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Evaluation of the Effect of Primary Indicators of Technological Innovations on the Outcomes of Innovative Activity in Federal Subjects of the Far Eastern Federal District

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Abstract. The article throws light onto the issues of evaluation of the effect of primary indicators of innovative activity on its outcomes. The authors propose an adaptive method of evaluating the effect of primary indicators of technological innovations on the outcomes of innovative activity in the region based on literature analysis and own solutions. To do that, they performed a comparative analysis and evaluation of such indicators as the volume of innovative products, works, and services, expenditures connected with technological innovations, and the number of used state-of-the-art manufacturing technologies of federal subjects of the Far Eastern Federal District in 2015-2017.
To identify the effect of primary indicators of innovative activity on the release of innovative products, the authors calculated correlation interdependencies of indicators. Study results show that the level of correlation dependence is high or average in the Russian Federation in general and in most federal subjects of the Far Eastern Federal District (FEFD). This demonstrates the effect of primary indicators of technological innovations on the outcomes of innovative activity in federal subjects of the FEFD.

1. Introduction

Nowadays, as significance of the innovative process in the socioeconomic development of the society is universally understood, the issues of measuring outcomes of innovative activity, including issues of analysis and evaluation of the effect and interrelation of primary indicators of innovative activity on its outcomes have become quite *urgent*. That is why *the purpose* of this article was to develop a method to evaluate the effect of primary indicators of innovative activity on its outcomes.

Currently, there are numerous publications dedicated to the methodology and methods of evaluating innovative development of economic entities. According to I.M. Bortnik [1], the methodological foundation of the American and European evaluation systems may be used as a basis for the development of an innovativeness evaluation system for regions of the Russian Federation. A range of custom approaches to the issue of evaluation of the innovative development level of federal subjects is described in publications by Russian researchers [2-7].

Analysis of foreign [8-11] and Russian regional innovative development evaluation systems shows that there are two primary approaches based on the development of innovative development indices to

determine a region's position relative to other regions (rating system) and on methods of comparative analysis of a complex system of dynamic innovative indicators.

The authors propose an adaptive method of evaluating the effect of primary indicators of technological innovations on the outcomes of innovative activity in the region on the basis of literature analysis and own solutions. This method has some *scholarly importance* for the study of issues of evaluation of regional innovative development. To do that, they performed a comparative analysis and evaluation of such indicators as the volume of innovative products, works, and services (Vip), expenditures connected with technological innovations, and the number of used state-of-the-art manufacturing technologies (USMT) of federal subjects of the Far Eastern Federal District in 2005, 2010, and 2014-2017.

2. Study results

See primary outcome indicator "volume of innovative products, works, and services" for federal subjects of the FEFD for 2005, 2010, and 2014-2017 in table 1.

Table 1. Volume of innovative products, works, and services (mn rubles) (Vip).

Federal subjects	2005	2010	2014	2015	2016	2017
Russian Federation	**545,540**	**1,243,713**	**3,579,924**	**3,843,429**	**4,364,322**	**4,166,999**
Far Eastern Federal District	**4,510.6**	**16,178.9**	**468,731.8**	**140,539.4**	**73,023.4**	**89,267**
Sakha Republic (Yakutia)	236.1	2,184.7	6,144.3	2,826.3	27,103.9	7,537
Kamchatka Krai	12.8	34	595	172	568.7	1,303.1
Primorsky Krai	2,108.5	5,381.8	784.4	776.4	1,166.5	1,560.7
Khabarovsk Krai	2,090.7	4,557	29,571.4	29,603.1	41,334.9	73,957.9
Amur Region	33.8	1,344.7	5,242.9	5,485.2	1,725.9	1,683.1
Magadan Region	4.1	2,397	49.7	8,959.3	245.8	557
Sakhalin Region	24.5	86	426,273.2	92,528.8	196.8	1,397.5
Jewish Autonomous Region	-	6.7	40.4	80.3	50.6	277.5
Chukotka Autonomous Region	-	186.9	30.6	108	630.4	993.2

Source: data of the Russian Federal State Statistics Service [17].

Analysis of the table above demonstrates that this indicator increased 7.6 times from 2005 to 2017 in Russia in whole (from 545,540 mn rubles in 2005 to 4,166,999 mn rubles in 2017), in the FEFD - 16.8 times, in the Sakha Republic (Yakutia) (SRY) - 31.9 times.

Expenditures connected with technological innovations are among the crucial indicators reflecting expenditures connected with innovative activity. In economic literature and in statistics, expenditures connected with technological innovations are usually understood as the expenditures connected with implementation of various innovative activities in economic entities of any scale.

Total expenditures connected with technological, marketing and organizational innovations in the Russian Federation in 2017 amounted to 1,416.9 bn rubles: TI - 1,405.0 bn rubles (99.2% of total expenditures), marketing innovations - 4.3 bn rubles (0.3%), organizational innovations - 7.7 bn rubles (0.5%) [18]. In the Sakha Republic (Yakutia) (hereinafter referred to as the SRY) these indicators are 85.1%, 10.8% and 4.1%, respectively [19]. Analysis of intensity of expenditures connected with technological innovations (ECTI) by types of economic activity demonstrates that the largest figures are observed in the service industry (10.6%), high-technology manufacturing industry (4.5%) and in the sphere of information and communications technology (ICT) (2.3%) [20].

Table 2. Expenditures connected with technological innovations (mn rubles) (Vecti).

Federal subjects	2005	2010	2014	2015	2016	2017
Russian Federation	143,222.6	400,803.8	1,211,897	1,203,638	1,284,590	1,404,985
Far Eastern Federal District	3,350.7	24,167.3	59,152.4	67,231	56,374.7	58,581.8
Sakha Republic (Yakutia)	1,292.1	701.2	3,584.2	1,632.3	3,432.6	4,119.2
Kamchatka Krai	17.4	172.5	569.9	539.6	278.6	437.1
Primorsky Krai	374.6	960.4	1,852.8	1,040.5	1,059	2,087.8
Khabarovsk Krai	1,588.9	3,871.7	6,523.8	7,587.3	10,615.2	8,958.7
Amur Region	0.5	1,348.4	3,689.8	3,731.4	1,876.5	3,817
Magadan Region	9.0	1,375.9	245.5	909	316.2	819.6
Sakhalin Region	65.1	15,649.1	42,587.6	51,041.3	38,610	37,940.7
Jewish Autonomous Region	3.2	73.8	64	55.6	19.9	61.5
Chukotka Autonomous Region	-	14.2	34.9	694.1	166.5	340.2

Source: data of the Russian Federal State Statistics Service [17].

We *may* assume that the larger the amount of expenditures connected with technological innovations is, the larger the amount of innovative products must be and, therefore, this positively affects the growth of the gross regional product (GRP). According to publication [21], GRP volume (V_{grp}) is highly correlated with expenditures connected with technological innovations. That is why analysis and identification of the correlation between expenditures connected with technological innovations and innovative product output appears to be a rather relevant goal. To do that, the authors propose a method of assessing efficiency of expenditures connected with technological innovations on the basis of calculating factors of efficiency of expenditures connected with technological innovations in terms of innovative product output (K_i) in federal regions that may be determined using the following formula:

$$K_i = V_{ip}/V_{ecti}, \quad (1)$$

where

V_{ip} - volume of innovative products, works, services (mn rubles);

V_{ecti} - volume of expenditures connected with technological innovations (mn rubles).

Table 3. Factor of efficiency of expenditures connected with technological innovations in terms of innovative product output (K = Vip/Vecti).

Federal subjects	2005	2010	2014	2015	2016	2017
Russian Federation	3.81	3.10	2.95	3.19	3.40	2.97
Far Eastern Federal District	**1.35**	**0.67**	**7.92**	**2.09**	**1.30**	**1.52**
Sakha Republic (Yakutia)	0.18	3.12	1.71	1.73	7.90	1.83
Kamchatka Krai	0.74	0.20	1.04	0.32	2.04	2.98
Primorsky Krai	5.63	5.60	0.42	0.75	1.10	0.75
Khabarovsk Krai	1.32	1.18	4.53	3.90	3.89	8.26
Amur Region	67.60	1.00	1.42	1.47	0.92	0.44
Magadan Region	0.46	1.74	0.20	9.86	0.78	0.68
Sakhalin Region	0.38	0.01	10.01	1.81	0.01	0.04
Jewish Autonomous Region	-	0.09	0.63	1.44	2.54	4.51
Chukotka Autonomous Region	-	13.16	0.88	0.16	3.79	2.92

Source: data of the Russian Federal State Statistics Service [17].

See results of calculations of a sample factor of efficiency of expenditures connected with technological innovations in terms of innovative product output in 2005, 2010, and 2014-2017 for the Russian Federation in whole and for federal subjects of the FEFD (table 3).

Analysis of table 3 demonstrates that the factor of efficiency of expenditures connected with technological innovations for the Russian Federation in whole in 2005-2017 had a downward trend (K was 3.81 in 2005 and 2.97 in 2017), whereas in the FEFD and the SRY - an upward trend (FEFD - 1.35 and 1.52, SRY - 0.18 and 1.83, respectively).

Figure 1 demonstrates the distribution of values of factors of efficiency of expenditures connected with technological innovations in terms of innovative product output for federal subjects of the FEFD in 2017.

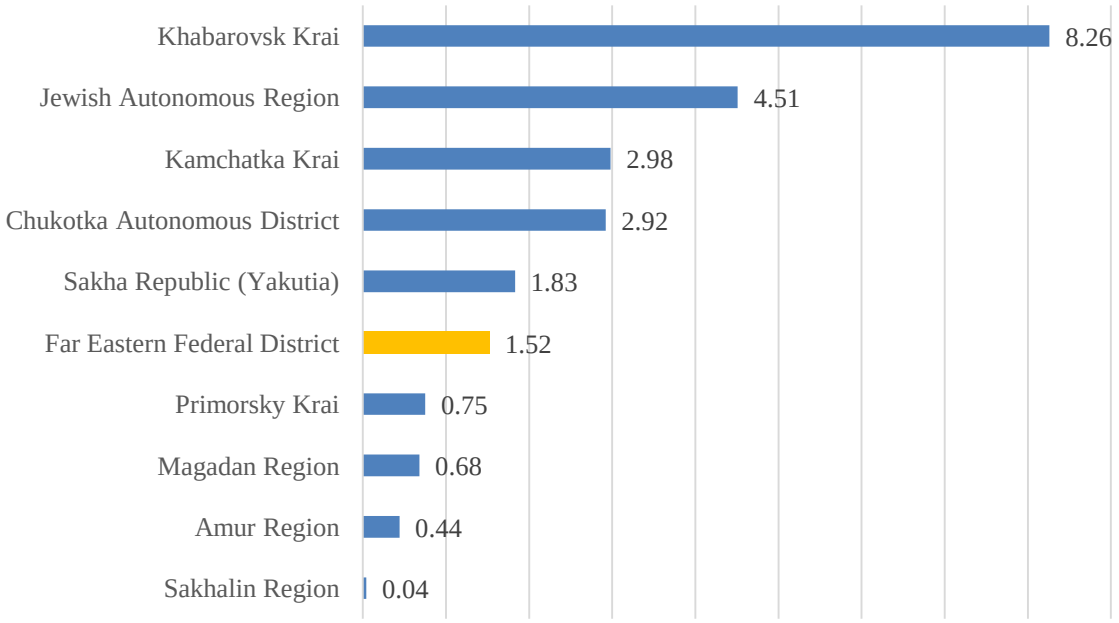

Figure 1. The distribution of values of factors of efficiency of expenditures connected with technological innovations in terms of innovative product output for federal subjects of the FEFD in 2017.

The figure above demonstrates that the highest factors of efficiency are observed in the Khabarovsk Krai (8.26), the Jewish Autonomous Region (4.51) and the Kamchatka Krai (2.98), whereas in the Sakha Republic (Yakutia) it is 1.83. This means that the efficiency of each ruble of expenditures connected with TI in federal subjects of the said district allowed the innovative product output in the amount of 1.83-8.26 rubles, whereas the district-average value is 1.52 rubles.

Furthermore, in order to evaluate the effect of the primary indicators of innovative process on the results of innovative activity in federal subjects of the FEFD, the authors calculated correlation interdependencies (R - Pearson Correlation Coefficient) of indicators for 2005, 2010, and 2014-2017.

If we use the following correlation interdependence evaluation criterion scale: 0.66-1.0 - high, 0.33-0.66 - medium, 0.00-0.33 - low, then table 4 demonstrates that all couples in the Russian Federation in whole have a high level of correlation dependence (R - 0.864-0.982), except for the couple of V_{ip} and specific weight of the organizations effectuating technological innovations (TI). In the FEFD, high R is observed in the following couples: V_{grp} and V_{ecti} (R = 0.97), V_{ip} and specific weight of TI (R = 0.709). Other couples have medium R (0.420-0.526). See more detailed correlation dependence of indicators of innovative activity in a pie chart (figure 2).

Table 4. Correlation interdependencies (R) of the primary indicators of innovative activity in the Russian Federation and in federal subjects of the Far Eastern Federal District.

Federal subjects	V_{grp} and V_{ip}	V_{grp} and V_{ecti}	V_{ip} and V_{ecti}	V_{ip} and specific weight of TI	V_{ip} and the number of USMT
Russian Federation	**0.982**	**0.979**	**0.992**	**-0.651**	**0.864**
Far Eastern Federal District	**0.453**	**0.970**	**0.526**	**0.709**	**0.420**
Sakha Republic (Yakutia)	0.704	0.697	0.559	0.357	-0.276
Kamchatka Krai	0.706	0.707	0.493	0.287	0.648
Primorsky Krai	-0.439	0.677	-0.319	0.161	-0.218
Khabarovsk Krai	0.942	0.955	0.817	-0.778	0.654
Amur Region	0.668	0.781	0.782	0.545	0.648
Magadan Region	0.331	0.057	0.504	0.179	0.303
Sakhalin Region	0.472	0.976	0.417	0.030	0.202
Jewish Autonomous Region	0.839	0.438	0.066	0.170	-0.632
Chukotka Autonomous Region	0.388	0.469	0.075	-0.701	-0.765

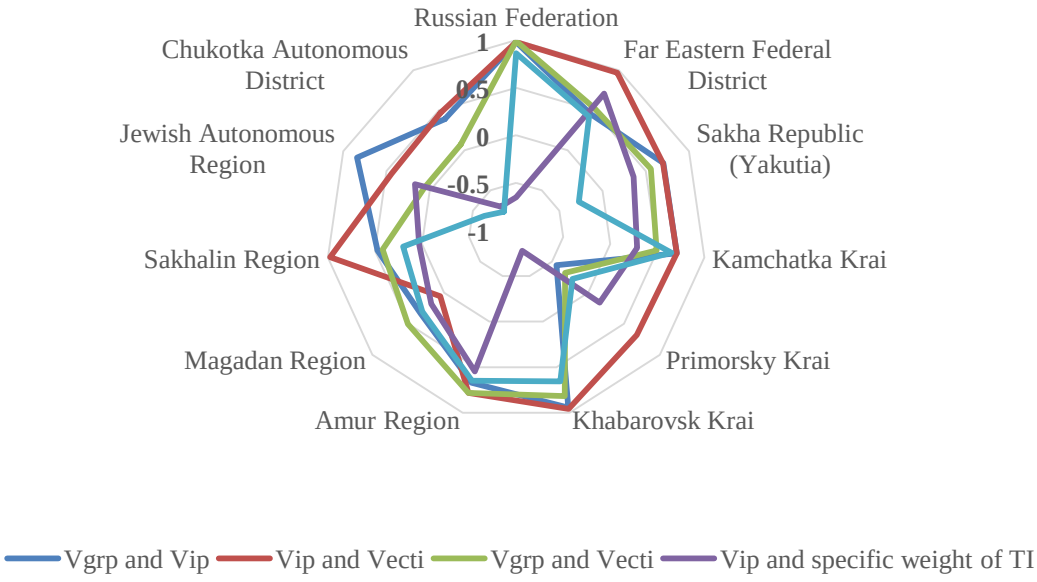

Figure 2. Correlation interdependencies of the GRP, volume of innovative products and the primary indicators of innovative activity.

The figure above demonstrates that couples V_{grp} – V_{ip}, V_{grp} – V_{ecti}, V_{ip} – V_{ecti}, and V_{ip}– specific weight of TI feature high or medium correlation interdependence in the Russian Federation in whole, in the FEFD and in most federal subjects of the district.

3. Conclusion

Therefore, study results demonstrate correlation interdependence and effect of the primary indicators of innovative activity on the volumes of GRP and innovative products. *Practical relevance* of the obtained study results consists in the possibility of using the proposed method for analysis and

comparative quantification of the effect of the primary indicators of innovative process on the outcomes of innovative activity in federal subjects and municipal divisions of the Russian Federation.

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