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MULTISECTORIAL, MULTIVARIABLE, MULTICRITERIA STOHASTIC OPTIMIZATION MODELS SYSTEM

Aleksandras Vytautas Rutkauskas

Vilnius Gediminas Technical University, Faculty of Business Management,
Saulėtekio al. 11, LT-10223 Vilnius, Lithuania
Email: aleksandras.rutkauskas@vgtu.lt

Abstract. The multisectorial multivariable multicriterial stochastic optimization model system is an adaptive system of stochastic dependencies, which integrates the following items, formed in time and in uncertainty: intersector connections, multifactorial dependencies describing the connection between the producible volume of sector product or service and factors governing the sector creative potential; functions of integral scientific knowledge, innovation and technology cluster both when forming the creative powers of the sector and the whole multisectorial system and when serving as an adaptive complex system technology; analytic mechanism defining rational import-export proportions. Making use of statistical data, the system of models was adopted for the analysis of the situation of Lithuanian economic development. Evaluations are presented in a three-dimensional space of efficiency, reliability and risk. The advantages of the proposed system are discussed within the context of coordination of regional economic development and globalization processes, as well as conflicts arising within the economy.

Keywords: multisectoral, multicriterial, stochastic optimization, globalization.

JEL classification: O10, G00, P00, C00.

1. Introduction

The article briefly describes the parallels between goals of regional economic development and actual evolution of globalization processes in economics. In addition, attention is drawn to the fact that the principles and goals of regional economic development had never narrowed to purely short-term goals of economic efficiency, but would rather be based on a wide collection of social and ecological development values. The practical development of intensive globalization does not always agree with all the requirements of said collection. This paper describes the opportunities for using one tool to maintain and strengthen the basic principles of regional economic development in the turmoil of globalization – the multisectorial multivariable multicriteria optimization model system.

The multisectorial multivariable multicriteria stochastic optimization model system is understood in the paper as an adaptive system of stochastic dependencies, which integrates the following items, formed in time and in uncertainty: intersector connections, multivariable dependencies describing the connection between the generatable volume of sector product or service and factors governing the sector creative potential; functions of integral scientific knowledge, innovation and technology cluster both when forming the creative powers of the sector and the whole multisectorial system and when serving as an adaptive complex system technology; analytic mechanism defining rational import-export proportions.

In this paper, a system of models is proposed that is based on available statistical data and acquired analytical experience, which will be adapted to investigate the situation of Lithuanian economic development.

In order to understand the somewhat complicated title of the paper – multisectoral multivariable multicriteria stochastic optimization system – the main moments of each aspect included in the title will be briefly revealed, which ensures the inclusion of that aspect into the title.

The term multisectoral is used for defining, while achieving certain goals, the structurization and complexity of interactions of multiple systems. In this paper the term multisectoral is mainly connected with the solution to problems of opportunity analysis and directional development design of multisectoral economics.

The plentiful presentation of Leontjev J/O scheme was used in both pragmatic utilization and textbook literature, as well as authors investigating the theoretical ponderings of the J/O scheme and the expansion of its possibilities for solving the

problems of regional economics (Hoover 1971; Shoffer *et al.* 2004; Yan 1969; Liu 2008; Perlich 2008; Held *et al.* 2000; Stimpson *et al.* 2006; Spall 2003).

The term multivariable or simply function with multiple variables is more connected with the search for solutions to systems with multiple variable functions (Moradi 2014). Since in a multisectoral model, the possibilities of different sectors to make a certain quantity of products or provide a certain volume of services depend on widely different factors, which require rather complicated function forms to reflect their interaction in order to adequately reflect the model of these factors, this requires the use of complicated multivariable function forms.

The complexity increases significantly when factors turn out to be random quantities with different dimensions.

The term stochasticity is seemingly unrelated to any challenges to information provision or practical realization. However, in order to achieve an adequate identification of many processes, including economic ones, stochastic models of such processes are necessary both when describing their historical trends and, even more, when projecting their development or evaluating development opportunities (Kendrick 2005; Stasytytė, Rutkauskas 2008; Rutkauskas 2003; Rutkauskas *et al.* 2008; Rutkauskas *et al.* 2010).

The multi-purposeness and multicriteriosity of development is a natural element of economics (Ferreira 2013; Yazdani-Chamzini *et al.* 2013; Zavadskas *et al.* 2014). After all, the natural ecological and other resources entering into the chain of economic activity only gradually gain the characteristics of economic efficiency or price. Therefore the multi-purposeness of development, as well as the search for it, i.e. multicriteriosity naturally belongs within the array of tools for searching for optimal solutions.

Multicriteria optimization, much like the preparation of multicriteria optimization methods themselves, receives a lot of attention both in foreign and in national scientific and practical publications (Brauers, Ginevičius 2013; Ginevičius *et al*. 2004; Skibniewski *et al.* 2013; Tamošaitienė *et al.* 2013; Medineckienė *et al.* 2011). In practice, however, these are models and problems of deterministic optimization.

Separate attention is needed for the concept of stochastic optimization. This concept is not developed systematically as a whole either for the analysis of situations, which can only be object of stochastic optimization object, or methods that should be used in particular situations. In terms of structurization, the paper analyses situations which allow the values of the function y of stochastic variables $y = y(X_1, X_2 ... X_n)$ to be considered as Markowitz random fields, for which the governing parameter is the measure of risk of the distribution. Preparation of the solution algorithm involved using both theoretical work (Held *et al.* 2000; Stimpson 2006; Spall 2003) and numerical solvers (Brauers e*t al.* 2010; Ginevičius, Podvezko 2004).

Since the multisectoral multivariable stochastic optimization model system is designed for the quantitative analysis and projecting of regional economic development within the context of globalization, this paper pays a lot of attention to widely known and well cited works on global transformations – Hoover (1971), Shoffer *et al.* (2004), Yan (1969) – and works on problems of regional economic development – Held *et al.* (2000), Stimpson *et al.* (2006).

2. Peculiarities of regional economic development

In this paper it is considered as an economic region both a region of a separate country, usually large, and a separate country itself, both being regional components of the global economy. The term regional economic development is used in this context as well.

2.1. Regional economic development as the economy most obviously reflecting the characteristics of economic globalization

Although many authors suggest models of a mature or final globalized economy, these are unlikely equivalents of future reality. These models hardly leave any space for the role of regional economies, even though both the UN and the EU documents contain the problems of regional economic vitality, as well as the creation of full-fledged living conditions, among the major issues. Therefore one should not doubt that the creation of models and concept of cultivation of regional economic efficiency will become a priority direction of economic science. After all, international and interregional trade, as well as interregional division of labour, were the first sprouts of globalization. The forming networking opportunities of business organization and management open completely new perspectives for synchronized international division of labour and, perhaps most importantly, for rational and full-fledged use of natural resources.

Apparently, analysis of the phenomenon of globalization requires understanding the tendencies and patterns which globalization reveals for the development of human society and geopro-

cesses, while trying to simply prove which of those are conditioned by an objectively arisen necessity and while are conditioned subjectively and often reveal only particular interests and which are simply the phenomena following the development of new reality.

Undoubtedly the above mentioned tendencies first of all affect the development of human society and it is there that they are most obviously seen. However, an attempt to reveal the reasons of new tendencies and to perceive indications of patterns in them requires also a new impeccable technique of their understanding and universal methods of analysis.

If the processes of globalization, which initially are usually seen only as phenomena happening in a social space, encompassing changes in self-organization of various social structures of a particular country as well as intensification and deepening of international relations, but eventually transforming into an integrated evaluation of consequences of human economic activity on geoprocesses of the Earth and an attempt to design an economic mechanism of ecology, are observed more closely.

Note, however, that when determining what lies beyond globalization there is a clash of rather differing opinions, therefore wide attention was drawn to an attempt by a group of authors (Held *et al.* 2000) to structure the trajectories along which the consequences of globalization could manifest, dividing the opinions into three groups: hyperglobalist, sceptic and transformationalist (Table 1).

In the aforementioned work one can see the directions of named and intensive globalization, which had already become the main strategies of regional economic development before the start of the period of intensive globalization. These are:

a) globalization of trade;
b) globalization of finances;
c) organizational globalization of business;
d) global movement of workforce.

This is solid evidence that even the economic development projects of regions – both, as a rule, regions of large countries as well as regions comprising small countries – always reflected the mentioned strategies – if not as strategies of goal attainment, then at least as processes with clear influence upon the regional economic development strategies.

The regional economic development is in turn investigated not only as a result of interaction of work, capital and technology, which would be maximised considering the current market prices. As stressed by P. J. Simpson *et al.* (2006), the product of regional economic development is understood as employment, created wealth, realized investment, created infrastructure, quality of life and a number of other indicators, the understanding of which requires a deeper social-economic-value analysis. Based on this, the authors propose

Table 1. Understanding Globalization: Three trends (complied by the author based on Held *et al.* 2000)

	Hyperglobalists	**Skeptics**	**Transformationalist**
What new?	Global age	Commercial units, weaker geo-management than before	Unprecedented historical global interconnectedness
Dominant features	Global capitalisming, global government, a global civil society	Less dependency in the world than in 1890.	„Dense“ (intensive and extensive) globalization
Power of national governments	Decreasing or endangered	Stronger and enhanced	Redesigned, re-structured
Managing powers of globalisation	Capitalism and technology	State or market	Combined forces o f modernization
Stratification model	Old hierarchies loss	The increasing marginalization of the South	Architecture of the new world order
The predominant motive	McDonalds, Madonna, and others.	The National interest	Transformation of Political Community
Definition of Globalization	Reorganisation of a structure of human activity	As internationalization and regionalization	As a restructuring of intra-regional relations and activities at a distance
The historical trajectory	Global civilization	Regional blocks, the clash of civilizations	Indefinite: global integration and fragmentation
Summarizing statement	End the nation-state	Internationalization depends on the state's consent and support	Globalization has transformed the state's power and global politics

an understanding of regional economy which relates to the understanding of a number of authors, which states that "regional economic development is the use of economic processes and regionally available resources, leading to sustainable expansion and desired economic results for the region, as well as satisfying the expectations of the business, the inhabitants and the visitors". In this paper the structure of a system of models will be investigated, which allows taking into account the aforementioned and other demands of regional economic development, and the possibility of a solution of informative supply and calibration. The model is named the same as the title given in the title of the paper, the acronym is 3MSOMS and it will be used in the subsequent text.

2.2. 3MSOMS – and adequate tool for generating regional economic development solutions: goals and structure

3MSOMS is based on:

a) Temporally and uncertainty-wise constant system of intersector communications, and possibilities of an input-output system;

b) Multivariable equations, which describe the dependencies of volumes of producible product or providable service in a sector and the extent of factors determining the sector productive potential;

c) Extensive analysis of import requirements and export possibilities, attempting to optimize the import-export effect, satisfying the needs of production and inhabitants and taking into account the possibilities of the country's payment balance;

d) Sustainability criteria while aiming for maximum utility;

e) Use of possibilities of integral KNIT cluster and its separate components (Rutkauskas *et al*. 2013, 2014);

f) Change of communication with the EU and respective information about EU member states' multisector dynamics.

The basis of the intersector communication system is the use of the product O_i created in, and import I_i of, sector *i* by itself and in other sectors and for export:

g) In production of when providing services

$$\sum_{j=1}^{k} O_j \ ;$$

h) Satisfying the investment requirements in basic capital $I_j : \sum_{j=1}^{k} J_j^{inv}$;

i) Satisfying the working capital needs of all sectors, the reserve and stock changes $H_j : \sum_{j=1}^{n} H_j$;

j) Satisfying the consumption needs of the population $\sum_{j=1}^{n} V_j$;

k) Satisfying the needs of the public sector $\sum_{j=1}^{n} L_j$;

l) Satisfying the export needs E_i ;

m) Loss Q_i ;

Therefore there is a balance of the use of a product produced in the sector:

$$O_i + I_i = \sum_{j=1}^{k} Q_j + \sum_{j=1}^{k} I_j + \sum_{j=1}^{k} H_j + \sum_{j=1}^{k} V_j + \sum_{j=1}^{k} L_j + E_i + \sum_{j=1}^{k} Q_j \ , \quad (1)$$

where:

i = 1, 2, 3, ..., k.

$$O = \sum_{i=1}^{k} O_i \ . \quad (2)$$

The main input-output dependencies which will be used in the calculations of the following section are as follows:

$$f = (1 - A)q; \quad (3)$$

from which follows a relation

$$q = (1 - A)^{-1} f. \quad (4)$$

Here q is the vector of production volume; A is the direct input production consumption matrix; f is the final consumption (produced added value) vector; $(1\text{-}A)^{-1}$ is the inverse matrix by Leontjev multisectorial, multivariable, multicriteria stochastic optimization models system.

The multivariable dependency between the volume of products or services produced in a sector – O_i – and the main factors – main capital C_i and employee number L_i – is:

$$O_i = o_i(C_i \otimes e^{IT}; L_i \otimes e^{KN}), \quad (5)$$

where:

e^{IT} – indicator of main capital investment and technology level;

e^{KN} – indicator of knowledge (human capital level).

An aspect of 3MSOMS requiring separate attention is the multicriterion stochastic optimization. Here the basis for finding solutions to, and posing, numerous optimization problems can be the logic of Fig. 1. Here the set of possibilities (possible solutions) is described as a Markowitz random field (Rutkauskas, Stasytytė 2011b) – that is a sequence of random values ranked by their

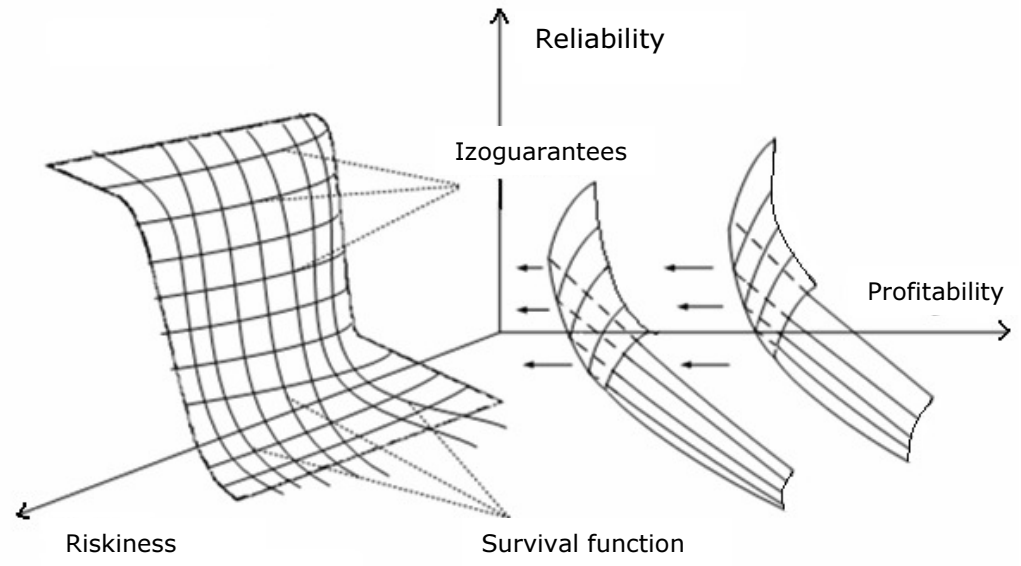

Fig. 1. Scheme of decision-making (Rutkauskas, Stasytytė 2011a)

risk level, while the efficiency function forms naturally as a convex surface to the possibility set, and the touching of these surfaces usually produces a single solution; described by the effect measured with the natural unit of measurement (time, profitability, return on investment, etc.) of the investigated process, the significance of the effect and risk level, or simply by the risk of a random value as an element of the Markowitz random field which gained the choice of optimization.

3. Practical 3MSOMS application

Various aspects of 3MSOMS were discussed earlier in the text, so the attention will be focused on practical calculations and evaluations. The calculations are performed using the methodology presented in scientific and practical literature (Chenery, Srinivasan 1989; Economic… 2008; Bureau… 2008)

Of course, in analytic evaluation one can try to include all the opportunities of the multi-sector model discussed, but let us focus on the optimal distribution of investment resources among the different production and service sectors, so that the marginal investment unit would create the maximum benefit for the consumer from the potentially creatable scope of final consumption.

Considering the available statistic accountability or statistic evaluation data, it is possible to define these areas of activity or simply these 3MSOMS sectors:

1. Agriculture, forestry and fishing (A);
2. Industry, with the exception of energy (electricity, gas, steam and air conditioning) (B_C_E);
3. Energy (electricity, gas, steam and air conditioning supply) (D);
4. Construction (F);
5. Wholesale and retail trade, transportation, accommodation and food service activities (G, I);
6. Information and communication (J);
7. Financial and insurance activities (K);
8. Real estate activities (L);
9. Professional, scientific and technical activities, administrative and support service activities (M_N);
10. Public administration and defense, education, human health and social work (O_Q);
11. Arts, entertainment and recreation, repair of household goods and other services (R_U).

Here it should be reminded that it will be continued to use the opportunities of stochastic definition and stochastic optimization.

The combined and complex creation of added value by material investment will be described using the following succesion – using the power of material investment to create material wealth an in turn to create the prerequisites and opportunities for a corresponding creation of general consumption volumes, these opportunities will be quantitatively evaluated:

- using the inverse matrix of V. Leontjev, the volumes of final consumption that can be created will be evaluated;
- after thorough analysis of the potential effects of distribution of material investment between distinct activities, the prerequisites and information necessary for the derivation of an optimal solution will be formed.

In practice this means that having the data on intersector flows (Table 2), the so-called direct flows coefficient matrix or simply the direct expenditure matrix A can be derived. For further

evaluation, the matrix (I-A) will be used, which is necessary for the derivation of the inverse V. Leontjev matrix $(I-A)^{-1}$ (Table 3), which becomes the main tool connecting production (intermediate consumption) and final consumption vectors.

Both the direct expenditure matrix and the inverse V. Leontjev matrix (Table 3) are reasonably adequate for the description of interaction between volume vectors of production and final consumption. In Table 4 there is shown both the direct values of these vectors formed in practice, as well as the analytical estimates.

The first two columns of matrix (Table 4) show the real vector of production consumption volume (column 1) and the analytically evaluated general consumption volume vector (column 2). Columns 3 and 4 of Table 4 show the corresponding vectors of final consumption.

Next, in order to gradually arrive at the solution to the complex problem of stochastic optimization, a simpler situation shall be investigated – how the perspectives of creatable general consumption volume would look if one uses the expert-suggested stochastic estimates of direct expenditure matrix coefficients and attempted to ensure the formed volumes of final consumption. With a larger spectrum of statistical observations, the considered direct expenditure coefficients could be simply the object of statistic evaluations.

In this case it is clear that in the case of determined direct expenditure coefficients the sum of general consumption over all sectors is 237579,2 Lt.

Table 2. Inter-flow data (compiled by the author)

Products according to CPA / Componnents of added value	A	B_C_E	D	F	G_I	J	K	L	M_N	O_Q	R_U
A	1010	4077	0	0	62	0	0	0	0	42	3
B_C_E	2907	26300	2218	1747	4452	457	113	761	795	1828	245
D	168	1044	3009	36	1279	65	36	8	339	459	125
F	31	106	288	1695	70	2	8	0	124	106	97
G_I	949	4960	270	394	6341	217	160	103	552	588	106
J	66	73	30	27	353	981	140	5	128	328	58
K	147	372	55	62	432	40	490	276	110	528	37
L	128	88	11	54	1095	102	49	101	207	165	143
M_N	160	1208	110	347	1792	236	334	73	1211	785	135
O_Q	1	24	3	7	69	6	31	3	37	249	4
R_U	43	84	25	23	75	15	9	0	42	222	465

Table 3. Inverse matrix according to V. Leonjev (compiled by the author)

Products according to CPA / Componnents of added value	A	B_C_E	D	F	G_I	J	K	L	M_N	O_Q	R_U
A	1.118	0.055	0.020	0.014	0.009	0.007	0.003	0.007	0.007	0.009	0.009
B_C_E	0.424	1.352	0.479	0.334	0.181	0.166	0.082	0.169	0.176	0.165	0.177
D	0.039	0.024	1.466	0.019	0.053	0.030	0.026	0.007	0.068	0.044	0.073
F	0.007	0.003	0.055	1.226	0.005	0.003	0.006	0.001	0.022	0.010	0.046
G_I	0.138	0.079	0.080	0.085	1.175	0.071	0.068	0.032	0.094	0.054	0.065
J	0.011	0.003	0.008	0.007	0.013	1.218	0.050	0.004	0.021	0.024	0.028
K	0.022	0.008	0.014	0.013	0.016	0.014	1.139	0.050	0.019	0.035	0.021
L	0.018	0.004	0.006	0.012	0.030	0.027	0.019	1.018	0.029	0.013	0.055
M_N	0.034	0.023	0.033	0.063	0.058	0.067	0.114	0.022	1.158	0.058	0.066
O_Q	0.001	0.001	0.001	0.001	0.002	0.002	0.009	0.001	0.005	1.014	0.002
R_U	0.006	0.002	0.006	0.005	0.003	0.005	0.004	0.001	0.007	0.014	1.164

Table 4. The vector values and analytical estimates of the production and consumption of the final volume (compiled by the author)

	Vector of the actual use of the production volumes	Analytic vector of volumes of production use	Vector of the actual use of the production volumes	Analytic vector of volumes of production use
A	5902.3	5902.3	11124.2	11097.5
B_C_E	69231.5	69231.5	111414.0	111055.1
D	3126.4	3126.4	9786.8	9695.0
F	6822.7	6822.7	9381.6	9348.6
G_I	32461.1	32461.1	47263.5	47101.7
J	3416.2	3416.2	5645.5	5604.9
K	1639.1	1639.1	4229.9	4186.0
L	4494.7	4494.7	6673.7	6639.1
M_N	3277.3	3277.3	9774.3	9667.8
O_Q	19347.6	19347.6	19790.3	19781.1
R_U	2399.5	2399.5	3425.2	3402.5

Meanwhile in the case of an assumption about the stochasticity of direct expenditure matrix a set of final consumption probabilities is found, which is shown in Fig. 2.

The mean value of this probability distributions' set is not too distant from the volume of general consumption in the determined case. However, the reasonable spread of probabilities suggests that the optimization of the fostered intersector distribution of capital investment should be meaningful.

Fig. 3 shows the three-dimensional geometric view of the consequences of distributing the marginal investment unit among the 11 chosen sectors, i.e. how the final consumption opportunities created by the investment distribution would be positioned when each opportunity is measured by its magnitude, the significance of that magnitude and the risk level at which the investigated opportunity is situated.

The utility function chosen is:

$$U = \frac{e \cdot p_e}{r_e}, \qquad (6)$$

where: e – efficiency; p_e – reliability of efficiency; r_e – risk level of efficiency.

Fig. 4 shows its geometry.

Further, the intersection point between the opportunity surface and the chosen efficiency function can be found (Fig. 5 and Fig. 6).

In the case being investigated, the coordinates of the intersection are e = 1,32, p_e = 0,47, r_e = 0,013 and this intersection is generated by the following distribution of the investment unit among the eleven sectors (Table 5) according the following formula:

$$w_1, w_2, \ldots w_{11}; \quad \sum_{1}^{11} w_1 = 1, \qquad (7)$$

where:

$w_1, \ldots, w_{11}$ – weights of investment allocation into the corresponding sector.

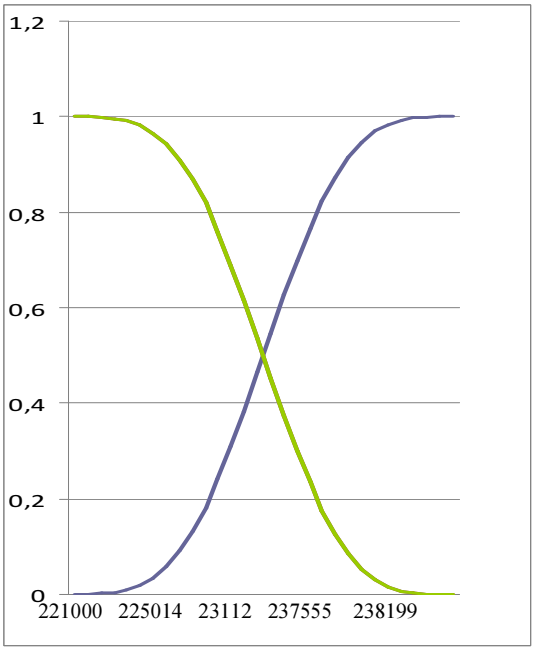

Fig. 2. Options set of final consumption (compiled by the author)

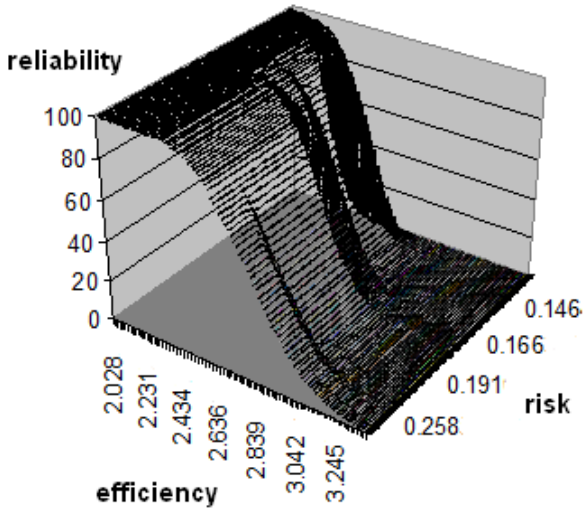

Fig. 3. Surface of opportunities (compiled by the author)

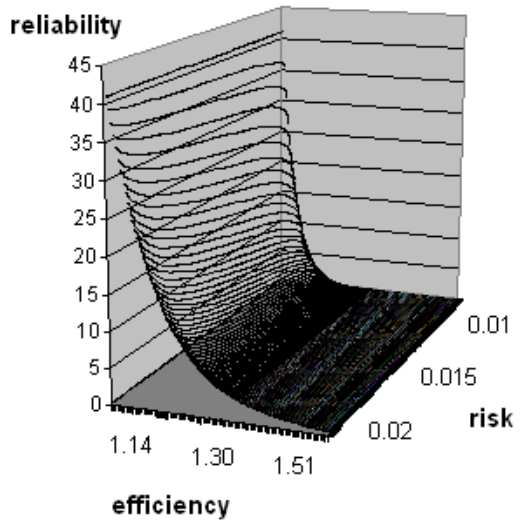

Fig. 4. Efficiency function (compiled by the author)

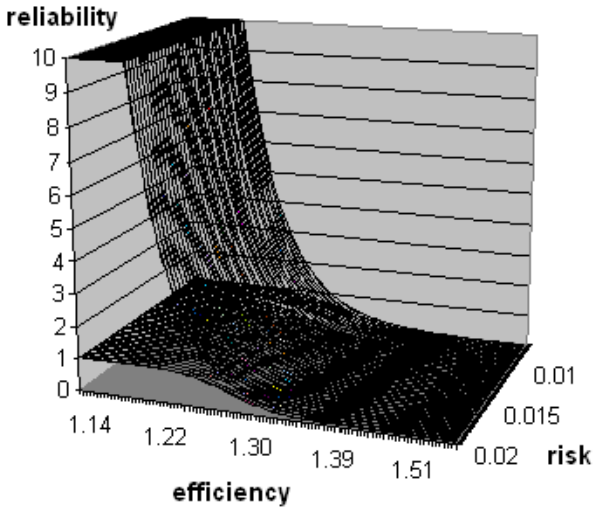

Fig. 5. The intersection of surface of opportunities and efficiency function: three-dimensional view (complied by the author)

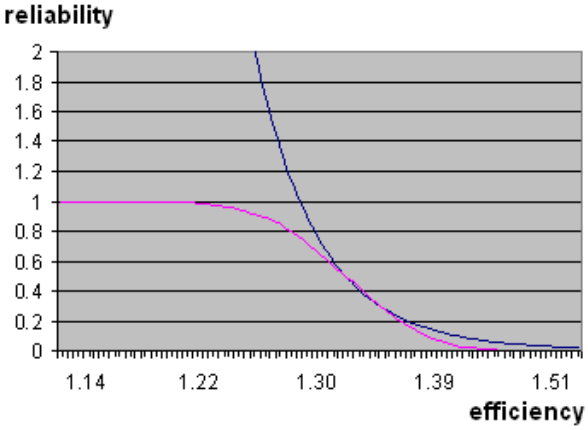

Fig. 6. The intersection of surface of opportunities and efficiency function: two-dimensional view (compiled by the author)

Until now it was visually investigated the formation of marginal investment unit by the principle of integral index. But for this it is necessary to understand how the relations between material investment and forming material wealth volume, as well as the relations between material wealth volume and the volume of production in a given sector, are generated, when the number of employees and the level of work intensity in the sector are determined by other circumstances. This is a complicated problem which generally does not have a unique solution and whose solution often requires the aid of expert systems.

In the analysed case, the problem was investigated with the help of quarterly business financial report data. Based on this data, a regression system between forming material wealth volume and the corresponding material investment volume was selected, as well as regression relation between volumes of production in separate sections and corresponding material wealth volumes, employee numbers and their qualitative characteristic. The relations obtained partially allow us to showcase the integral set of the creatable production volume of a limiting investment unit in each sector.

4. Conclusions

The processes of globalization in economics influence social, demografic, migratory and other processes, which are often only partially understood both in terms of principles and of consequences.

The regional development economics, as a fosterer of globalization processes such as international trade and international workforce sharing loses the potential for constructive influence on the ungovernable consequences of the globalization process, which are incompatible with the regional development guidelines declared by the UN, EU and other international organizations and forums.

3MSOMS is an attempt to concentrate into a unified whole those investigations of economic growth aspects and opportunities which are designed for the investigation of different development aspects – the problem of intersector development structure and dynamics, the problem of optimization of the structure of knowledge, innovation and technology cluster; the problem of managing uncertainty and risk.

Table 5. The intersectoral distribution of marginal investment unit (compiled by the author)

0.09	0.06	0.22	0.01	0.08	0.04	0.00	0.06	0.29	0.08	0.05
W_1	W_2	W_3	W_4	W_5	W_6	W_7	W_8	W_9	W_{10}	W_{11}

Table 6. Data used

Period	Property and equipment	Investment in tangible assets	Gross output	The added value	Number of employed	Hours worked
2010Q1	85263814	1442590	37081.2	19231.5	1221.0	560511.3
2010Q2	85316039	2598806	42714.0	21808.4	1229.8	582707.2
2010Q3	84197734	3053903	46205.6	22689.8	1260.7	597708.2
2010Q4	81711009	4161914	46036.6	22184.7	1275.5	608345.1
2011Q1	88276095	2180875	43052.6	21271.2	1232.7	564413.4
2011Q2	88442921	3443460	48566.0	24381.0	1260.7	594924.1
2011Q3	89111394	3508639	53825.5	25845.3	1259.7	571410.0
2011Q4	88699929	4876402	49863.3	24568.6	1257.8	597862.4
2012Q1	92072267	2507115	45907.9	22912.6	1250.8	579617.4
2012Q2	92133274	3568560	48755.0	25488.1	1283.3	602859.8
2012Q3	93154667	3831339	57131.0	27866.5	1297.2	587732.7
2012Q4	93067124	4519144	53787.4	26410.7	1268.2	597654.5
2013Q1	91634314	2637711	48481.7	24095.4	1265.7	578653.1
2013Q2	91747600	4087861	51680.5	26849.5	1296.5	603405.5

Experimental applications of 3MSOMS showcased the constructivity of the system when investigating in a combined fashion the processes with seemingly no common dimensions, but also revealed the necessity of increasing the opportunities for the information supply and analytic universality of the system.

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