

## **COMPETITIVE FINANCING OF SCIENTIFIC ACTIVITY: ASSESSMENT BY RESULT**

**Svetlana Panikarova – Maxim Vlasov**

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### **Abstract**

The aim of this research is to formulate the quantitative evaluation system of competition – based research financing efficacy. As a result of conducted research authors present their approach to evaluating competition – based financing by means of a quantitative evaluation of fundamental research for different areas of knowledge and different competitions. Academic efficacy index is introduced that demonstrates the dynamics of changes in knowledge generation level depending on changes in financing for one monetary unit. Authors demonstrate the direct proportional dependence between the number of published articles on fundamental research results and the amount of competition – based financing for fundamental research programs for all types of competitions which demonstrates the high significance of competition – based financing for the effective development of science. Authors provide empirical evidence of the fact that the stronger correlation dependence between financing dynamics and the number of published papers within the project is, the higher academic research efficacy index is. Therefore, the increase of competition-based financing for research allows for increasing publication activities of the researchers.

**Key words:** knowledge generation, academic efficacy, evaluation system

**JEL Code:** O31, O32

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### **Introduction**

Speedy development of knowledge – based economy predefines theoretical and practical interest towards the topic of competitive – based financing for research predetermined both by the need for developing theoretical apparatus for evaluating knowledge generation processes and the practical need for forming applied methods of conducting competition procedures in the field of publishing activities financing.

At the same time, there is a considerable number of works devoted to the topic of competitive – based financing for fundamental research in Russian and foreign academic literature.

Apparently, it is related to the seemingly evident causal relation between financing and results. However such causal relations have different proportion coefficients in different fields of knowledge depending on the terms of competitions.

The competitive system performs two main functions: firstly it is an instrument for selecting perspective topics by means of qualified academic expertise; secondly it provides quality monitoring for conducted research as it is necessary to consider the performance level and publications output of the previous project before providing financing for the next one. At the same time today there are no quantitative methods of evaluating competition – based financing efficacy using quantitative academic performance indicators.

Therefore the aim of this research is to formulate a methodical approach to the quantitative evaluation of competitive – based fundamental research financing in different knowledge areas considering different tasks of competitions.

## **1. Problem statement**

Competition – based research financing is one of the necessary elements of knowledge - based economy functioning as targeted knowledge generation happens in competition – based environment. Only new knowledge can act as the basis for innovation activities development.

Quantitative evaluation of real products of knowledge – based economy is a top – priority theoretical and applied task.

Analysis, generalization and critical understanding of the practice of forming and implementing academic policy including competition – based financing is presented in the research by L.M. Grokhberg and his co-authors. Yet it is of a descriptive nature and does not offer any quantitative methods of evaluating research work efficacy results and competition – based financing efficacy (Grohberg at all, 2011).

JL Rosenbloom and DK Ginther documented the quantitative and qualitative effects of federal funding of social science research, both to illustrate the complex ways in which R&D funding can advance scientific understanding and identify the challenges that such problem-driven social science research may encounter (Rosenbloom&Ginther, 2016).

P.Pisar and M. Sipikal analyzed the performance-based funding and proved the fact that this system has resulted in an increase in publication performance, but at the same time in a higher orientation on quantity instead of quality with several new negative effects (Pisar &Sipikal, 2017).

In his article Komkov N.I. et al mentions that despite a relatively short period (about 20 years) creation of organizational support of innovation projects competition technologies has a positive influence on the development of innovations in the Russian Federation. Not offering any quantitative methods these authors believe that existing mechanisms should be permanently perfected and their transparency and reporting in terms of costs efficacy should be supported by the publication of the best projects in several collections (Komkov et al, 2012).

The work by Fedotov A.V. and Vasetskaya N.E. demonstrates that such publication activities indicators as the number of publications and citations index are important for evaluating research activities efficacy of research organizations. They analyze the correlation between publishing activity results and amount of financing allocated for research and development. Academic research financing mechanisms are viewed as factors influencing publication activities of Russian researchers (Fedotov, 2013).

Descriptive statistics and regression analysis showed that various forms of research funding have a significant effect on their research performance. The results of this study also showed that the attributes of academic researchers, such as gender, age, where their Ph.D. was completed, and major, have an influence on their research performance (Doh et al, 2017).

Research by Borisov V.V. analyzes three main mechanisms of initiative research projects financing: basic financing for state research institutions, competition – based financing in the form of state research fund grants and competition - based financing within the framework of state order. As a result of evaluating results of competitions announced within the framework of federal; target programs author identifies weak points of financing projects on state order (Borisov, 2011).

While the presence of funding acknowledgments may serve as an indicator of quality to some extent, C. Mejia and Y. Kajikawa evaluated whether funding agencies allocate resources to a novel and innovative research rather than mature fields. They found that the incremental and matured research areas show the highest counts of funding acknowledgments (Mejia&Kajikawa, 2017).

R. Whitley, J. Glaser, G. Laudel found that the increased number of actors exercising authority over research goals does not necessarily lead to a greater diversity of interests funding research. A narrowing of goals and frameworks is especially probable when the increasing importance of external project funding is combined with reductions in state financing of universities and public research institutes. The growing standardization of project cycle times and resource packages across funding agencies and scientific communities make it more difficult

for researchers to pursue projects that deviate from these norms, especially, if they challenge mainstream beliefs and assessment criteria (Whitley et al, 2018).

The problems related to the development of competition – based financing of fundamental international research using the example of pilot Russian – American competition for academic projects are evaluated in the work by Koulchin Y.N. and Shtetz M.B. The authors define the procedure for conducting the competition, priority topics for competition chapters and look into the process of application materials formalization and expertize (Kulchin&Shtets, 2011). Providing justification for competition – based financing Y.N. Koulchin and M.B. Shtetz believe that implementation of competitions- based financing system for fundamental research will facilitate upgrading the level of personnel qualification, creation of competitive environment in academic society, broadening and deepening of fundamental knowledge in priority areas, stimulation of new knowledge generation, upgrading economic efficacy of academic research as well as integration of fundamental science into international community (Kulchin&Shtets, 2011).

Importance of academic expertize is analyzed in the research by Yudin B.G. The author mentions that the expertize which is conducted systematically on the yearly basis by the respected academic community representatives allows for identifying and analyzing overall results of many expert evaluations conducted by them (Yudin, 2007).

A. Scandura investigated the impact of publicly funded university-industry collaboration on UK firms' R&D effort. The results show a positive and significant impact on the share of R&D employment two years after the end of projects (Scandura, 2016).

K. Aagaard and JW. Schneider examined the effects of changes in selected funding factors based on the notion that funding plays a decisive role in defining the scope, content, and direction of public research (Aagaard&Schneider, 2015).

Alongside with that complex aspect of quantitative evaluation of competition based financing deal with defining academic research efficacy determinants (Jacob&Lamari, 2012) and formulation of research financing mechanisms using target capital resources (Kotov, 2013).

Therefore despite the existence of academic research devoted to the analysis of research competition based financing modern economic science has no materials concerning the quantitative and dynamic evaluation of research competition – based financing efficacy.

For quantitative evaluation of research competition – based financing efficacy authors suggest introducing Science Result Index (ScRI), which shows changes of new knowledge generation depending on financing changes per one monetary unit.

Therefore ScRI can be calculated using the following formula:

$$ScRI = dK/dF$$

where:

ScRI – Science Result Index

dK – increase/decrease of new knowledge generation

dF – changes in academic activities financing.

## 2. Empiric research procedure

Authors analyzed report data for fundamental research for 2010-2013 at research institutions of one of the regional branches of the Russian Academy of sciences that received financing on a competitive basis.

In order to ensure comparability of obtained data authors conducted norm regulation for financing amount and number of published articles in terms of the overall financing and number of articles in each academic field respectively.

As a result, the authors obtained a data pool in the form of relative shares of financing and publication activities (in the form of overall number of published articles) in a total data amount.

Analyzed data included the scope of financing from different fundamental research competitions in different academic areas as an independent variable and the number of articles published as a result of research performed within the framework of different competition-based projects as a dependent variable.

Working hypotheses for empirical research were formed on the basis of previous research by the authors and data pool available for analysis.

The first two hypotheses are quite obvious and set the interrelation between the number of published articles and financing received for initial projects.

Hypothesis 1: Publication activity is directly related to the spread of financing according to the competition between RAS research programs.

Hypothesis 2: Publication activity is directly related to the spread of financing on the basis of initiative projects competition.

The research programs include projects performed according to given academic areas or tasks. The difference between the firsts and the second hypothesis is in the evaluation of publication activities of those projects academic tasks of which were determined by the project authors themselves.

The third hypothesis can also be deemed obvious yet its quantitative content is not trivial.

Hypothesis 3: The speed of publication activities growth according to the results of fundamental research is different depending on different sources of financing. One can suggest that the speed of publications growth is related to the novelty of tasks solved.

The third hypothesis is related to the fact that the research tasks in different competitions can be different: from solving traditional tasks in given research programs to conducting initiative research.

### 3. Obtained results and their discussion

In order to check the first hypothesis authors compared the shares of published academic papers on the given fundamental research projects and their share in the overall amount of relevant competition financing (Table 1).

**Table 1. Dependence of publishing activities on financing on given fundamental research competition – based programs**

Types of programs indicators	Programs of RAS Presidium		Programs of RAS academic areas	
	Share of financing, %	Share of published articles, %	Share of financing, %	Share of published articles, %
Research areas				
Mathematics	14,9	22,1	25,8	24,6
Physics	26,3	22,2	30,4	24,7
Chemistry	14,9	11,5	23,2	23,9
Biology	21,2	22,7	3,6	3,7
Earth Sciences	13,8	15,3	13,7	17,9
Economics	3,1	2,0	-	-
Humanities	2,8	4,2	3,3	4,2
Correlation coefficient	0,91		0,96	

Source: own elaboration

The data given in Table 1 demonstrates a solid proof of the first hypothesis on direct dependence between the share of published articles based on fundamental research and the share of obtained competition – based financing for the given research programs.

The certain decrease of couple correlation coefficient in the identified dependencies for RAS Presidium program competition can probably be explained by a higher degree of risk of solving research tasks stated by the Presidium. One can think that EAS Presidium programs have tasks more related to search than those at field branches.

In order to check the second hypothesis, the authors compared the shares of published articles resulting from fundamental research and the share of their financing in an overall financing of initiative academic projects competitions. (Table 2).

**Table 2. Interdependence between publication activities and competition – based financing from initiative projects**

Academic areas	Share of financing,%	Share of published articles, %
Mathematics	6,6	4,7
Physics	30,4	24,4
Chemistry	7,0	9,7
Biology	23,3	18,7
Earth Sciences	29,2	36,0
Economics	2,3	2,8
Humanities	1,2	3,7
Correlation Coefficient	0,94	

Source: own elaboration

The data presented in Table 2 clearly demonstrate the justifiability of the second hypothesis on the direct proportional interdependence between the share of published articles resulting from fundamental research and the spread of financing according to initiative project competition.

In order to verify the third hypothesis, the authors made the graphical illustration of the dependence between publication activities and the share of financing for the competitions for the given research programs - RAS Presidium competition (Fig.1), programs of RAS topical branches (Fig. 2), initiative projects competition (Fig. 3).

Analysis of the given graphs demonstrates the justifiability of the third hypothesis on the different speed of publication activities growth resulting from fundamental research depending on financing according to different competitions.

The lowest speed of publication activities is seen at the competition – based projects within RAS Presidium programs ( $dN/dK = 0,906$ ), and the highest – at projects related to RAS topical branches programs ( $dN/dK = 1,092$ ). Publication activities in performing initiative projects are an intermediate position between two previously described cases ( $dN/dK = 0,956$ ).

It seems that such a result can be explained by a greater risk of obtaining positive results in solving the tasks of RAS Presidium. Longer time for model preparation and experiments leads to less time for preparing academic publications.

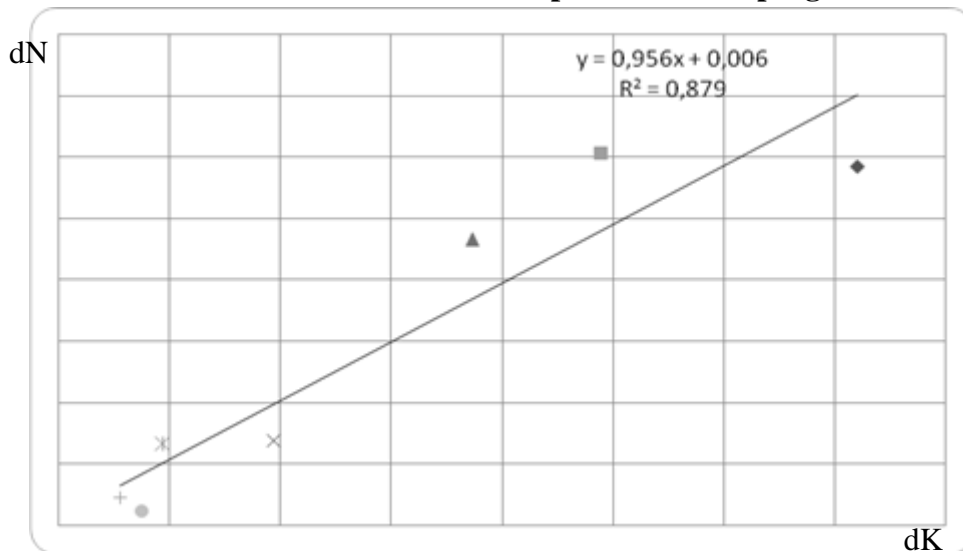
One must mention that the conclusion on higher “volatility” of fundamental results of RAS Presidium competition programs coincides with the conclusions on the greater spread of data on competitions received during the verification of the first hypothesis.

**Fig. 1: Dependence of published articles dN on the share of financing dK for research institutions from different areas within RAS Presidium programs**



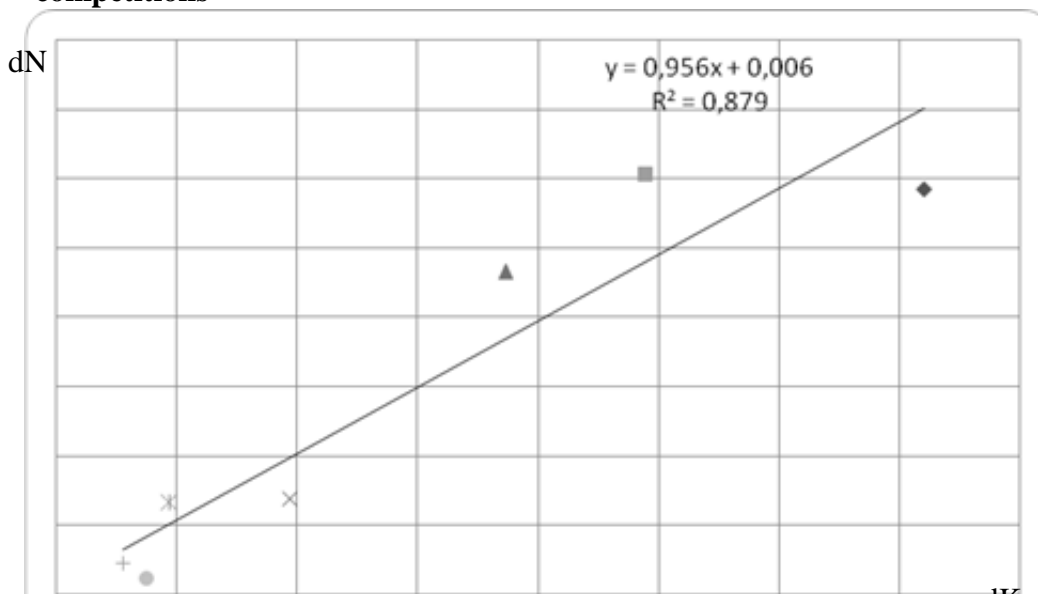
Source: own elaboration

**Fig. 2: Dependence of published articles dN on the share of financing dK for institutions from different academic areas for RAS topical branches programs.**



Source: own elaboration

**Fig. 3: Interdependence between the share of published articles dN on the share of financing dK for institutions in different areas of science according to the initial project competitions**





Source: own elaboration

## Conclusions

As a result of conducted theoretical and practical research, the following conclusions can be made.

First of all, we have empirically proven the hypothesis on direct proportional dependence between publication activities and the spread of competition – based financing for RAS target research programs. Therefore the increase of competitive financing for target research programs allows for strengthening publication activities of the researcher.

Secondly, we have empirically proven the hypothesis on direct proportional dependence between publication activities and the spread of competition – based financing for initiative projects. It means that increasing financing for initiative projects competitions leads to growing publication activities of the researchers.

Thirdly, it has been defined that the speed of publication activity growth according to the results of fundamental research differs according to different competition financing. The speed of publication activity growth decreases depending on higher “risk” of solving academic tasks.

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**Contact**

Svetlana Panikarova

Ural Federal University named after the first President of Russia B.N.Yeltsin

620002, 19 Mira street, Ekaterinburg, Russia

Institute of economics, the Ural branch of Russian Academy of Sciences

620014, 29 Moskovskay street, Ekaterinburg, Russia

Panikarova\_s@mail.ru

Maxim Vlasov

Ural Federal University named after the first President of Russia B.N.Yeltsin

620002, 19 Mira street, Ekaterinburg, Russia

Institute of economics, the Ural branch of Russian Academy of Sciences

620014, 29 Moskovskay street, Ekaterinburg, Russia

MVlassov@mail.ru