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Analysis of Regression Relationship between the Number of Organisations of the Russian Regional Innovation Infrastructure and the University Infrastructure and the Gross Regional Product

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Abstract: We took databases of the National Information and Analytical Center for monitoring innovation infrastructure of scientific and technological activities and regional innovation systems and the Web portal of innovation and business information support "Innovations and entrepreneurship", Webometrics database according to rankings of all Russian universities, as well as the database of the Russian Federal State Statistics Service on the gross regional product for all regions of Russia as an empirical basis in order to determine the regression relationship between the number of organisations of the regional innovation and university infrastructure and the gross regional product. Data on the first two innovation databases had been collected as of the end of December 2014, and the distribution of universities according to the Russian regions was made according to Webometrics data (July, 2015) and university websites. Initially high determination coefficients R2 obtained in the course of searching the relationship between the number of innovation infrastructure organisations and universities according to two databases for all Russian regions were sharply decreasing, when excluding the data for Moscow and Saint Petersburg. The obtained results, if compared with the gross regional product and the population of regions, allow planning the allocation of the university and innovation infrastructure according to regions of Russia. Further, the article also explores linear regression equations obtained between the above mentioned databases number of organisations of the regional innovation infrastructure on the one part and the gross regional product on the other part for the years 2007 and 2014. It is obvious that the Russian regional innovation infrastructure is low-developed, that is why it is not still the engine for economic growth of regions, but on the contrary, economic strength of regions, their urban infrastructure and culture are the driver for the development of the regional innovation infrastructure.

Keywords: regional innovation potential; regional innovation infrastructure; university infrastructure; Russian regions; correlation; regression correlation; coefficient of determination; benchmarking methodology; pair correlation matrix; gross regional product; linear regression equation; GRP; ROSSTAT; Database.

INTRODUCTION

The definition "regional innovation infrastructure" was introduced into scientific use by R.Rothwell in 1982 and 1984 [1- 3]. He wrote that at present the emerging cluster of new technical and economic capacities would strengthen the world economy in the expansion phase of Kondratyev's 5th wave, and that during that period the technology-intensive new small firms would be the driving force for the regional recovery. Based on this he came to the conclusion concerning the necessity to develop the regional innovation policy and to creation the regional innovation infrastructure [1].

Alongside with the term "regional innovation infrastructure" the term "regional innovation networks" [4,5] has started to be applied in foreign literature since 1985. The above-mentioned works, together with the wide cluster of works devoted to the national innovation systems, contributed to the introduction of the concept "regional innovation system" [6] into the scientific use in ten years. This concept was developed in P. Cooke's works [7, 8].

In Russia the conceptual framework of the regional innovation infrastructure management has been developed in the work [9] for the first time, and matrix-analytical tools for benchmarking of this infrastructure – in the works [10-12].

In this Article, the university infrastructure is considered as a part of the innovation infrastructure consisting of innovation organisations of various types (production and technological, expert and consulting, staff, information and finance organisations and companies).

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This work will be devoted to study of the regression relationship between the number of organisations of the Russian regional innovation and university infrastructure, as well as the regressive relationship between the number of objects of the Russian regional innovation infrastructure and the gross regional product. It should be noted that the similar regression relationship between the number of organisations of the Russian regional university infrastructure and the gross regional product was studied in the work [13].

METHODS

We took databases of the National Information and Analysis Center for monitoring the innovation infrastructure of scientific and technological activities and the regional innovation systems [14] and the Web portal of innovation and business information support "Innovations and business" [15], Webometrics database according to rankings of all Russian universities, as well as the database of the Russian Federal State Statistics Service on the gross regional product for all regions of Russia as an empirical basis in order to determine the regressive relationship between the number of objects of the regional innovation and university infrastructure and the gross regional product. Data on the first two innovation databases had been collected as of the end of December 2007 and 2014 [6], the distribution of universities according to the Russian regions was made according to Webometrics data (July, 2015) and university websites [13], and the distribution of the gross regional product of the constituent entities of the Russian Federation over the Russian regions was made based on the data for 2007 and 2013 [13].

The analysis of the distribution of the gross regional product for 82 regions of Russia allowed exclusion of outliers, which relate to the Northern and Eastern oil-and-gas-bearing regions, and carrying-out the regressive analysis for a less number of regions (80). The regressive relationship between the number of organisations of the innovation and university infrastructure for all Russian regions was determined either with or without taking into account the data for Moscow and Saint Petersburg.

Standard options of Microsoft Excel were used for the linear regression analysis..

RESULTS AND DISCUSSION

Analysis of regression relationship between the number of organisations of the Russian regional innovation infrastructure and the gross regional product

Initial data for the regression analysis between the number of objects of the Russian regional innovation infrastructure and the gross regional product is shown in the Table 1. Equations of linear regression between the number of innovation infrastructure organisations according to two databases and the gross regional product, either with or without taking into account the data for the Khanty-Mansiysk Autonomous District – Yugra and the Yamalo-Nenets Autonomous District, calculated based on it, are shown in Figures 1-8.

Table 1. Distribution of Gross Regional Product and the Number of innovation infrastructure organisations on the first and second databases in the Regions of Russia

		2007			2014		
№	Russian Regions	GRP,2007, Million Rubles	N_{in}^{1}	N_{in}^{2}	GRP,2013, Million Rubles	N_{in}^{1}	N_{in}^{2}
1	Moskva	6 696 259,10	124	266	11 632 506,4	224	429
2	Sankt-Peterburg	1 119 660,30	35	42	2 496 549,1	52	83
3	Moskovskaya oblast	1295649,9	24	29	2 551 284,2	43	49
4	Rostovskaya oblast	450 434,70	13	12	923 531,7	37	25
5	Krasnodarskij kraj	648 211,30	8	13	1 617 875,9	12	22
6	Sverdlovskaya oblast	820 792,50	25	26	1 586 228,7	39	38
7	Samarskaya oblast	584 968,60	8	11	1 040 713,5	22	25
8	RespublikaTatarstan (Tatarstan)	757 401,40	12	22	1 547 151,7	36	40
9	Respublika Bashkortostan	590 054,10	5	6	1 266 983,0	28	19
10	Novosibirskaya oblast	365 531,20	11	32	821 415,4	59	41
11	Stavropol'skij kraj	222 239,60	5	9	478 368,0	6	13
12	Krasnojarskij kraj	734 154,80	5	10	1 256 674,5	24	20
13	Chelyabinskaya oblast	575 643,70	5	15	879 274,0	15	27
14	Volgogradskaya oblast	331 766,80	5	5	606 122,6	9	10
15	Voronezhskaya oblast	222 811,90	15	11	606 667,7	34	27
16	Omskaja oblast	296 004,70	4	6	553 242,7	7	12
17	Respublika Dagestan	156 928,80	2	4	429 510,6	7	8
18	Nizhegorodskaya oblast	473 307,40	15	23	925 832,9	32	40
19	Permskaya oblast	477 794,20	3	4	893 409,8	6	13
20	Irkutskaja oblast	402 654,70	5	10	796 587,0	16	22
21	Orenburgskaya oblast	370 880,90	0	3	709 523,7	5	6
22	Kemerovskaya oblast	437 790,20	4	3	668 311,9	7	8
23	Altajskij kraj	223 563,40	9	10	410 824,6	21	21
24	Yaroslavskaya oblast	186 577,50	10	9	360 731,5	14	12
25	Ryazanskaya oblast	121 305,20	3	3	278 731,8	5	5
26	Habarovskij kraj	231 293,20	27	11	473 695,2	20	17
27	Tyumenskaya oblast	2 758 813,10	9	7	854 797,9	21	13
28	Saratovskaya oblast	252867,2	9	7	528 676,4	23	17
29	Smolenskaya oblast	95 703,40	6	2	225 594,8	7	3
30	Leningradskaya oblast	309 028,60	3	3	692 798,6	7	4
31	Astrakhanskaya Oblast	100 359,20	3	2	267 511,5	16	10
32	Ivanovskaya oblast	74 752,00	5	4	157 735,1	6	9
33	Murmanskaya oblast	191 584,60	3	7	307 459,3	9	12
34	Udmurtskaya Respublika	205 647,40	3	6	404 833,7	12	17
35	Hanty-Mansijskij AO -Jugra	1 728 340,20	3	3	2 789 654,0	5	4
36	Kaliningradskaya oblast	143 927,70	5	6	277 362,6	11	10
37	Kaluzhskaya oblast	111 869,00	8	16	293 433,8	12	25
38	Kurskaya oblast	128 799,00	4	3	272 238,0	5	7
39	Primorskij kraj	259 041,40	13	11	575 615,4	15	19
40	Tverskaya oblast	156 034,60	5	8	291 408,1	13	12
41	Tul'skaya oblast	174 110,90	17	4	347 060,2	15	10
42	Belgorodskaya oblast	237 013,30	4	7	569 414,1	17	14
43	Kirovskaya oblast'	118 154,90	3	4	224 726,5	6	8
44	Respublika Severnaya Osetiya - Alaniya	52 804,80	3	1	112 138,5	3	2
45	Bryanskaya oblast	102 706,20	6	6	223 324,3	9	9
46	Respublika Komi	241 150,50	2	8	490 741,1	4	10
47	Tomskaya oblast	214 487,00	17	29	402 546,1	32	43
48	Vologodskaya oblast	243 336,30	2	3	341 137,6	6	7
49	Lipetskaya oblast	209 821,50	2	2	314 790,4	3	6
50	Penzenskaya oblast	119 104,00	3	4	270 854,1	13	7

51	Pskovskaya oblast	61 561,90	3	1	114 246,5	3	4
52	Chuvashskaya Respublika - Chuvashiya	123 453,30	4	3	224 447,6	8	10
53	Vladimirskaya oblast	146 663,00	4	3	307 486,0	7	6
54	Orlovskaya oblast	77 101,20	2	6	164 525,8	3	11
55	Respublika Buryatiya	107 442,00	2	4	177 692,0	7	8
56	Respublika Sakha (Yakutiya)	242 656,50	5	7	569 131,6	13	9
57	Tambovskaya oblast	106 039,60	9	9	235 859,7	10	12
58	Kurganskaya oblast	81 076,00	1	3	165 150,3	6	5
59	Amurskaya oblast	111 761,20	3	4	211 224,4	5	7
60	Arhangel'skaya oblast	268 672,10	3	4	512 393,6	9	8
61	Zabajkal'skij kraj	110 822,40	0	0	229 782,0	5	5
62	Kamchatskij kraj	66 076,80	1	1	131 560,6	2	2
63	Respublika Mordoviya	77 048,80	3	3	149 331,7	6	11
64	Ul'yanovskaya oblast	124 676,20	7	11	260 340,6	13	14
65	Respublika Kareliya	104 603,30	5	9	175 975,0	7	13
66	Kabardino-Balkarskaya Respublika	48 908,70	2	1	113 229,8	10	2
67	Kostromskaya oblast	65 700,40	2	1	143 108,2	2	3
68	Novgorodskaya oblast	86 664,90	6	5	177 930,1	8	6
69	Respublika Marij Èl	55 069,20	2	3	124 400,2	6	5
70	Respublika Hakasiya	63 722,00	0	0	143 534,2	0	3
71	Chechenskaya Respublika	48 056,10	0	0	118 150,7	3	1
72	Karachaevo-Cherkesskaya Respublika	27 469,70	1	0	62 704,4	3	1
73	Respublika Adygeya (Adygeya)	29 085,10	1	1	72 011,6	1	2
74	Respublika Kalmykiya	17 225,80	1	1	41 136,8	1	2
75	Respublika Tyva (Tuva)	19 384,20	1	1	41 749,2	2	4
76	Sahalinskaya oblast	286 273,00	2	1	673 775,4	2	3
77	Evrejskaya avtonomnaya oblast	23 726,10	0	0	37 885,4	0	2
78	Magadanskaja oblast	35 314,40	0	0	88 490,1	0	2
79	Respublika Ingushetiya	16 812,40	0	0	45 171,0	0	1
80	Yamalo-Nenetskij Avtonomnyj Okrug	594 678,60	1	1	1 373 494,9	0	3
81	Nenetskij avtonomnyj okrug	0	0	0	171 771,9	0	0
82	Čhukotskij avtonomnyj okrug	20 984,10	0	0	46 989,7	0	0
	Итого		**583**	**836**		**1192**	**1475**

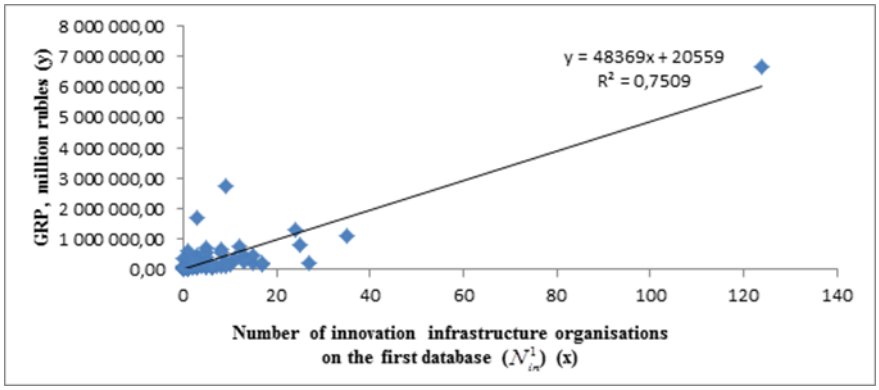

Figure 1. Linear Regression Relationship between Gross Regional Product (2007) and Number of innovation infrastructure organisations in 82 Regions of Russia (2007)

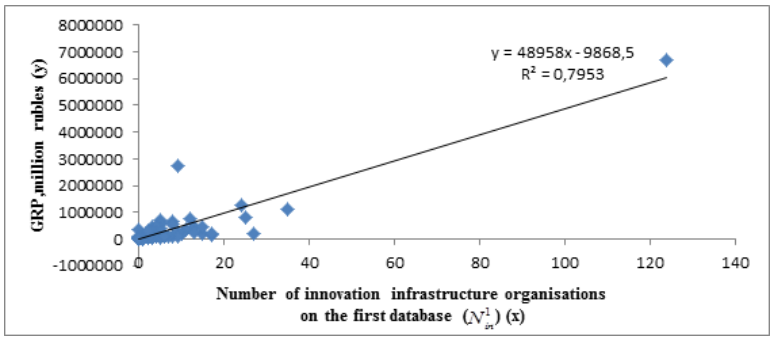

Figure 2. Linear Regression Relationship between Gross Regional Product (2007) and Number of innovation infrastructure organisations in 80 Regions of Russia (2007)

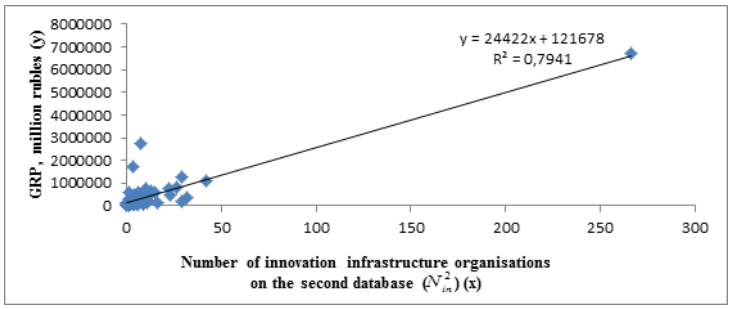

Figure 3. Linear Regression Relationship between Gross Regional Product (2007) and Number of innovation infrastructure organisations in 82 Regions of Russia (2007)

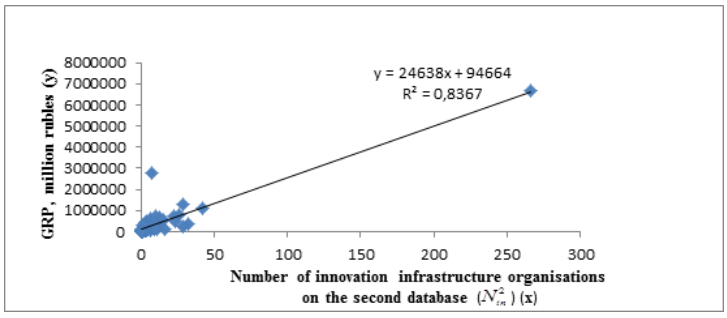

Figure 4. Linear Regression Relationship between Gross Regional Product (2007) and Number of innovation infrastructure organisations in 80 Regions of Russia (2007)

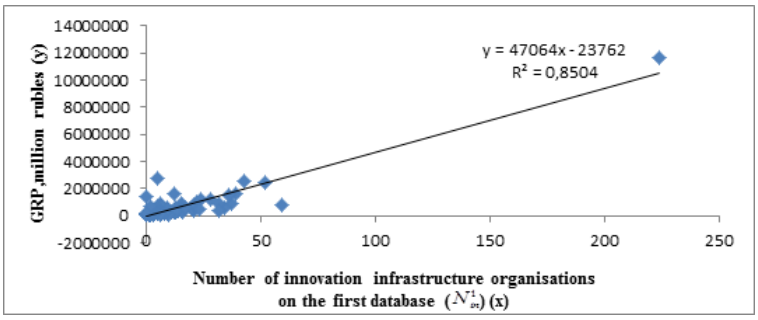

Figure 5. Linear Regression Relationship between Gross Regional Product (2013) and Number of innovation infrastructure organisations in 82 Regions of Russia (2014)

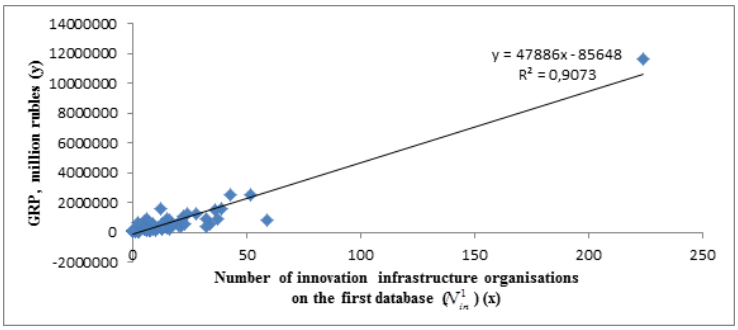

Figure 6. Linear Regression Relationship between Gross Regional Product (2013) and Number of innovation infrastructure organisations in 80 Regions of Russia (2014)

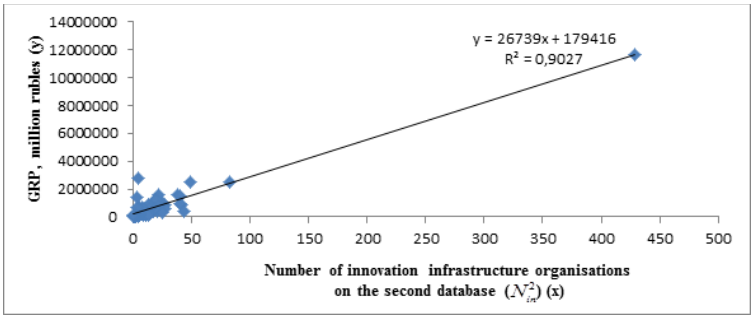

Figure 7. Linear Regression Relationship between Gross Regional Product (2013) and Number of innovation infrastructure organisations in 82 Regions of Russia (2014)

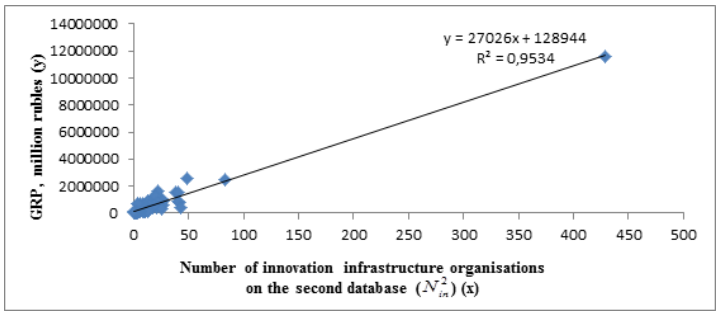

Figure 8. Linear Regression Relationship between Gross Regional Product (2013) and Number of innovation infrastructure organisations in 80 Regions of Russia (2014)

As compared to the year 2007, in 2014 the determination coefficient increased approximately by 0.1 in all databases and samples of the regions. Within the framework of one year, when excluding two outliers, the determination coefficient increased approximately by 0.04-0.05.

In general, very high determination coefficients were obtained. Herewith, we must not speak that the development of the regional innovation infrastructure has contributed to the growth of the gross regional product. Rather on the contrary, in the regions with high gross regional product there is a great potential for the development of the regional innovation infrastructure.

Regression relationship between the number of organisations of innovation and university infrastructure for regions of Russia

Initial data for the regressive analysis is shown in the Table 2. In it the data on N_{in}^1 and N_{in}^2 for the year 2014 are taken from the Table 1. Matrices of pair correlations between the number of the innovation infrastructure organisations and universities according to two databases, either with or without taking into account the data for Moscow and Saint Petersburg, calculated based on it, are shown in the Tables 3 and 4.

Table 2. Distribution of the Number of Universities (2015) and the Number of innovation infrastructure organisations (2014) on the first and second databases in the Regions of Russia

№	Russian Regions	N_{un}	N_{in}^1	N_{in}^2	№№ п/п	Russian Regions	N_{un}	N_{in}^1	N_{in}^2
1	Moskva	309	224	429	42	Belgorodskaya oblast	10	17	14
2	Sankt-Peterburg	110	52	83	43	Kirovskaya oblast	10	6	8
3	Moskovskaya oblast	67	43	49	44	Respublika Severnaya Osetiya - Alaniya	10	3	2
4	Rostovskaya oblast	46	37	25	45	Bryanskaya oblast	9	9	9
5	Krasnodarskij kraj	43	12	22	46	Respublika Komi	9	4	10
6	Sverdlovskaya oblast	40	39	38	47	Tomskaya oblast	9	32	43
7	Samarskaya oblast	36	22	25	48	Vologodskaya oblast	8	6	7
8	RespublikaTatarstan (Tatarstan)	34	36	40	49	Lipetskaya oblast	8	3	6
9	Respublika Bashkortostan	30	28	19	50	Penzenskaya oblast	8	13	7
10	Novosibirskaya oblast	28	59	41	51	Pskovskaya oblast	8	3	4
11	Stavropol'skij kraj	27	6	13	52	Chuvashskaya Respublika - Chuvashiya	8	8	10
12	Krasnojarskij kraj	27	24	20	53	Vladimirskaya oblast	7	7	6
13	Chelyabinskaya oblast	25	15	27	54	Orlovskaya oblast	7	3	11
14	Volgogradskaya oblast	24	9	10	55	Respublika Buryatiya	7	7	8
15	Voronezhskaya oblast	24	34	27	56	Respublika Sakha (Yakutiya)	7	13	9
16	Omskaja oblast	24	7	12	57	Tambovskaya oblast	7	10	12
17	Respublika Dagestan	24	7	8	58	Kurganskaya oblast	6	6	5
18	Nizhegorodskaya oblast	23	32	40	59	Amurskaya oblast	5	5	7
19	Permskaya oblast	23	6	13	60	Arhangel'skaya oblast	5	9	8
20	Irkutskaja oblast	20	16	22	61	Zabajkal'skij kraj	5	5	5
21	Orenburgskaya oblast	20	5	6	62	Kamchatskij kraj	5	2	2
22	Kemerovskaya oblast	19	7	8	63	Respublika Mordoviya	5	6	11
23	Altajskij kraj	18	21	21	64	Ul'yanovskaya oblast	5	13	14
24	Yaroslavskaya oblast	18	14	12	65	Respublika Kareliya	4	7	13
25	Ryazanskaya oblast	17	5	5	66	Kabardino-Balkarskaya Respublika	3	10	2
26	Habarovskij kraj	17	20	17	67	Kostromskaya oblast	3	2	3
27	Tyumenskaya oblast	16	21	13	68	Novgorodskaya oblast	3	8	6
28	Saratovskaya oblast	15	23	17	69	Respublika Marij Èl	3	6	5
29	Smolenskaya oblast	15	7	3	70	Respublika Hakasiya	3	0	3
30	Leningradskaya oblast	13	7	4	71	Chechenskaya Respublika	3	3	1
31	Astrakhanskaya Oblast	12	16	10	72	Karachaevo-Cherkesskaya Respublika	2	3	1
32	Ivanovskaya oblast	12	6	9	73	Respublika Adygeya (Adygeya)	2	1	2
33	Murmanskaya oblast	12	9	12	74	Respublika Kalmykiya	2	1	2
34	Udmurtskaya Respublika	12	12	17	75	Respublika Tyva (Tuva)	2	2	4
35	Hanty-Mansijskij AO -Jugra	12	5	4	76	Sahalinskaya oblast	2	2	3
36	Kaliningradskaya oblast	11	11	10	77	Evrejskaya avtonomnaya oblast'	1	0	2

37	Kaluzhskaya oblast	11	12	25	78	Magadanskaja oblast	1	0	2
38	Kurskaya oblast	11	5	7	79	Respublika Ingushetiya	1	0	1
39	Primorskij kraj	11	15	19	80	Yamalo-Nenetskij Avtonomnyj Okrug	1	0	3
40	Tverskaya oblast	11	13	12	81	Nenetskij avtonomnyj okrug	0	0	0
41	Tul'skaya oblast	11	15	10	82	Čhukotskij avtonomnyj okrug	0	0	0
						Итоrо	1482	1192	1475

Table 3 - Pair correlation matrix (R^2) between the number of Universities and innovation infrastructure organisations on two databases for 82 Regions of Russia

	N_{in}^1	N_{in}^2	N_{un}
N_{in}^1	1	0.935	0.897
N_{in}^2	0.935	1	0.931
N_{un}	0.897	0.931	1

Table 4 - Pair correlation matrix (R^2) between the number of Universities and innovation infrastructure organisations on two databases for 80 Regions of Russia

	N_{in}^1	N_{in}^2	N_{un}
N_{in}^1	1	0.806	0.512
N_{in}^2	0.806	1	0.554
N_{un}	0.512	0.554	1

Diagrams of all six linear regression relationships corresponding to the Tables 3 and 4 are shown in Figures 9-14. Comparison of the Tables 3 and 4 show that the exclusion of Moscow and Saint Petersburg, which data can be considered as outliers, from statistical processing leads not to the improvement, but to the deterioration of the correlation relationship: when calculating the correlation between the number of the innovation infrastructure organisations and universities according to two databases, the coefficient of determination R^2 decreased approximately from 0. 9 to 0. 5.

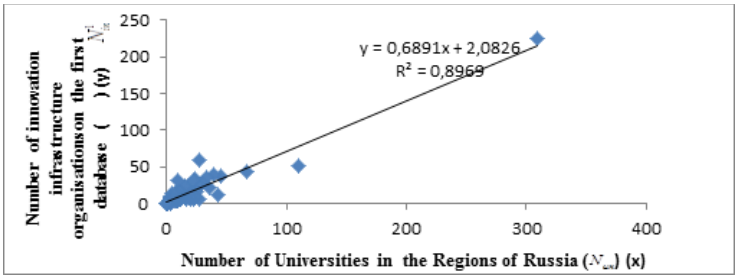

Figure 9.Linear Regression Relationship between the Number of innovation infrastructure organisations on the first database (2014) and the Number Universities in 82 Regions of Russia (2015)

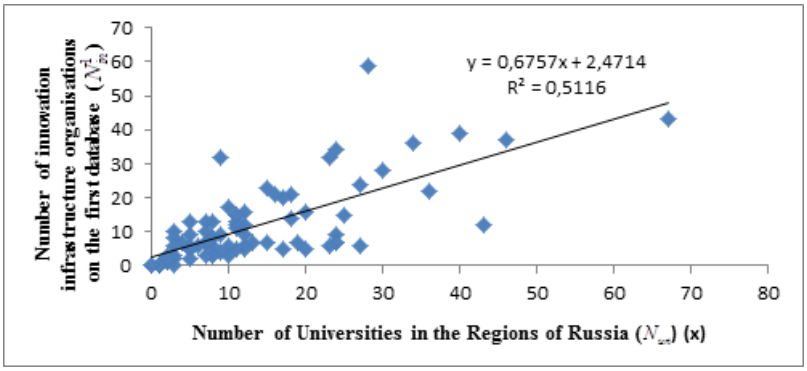

Figure 10.Linear Regression Relationship between the Number of innovation infrastructure organisations on the first database (2014) and the Number Universities in 80 Regions of Russia (2015)

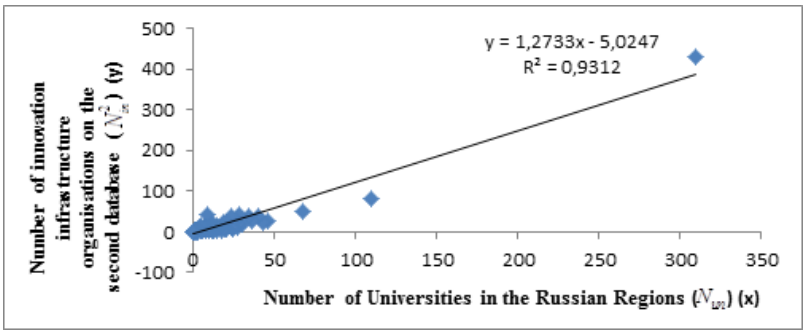

Figure 11.Linear Regression Relationship between the Number of innovation infrastructure organisations on the second database (2014) and the Number Universities in 82 Regions of Russia (2015)

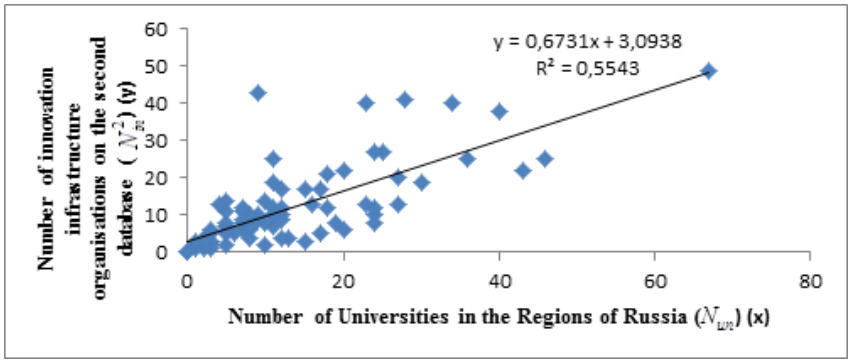

Figure 12.Linear Regression Relationship between the Number of innovation infrastructure organisations on the second database (2014) and the Number Universities in 80 Regions of Russia (2015)

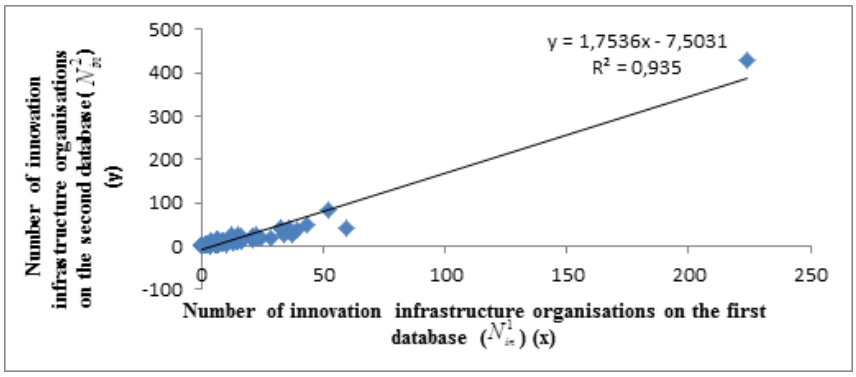

Figure 13.Linear Regression Relationship of the Number of innovation infrastructure organisations on the first and second databases (2014) in 82 Regions of Russia

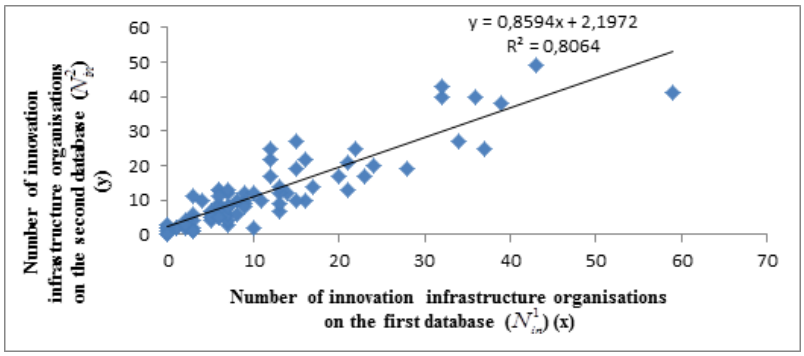

Figure 14.Linear Regression Relationship of the Number of innovation infrastructure organisations on the first and second databases (2014) in 80 Regions of Russia

At the same time, when analyzing the regression relationship between the number of organisations of the innovation infrastructure according to two databases, the determination coefficient R^2 decrease not by much (Tabl. 3, 4, Fig. 13, 14).

CONCLUSION

Thus, we have obtained in the work the linear regression equations between the number of organisations of the regional innovation infrastructure according to two databases and the gross regional product for different years. Initially high determination coefficients (R^2) obtained in the course of searching the above-mentioned relationship increased still more, when excluding the data for the Khanty-Mansiysk Autonomous District – Yugra and the Yamalo-Nenets Autonomous District. This should be expected, because the data for these oil-and-gas bearing regions were the outliers. Due to the fact that currently the Russian regional innovation infrastructure is low-developed, so it is still not the engine for the economic growth of regions. On the contrary, the economic strength of regions, their urban infrastructure and culture are the driver for the development of the regional innovation infrastructure. We also received in the work the linear regression equations between the number of the innovation infrastructure organisations and universities according to two databases of the innovation infrastructure objects.

Initially high determination coefficients R^2 obtained in the course of searching the relationship between the number of the innovation infrastructure organisations and universities according to two databases for all Russian regions were sharply decreasing, when excluding the data for Moscow and Saint Petersburg. At the similar regression analysis of the relationship between the number of the innovation infrastructure organisations according to two databases, such sharp decrease of the determination coefficient was not observed. The reasons of such effect remain open for us. The obtained results, if compared with the gross regional product and the population of regions, allow planning the allocation of the university and innovation infrastructure according to regions of Russia.

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