken as the reference value. These values are given in Table 2. The normalisation of the values of the indicators was based on formula 4.

To be able to perform multi-criteria assessment of the regional economic development, weights of the indicators have to be established (Table 3). These have been identified by the experts. The expert opinions as shown by the compatibility analysis were rather unanimous.

Table 2. Maximum values of economic development indicators of Lithuanian regions

Type of economic activity	Indicators							
	Employed persons by economic activity (% of the region's population)	Foreign direct investment (LTL mill. per 1000 individuals of the region's population)	Economic entities in operation by economic activity (units per 1000 individuals of the region's population)	Turnover by economic activity (LTL thousands per 100 individuals of the region's population)	Exports of goods of Lithuanian origin (LTL mill. per 10 000 individuals of the region's population)	New non-residential buildings completed (thousands m^2 per 1000 individuals of the region's population)	Gross agricultural production (LTL thousands per 1000 individuals of the region's population)	Number of road vehicles (units, per 1000 individuals of the region's population)
Industry	25.5	24.77	3.01	14815.8	1196.14	-	-	-
Construction	11.7	1.23	3.12	5621.13	-	0.38	-	-
Agriculture, forestry and fishery	30.5	0.62	0.94	952.87	-	-	7141.43	-
Transport	-	2.02	3.49	15273.1	-	-	-	77.31

Source: own study.

Table 3. Weights of the regional economic development indicators of the country

Activity	Indicators								
	Employed persons by economic activity	Foreign direct investment	Economic entities in operation by economic activity	Turnover by economic activity	Exports of goods of Lithuanian origin	New non-residential buildings completed	Gross agricultural production	Number of road vehicles	Total
Industry	0.40	0.06	0.26	0.08	0.20	-	-	-	1.0
Construction	0.53	0.07	0.10	0.09	-	0.21	-	-	1.0
Agriculture	0.29	0.18	0.18	0.09	-	-	0.26	-	1.0
Transport	-	0.36	0.34	0.20	-	-	-	0.10	1.0

Source: own study.

The multi-criteria assessment of the economic development of Lithuanian regions was based on formula 2 and 3. The calculation results are presented in Table 4.

There is a question to what extent the economic development potential of the individual regions has been tapped. To this end, the potential rate of development in addition to the actual rate has to be known.

Table 4. Results of the multi-criteria assessment of the economic development of the country's regions

Seq. No.	Regions	2010		2011		2012	
		Value	Location	Value	Location	Value	Location
1	Vilnius	0.3733	4	0.4244	9	0.3844	4
2	Kaunas	0.3013	6	0.4384	7	0.3589	5
3	Klaipėda	0.4396	2	0.5709	2	0.4794	1
4	Alytus	0.2716	10	0.4447	5	0.3118	9
5	Marijampolė	0.4542	1	0.4125	10	0.3369	7
6	Panevėžys	0.2756	9	0.4437	6	0.3310	8
7	Šiauliai	0.3530	5	0.4852	3	0.4417	3
8	Telšiai	0.3855	3	0.5865	1	0.4658	2
9	Utena	0.2895	7	0.4481	4	0.2952	10
10	Tauragė	0.2838	8	0.4292	8	0.3423	6

Source: own study.

The normalisation of the values of the indicators based on formula 4 has revealed that the maximum value for each indicator in each activity is 1.0. Consequently, a variant can be shaped for each activity where all the indicators will have the value 1.0. As a result:

$$K_j^p = 1.0 \tag{5}$$

where:

K_j^p - is the maximum possible value of the activity j.

We can derive the value of $K_k^p = 1.0$ in a similar way.

The untapped economic development potential of a region will be reflected by the difference between K_k^p and the actual development (Figure 3).

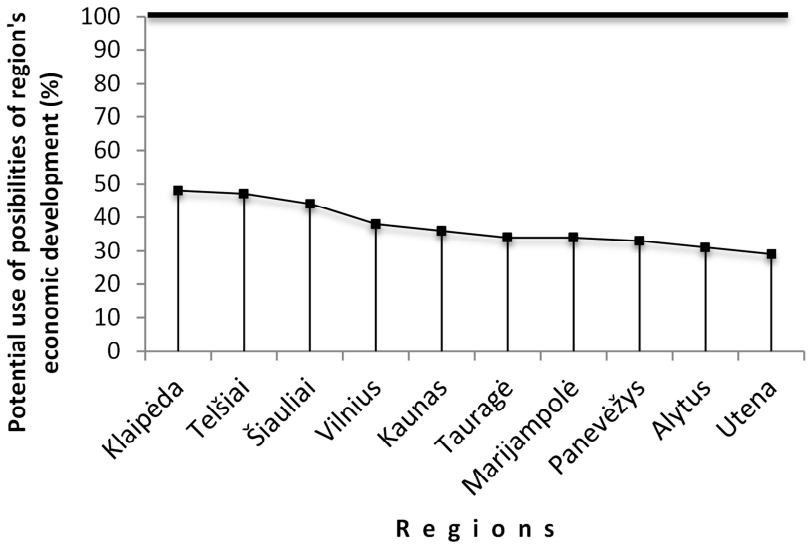

Figure 3. Tapping of the potential regional economic development capacities in Lithuania

Source: own study.

As can be seen from Figure 3, the development of Klaipėda region, which demonstrates the most rapid economic development rate, is by 1.62 times larger compared to the region with the slowest development rate. Moreover, the untapped capacities in Klaipėda constitute more than 50%, while in Utena this figure is as high as 70%.

CONCLUSIONS

There are two multi-criteria assessment lines: first – the prioritisation of the variables of a target process, second – the assessment of the status of an isolated process at a given moment of time.

The method for normalisation of the values of indicators differs depending on the task set for the multi-criteria assessment. In the first case the normalised value of the indicator will derive from the value of other indicators of the same variable; in the second case the normalisation of the values of indicators will be sought in isolation from the values of other indicators of the same variable.

Such normalisation of the values of indicators enables to identify the maximum value of the target process in the target situation, which is 1. Its comparison with the actual assessed value discloses the scope of unrealised potential.

The calculations have revealed that the proposed methodology is suitable for addressing real life problems.

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