Scientific Journal of Riga Technical University
Economics and Business. Economy

2011

Volume 21

Evaluation of Interrelations among Indicators of Researches Register's Innovative Potential

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Abstract — the scientific hypothesis of the research is that the lack of natural resources does not allow following the extensive way of economy's development, so it is important to use the innovative potential efficiently. It is necessary to develop the system of indicators which are dedicated to estimate the scientific and innovative potential of the research works based on revealing the interrelations of indicators. The application of economic-statistical methods may solve this problem.

Keywords: innovation, interrelation of estimated indicators, state register.

I. INTRODUCTION

The target method of financing the scientific activity based on satisfaction of the demand for knowledge within a society should be chosen when reforming the structure of scientific researches so that they should completely correspond to the demands of a society. The obtained results of scientific research can be used to work out the measures of improving the regulations of scientific, technical and innovative activity in the context of formation and operation of the state register of the scientific activity. In an innovative process there is a necessity of continuous identification and investigation of the innovations' market, working out offers and forms of bringing innovations to the consumer, including the transfer of the scientific and technical information. Accordingly the data included in the register should be structured and assessed.

In the Republic of Belarus the system of formation and usage of the state register of scientific research is being created. The given system registers, stores and provides opportunity for data use regarding scientific research. Thus the state register of scientific research is the state information resource. The result should be presented in the form of the goods which can be sold on the market. Therefore, it is necessary to define the target customer. If the local market has no demand for this knowledge it should be offered for export.

II. ANALYSIS AND CHOICE OF STATISTICAL METHODS OF EVALUATION OF THE INFORMATION ABOUT THE SCIENTIFIC RESEARCH

It is expedient to use the grouping of indicators for revealing the interrelations when processing the information resources. Grouping is a system for classifying things into groups. The grouping method allows to provide primary generalization of the data. Thanks to grouping it is possible to correlate summary indicators on sample as a whole with summary indicators on groups.

There is an opportunity to compare and analyze the reasons of distinctions between the groups, to study interrelations between indicators. The grouping allows to make conclusions about the structure of the sample and about the role of separate groups of this sample. The grouping forms a basis for the subsequent report and the analysis of the data.

Indicators, which are used for grouping, are named grouping indicators. A grouping indicator sometimes is named the grouping basis. The correct choice of an essential grouping indicator gives an opportunity to make scientifically substantiated conclusions as a result of the statistical research. Grouping indicators can have quantitative expression (financing volume, quantity of executors, customers) as well as qualitative (the bases for performance of research, a financing source, object of techniques, science sector).

It is necessary to use the following measures when grouping:

– Arithmetic means is the most widespread kind of average. It is used when calculation is carried out under not grouped statistical data when it is necessary to receive an average composed. Arithmetic means is an average value of an indicator at which the value of the total amount of indicators in aggregate remains invariable. It can be calculated using the formula below:

$$\overline{X} = \frac{\sum X_i}{n}, \tag{1}$$

n is the size of the sample.

– The relative size of structure (RSS) defines a share (relative proportion) of a part of the sample in the total amount. It is calculated as the relation of the amount of a part to the sample to the whole sample, defining thereby the relative proportion of a part in the total amount of the sample (%):

$$RSS = \frac{x_i}{X} \cdot 100\%, \tag{2}$$

x_i - amount of a part of an investigated sample;
X - total amount of investigated sample.

– The relative size of coordination (RSC) characterizes parity between two parts of the investigated sample, one of which acts as a base of comparison (%):

$$RSC = \frac{X_i}{X_b} \cdot 100\% \tag{3}$$

Xi - one of the parts of an investigated sample;
X_b - a part of the sample, which is the base of comparison.

– Relative size of comparison (RSCr) is a ratio of two identical indicators, which characterize different objects at a particular period of time:

$$RSCr = \frac{X_A}{X_B} \cdot 100\%, \quad (4)$$

X_A - indicator of the first investigated object;
X_B – the same indicator of the second investigated object (base of comparison).

– Relative size of intensity (RSI) is expressed, as a rule, by the called numbers. In statistical practice the relative sizes of intensity are applied for analysis of the degree of dimensions of the phenomenon in relation to the environment in which this phenomenon is distributed. Here RSI shows how many units of one sample (numerator) are necessary per one, per ten and per hundred units of the other sample (denominator).

$$RSI = \frac{X}{Y_X}, \quad (5)$$

X - distribution of phenomenon;
Yx - the environment of the distribution of phenomenon X.

– Net gain expresses absolute speed of change in dynamics and is defined as a difference between the given level and the base level of an indicator. It is calculated using the formula (6).

$$\Delta = X_i - X, \quad (6)$$

– The geometric average:

$$\overline{X} = \sqrt[n]{X_1 \cdot X_2 \cdots X_n}, \quad (7)$$

It is useful to reveal tendency.

Growth index is the ratio of the chosen level and the base level of the indicator:

$$Ip = \frac{X_i}{X_b}, \quad (8)$$

Gain index is the ratio of net gain to the base level of the indicator:

$$Ir = \frac{\Delta}{X_b} = Ip - 1. \quad (9)$$

III. Development of the Models of Interrelations of the Indicators Formed in Information Resources

For constructing the model of interrelation it is necessary to define the estimation indicators using given information. It is useful to unite chosen indicators in groups which allows to structure the information and to reveal the interrelations.

A. The intensity indicators

If there is some information on the number of the research projects in the register and on the number of research projects, that have been rejected, it is possible to reveal the reliability of scientific research. The level of reliability (in percent) is calculated using the relative size of the structure. It is important to study it in dynamics due to its relative insignificance. The greatest reliability is observed at the initial stage of reports when the quantity of the rejected research projects is insignificant comparing with the high level of the registered research projects though the last factor makes a smaller impact on the reliability; it characterizes a saturation of branch more likely and is a link between other indicators. Given standard distribution, decrease in the number of research projects should be reflected in an absolute decrease in the rejected research projects, however if reliability is continuously decreasing, the cause is the growth of the rejected research projects. It is possible to ascertain that during the given period the system is unstable, however the subsequent relative growth of the reliability of scientific research shows the spent efforts on the quality increase. Hence, the given technique is necessary to adhere.

On the basis of data comparison on financing volumes, including financing from the state budget, it is possible to reveal a share of the state budget financing for scientific research. The given indicator can be calculated according to the equation (2). For the analysis of this indicator it is necessary to compare it to a budget share in financing of scientific researches throughout the country. It is necessary to evaluate the attraction of financing sources.

Also it is possible to express the intensity of the scientific sector and the ministry using the indicator of the relative size of the structure which characterizes the share of the registered research projects, belonging to the particular scientific sector or the ministry in the given period. Comparison of the dynamics of growth indexes of the whole amount of registered research projects and the number of research projects in a certain sector allows revealing the most developing segment.

The greatest interest represents the intensity of research and finances in priority directions which can be expressed by the relative size of structure. At the last stage of research in one priority direction and a choice of others, considerable dynamics of the intensity of research in priority directions is characteristic.

B. Comparison indicators

Comparison indicators characterize the level of a deviation from a preset value. For estimation of the information the most rational is the choice of an average value.

Further it is possible to calculate a number of average indicators describing the innovating potential using the equation (1):

- Average financing volume of a research project;
- Average number of research projects elaborated by one organization (executor);
- Average number of the research projects received by one organization (customer);
- Average size of performance intensity of versatile research as the organization-executor pays off to similar previous indicators;
- Average value of the research financed by state budget means.

The current research focuses on deviations of private financing from average value.

C. Grouping indicators

Grouping indicators allow structuring the data in various samples and calculating intensity of their presence. In table 1 the sample of research projects, executors and customers financed by the means of the state budget is presented.

TABLE 1

THE INTENSITY OF FINANCING THE RESEARCH PROJECTS, CUSTOMERS AND EXECUTORS BY STATE BUDGET MEANS

Covering size	Quantity			Intensity of a sample		
	Re-search	Execu-tor	Custo-mer	Re-search	Execu tor	Custo-mer
0	168	56	80	4,4	4,7	6,2
Less than average	967	258	567	25,5	22,1	44,0
Less than 100	2626	841	635	69,4	72,1	49,2
100	25	12	8	0,7	1,1	0,6
Total	3786	1167	1290	100	100	100

Calculation of the level of suitability of executors and customers to perform the research as the ratio of the number of versatile research projects made by an organization to average number of research projects carried out by executor and the customer on different bases can be done at the next step. The communication with other elements of model of interrelation passes through such parameter as the number of research projects.

Proceeding from average financing of one research project, it is possible to define the relative size of coordination of financing per research project under the equation (3). Then it is possible to group research projects and their financing on the basis of rates of increase (table 2).

TABLE 2

THE INTENSITY OF FINANCING AND THE EXECUTING RESEARCH ON THE BASIS OF A DEVIATION FROM AVERAGE FINANCING VOLUME

Relative size of coordination of financing per research project	The relative density, corresponding to a sample	
	Research project	Financing volume
Less than 1	0,57	0,26
1 up to 2	0,34	0,49
2 up to 3	0,04	0,11
More than 3	0,04	0,14
Total	1	1

According to a government program of innovative development a number of priority directions of scientific and technical development is allocated. It is useful to group them in various samples. If we choose average financing per research project as a criterion, it is obviously possible to group research projects in the following directions:

– intensively stimulated (financing per research project above average in priority directions);
– intensity of stimulation above an average in the given period;
– branches which are not the capable to involve financing.

It is interesting to compare the given grouping during the various accounting periods (figure 1 and 2).

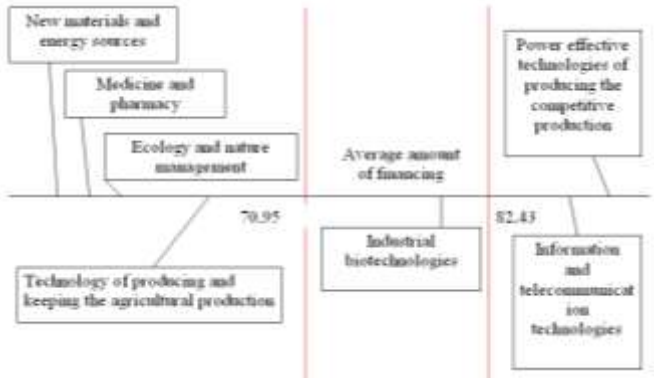

Fig.1. Distribution of priority directions by intensity of branch's stimulation in 2006

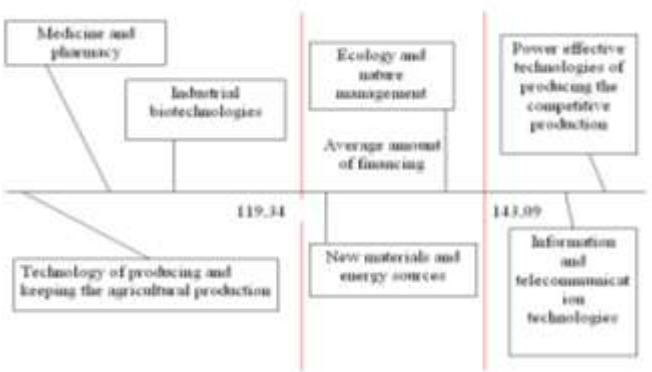

Fig.2. Distribution of priority directions by intensity of branch's stimulation in 2008

D. Efficiency indicators

Commercial implementation of scientific research begins at the moment of income inflow from selling an innovation. Annual effect from innovation should be planned so that it could be possible to predict it's effectiveness.

$$E = \sum Ea \cdot T, \tag{10}$$

Ea— annual effect from introduction of innovations;
T — planned term of innovation operation.

To define profitability of innovations:

$$R_i = \frac{E}{I} \cdot 100\%, \tag{11}$$

I — amount of investing in innovation.

It is necessary to compare a share of executors and a financing share. The number of accomplished research projects by resources shows what number of executors has a particular share of total financing.

If we can assume that financing volume is equivalent to the number of executed research projects it is possible to find the factor of business activity as the relation of financing volume to the number of executors (for various areas).

If we obtain the data about the labor used in research and compare it to available number of scientific and technical workers by branches, it is possible to find the most perspective branches.

Figure 3presents the schematic interrelations of indicators on scientific research. The summary information on indicators of the estimation of innovative potential is described in table 3.

TABLE 3

SUMMARY INFORMATION ON INDICATORS OF THE ESTIMATION OF INNOVATIVE POTENTIAL

Initial data		Total indicator	The settlement formula	Application possibility
Number of registered research projects (Q)	Rejected by advisory councils (O)	Reliability of scientific research	$100\% \cdot (1 - \frac{O}{Q})$	The dynamics of this indicator characterizes the balance of system
Financing volume (F)	Financing from state budget means (S)	Share of financing by state budget means (CS)	$\frac{S}{F} \cdot 100\%$	The analysis of potential ability for system to work independently
Share of financing by state budget means in each reference group (CSi)	Number of studied groups (m)	Average share of state financing ($\overline{CS}$)	$\frac{\sum_{i=1}^{m} CS_i}{m}$	Comparison of the general Cs with its average level allows to reveal potential of the system to increase the size of the group, attracting alternative sources of financing
Number of research projects with certain share of state financing (Qs)	Number of registered research projects (Q)	Intensity of state financing per research project	$\frac{\sum Q_s}{Q}$	To reveal laws of branch development , a part of state share in financing
Number of the executors who are elaborating scientific research in spheres with certain share of state financing (Ec)	Number of the executors occupied in various spheres (Es)	Intensity of state financing of executors by organizations	$\frac{\sum Ec}{Es}$	
Number of the customers working in spheres with certain level of state financing (Cc)	Number of the customers occupied in various spheres (Cp)	Intensity of state financing of customers	$\frac{\sum Cc}{Cp}$	
Volume of financing (F)	Number of research projects in the register (Q)	Volume of financing per research project (F1)	$\frac{F}{Q}$	Possibility of revealing the spheres with the best conditions for performance and placing of orders
Volume of financing in priority directions (Fp)	Number of research projects in priority directions in the register (Q_p)	Volume of financing per research project in priority directions (F_{n1})	$\frac{F_p}{Q_p}$	Possibility of revealing the spheres with the best conditions for performance and placing of orders in priority directions
The number of executors in certain branch (Ep)	The number of customers in certain branch (C)	Suitability level of executors and customers	$\frac{E}{Ep}; \frac{C}{Cp}$	Estimation of the level of specialization and coordination
Tonal number of executors (E)	Total number of customers			
Number of research projects in certain branch (Q_i)	Volume of financing in branch (F_i)	Relative size of coordination of financing per research project	$\frac{F_i \cdot Q}{Q_i \cdot F}$	Development intensity
Number of research projects in certain priority branch (Q1, Q2)	Total number of priority directions (n)	Appeal of priority directions	$\overline{A} = \sqrt[n]{Q_1 \cdot Q_2 \cdots Q_n}$	Appeal level of research in priority directions
Volume of financing per research project in priority directions (F_{p1})	Volume of financing per research project (F_1)	Level of financing of the priority research	$\frac{F_{p1}}{F_1}$	Financial level of research

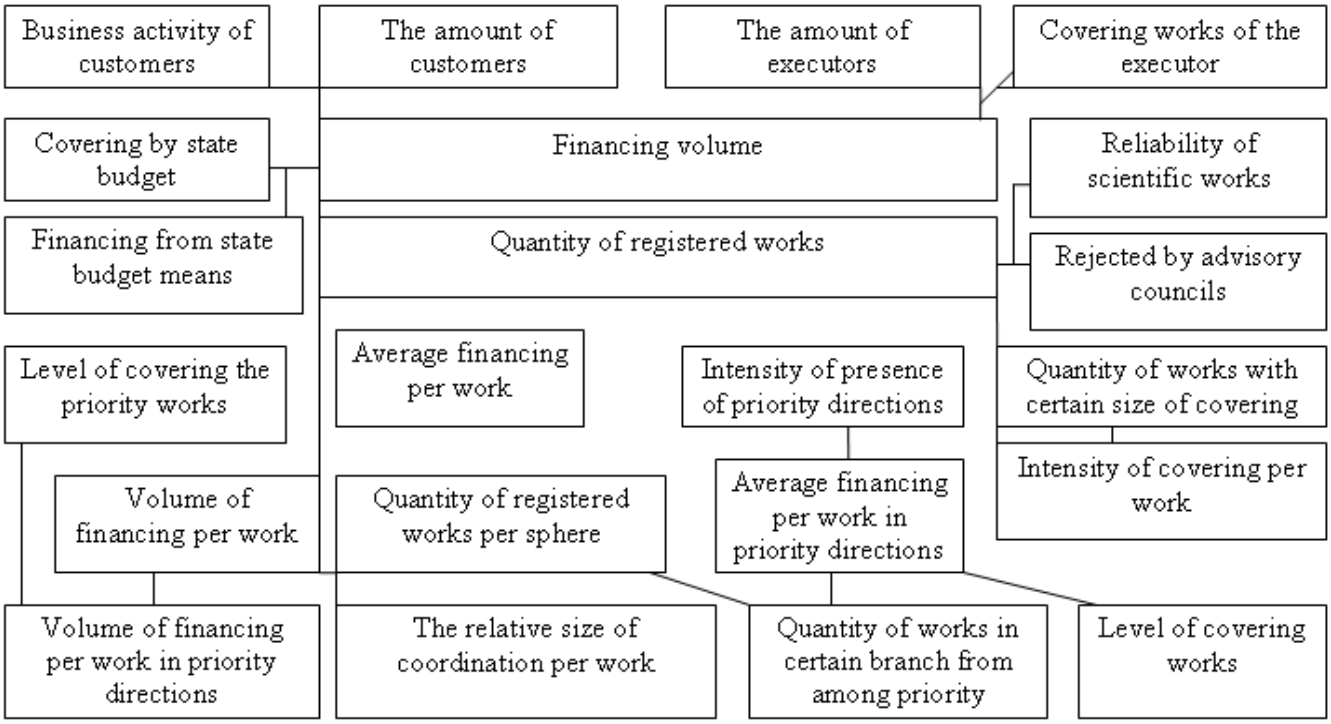

Fig.3. The model of indicators' interrelation concerning scientific research

The accurate interrelation of indicators is traced. Dynamics of initial levels influences changes of indicators on system as a whole. This law of system development is traced by means of an indicator of reliability of scientific research. Reliability of scientific research is a function of the number of the registered research projects and research projects rejected by advisory council. Improvement of this indicator should be correlated with the increase of dependent variables.

Qualitative growth of innovative elaborations can be quantitatively expressed through the number of research projects registered in the register which in turn is a function of total number of inventors and the economic support allocated to elaborations.

IV. CONCLUSIONS

The analysis of the system of indicators as a base for evaluation of research while forming state register was carried out. Elaboration of the model of interrelations of indicators was the aim of the described research. The purpose of the described research was to elaborate the model of interrelation of estimated indicators of researches register's innovative potential. Statistical methods of estimating the information resources have been studied. The methodological model of evaluation of the sample of research projects registered in the state register was generated.

The received results of research can be used for development of the measures for improvement of the regulation of scientific, technical and innovative activity in the context of formation and operation of the register of scientific research. The task is solved by the application of economic-statistical methods. Improvement of chosen indicator should be correlated with the dynamics of increase rates of dependent variables.

At the last stage of the Government innovative development program the increase rates of reliability should correspond to the increase rates of the registered research projects. Qualitative growth of innovative activity can be expressed quantitatively through the number of research projects registered in the register as they are the function of total number of inventors and the economic support rendered to research. Using the data about the planned volume of financing and the number of executors, it is possible to predict the rate of qualitative growth. Comparing the tendencies in financing volumes of research in priority directions and of all other research projects allows revealing the factors influencing the efficiency of the system.

Evaluation of research project's productivity has multidimensional character. It constrains descriptions of created scientific and technical product's benefits and advantages. Therefore the basic direction of improvement of the given evaluation model is creating and using new tables for quantitative analysis, which conforms to modern criteria and other parameters of the research projects.

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Irina Bariseviča. Pētījumu inovatīvā potenciāla indikatoru mijiedarbības novērtējums
Pētījuma mērķis bija izstrādāt inovatīvā potenciāla informācijas resursu rādītāju saistību novērtēšanas modeli. Pētījumu laikā tika izskatītas un atlasītas statistikās metodes, lai novērtētu informācijas resursus, kas reģistrēti valsts reģistrā, izstrādāts modelis dokumentu kopuma novērtēšanai. Lai uzlabotu zinātnes pārvaldības vadības sistēmu, izstrādāti rādītāji zinātnes un inovācijas potenciāla novērtēšanai, kas balstīti uz rādītāju sakarību izvērtēšanu. Šim nolūkam tika izmantotas ekonomiski statistikās metodes.
Iegūtos rezultātus var izmantot, lai attīstītu, uzlabotu un regulētu zinātnes, tehnoloģijas un inovāciju aktivitātes, veidojot un uzturot zinātnisko rakstu reģistru.
Jebkura sistēma tiecas sasniegt stabilitāti, bet progress nav iespējams bez dinamiskas attīstības. Šādas attīstības modelis tiek pārraudzīts ar ticamību rādītāju sistēmas palīdzību. Rezultāti būtu jāsalīdzina ar izaugsmes saistīto rādītāju pieaugumu. Pēdējā posmā valsts inovatīvās attīstības programmas ticamības rādītāju pieauguma tempiem jāatbilst reģistrēto zinātnisko darbu pieauguma tempiem.
Kvalitatīvs inovatīvo izstrāžu palielinājums var būt kvantitatīvi izteikts ar reģistrēto dokumentu skaitu reģistrā, kas savukārt ir funkcija no kopējā izgudrojumu skaita un to ekonomiskajam atbalstam. Ja dati par plānoto finanšu līdzekļu apjomu un izpildītāju skaitu, ir iespējams prognozēt kvalitatīvo izaugsmi.
Salīdzinot tendences par prioritāro darba finansējumu un pārējo var identificēt faktorus, kas ietekmē sistēmas efektivitāti. Novirzi no vidējā finansējuma avr izmantot, lai grupētu darbus stimulēšanas secībā.

Ирина Барисевич. Взаимосвязи показателей оценки информационных ресурсов по инновационным разработкам
Целью описанного исследования была разработка модели взаимосвязей показателей оценки информационных ресурсов по инновационным разработкам. В ходе его проведения были изучены и подобраны статистические методы оценки информационных ресурсов, сформирована методологическая модель оценки совокупности работ, зарегистрированных в государственном реестре. С целью совершенствования системы управления научными разработками была разработана система показателей оценки научного и инновационного потенциала данных работ, основанная на выявлении взаимосвязей показателей. Поставленная задача решена путем применения экономико-статистических методов.
Полученные результаты исследования могут быть использованы при дальнейшей разработке мер по совершенствованию регулирования научной, научно-технической и инновационной деятельности в контексте формирования и ведения реестра научных работ.
Любая система стремится к стабильности, однако прогресс невозможен без динамического развития. Эта закономерность развития системы отслеживается с помощью показателя достоверности. Улучшение этого показателя должно быть соотнесено с динамикой темпов роста зависимых переменных. На завершающем этапе Государственной программы инновационного развития темпы роста достоверности соответствуют темпам роста зарегистрированных работ.
Качественный рост инновационных разработок количественно может быть выражен через количество работ, зарегистрированных в реестре, которые в свою очередь являются функцией общего числа изобретателей и экономической поддержки, оказываемой разработке. Имея данные о планируем объеме финансирования и числе исполнителей, можно предсказать прогнозный темп качественного роста.
Сравнение тенденций относительно объемов финансирования по приоритетным работам и остальным позволяет выявить факторы, влияющие на эффективность функционирования системы. Использование отклонения от среднего финансирования работы, позволяет сгруппировать все работы по уровню поощрения.