ASSESSING THE EFFECTIVENESS OF PUBLIC INVESTMENT IN RESEARCH AND DEVELOPMENT BY FEDERAL EXECUTIVE BODIES IN RUSSIA

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A b s t r a c t

The purpose of this study is to develop an instrument to measure the effectiveness of public investment in R&D and make timely adjustments to scientific and technical policy. This will contribute to the growth of fundamental results, patents as well as their commercialization and innovative development for the overall economy. This article assesses the effectiveness of public investment in research and technological development (RTD), including attracted extra-budgetary funds, on the basis of the authors' methodology for assessing the efficiency of public spending on RTD projects. The main distributors of state budget funds in Russia are the Federal Executive Bodies (FEB). The proposed tool first allows the evaluation of the effectiveness of public expenditure on RTD in general, although it does not involve comparing individual FEB administrations, but only evaluates their work in promoting the development of their assigned research areas in terms of dynamics. This method sets the general rules for an evaluation of effectiveness in the state financial support of RTD, defines the key indicators reflecting the performance of such support and the use of science as a tool for ensuring the achievement of indicators and the socio-economic development of the state.

OCENA EFEKTYWNOŚCI INWESTYCJI PUBLICZNYCH W OBSZARZE BADAŃ I ROZWOJU FEDERALNYCH ORGANÓW WŁADZY WYKONAWCZEJ W ROSJI

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S ł o w a k l u c z o w e: inwestycje publiczne, federalne organy władzy wykonawczej, badania i rozwój technologiczny.

A b s t r a k t

Celem badań jest opracowanie narzędzia do oceny efektywności inwestycji publicznych w sferze badań i rozwoju oraz w zakresie polityki badań naukowo-technologicznych. Ma się to przyczynić do rozwoju badań podstawowych, patentów, a także ich komercjalizacji oraz rozwoju innowacyjności całej gospodarki. W artykule oceniono efektywność inwestycji publicznych w branży badań naukowych i rozwoju technologicznego (BRT), w tym pozyskanych środków pozabudżetowych. Ocenę przeprowadzono autorską metodą oceny efektywności wydatków publicznych na BRT. Głównym ośrodkiem rozdzielania środków budżetowych w Rosji są federalne organy władzy wykonawczej (FEB). Oferowane narzędzie pozwala ocenić efektywność całkowitych wydatków publicznych na badania i rozwój, chociaż nie porównuje poszczególnych instytucji federalnych organów wykonawczych, tylko ocenia ich pracę na rzecz rozwoju powierzonych kierunków badań. Metoda ta określa ogólne zasady oceny efektywności rządowego wsparcia finansowego na BRT. Definiuje główne wskaźniki odzwierciedlające skuteczność takiego wsparcia i wykorzystania nauki jako narzędzia gwarantującego osiągnięcie rozwoju społeczno-gospodarczego kraju.

Introduction

Assessing the effectiveness of public RTD spending is a necessary element of public administration to ensure technological transition by creating a critical mass of new technologies, as well as technologies that may remove the dependence on imports of industrial technology by Russia, which is unparalleled in the world. The developed methodology defines a unified approach to effectiveness monitoring of the state allocators of budget funds, which is aimed at the development of an active innovation economy. This would enable the transition to more effective models of RTD investment management (ILYINA 2015). In addition, the methodology identifies key indicators and a procedure for state financial support effectiveness evaluation in relation to research, developmental and technological works and the use of RTD project results to ensure sustainable development of the economy (SHASH, BORODIN 2015).

The indicators used to assess the efficiency of public spending on RTD are typical for all government programs in terms of RTD support. These indicators need to be converted to a single system of measurement by calculating the ratio of their values for the current period with regards to the previous period.

$$S_i' = \frac{S_i^T}{S_i^{T-1}} \tag{1}$$

where:
S_i^T is the value of the corresponding indicator in the assessment year;
S_i^{T-1} is the value of the corresponding indicator in the previous year or planned value.

The next step is the calculation of the ratio of budgetary to extra-budgetary funds.

$$R' = \frac{R^T}{R} \tag{2}$$

where:
R – the amount of budgetary funds raised to finance research;
R^T – the amount of extra-budgetary funds raised to finance research.

The calculation of the change in RTD financing indicators is made by calculating the relationship values of all funding in the current year to the corresponding value in funding during the previous period, defined by using correlation analysis.

The change in RTD funding in general (F') is calculated as the ratio of the volume of RTD project funding in the current year (F^T) to appropriate funding in the previous period ($F_j^{T-1}F^{T-1}$).

$$F' = \frac{F^T}{F^{T-1}} \tag{3}$$

Then the total ratio of productivity growth with regards to extra budgetary resources of public expenditure on RTD (P) is calculated.

$$P = \frac{\sqrt[32]{(\Pi_{i=1}^{31} S_i') \cdot R'}}{F'} \tag{4}$$

If *P*>1, then the activities of the FEB are effective, as the average rate of productivity growth is above the financing growth rate. If *P*<1, then the activities of the FEB are ineffective.

Assessing the effectiveness of public sector investment in RTD made by the FEB is done through an analysis of their activities over a certain period on the basis of several relative indicators. This is done because a comparison between FEB agencies is not valid due to the nature of their activities.

Openness and transparency of FEB activity in the Russian Federation are among the main indicators of their work in the implementation of established powers, as well as a necessary element for evaluating the effectiveness of public investment in R&D (ZHURAVLEVA 2011).

This article presents an analysis of the effectiveness of RTD funding from the ESF, in accordance with the data presented by the Federal system of monitoring the effectiveness of scientific organizations (FSMSO) implementation of research, development and engineering work in 2013 and 2014 (*Federal System...* 2016). FSMSO aggregates information on the activities of scientific organizations, including the financing of scientific research and the received results of intellectual activity. The analysis is based on data from 1013 organizations carrying out scientific activities that had posted reports in FSMSO during the analyzed period. The organizations selected were grouped according to departmental affiliation. On the basis of this grouping, 14 FEB (see Table 1) with the highest number of subordinated organizations (starting from three) were selected.

Table 1

The designation of the FEB studied in the research

Full Title	Abbreviated Title
The Ministry of Science and Education	Minobrnauki
The Ministry of Culture	Minculture
The Federal Biomedical Agency	FMBA
The Federal Service for Supervision of Consumer Rights Protection and Human Well-Being	Rospotrebnadzor
The Ministry of Industry and Trade of the Russian Federation	Minpromtorg
The Federal Service for Hydrometeorology and Environmental Monitoring of Russia	Roshydromet
The Federal Agency for subsoil use	Rosnedra
Ministry of Sports in Russia	Minsport
The Russian Federation Ministry of Agriculture	Minsel'khoz
The Federal Agency for fishery	Rosrybolovstvo
Federal Agency on Technical Regulation and Metrology	Rosstandart
The Ministry of Energy of the Russian Federation	Minenergo
The Roscosmos State Corporation for Space Activities	Roscosmos
The Ministry of Health of the Russian Federation	Minzdrav

Source: own elaboration.

Assessing the effectiveness of public RTD investment by the FEB is calculated on the basis of the developed technique of comparing the productivity growth rate and RTD funding. The efficiency of public investment in RTD must be assessed against the strategic target indicators. This assessment will allow prompt adjustment to the direction of expenditure, in order to achieve maximum cost-effectiveness (ILYINA, SERGEEVA 2015). Indicators of publication, patent and innovative activity are the main performance indicators of RTD financed by the FEB.

The total inventory of performance indicators used in assessing the efficiency of public RTD investment by the FEB, formed on the basis of the data from the unified state information accounting system of RTD (EGISU NIOKTR) and FSMSO, is presented in Table 2.

Table 2

The performance indicators used in assessing the efficiency of public R&D investment directed by the FEB

The Performance Indicators	No.
1	2
Publication activity	
Number of publications in Web of Science	1
Number of publications in Scopus	2
Number of publications in Russian Science Citation Index	3
Citation of publications indexed in the Russian science citation index	4
The number of publications in WoS and Scopus per each researcher	5
Patent activity	
The number of scientific, design and technological works	6
Number of RIA (results of intellectual activity) created	7
The amount of RIA taken into account in the state information systems	8
The number of RIA with state registration and (or) legal protection in Russia	9
The amount of RIA that have legal protection outside of Russia	10
The number of RIA used	11
The number of RIA used, confirmed by acts of use (implementation)	12
The number of RIA used, transferred under a license agreement	13
The number of RIA used, transferred by contract for alienation, including those submitted as collateral	14
The number of RIA used, made as a contribution to the authorized capital	15
Income from RIA use	16
The average net income for a single RIA	17
Small innovative enterprises	
The number of SIE created	18
The total average number of SIE employees	19
Comprehensive income from SIE	20

1	2
Scientific Personnel	
The number of scientific conferences with international participation	21
The percentage of young researchers (up to 39 years) in the total number of researchers	22
The percentage of postgraduates in the total number of students	23
The number of researchers working in leading Russian and international scientific and educational organizations	24
Scientific infrastructure	
The total cost of CCU (center for collective use)	25
The total cost of USI (unique scientific installations)	26
Financial and quantitative indicators of R&D	
Revenues from RTD	27
Income from scientific-technical services	28
The share of extra-budgetary funds in the total amount of funds received	29
The amount of fundamental research	30
The amount of applied research	31
The number of RTD works	32

Source: own elaboration.

The highest average growth rate of performance indicators of RTD presented in the context of the 20 indicators, including the number of RIA with legal protection abroad; the number of RIA used, confirmed by acts of use (introduction); the number of RIA used, given by contract for alienation, including those submitted as collateral; revenues from scientific and technical services, etc. (see Figure 1).

Indicators whose value is less than one, characterizes the decline in the effectiveness of RTD, and requires analysis of the factors influencing that decline, as well as the development of a number of measures aimed at creating favorable conditions for their growth. Reduced growth rates have been observed for 12 of the 32 indicators: the number of fundamental research, the share of extra-budgetary funds in the total amount of funds received, the percentage of graduate students in the total number of students, the number of the generated SIE etc.

Each FEB has an impact on the overall performance of the RTD sector within the framework of its activities. A comparative diagram demonstrating the average growth rate of RTD productivity, the FEB studied and RTD productivity growth rate of Minobrnauki, Minzdrav, Minpromtorg and Minsport is presented below (see Figure 2).
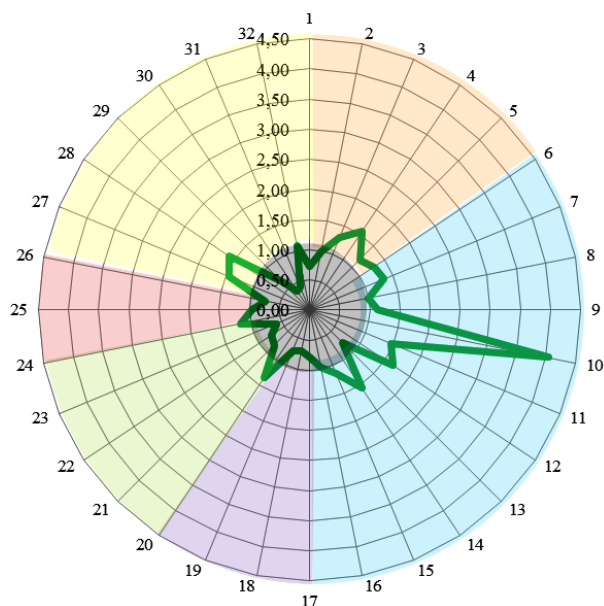
Fig. 1. The average growth rate of performance indicators of R&D by the FEB studied from 2014–2015

Source: own elaboration.

The value of the Minobrnauki effectiveness is above average for the 22 indicators which include total income of SIE, the number of publications in WoS and Scopus per each researcher, the number of RIA used, confirmed by acts of use (implementation), the share of extrabudgetary funds in the total amount of funds received etc.

Minzdrav shows values above the average for the 21 performance indicators including total income of SIE, the proportion of young researchers (up to 39 years of age) within the total number of researchers, the proportion of postgraduates in the total number of students, the total cost of center for collective use (CCU), the number of Web of Science publications etc.

Minpromtorg has values above the average for the 17 performance indicators, including the number of Scopus publications, citations of publications indexed in the Russian science citation index, the average net income for a single RIA, the percentage of young researchers (up to 39 years of age) within the total number of researchers, number of researchers working in leading Russian and international scientific and scientific-educational organizations, etc.

Minsport has values above average for the 12 performance indicators including the number of Scopus publications, income from RIA use, the
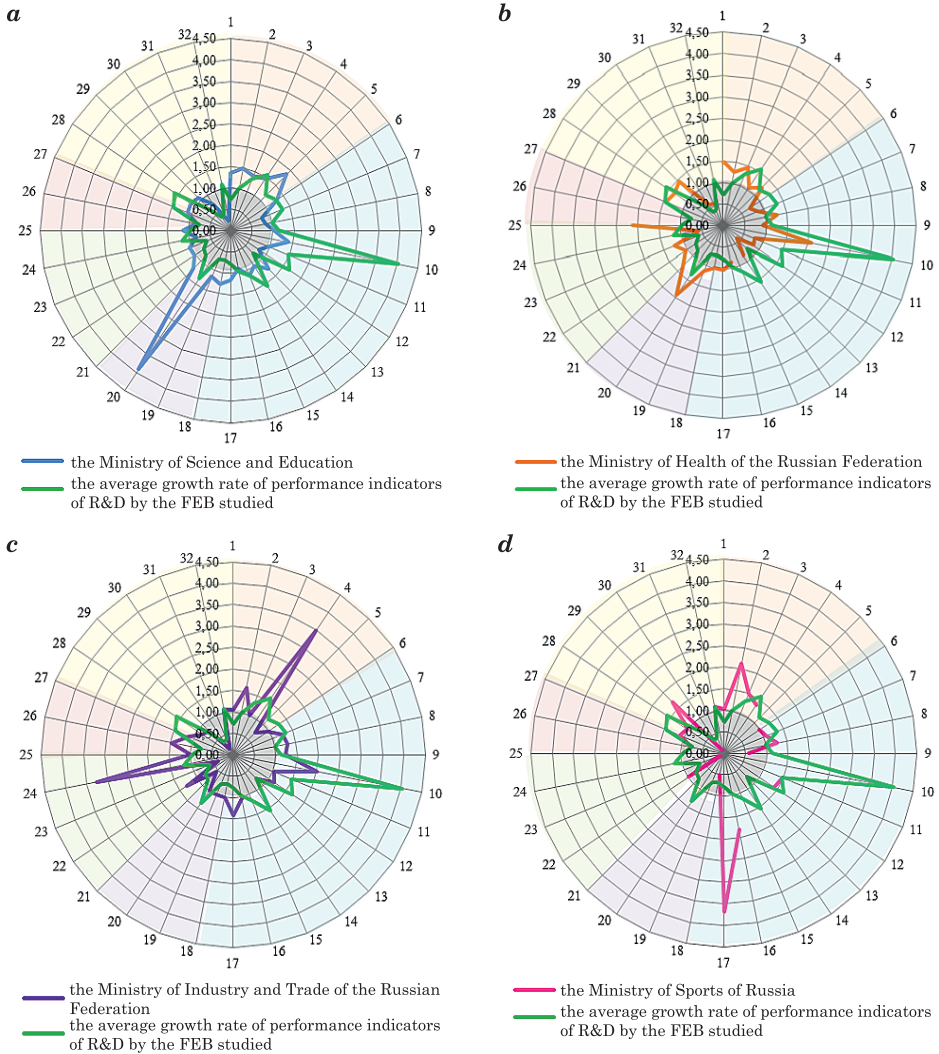
Fig. 2. A comparison of the average growth rate of productivity of the FEB studied with the rates of productivity growth for: *a* – Minobrnauki, *b* – Minzdrav, *c* – Minpromtorg, *d* – Minsport
Source: own elaboration.

average net income for a single RIA, the share of extra-budgetary funds within the total amount of funds received etc.

Thus, the greatest contribution to the increase of RIA productivity by the studied FEB is observed in such groups of indicators as scientific staff (Minzdrav, Minpromtorg); small innovative enterprises (Minzdrav, Minobrnauki); publication activity (Minpromtorg, Minobrnauki, Minsport);

research infrastructure (the Ministry of Trade and Industry); and patent activity (Minsport). It should be noted that the increase in the share of extra-budgetary resources also had a positive growth rate within Minobrnauki and Minsport.

For the purpose of testing the proposed methodology and the choice of the optimal lag between the RTD funding and its performance calculations of the funding growth rate from 2010 to 2013, the following research was carried out. The costs of applied and fundamental research directed from the Federal budget are presented in Table 3.

Table 3

Expenditure on applied and fundamental research directed from the Federal budget

FEB	Spending on basic and applied research from the Federal budget, thousand rubles				The growth rate of costs		
	2011	2012	2013	2014	2011–2012	2012–2013	2014–2015
The Ministry of Science and Education	39,309,302	47,861,088	33,639,825	31,365,887	1.218	0.703	0.932
Minculture	296,699.2	312,943.5	425,464.3	380,625.4	1.055	1.360	0.895
FMBA	976,269.5	1,348,104	2,248,812	1,496,599	1.381	1.668	0.666
Rospotrebnadzor	1,256,562	1,725,792	2,359,338	2,266,875	1.373	1.367	0.961
Minpromtorg	42,120,411	66,500,878	79,139,440	82,777,688	1.579	1.190	1.046
Roshydromet	1,309,349	1,598,911	1,579,735	1,635,279	1.221	0.988	1.035
Rosnedra	231,411.8	221,068.8	221,068.8	205,015.4	0.955	1.000	0.927
Minsport	264,599.9	496,735.3	349,820.4	326,681.5	1.877	0.704	0.934
Minsel'khoz	458,666.5	461,826.9	367,950	376,400.5	1.007	0.797	1.023
Rosrybolovstvo	3,854,646	3,641,847	3,558,568	3,563,665	0.945	0.977	1.001
Rosstandart	619,619.7	359,167.6	838,475.2	1,256,475	0.580	2.334	1.499
Minenergo	775,796	828,767.8	1,183,780	1,138,137	1.068	1.428	0.961
Roscosmos	50,838,512	57,846,270	72,749,480	87,763,809	1.138	1.258	1.206
Minzdrav	3,858,474	5,954,863	7251,925	24,179,764	1.543	1.218	3.334

Source: own elaboration.

In order to identify the correlation between funding and performance, an analysis of these indicators with a lag of 1, 2 and 3 years was carried out. The correlation coefficient between the average growth rate of productivity in 2015–2016 and the growth rate of consumption in 2012–2013 is 0.462, which illustrates a close positive relationship. For the growth rate of expenditure in 2011–2012, the correlation is -0.125, and the correlation for the growth rate of expenditure in 2013–2014 is 0.018. Due to the fact that the correlation coefficient between the average growth rate of productivity over the period

2013–2014 and the growth rate of public expenditures in 2012–2013 is at a maximum, there is correspondence with our hypothesis for the existence of a positive relationship between RTD funding and the growth of productivity, we can conclude that a lag of 2 years is optimal for evaluating the effectiveness of public expenditure on RTD conducted by the FEB. The results of the evaluation of public RTD expenditure effectiveness for the studied FEB are presented in Figure 3.
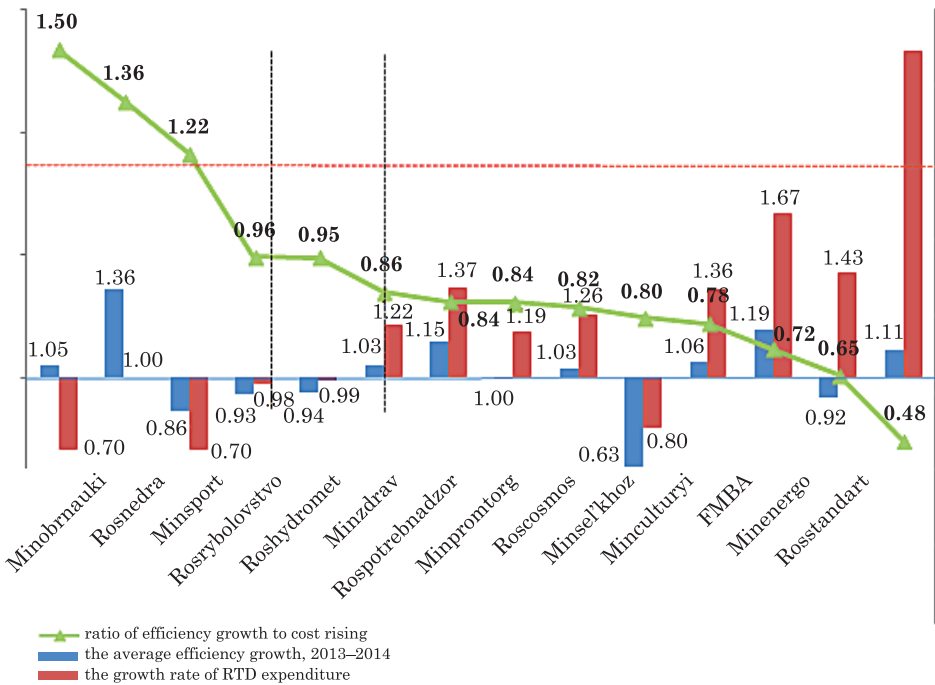

Fig. 3. Evaluation of public spending efficiency for the studied FEB
Source: own elaboration.

According to the results of the effectiveness evaluation for public RTD expenditures made by the studied FEB, we can draw the following conclusions:
   – the leaders are the FEB which have a ratio of productivity growth to RTD expenditure growth larger than one (Minobrnauki, Rosnedra, Minpsport);
   – the effective FEB are those whose ratio of productivity growth to the RTD expenditure growth is approximately equal to one (Rosrybolovstvo, Roshydromet);
   – the lagging entities (not effective) are those FEB whose ratio of productivity growth to RTD expenditure growth is less than one (Minzdrav, Rospotrebnadzor, Minpromtorg, Roscosmos, Minsel'khoz, Minculture, FMBA, Minenergo, Rosstandart).

The reduction of RTD expenditure in 2013 by 30% within Minobrnauki and Minsport (as compared to 2012) led to productivity growth within Minobrnauki by 5% in 2015, and reduced the efficiency of Minsport by 16% (less than the cost of RTD by 14%). In the absence of RTD expenditures, changes during the analyzed period showed an increase in performance of Rosnedra by up to 36%.

A direct impact on the efficiency of FEB was made by a significant growth of performance indicators for such groups as the publication activity and small innovative enterprises (Minobrnauki), the patent and publication activity (Minsport and Rosnedra), financial performance (in terms of increasing the share of extra-budgetary resources, Minobrnauki, Minsport, Rosnedra).

However, the Rosstandard's 2.3 time RTD expenditure increase led to an increase in productivity of only 11%, while Minenergo's performance decreased by 8% with a cost increase of 43%. Perhaps this is due to the implementation of long-term research projects. Analysis of this fact requires a more detailed study of FEB activities.

Summary

The main task of the FEB in the short term is to create a pool of technology ready for practical application. The effectiveness of R&D expenditure is directly dependent on the measures taken by the FEB as an investor / regulator to promote the introduction and use of technology. In the medium term, the FEB needs to focus on creating infrastructure for the development of new knowledge-based industries. In the long term, it should concentrate on the formation of a fundamental basis for the development of new industries, as well as the knowledge economy. By partially financing the cost of RTD, the government increases the attractiveness of the sector for business. Taking into account an advanced foreign experience and existing target indicators for the strategic development of the RTD sector, the following percentages of cost by the state and business is offered: in the short term it should aim for a 30% government participation and a 70% real sector participation; in the medium term it should aim for a 70% and 30% balance, respectively. For the long term, basic research funding should be carried out mainly by the state. The pursuit of such a ratio will provide an optimal effective interaction between the state and business in the development of an innovative economy. It is necessary to conduct periodic comprehensive assessments of the effectiveness of public RTD expenditure via the monitoring of the effectiveness of public incentives for RTD and innovation activities in order to work out timely management decisions. The results of the monitoring will allow observers to evaluate the

efficiency of public expenditure on RTD as a whole, to identify barriers to the planned development of the budget, and to determine the direction of activities that require additional stimulation in order to achieve the socio-economic goals and objectives of the state.

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