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COMPARATIVE ANALYSIS OF TAX CAPACITY IN REGIONS OF RUSSIA

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Abstract. Influence of tax policy of the state and its regions is vital for country's economy; it is the major source of allocation of expenditure obligations of tax capacity on the sub-federal level. The purpose of this research is to estimate the predictive tax capacity of regions (TCR) and to create a comparative evaluation of regions on the basis of criteria, which are influencing the tax capacity using different methods of evaluation: multiple criteria decision-making (MCDM) and econometric methods. Criteria, which are having the greatest influence on the TCR, were identified on the basis of empirical data both using regression analysis and expert estimates. The objective, subjective, and cumulative weights have been calculated, the degree of concordance of expert opinions was gauged. The comparative evaluation of the TCR in four regions of Russia in 2000–2012 was performed on the basis of MCDM methods.

Keywords: tax capacity, region, correlation and regression analysis, experts, concordance, MCDM.

JEL Classification: C25, C44, C53, C58, G17, H21.

Introduction

In the second half of the twentieth century problems of tax federalism and intergovernmental fiscal relations formed a new branch of economic study. The topic is currently relevant for many countries. A variety of research on tax and budget relations can be found all over the world (Burman, Phaup 2011; Ong Lynette 2011; Walia 2013; Naik 2013; Gilardi, Wasserfallen 2014; Skackauskiene 2013; Skackauskiene, Tuncikiene 2012; Bivainis, Skackauskiene 2008). There still is a need to estimate an adequate amount of expenditure obligations of tax capacity on the sub-federal level. Purpose and novelty of this research is related to the need to create an effective tax system of fiscal federalism, an intergovern-

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mental system of aligning reduction of inequality among regions, and development of the financial policy at the level of the federal center and regional authorities.

The purpose of this study is to evaluate predictive capability of tax capacity of region (TCR) and to carry out comparative assessment of regions on the basis of criteria, which influence the tax capacity, using different econometric methods.

To achieve this goal the following tasks were implemented:

- a set of criteria making influence on the TCR was elicited from the literature;
- criteria, which make substantial influence on the TCR were identified in two ways: based on empirical data by using regression analysis, and on expert evaluation;
- relative degree of the influence of the criteria in terms of weights was estimated, based on expert opinions;
- concordance of opinions of the experts was gauged;
- tax capacity in different regions of Russia was evaluated using multiple criteria decision-making (MCDM) methods; the regions were compared;
- results obtained from regression analysis and MCDM methods were compared.

1. The economic essence of the tax capacity of the region

Importance of tax policy proved to have a considerable effect on growth of certain sectors of economy, sometimes even devastating effect (Nasulea 2014). Predictable tax policy makes economic environment much more favourable for investors (Savrina 2013). Closely related tax capacity topic is popular subject of research among scientists. An incomplete list of examples could be the following: Bird, Martinez-Vazquez (2008), Barro (1986), Le *et al.* (2012), Bird *et al.* (2004), Schratzenstaller (2011), etc. Approaches of defining the essence of tax capacity vary depending on the context of a particular paper. Thus, in "Tax Capacity and Tax Effort: Extended Cross – Country Analysis from 1994 to 2009" (Le *et al.* 2012) we derive that tax capacity primarily depends on such a dynamic characteristic as tax-to-GDP ratio, which is estimated empirically observing country's specific macroeconomic, demographic, and institutional features. Barro (1986) in "State Fiscal Capacity Measures: A Theoretical Critique" characterizes tax capacity as the ability of the administrative and territorial unit to receive tax revenues from their own sources, regardless of the existing level of the fiscal influence.

The outlined examples demonstrate that the TCR could be considered both as being dependent on external criteria as is demonstrated by the former example, while the theoretical definition provided in the latter example suggests that the TCR stems from the internal tax-collection potential.

The subject of determining the tax potential, and in particular the TCR, commenced to develop along with formation of the modern Russian model of fiscal federalism in the early 90s of the last century. The lack of regulatory definitions of the TCR in the Russian legislation is in fact generating (instead of impairing) substantial efforts in developing concepts of the TCR. Presently, the following major approaches can be discerned: resource, fiscal, and mixed approaches (Parfenova, Pugachev 2013).

The resource approach views the tax capacity as a resource of the budget income, accumulated from tax payments (Bushinsky 2009; Karataev 2010; Matrusov 1995; Osipov 2008; etc.)

The fiscal approach views the TCR as being a maximizing source of all possible tax payments to the budget (e.g. Panskov 2013).

Within the framework of the mixed approach, the tax capacity is understood as a maximizing amount of tax revenue that could be collected in a territory of a federal subject of the Russian Federation within a specified period, provided that all available resources in the region were used (Tolstaya 2010; Krasnitsky 2009).

In general, the tax capacity of the region can be considered as a compound of two components: budgetary and fiscal. It is the maximizing amount of budget revenues, which is potentially accumulated within a specified period of time by mediation of tax authorities as taxes, levies and other mandatory payments of corporates and individuals as is determined by the current legislation within a territory, in accordance with the tax policy of the State and the level of economic development of the region (Parfenova, Pugachev 2013).

The model of tax policy within the Federation, and intergovernmental fiscal relations determine the TCR. Treatment of the TCR within such models for the purpose of tax planning and forecasting requires invention of tools, which quantify the TCR. And quantitative evaluation of the TCR requires to identify a set of criteria, which make effect on the TCR.

2. A study of criteria influencing the tax capacity of the region

Criteria, which make effect on the TCR within a separate tax system can be elicited from the historical data, which describe structure of tax income of the budget, taking into consideration the tax base of the income. Take the Yaroslavl region, the region in the north of European Russia, the Central Federal District, as an example. The major components of the total tax capacity of the Yaroslavl region (including revenues to budgets of all levels of budgetary system) in 2013 were the excise tax (46%), the tax on personal income (PIT) (17%), value added tax (hereinafter VAT) (15%), and corporate income tax (11%). The structure of the total tax capacity of the Yaroslavl region in 2013 is presented in Figure 1.

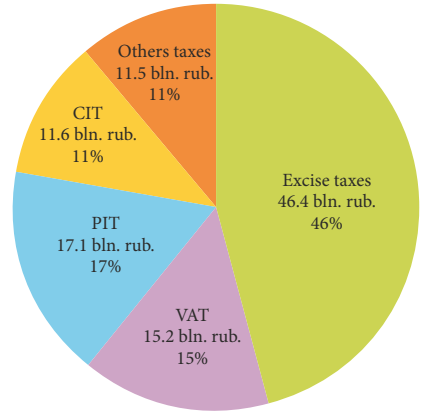

Fig. 1. Structure of tax capacity in the Yaroslavl region, 2013

It follows from collected empirical data that the tax capacity of the Yaroslavl region is formed primarily by 4 types of tax, which in total make 89%. Major criteria effecting the TCR other conditions equal, are found among entries recorded in the fiscal database of taxes formed in accordance with the Tax Code of the Russian Federation, are as follows: the gross regional

product (for indirect taxes), net income after deduction of social security contributions (personal income tax), and corporate profit.

There is a large range of research performed both by Russian and non-Russian authors, where criteria determining the TCR are defined and analyzed. The following authors could be considered as representatives of the research in the field: R. M. Bird, M. N. Eltony, J. R. Lotz, E. Morss, K. Shin, J. G. Stotsky, A. WoldeMariam, E. S. Vylkova, A. S. Karataev, O. A. Mironova, V. G. Panskov, F. F. Hanafheev, and others. It would be interesting to extend the research to other types of financial systems (Podviezko 2015). Summary of found in the literature criteria influencing the TCR is provided in Table 1.

Table 1. Criteria determining the TCR

№	Criteria	Authors
1	Gross regional product (GRP)	Bird, Martinez-Vazquez 2008; Eltony 2002; Lotz, Morss 1970; Stotsky, WoldeMariam 1997; Hanafeev 2008; Parfenova *et al.* 2013
2	The ratio of exports or imports to the GRP	Bird, Martinez-Vazquez 2008
3	Inflation	Karataev 2010; Vylkova, Pozov 2013
4	Urals crude oil price	Panskov 2013; Vylkova, Pozov 2013
5	Geographic and economic location of the region	Mironova, Hanafeev 2013; Popenkov 2006; Kolesnikova 2004
6	Location of productive forces	Bird, Martinez-Vazquez 2008; Shin 1969; Mironova, Hanafeev 2013;Vylkova, Pozov 2013; Kuznetsova 2007; Popenkov 2006; Kolesnikova 2004; Hanafeev 2008
7	The scale of the shadow economy	Bird, Martinez-Vazquez 2008; Mironova, Hanafeev 2013; Panskov 2013
8	Investment climate	Panskov 2013; Karataev 2010; Kuznetsova 2007
9	Quality of tax administration	Shin 1969; Mironova, Hanafeev 2013; Karataev 2010; Kuznetsova 2007; Vylkova, Pozov 2013
10	Demographic characteristics of the region	Bird, Martinez-Vazquez 2008

Thus, we can identify the following criteria, which determine the TCR, as the most popular among researchers: the GRP, economic and geographic location of the region, location of productive forces, quality of tax administration, investment climate, and the scale of the shadow economy. These factors characterize the scale of production, the resource base, investment attractiveness of a region, consequently being components of tax base.

Naturally, magnitude of the shadow economy undermines the TCR. In Russia the shadow economy was and still steadily remains considerable. In accordance to the latest research performed by OAO Sberbank (2014) the shadow economy was a considerable factor in 2014 as it made up 20–35% of the total economy. Since the shadow economy is currently regarded to be rather similar in the regions investigated until some more precise

research will have appeared in the literature, the shadow economy factor was not included into the research.

Besides the factor of the shadow economy the following factors were not included into the research, because in the period of investigation such factors in the literature were often treated as inconsiderable: exports and imports to the GDP, inflation, Urals crude oil price, demographic factors. Negligible influence of the latter factors is explained by the stable balance of payments of Russia; absence of the Olivera-Tanzi effect partly because of reduction of inflation since 2000, which in accordance with the information provided by the Federal State Statistics Service of the Russian Federation became 106–114% after 110–233% in the 90s; the exchange crude oil price fluctuations were outweighed by increase of oil production, which also somewhat stimulated the TCR, stabilization of population of Russia.

It is important to note that currently the set of criteria affecting tax capacity is mainly being identified using empirical methods. We are going to use regression analysis in order to find most affecting tax capacity criteria in the Yaroslavl region within the Central Federal District.

3. Eliciting a set of criteria effecting the tax capacity of the region, with the use of regression analysis

In order to determine the set of criteria, that effect the tax capacity of the Yaroslavl region we used the database of the Federal State Statistics Service (Rosstat), and identified popular approaches in the literature. The set of criteria is listed in Table 2.

Table 2. Criteria determining the TCR

Criterion	Abbreviation	Comment
Gross regional product	GRP	Includes the tax base for the VAT and excise duties, special tax regimes, corporate income tax and reflects the overall dynamics of the regional economy. It is reflected in six sources as a criterion effecting the TCR.
Personal income excluding social security contributions	PILSC	Includes tax base for personal income tax.
Corporate profit	CP	Includes tax base for corporate income tax.
Net corporate profit	FIS	Makes the tax base for corporate income tax.
The number of occupied employees	FS	Reflects the overall dynamics of the economy of the region and is connected with the criterion of productive forces.
Fixed asset investment	FAI	Reflects dynamics and forms of the tax base for property tax; is associated with the investment climate in the region.
Foreign investments	FDI	Reflects the general dynamics of the economy of the region and is connected with the investment climate in the region.
Retail trade turnover	RTT	Includes the tax base for the VAT, excise duties and special tax regimes of trade organizations.

Prior to using regression analysis for the purpose of identifying the criteria that determine the TCR, statistical data of the Central Federal District was collected. Absolute values were transformed to relative ones using corresponding consumer price indices for the purpose of elimination of autocorrelation, by the following formula:

$$a_{ii} = \frac{a_i}{a_{i-1} CPI_i}, \quad (1)$$

where a_i is the value of the index in the i-th year, CPI_i is the Consumer Price Index in the i-th year.

In order to calculate the TCR in any given year, data on growth of debt on taxes and duties of the budget system in the relevant year have been added to the largest collection of taxes, fees and other mandatory payments. The statistical data for all regions of the Central Federal District of Russia are presented in Table 3.

Table 3. Growth rate of criteria, which determine tax capacity of Central Federal District regions in 2010–2011, %

Region	TCR	GRP	FIS	PILSC	FS	RTT	FDI	FAI	CP
				2010					
Belgorodsk	127.03	122.14	160.21	104.74	100.66	110.17	6832.89	130.19	153.95
Bryansk	155.49	117.88	239.19	109.62	98.18	115.79	170.13	109.44	224.96
Vladimir	107.35	110.91	114.97	104.37	100.09	114.06	64.18	109.53	119.65
Voronezh	114.71	130.65	300	111.54	100.06	117.83	273.09	110.54	139
Ivanovo	106.51	121.74	10.93	112.05	135.06	120.39	369.03	97.27	135.06
Kaluga	114.13	118.84	131.06	106.22	99.98	112.77	73.08	86.95	128.5
Kostroma	104.4	114.26	94.11	103.2	97.98	110.85	231.79	95.24	97.17
Kursk	98.93	115.05	266.5	105.74	101.01	112.63	298.86	119.89	240.99
Lipeck	94.43	107.19	92.29	99.61	99.93	112.4	59.27	110.73	96.26
Moscow	111.36	112.1	91.68	100.28	101.45	108.32	174.79	108.14	106.89
Moscow dist.	106.46	118.02	105.04	107.52	100.35	112.27	83.14	94.82	99.23
Orlyol	109.02	120.81	109.62	107.13	100.23	111.13	17.58	159.87	114.28
Ryazan	118.25	114.62	84.17	98.52	99.92	109.96	98.26	123.5	86.22
Smolensk	106.17	115.49	142.52	102.65	100	105.08	115.26	116.56	132.61
Tambov	97.5	124.3	88.95	104.95	100.1	110.91	75.83	115.85	102.05
Tver	96.35	110.22	100.98	100.57	99.66	106.6	115.98	97.1	114.74
Tula	118.87	108.67	107.46	105.33	99.96	107.18	130.54	96	118.04
Yaroslavl	115.32	114.84	70.22	99.23	99.08	114.62	85.35	91.21	84.34
				2011					
Belgorodsk	138.7	119.69	253.39	107.8	100.07	104.68	87.92	120.83	211051
Bryansk	64.57	103.13	81.86	100.59	98.2	106.86	64.58	141.35	78.44
Vladimir	104.09	107.19	149.65	103.87	100.03	104.91	131.21	88.5	120.41
Voronezh	111.88	100.98	60.64	104.76	99.91	108	132.4	129.33	127.12
Ivanovo	107.24	100.54	107.34	101.32	99.88	106.97	72.15	83.56	97.66

End of Table 3

Region	TCR	GRP	FIS	PILSC	FS	RTT	FDI	FAI	CP
Kaluga	143.68	109.79	204.85	101.69	99.85	106.98	97.13	113.76	142.31
Kostroma	100.4	105.45	48842.8	108.18	101.36	109.88	47.46	120.13	142.83
Kursk	129.29	108.77	332.12	99.25	98.81	102.62	608.83	102.21	191.63
Lipeck	92.97	103.01	129.15	95.86	99.85	103.36	236.49	110.45	120.94
Moscow	106.14	108.06	127.67	99.97	100.3	104.53	146.82	90.47	109.84
Moscow dist.	108.81	109.48	161.91	101.62	100.74	105.32	126.93	95.45	130.96
Orlyol	109.68	103.72	366.42	105.23	98.81	107.44	2629.97	97.21	145.54
Ryazan	114.43	103.62	169.48	101.72	101.19	100.45	102.96	97.98	130.47
Smolensk	106.38	108.23	151.45	100.27	100.24	104.55	104.96	128.3	99.84
Tambov	100.11	91.95	96.66	98.24	100.6	98.65	450.86	99.19	87.29
Tver	104.75	100.82	101.39	100.16	98.73	103.76	46.82	107.52	104.65
Tula	98.1	100.24	139.3	99.56	101.07	107.94	67.98	105.6	105.94
Yaroslavl	109.77	99.67	–850.1	90.59	98.13	102.35	42.87	114.02	156.13

For the purpose of making analysis of the influence of each criterion on the targeting value of the TCR the database for 2010–2011, which reflects dynamics of the influencing criteria for all regions of the Central Federal District, was formed. A weak correlation between criteria and the TCR or the absence of such was revealed on the basis of regression analysis (Table 4). The oddity could be explained by the use of statistics for 2 years, which has led to the analysis of accounting tactical features of two different periods. In order to eliminate the described effect, a similar analysis for the Central Federal District was carried out as well, but only for 2011. Results were the same as in the analysis of the criteria for 2010–2011 (Table 4).

Table 4. Results of correlation and regression analysis of the relationship between the performance criteria and the tax capacity of the Central Federal District regions, 2010–2011

Criteria	Data analysis 2010–2011 (ν = 34)		Data analysis 2011 (ν = 16)	
	The coefficient of determination (R^2)	Statistical significance (t- t-test)	The coefficient of determination (R^2)	Statistical significance (R^2)
GRP	0.111	0.01	0.041	not statistically significant
PILSC	0.073	0.05	0.087	not statistically significant
CP	0.101	0.01	0.173	0.01
FIS	0.010	not statistically significant	0.125	0.05
FS	0.002	not statistically significant	0.014	not statistically significant
FAI	0.006	not statistically significant	0.003	not statistically significant
FDI	0.036	not statistically significant	0.080	not statistically significant
RTT	0.013	not statistically significant	0.0461	not statistically significant

Note: ν is the number of degrees of freedom

Thus, the analysis performed for specified periods showed the absence of connection or the presence of a weak connection between the performance criteria and the TCR (the values of the coefficient of determination are low, less than 0.3). That gives evidence of the weak impact of market criteria specific to the period of the TCR and, at the same time, evidence of the decisive role of structure and characteristics of the regional economy in a given region within the formation of the TCR, and that requires a set of influencing criteria for individual regions.

Out of 30 regions of the Central Federal District 4 regions were chosen for further investigation. The Yarolslavl region was naturally chosen as the home-region, along with its peer region Voronezh with a similar socio-economic development and allegedly similar high tax potential. Other two chosen regions of the same district, which are usually mentioned as being at the bottom in terms of tax capacity and socio-economic development, Ivanovo and Kostroma, were augmented for reference purposes. All four regions are located in the European part of Russia; they have similar natural conditions; comparable population; similar (in pairs) levels of tax potential; and socio-economic development in general (Yaroslavl and Voronezh regions are regarded as leaders in the CFD; while Ivanovo and Kostroma as outsiders). The statistical base of these regions was founded in 1997 (Table 5).

Table 5. The criteria and indicators of the rate of growth in the tax capacity of Yaroslavl, Voronezh, Ivanovo and Kostroma regions in 1997–2012, %

	TCR	GRP	FIS	PILSC	CP	FS	RTT	FIS	FAI
Yaroslavl region									
1997	102.04	96.78		104.40	54.20	97.62	91.34		
1998	50.27	66.56		59.30	22.00	98.71	66.46		73.93
1999	124.93	120.90	701.62	119.60	202.26	102.65	117.27		213.85
2000	122.85	106.88	129.62	116.80	112.07	102.32	99.40	16.65	260.38
2001	134.98	126.58	107.89	113.85	108.56	99.50	103.39	144.87	390.48
2002	120.03	105.35	50.36	115.21	82.28	101.88	105.94	227.64	196.64
2003	79.81	94.50	108.03	114.47	80.88	98.61	105.16	359.88	196.76
2004	97.10	109.33	76.75	108.54	80.00	100.56	110.83	50.47	134.31
2005	102.49	103.95	107.37	107.61	108.50	99.13	113.19	81.63	141.13
2006	91.19	105.67	105.92	120.16	99.04	100.69	118.47	49.36	79.15
2007	126.87	107.27	115.10	108.09	112.73	100.48	114.27	474.09	104.85
2008	98.69	100.35	–21.09	110.26	59.28	99.90	116.97	80.94	108.73
2009	85.52	90.36	30.66	92.59	95.45	97.75	92.79	57.84	94.97
2010	109.77	99.67	–850.10	90.59	156.13	98.13	102.35	42.87	114.02
2011	115.32	114.84	70.22	99.23	84.34	99.08	114.62	85.35	91.21
2012	119.77	105.59	267.00	112.67	155.85	100.30	105.09	756.76	89.61
Voronezh region									
1997	105.27	102.88		126.85		97.92	110.27		84.26
1998	55.68	59.18		68.01		96.86	82.65		63.81
1999	114.07	118.76	–5872.17	110.88	183.50	111.78	107.90	330.15	110.97

Continue of Table 5

	TCR	GRP	FIS	PILSC	CP	FS	RTT	FIS	FAI
2000	102.53	111.39	59.44	96.58	73.01	98.72	97.83	95.08	119.52
2001	106.62	102.82	81.70	115.24	97.23	98.67	113.98	117.93	107.59
2002	119.33	120.38	–7.13	109.76	73.69	101.43	100.22	169.09	134.30
2003	82.60	101.70	243.32	118.02	128.93	97.63	108.24	46.36	110.79
2004	94.41	102.93	–507.29	107.96	101.72	99.41	111.93	172.87	97.25
2005	106.68	103.91	123.10	121.23	111.84	99.61	113.39	84.76	119.56
2006	109.13	114.55	130.27	118.20	103.46	100.16	103.46	187.64	124.91
2007	115.25	117.41	131.59	106.26	123.86	100.45	109.28	129.73	147.16
2008	104.72	112.72	130.64	108.94	130.64	100.25	124.79	65.62	126.13
2009	85.17	94.78	24.08	98.79	49.60	99.11	100.13	147.28	90.77
2010	111.88	100.98	60.64	104.76	127.12	99.91	108.00	132.40	129.33
2011	114.71	130.65	300.00	111.54	139.00	100.06	117.83	273.09	110.54
2012	116.27	118.51	246.28	112.18	125.03	100.28	114.33	75.52	110.21
					Ivanovo region				
1997	105.45	85.50		109.95		99.30	106.90		93.07
1998	53.06	63.00		53.23		93.50	56.34		96.89
1999	101.45	101.22	–64.29	103.98	136.77	102.44	102.79	287.77	47.22
2000	112.06	123.59	97.56	117.40	106.12	100.10	120.44	643.22	165.88
2001	99.04	107.52	70.18	96.74	97.60	99.88	101.29	11.12	100.10
2002	123.23	109.43	–57.61	113.86	71.87	98.49	108.18	216.26	100.69
2003	86.83	98.27	202.58	128.50	94.05	98.53	102.16	26.16	155.29
2004	107.88	107.95	–57.25	113.69	137.13	100.95	110.16	892.86	156.86
2005	101.58	101.75	191.91	110.00	98.62	99.60	111.65	30.67	123.40
2006	104.12	111.24	11.27	117.89	79.54	101.30	124.60	8968.61	109.50
2007	104.63	118.20	1136.95	114.24	138.16	102.06	112.59	37.46	102.96
2008	112.04	101.53	14.42	132.11	65.68	100.32	132.94	227.28	130.52
2009	84.23	92.00	–508.85	97.38	88.61	98.85	93.98	68.93	112.75
2010	107.24	100.54	107.34	101.32	97.66	99.88	106.97	72.15	83.56
2011	106.51	121.75	10.93	112.05	135.06	100.16	120.39	369.03	97.27
2012	114.11	100.19	–759.89	118.79	108.22	100.22	118.56	30.42	74.36
					Kostroma region				
1997	135.96	108.88		104.35		97.57	98.54		95.75
1998	58.83	61.96		58.68		96.50	62.89		71.06
1999	92.47	119.32	1931.62	123.99	136.23	103.48	121.08	74.07	143.70
2000	101.92	102.31	108.01	107.80	93.76	98.87	109.19	205.93	119.37
2001	106.71	110.58	52.49	106.96	99.16	98.53	101.02	16.69	87.20
2002	104.52	101.02	–138.18	113.56	83.24	99.60	107.35	1206.90	110.75
2003	101.39	94.87	23.11	89.05	70.67	99.63	106.55	308.37	82.91
2004	92.18	112.72	–189.96	111.51	124.64	100.12	113.38	549.52	189.10

End of Table 5

	TCR	GRP	FIS	PILSC	CP	FS	RTT	FIS	FAI
2005	95.44	108.29	171.34	117.79	110.74	99.66	105.88	64.77	103.17
2006	121.67	112.10	55.61	119.48	119.43	99.78	115.53	42.44	77.36
2007	103.27	106.88	415.51	109.93	126.60	100.22	110.81	25.01	104.11
2008	113.78	108.87	90.08	106.21	100.89	99.88	114.79	126.09	106.83
2009	89.00	89.51	0.20	98.74	55.50	97.87	97.22	87.32	61.83
2010	100.40	105.45	48842.80	108.18	142.83	101.36	109.88	47.46	120.13
2011	104.40	114.26	94.11	103.20	97.17	97.98	110.85	231.79	95.24
2012	102.97	109.85	210.27	99.20	162.24	98.57	102.15	106.31	129.42

The results of correlation and regression analysis, the relationship between the performance criteria and the TCR for Yaroslavl, Voronezh, Ivanovo and Kostroma regions are presented in Table 6.

Large coefficients of determination suggest existence of association between criteria and results, and that structure of the regional economy determines the structure and formation of the TCR (contrary to what was observed in the analysis performed for specified periods for all regions of the Central Federal District). Moreover, the coefficients of determination, which reveal the level of association between criteria and results, appeared to be different in regions, which proves that such associations depend on particularities of economy of every region.

It is notable that instability of net corporate profit among the regions has led to the absence of the relationship with this variable (see Table 6). In addition, such extreme points as in 1997–1999 and in 2009–2010, which were related to crises occurred in the economy of the Russian Federation, cause the reference-point effect, and produce negative effect on quality of the regression model. Nevertheless, it was decided not to exclude such values from the model for the purpose of using it in the future, when crises can occur as well.

For the purpose of choosing the most important criteria, which will be used in the further research presented below in the paper, the results of correlation-regression analysis presented in Table 6, were used. As the major part of taxes is collected from the following taxes: VAT; excise; corporate income tax; personal income tax; and property taxes, the criteria should be chosen to be related to the outlined taxes to reflect dynamics of tax income from the named taxes.

The highest level of dependence is noted between the TCP and GRP, and between the TCP and RTT. Retail trade turnover and the GRP are forming the major part of tax base related to the indirect taxes, therefore one criterion should be included in the model. Observations that dependence between the TCP and GRP is higher, and that the GRP is a general variable, which reflects the state of the regional economy, have determined the choice in favor of this criterion instead of retail trade turnover.

A high level of dependence could also be observed between the TCP and PILSC, which could be explained by the fact that the PILSC practically forms the total tax base of personal income, and personal income is forming a large part of the TCP. The FAI should also be

Table 6. The results of correlation and regression analysis, the relationship between the performance criteria and the tax capacity of the region in 1997–2012 (Steam regression)

Criteria	Yaroslavl region			Voronezh region			Invanovo region			Kostroma region		
	R^2 the line connection	The best connection		R^2 the line connection	The best connection		R^2 the line connection	The best connection		R^2 the line connection	The best connection	
		Type	R^2		Type	R^2		Type	R^2		Type	R^2
GRP	0.775	grade	0.83	0.796	grade	0.85	0.545	grade	0.66	0.444	polynomial 2 gr.	0.70
PILSC	0.426	polynomial 2 gr.	0.59	0.429	polynomial 2 gr.	0.65	0.581	grade	0.73	0.316	polynomial 2 gr.	0.61
CP	0.394	grade	0.598									
FS	0.246	polynomial 2 gr.	0.28	0.207	polynomial 2 gr.	0.24	0.508	polynomial 2 gr.	0.79			
FAI	0.266	polynomial 2 gr.	0.39	0.552	grade	0.63						
FDI												
RTT	0.330	polynomial 2 gr.	0.60	0.367	polynomial 2 gr.	0.53	0.736	grade	0.84	0.312	polynomial 2 gr.	0.77

included to the set of criteria as the criterion in spite of the absence of its clear statistical dependence, as it is forming a large part of tax base of corporate property.

Among the criteria reflecting corporate profits only the CP criterion showed some statistical dependence, only for Yaroslavl district. We chose not to omit this criterion for performing the analysis.

To summarize, the following criteria were chosen: GRP; PILSC; PILSC; FAI. They form the tax base stemming from the VAT, excises, personal income, corporate profits, and corporate property. Regression analysis confirmed influence of these criteria on the TCP.

4. Multiple criteria (MCDM) approach to the evaluation of the tax capacity of regions

As in the realm of economics decisions are deemed to be made both on psychological grounds and rationality (Morselli 2015), expert evaluation helps to comprise both approaches. MCDM methods proved to be efficient in the realm of economics including finance (Brauers *et al.* 2014, 2012; Podviezko 2012; Podvezko, Podviezko 2010). Consequently, such methods along with regression analysis were chosen by the authors for evaluation of the TPR.

The basis of quantitative multiple criteria MCDM (Multiple Criteria Decision Making) techniques constitute two the matrix of decisions $\mathbf{R} = || r_{ij} ||$, where values or criteria describing the purpose of the study are placed, and the vector $\Omega = (\omega_i)$ weights of these criteria, where $i = 1,2, \ldots, m$; $j = 1,2, \ldots, n$; m – number of criteria, n-number of the compared options (regions). The major result of using MCDM techniques is finding out, which of the compared variants $A_1, A_2, \ldots, A_n$ (regions) is the best according to the set of values

r_{ij} of all criteria R_1, R_2 ,..., R_m . In other words, to rank options in the order of importance (Tamosaitiene, Kaplinski 2013).

The idea of quantitative evaluation using MCDM methods is to join normalized values of criteria, which consequently are made dimensionless, and their weights into one cumulative criterion of evaluation. The simplest is the method of a simple additive weighting SAW (Simple Additive Weighting), evaluation criterion S_j is calculated by the formula (Hwang, Yoon 1981):

$$S_j = \sum_{i=1}^{m} \omega_i \tilde{r}_{ij} , \tag{2}$$

where ω_i is the weight of *i*-th criterion; $\tilde{r}_{ij}$ – normalized (dimensionless) value of the *i*-th criterion for the *j*-th option. One of normalization possibility, which we use in this paper, is:

$$\tilde{r}_{ij} = \frac{r_{ij}}{\sum_{j=1}^{m} r_{ij}} . \tag{3}$$

In order to increase reliability of results, we use another MCDM method – TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution) for multiple-criteria evaluation. This method is one of the most popular; the most commonly used and theoretically grounded multiple-criteria methods. The idea of the method is that among the compared options an object that has the shortest distance from the best option (on the set of all criteria) and the one having the largest distance from the worst case scenario will be recognized as the best alternative (Hwang, Yoon, 1981; Ginevicius, Podviezko 2013; Podviezko, Podvezko 2014).

TOPSIS method uses vector data normalization:

$$\tilde{r}_{ij} = \frac{r_{ij}}{\sqrt{\sum_{j=1}^{n} r_{ij}^2}}, \ (i = 1,2, .. ., m; j = 1,2, ..., n), \tag{4}$$

where r_{ij} and $\tilde{r}_{ij}$ respectively, the value and the normalized value *i*-th criterion for the *j*-th alternative.

In the TOPSIS method first the best solution is constructed:

$$V^{\star} = \{V_1^{*}, V_2^{*}, ..., V_m^{*}\} = \{(\max_j \omega_i r_{ij} \ / \ i \in I_1), (\min_j \omega_i \tilde{r}_{ij} / \ i \in I_2)\}, \tag{5}$$

and the worst one is found,

$$V^{-} = \{V_1^{-}, V_2^{-}, ..., V_m^{-}\} = \{(\min_j \omega_i r_{ij} \ / \ i \in I_1), (\max_j \omega_i \tilde{r}_{ij} / \ i \in I_2)\}, \tag{6}$$

where I_1 – the index set of maximized criteria, I_2 – the set of indexes of minimizing criteria, ω_i the weight of the *i*-th criterion.

Both distances D_j^{*} of each alternative to the best solution, and the distance D_j^{-} to the worst solution are calculated:

$$D_j^{*} = \sqrt{\sum_{i=1}^{m} (\omega_i \tilde{r}_{ij} - V_i^{*})^2} , \tag{7}$$

$$D_j^- = \sqrt{\sum_{i=1}^{m} (\omega_i \tilde{r}_{ij} - V_i^-)^2} \,. \tag{8}$$

The cumulative criterion C_j^* of the method TOPSIS is calculated by the formula:

$$C_j^* = \frac{D_j^-}{D_j^* + D_j^-} \quad (j = 1, 2, ..., n), \; (0 \le C_j^* \le 1) \,. \tag{9}$$

The best alternative corresponds to the largest value of the criterion C_j^*; alternatives are ranked in the descending order, in correspondence to the values of the cumulative criteria.

In practice, from weights elicited from qualified experts the weights suitable for the calculation can be created. Nevertheless, concordance of the opinions must be a priori tested using the theory of rank correlation by Kendall. The coefficient of concordance W allows to gauge the degree of consistency (Kendall 1955). Ranking is a common procedure, when the most important criterion is assigned rank equal to one, the second most important is assigned rank 2, and so on, the last which is the least important criterion is assigned a rank m (where m – a number of criteria).

Consequently, the table-matrix of ranks $E = \left\| e_{ij} \right\| \; (i = 1,...,m; j = 1,...,r)$ is created, where m is an amount of compared criteria and r is the number of experts.

The coefficient of concordance W is calculated by the formula (Kendall 1955):

$$W = \frac{12S}{r^2 m\left(m^2 - 1\right)} \,. \tag{10}$$

In the formula (10) the sum of squared deviations S i-rank-sum $e_i = \sum_{j=1}^{r} e_{ij}$ i-th criterion for all experts of the total medium $\overline{e} = \frac{\sum_{i=1}^{m} e_i}{m} = \frac{\sum_{i=1}^{m}\sum_{j=1}^{r} e_{ij}}{m}$ is calculated by the formula:

$$S = \sum_{i=1}^{m} \left(e_i - \overline{e}\right)^2 \,. \tag{11}$$

The degree of coherence of expert evaluations is not indicated by the coefficient of concordance W, but by test statistics χ^2 whose values are calculated by the formula:

$$\chi^2 = Wr\left(m-1\right) = \frac{12S}{rm\left(m+1\right)} \,. \tag{12}$$

It was proved (Kendall 1955), that if the value χ^2 exceeds the critical value of criteria χ^2_{kr}, taken from the χ^2 distribution table, for the number of degrees of freedom $\nu = m - 1$, and the chosen significance level α, then the null hypothesis about non-concordance of expert opinions can be rejected and therefore the alternative hypothesis is accepted.

At the first phase weights of importance of 10 criteria were ranked in accordance with opinions of 11 experts. The qualitative criteria, characterizing the level of development of the TCR (Table 5), have been added to statistical criteria from Table 5. Estimated value of

the concordance coefficient $W = 0.326$, and the corresponding value criterion $\chi^2 = 32.316$ has exceeded the critical value $\chi^2_{kr} = 16.919$, taken from the table of χ^2 distribution, for the number of degrees of freedom $\nu = 9$ and the chosen significance level $\alpha = 0.05$. Consequently, the statistical hypothesis about the consistency of expert opinions was adopted.

5. Estimates of weights of criteria, which determine the tax capacity of regions

In decision-making problems the so-called subjective weights of criteria are often used. They are calculated from elicited opinions of qualified experts in theory and practice in the realm, where the investigation takes place. A few methods of estimating weights were created (Saaty 1980; Hwang, Yoon 1981; Podvezko, Sivilevicius 2013; Zavadskas *et al.* 2012; Kersuliene *et al.* 2010). The general idea of such a subjective estimation of weights is that the weight of the most important criterion should have the largest value. Magnitudes of weights correspond to the level of importance of criteria. Usually, the values of weights are normalized so that their sum equals the unity:

$$\sum_{i=1}^{m} \omega_i = 1. \tag{13}$$

The method of direct estimation of weights when the sum of estimated weights for all the four criteria by each expert make up 100% was used in the paper.

The so-called objective weights of criteria, which are elicited from the structure of data given in the decision-matrix are estimated based on the level of dominance of criteria among themselves (Hwang, Yoon 1981; Cheng 2010; Hajiagha *et al.* 2012). Such objective weights of criteria are used in decision-making problems as well, and are estimated in this paper by using the multivariate regression model.

Such objective weights are rarely used in decision-making problems. Methods, which comprise both subjective and objective weights, are also available (Hwang, Yoon 1981; Ma *et al.* 1999).

Cumulative weights are calculated by the formula:

$$\omega_i = \frac{q_i W_i}{\sum_{i=1}^{m} q_i W_i}, \tag{14}$$

where q_i is a subjective weight, W_i – objective weight ω_i – cumulative weight.

Such cumulative weights comprise both opinions of qualified experts and data structure, namely the degree of mutual dominance of criteria at the time of evaluation.

Four criteria, selected by the results of regression analysis and expert opinions, were used in the analysis. Consequently, experts were asked to estimate their weights of relative importance in terms of their impact on the TCR. Summary of opinions of experts is presented in Table 7.

Table 7. Summary of opinions of experts on the degree of influence of criteria on the TCR

Ranks of criteria	Expert evaluation (E is an expert)										
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11
GRP	3	1	3	1	1	4	2	3	4	1	3
CP	1	2	2	3	2	2	1	2	2	2	1
PILSC	2	3	1	2	3	3	3	1	3	3	2
FAI	4	4	4	4	4	1	4	4	1	4	4
Opinions on weights of criteria, %											
GRP	15	35	20	35	35	15	31	25	15	40	20
CP	40	27	25	25	30	30	35	30	25	25	40
PILSC	35	25	35	25	25	20	25	35	20	20	25
FAI	10	13	20	15	10	35	9	10	40	15	15
Total	100	100	100	100	100	100	100	100	100	100	100

Expert estimates are denoted as e_{ik}. Weights are found as follows:

$$q_i = \frac{\sum_{k=1}^{r} e_{ik}}{100\sum_{i=1}^{m}\sum_{k=1}^{r} e_{ik}}, \quad (\sum_{i=1}^{m} q_i = 1). \tag{15}$$

In Table 8 values of subjective and objective weights are provided, as well as cumulative weights calculated by formula (14).

Table 8. Weights of TCR criteria

Criterion	Subjective weight, q_i	Objective weight, W_i	Generalized weight, ω_i
GRP	0.260	0.340	0.351
PILSC	0.302	0.233	0.280
CP	0.264	0.209	0.219
FAI	0.174	0.217	0.150

6. Comparative multiple criteria evaluation of perspective regions of the Russian Federation

Using multiple criteria decision-making (MCDM) methods SAW and TOPSIS, the tax capacity of four regions of Russia: Yaroslavl; Voronezh; Ivanovo; and Kostroma for the period 2000–2012 was evaluated. The period was curtailed as for 1997–1999 statistical data for some criteria was not available (see Table 5). Cumulative weights calculated by formula (14) based both on expert opinions, and correlation and regression analysis were used. Calculation results are presented in Table 9.

Results of evaluation provided in Table 9 revealed a very good correspondence between results obtained using the methods SAW and TOPSIS. Minor discrepancies among rankings of evaluations could be noticed only in 2004 and 2010. The differences were induced by small deviations between the cumulative criteria (deviation values for Yaroslavl and Voronezh regions made up 0.004 and 0.02). Moreover, some discrepancy allowance should

be reserved because of subjectivity in estimations of weights of criteria. Additional information about the TCR of the chosen regions was obtained using the stochastic approach. Correlation and regression prediction analysis of the TCR was performed using the available empirical data. The model is described by the following regression equation (16):

$$TCR_i = -84.778 + 14.298\ GRP_i + 3.575\ PILSC_i + 0.009\ CP_i + 0.029\ FAI_i. \quad (16)$$

Table 9. Results of multiple-criteria evaluation of gain of the TCR in four regions of Russia in 2000–2012

Year	Districts	Yaroslavl		Voronezh		Ivanovo		Kostroma	
2012	TOPSIS	0.5408	3	0.5720	2	0.2740	4	0.6804	1
	SAW	0.2518	3	0.2574	2	0.2267	4	0.2641	1
	Rank	3		2		4		1	
2011	TOPSIS	0.0137	4	0.9891	1	0.7556	2	0.2164	3
	SAW	0.2242	4	0.2774	1	0.2643	2	0.2341	3
	Rank	4		1		2		3	
2010	TOPSIS	0.6505	2	0.6300	3	0.2028	4	0.8043	1
	SAW	0.2522	3	0.2562	2	0.2257	4	0.2659	1
	Rank	2–3		2–3		4		1	
2009	TOPSIS	0.7916	2	0.2817	3	0.8606	1	0.1460	4
	SAW	0.2653	2	0.2375	3	0.2725	1	0.2248	4
	Rank	2		3		1		4	
2008	TOPSIS	0.0528	4	0.7541	1	0.3136	3	0.5049	2
	SAW	0.2216	4	0.2805	1	0.2468	3	0.2512	2
	lace	4		1		3		2	
2007	TOPSIS	0.0635	4	0.6800	1	0.5138	2	0.2715	3
	SAW	0.2362	4	0.2617	1	0.2592	2	0.2429	3
	Rank	4		1		2		3	
2006	TOPSIS	0.3302	4	0.7266	1	0.3634	3	0.5523	2
	SAW	0.2387	4	0.2646	1	0.2428	3	0.2539	2
	Rank	4		1		3		2	
2005	TOPSIS	0.5803	2	0.6129	1	0.3402	4	0.4669	3
	SAW	0.2520	2	0.2554	1	0.2412	4	0.2514	3
	Rank	2		1		4		3	
2004	TOPSIS	0.2554	4	0.2587	3	0.7800	2	0.8408	1
	SAW	0.2318	3	0.2274	4	0.2681	2	0.2727	1
	Rank	3–4		3–4		2		1	
2003	TOPSIS	0.5379	3	0.6243	1	0.5962	2	0.0065	4
	SAW	0.2578	3	0.2710	1	0.2662	2	0.2051	4
	Rank	3		1		2		4	
2002	TOPSIS	0.6910	1	0.4966	2	0.2036	4	0.2401	3
	SAW	0.2684	1	0.2538	2	0.2370	4	0.2408	3
	Rank	1		2		4		3	

End of Table 9

Year	Districts	Yaroslavl		Voronezh		Ivanovo		Kostroma	
2001	TOPSIS	0.9848	1	0.1888	2	0.0731	4	0.1402	3
	SAW	0.3115	1	0.2316	2	0.2219	4	0.2290	3
	Rank	1		2		4		3	
2000	TOPSIS	0.7500	1	0.1498	4	0.5953	2	0.2729	3
	SAW	0.2815	1	0.2182	4	0.2704	2	0.2299	3
	Rank	1		4		2		3	

The coefficient of determination R2 appeared to be 69.6%. F-Fisher test at a significance level (α) of 1% was performed. Consequently, the multiple regression equation is found to be statistically significant. The average error of approximation ($\overline{A}$) was 8.25%. These figures together indicate that the model is acceptable and can be used for the analytical purposes.

In this model the dependent variable reflects the growth rate, which depend on chosen variables. Table 10 shows the ranks resulting from evaluation of the TCR of the regions on the basis of correlation-regression analysis model.

Comparison of the ranks obtained using the stochastic approach (Table 10) and the ones obtained using MCDM methods (Table 9) for the four chosen regions showed rather good correspondence. There is a full correspondence between obtained ranks for the following years: 2003, 2004, 2006–2008, 2010, and 2011. Some differences were found for 2000–2002, 2005, 2009, and 2012. A few possible causes of the discrepancies could be named. Values of criteria, which determine growth of the TCR, are often close among the regions. Therefore, even small differences of such values result in differences in ranks. Weights are different, ones obtained by expert evaluation and by the correlation-regression analysis. Also, the presence of unexplained variation makes unexpected effects on the result.

Table 10. The comparative evaluation of growth of tax capacity in four regions of Russia in 2000–2012 based on regression analysis

Year	Yaroslavl	Voronezh	Ivanovo	Kostroma
2012	3	1	4	2
2011	4	1	2	3
2010	3	2	4	1
2009	3	1–2	1–2	4
2008	4	1	3	2
2007	4	1–2	1–2	3
2006	4	1	3	2
2005	2–3	2–3	4	1
2004	3	4	2	1
2003	3	1	2	4
2002	2–3	1	2–3	4
2001	1	4	3	2
2000	2	3	1	4

In general, we can conclude that using both MCDM and regression techniques to explore the options for evaluating and predicting the TCR is promising because of extremely negligible discrepancies between results obtained using such different methods as MCDM methods and regression analysis. The discrepancies could be explained by the effects of normalization of data. As in the sub-set such criteria that relate to the rate of growth values differ insignificantly, the MCDM methods become more sensitive to the data. It could be assumed that in the case if only criteria, which relate to the TCR were kept, MCDM methods would reveal the absolute degree of stability in terms of results, as differences between values of such criteria are more substantial, than values of criteria that relate to the rate of growth of the TCR. Nevertheless, absolute matching of ranks obtained by different evaluation methods is rarely found in the literature.

Conclusions

The study identified criteria that influence tax capacity of regions of the Russian Federation: gross regional product, personal income excluding social security contributions, corporate profit, investment in fixed assets. The set of the criteria was elicited from the structure of the TCR, and tax bases of component taxes. In the paper choice of criteria was made empirically using regression analysis. The results obtained by the empirical research were comprised with the results of expert evaluations, which were ultimately summarized using multiple criteria methods. The novel part of the paper is applying evaluation of the TCR of different regions by using simultaneously two different approaches: MCDA and regression analysis. The paper provides some insight on particularities of evaluation of tax capacity of the regions of the Russian Federation.

Comparative evaluation of the TCR of chosen regions of the Central Federal District of Russia for the period 2000–2012 using two MCDM methods showed the existence of minor differences between ranks caused by similarity of values of the criteria, which relate to the rate of growth of the TCR. The use of criteria that relate only to the current state of the TCR should have led to almost complete coincidence of ranks. It is important to note, that most periods are characterized by absolute similarity of ranks in the regions by the TCR obtained by different methods, which proves the suitability of multiple criteria assessment methods, and regression analysis. Such a combination of two different methods is a novel approach.

Tax authorities, which administer collection of taxes, should be interested in the research as contrary to the available information it reveals a different view on tax capacity of the regions. At times the regions, which are regarded to be leaders (Yaroslavl and Voronezh) are found at the bottom, and contrary the allegedly lagging regions (Ivanovo and Kostroma) are attaining good positions. Knowing relative positions of the regions allows finding causes of the lagging or prominent positions in terms of values of criteria, which describe the TPR.

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