INFLUENCE OF THE INDUSTRIAL STRUCTURE OF ECONOMY ON THE RISK LEVEL OF RUSSIAN REGIONS' TAX SYSTEMS

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Abstract

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The paper is aimed at study of the influence of industrial structure of regional economy on its tax system risk level. The tax systems risk level of Russian regions in 2006–2014 was assessed applying the H. Markowitz portfolio approach under the assumption that regional "portfolio" consists of main economic activities. It allowed us to evaluate contribution of various economic activities to total tax system risk, to decompose it into internal and external by origin and to identify the critical zones of instability in Russian regions. The coefficients of variation of tax yield rate revealed different relative impact of the economic activities on instability of regional tax systems. Besides, we found mainly positive albeit changing in strength correlation between internal and total tax system risk level and tax yield rate in economic activities. The diversification level of regional economies was evaluated by means of standard deviation of regional industrial structure from country structure considered as a benchmark. Inclusion of this level along with the tax yield rate and a set of control variables into two developed regressions estimated with GRP-weighted least-square method allowed us to confirm positive influence of diversification on the tax systems stability. Our results may be applicable to management of tax system risks at the regional level.

Keywords: region, industries, tax system, risk, portfolio, decomposition, diversification

INTRODUCTION

The researchers studying characteristics of tax systems, such as risk and efficiency, usually pay attention to various factors influencing them (Mahdavi, 2008; European Commission, 2013). Some of them examine interrelationship of tax systems volatility with economic growth (Fricke and Süssmuth, 2014; Cornia and Nelson, 2010) or economic cyclicality (Kodrzycki, 2014). Usually these dependencies are considered at the macro level without structural analysis. Only few researches are concerned about influence of industrial structure of economy on characteristics of tax systems. For example, (Karagöz, 2013) based on econometric analysis of Turkish economy revealed, among other factors, the positive influence of industrial sector and negative influence of agricultural sector shares in GRP on tax revenues. (Carrol, 2009) established

that growth in level of diversification of tax revenue improves tax system performance and enhances its stability, whereas its combination with tax revenue complexity may oppositely increase tax system volatility.

Obviously, the industries composing an economy show different performance and bring unequal relative tax revenues to the fiscal system. Besides, they respond to external shocks in different manner and demonstrate different reaction to factors influencing them. In the scope of economy total tax return is composed of tax returns in various industries. Their tax yield rates may covariate pro-cyclically or counter-cyclically, thereby reinforcing or offsetting the total tax system volatility. It means that both industrial structure of economy and the level of its diversity significantly affect tax system performance.

The authors who study diversification or specialization of economy propose a range of measures to evaluate them, and the complex observation of these techniques can be found in: (Measuring Economic Diversification, 2012; Palan, 2010). At a regional or state level an analysis of economy diversification based on time series or panel data is usually aimed to establish its impact on economic growth or economic stability. From this standpoint, authors usually explore the gains and losses of economic specialization or diversification. Thus (Pirasteh *et al.*, 2009) pointed out that more diversified economies may better mitigate risks occurring in various industries and therefore exhibit greater resistance to external shocks. They easily adapt their paths of development and may technologically benefit from positive return to diversity.

However, the empirical studies of the effects of diversification are rather ambiguous. Indeed, (Pede, 2013) has proved that diversification of US counties' economies in 1990–2007 was positively correlated with economic growth. On the contrary, (Essletzbichler, 2002) has established negative contribution of economic diversification to the rates of economic growth and its positive contribution to the growth rates stability. (Brown, 2012) in his single region time series multiple regression analysis has found favorable influence of diversification on reduction in the employment volatility. At the same time, many authors have pointed out that a more specialized economy can benefit from the so called comparative advantages and positive returns to scale. Therefore, under favorable market conditions such economies usually grow faster. Taking into account the advantages and disadvantages of the two competing strategies, (Hong and Xiao, 2016) argue that the greatest benefits an economy can derive from their right combination. Obviously, the choice of two strategies fits into a trade-off between growth and stability in economic policy.

Similarly, the researches of Russian regions provided some evidence of positive influence of economy diversification on its development indicators. Thus in (Ankudinov *et al.*, 2012) the authors by employing econometric analysis revealed the positive albeit weak influence of diversification on decline in both the level of unemployment and its volatility assessed by standard deviation. Another study of Russian regions conducted by (Mikheeva, 2013) for 2000–2011 established that more diversified regional economies in Russia on average demonstrate more stable economic growth, whereas more specialized regions show the higher rates of it. On the contrary, (Kravchenko, 2016) in the study of the regions of Siberian Federal District revealed strong negative influence of the share of employed persons in manufacturing activity and the level of export specialization on the level of unemployment, concluding that there is no evidence of positive impact of economic diversity on its stability.

Thus, results related to Russian economy are also contradictory. However, we have not found any research examining the precise effect of industrial diversification on fiscal risks.

It encourages our recent study to deal with impact of economic structure on tax system volatility as an independent issue that appears to be relatively new. This approach differs from the mentioned above where either tax system volatility was considered as result of tax revenues structure, or industrial structure was studied affecting parameters of real economy. Here we combine these two types of interactions and analyze indirect impulses transmitted from economic structure to tax system characteristics. We try to identify how fluctuations in various industries composing an economy generate total risk of the tax system.

Therefore we need to clarify what we mean by the tax system risk. Since an economy is composed of industries or activities, tax system risk level may be evaluated based on the "portfolio approach", referring to H. Markowitz theory, which was extended to tax systems risk assessment by (Seegert, 2015). In our previous research we also used the Markowitz portfolio theory and Sharpe ratio for assessment of Russian regions tax systems risk and efficiency as a whole (Malkina and Balakin, 2015) and allocated to different levels of budget system (Malkina and Balakin, 2016). Formerly we composed tax portfolio of 8 various taxes and tax groups. Here we build it directly from economic activities following its natural structure, which allows us to evaluate the contribution of each activity to total tax risk. Besides, we assume that economic activities in portfolio represent aggregated taxpayers with similar reactions to shocks.

Now we can formulate our *research hypothesis*. In our study we suggest that both industrial structure and level of diversification of economy do matter for tax system return and risk. Some industries like mining and quarrying should bring more revenue and add more risk to the tax system, whereas diversification of economy should partially mitigate it.

MATERIALS AND METHODS

Our study is based on the official information on 83 Russian regions in 2006–2014, provided by (Russian Federation State Statistics Service, 2007) and (the Federal Tax Service of Russia, 2007). The data embraces GRP and tax revenues disaggregated by 14 main economic activities, according to the All-Russian Classifier of Types of Economic Activity.

Our technique includes the following calculations.

1. *Annual tax yield rates in main economic activities for all regions* are assessed as ratio of their tax revenues to total GRP of the regions:

$$t_{ijk} = T_{ijk}/Y_{ij}, \tag{1}$$

where

T_{ijk} . the total tax revenues from "*k*" activity of the "*i*" region in the "*j*" year;

Y_{ij} .. the gross domestic product of the "*i*" region in the "*j*" year, and $i = \overrightarrow{1, m}, j = \overrightarrow{1, n}, k = \overrightarrow{1, K}$.

2. *Total tax system risk arising in each economic activity of each region* is evaluated by means of the H. Markowitz portfolio approach and consists of two parts:

– *internal risk*, measured by the inter-temporal variance of tax yield rate in each activity:

$$\sigma_{ik}{}^2 = \sum_{j=1}^{n}\left(t_{ijk} - t_{ik}\right)^2, \tag{2}$$

where $t_{ik} = \sum_{j=1}^{n} t_{ijk} / n$ – inter-temporal arithmetic mean of tax yield rate of "*k*" activity in "*i*" region.

– *external risk* calculated as the sum of the inter-temporal covariances of tax yield rate in each "*k*" activity with that in all other "*l*" activities, other than "*k*", where $l = \overrightarrow{1, L}, l \neq k, L = K - 1$:

$$Cov(t_{ik}; t_{il}) = \sum_{j=1}^{n}\left(t_{ijk} - t_{ik}\right)\cdot\left(t_{ijl} - t_{il}\right). \tag{3}$$

Total tax risk induced in each "*k*" economic activity in each "*i*" region may be calculated by one of the following ways:

$$R_{ik} = \sigma_{ik}{}^2 + \sum_{l=1; l \neq k}^{L} Cov(t_{ik}; t_{il}); R_{ik} = Cov(t_{ik}; t_i). \tag{4}$$

The second formula allows to figure out total risk as covariance between tax yield rate in the correspondent activity and total tax yield rate generated by all activities in the region. This approach corresponds to the A. Shorrocks technique proposed for inequality decomposition by sources (Shorrocks, 1982) and gives the same result.

Ultimately, total tax system risk in each "*i*" region is determined as follows:

$$\sigma_i = \sqrt{\sum_{k=1}^{K} R_{ik}} \ . \tag{5}$$

3. *The level of regional economy diversification* may be estimated using a range of methods. Thus, (Wagner, 2000) grouped them into equiproportional, type of industries, portfolio, and input-output and evaluated their strengths and weaknesses. Other authors demonstrated that results obtained with various methods are quite different (Palan, 2010), thus their choice is still challenge. After preliminary analysis we have chosen the measure that provides the strongest dependencies of the level of diversification with other variables – namely, the standard deviation of regional industrial structure from the country industrial structure considered as benchmark or standard:

$$SD_i = \sqrt{\frac{1}{K}\sum_{k=1}^{K}\left(s_{ik} - s_k\right)^2} \ , \tag{6}$$

where

s_{ik} ... the share of "*k*" activity in total GRP of "*i*" region,

s_k ..... the share of "*k*" activity in total GRP nation-wide.

This approach has some similarities and differences with the Ogive index, representing variance referred to benchmark shares equal to 1/K. Besides, the Ogive index proposes to multiply the sum of squared deviation to K, whilst our index proposes to divide them, which is consistent with the principles of a standard deviation construction.

4. *The level of instability of* industrial structure engaged in our regression analysis is assessed by inter-temporal standard deviation:

$$SD_i = \sqrt{\frac{1}{K}\sum_{k=1}^{K}\frac{1}{n}\sum_{j=1}^{n}\left(s_{ijk} - s_{ik}\right)^2}, \tag{7}$$

where

s_{ijk} ... the share of "*k*" activity in total GRP of "*i*" region in "*j*" year,

s_{ik} ... average share of "*k*" activity in GRP of "*i*" region for all years.

5. *The level of tax yield rate equality* in various industries that is also used in our regression analysis can be estimated by means of the F. Hachman index:

$$HI_i = 1 / \left(\sum_{k=1}^{K}\frac{\tau_{ik}}{s_{ik}}\cdot\tau_{ik}\right), \tag{8}$$

where

τ_{ik} ... the share of "*k*" activity in total tax revenue of "*i*" region.

6. Ultimately, the regions' tax systems risk, return and the level of diversification of economy were included in extended regression models with adding some control variables.

RESULTS

The results of assessment of risk level of the regional tax portfolios using formulas 1–5 are presented on the geographic map of Russian regions (the Fig. 1).

The highest level of tax system risk at a rate of 9.7% to GRP is observed in Zabaykalsky Krai (No. 75 in the map) located in the southeast of the Siberian Federal District. Since Zabaykalsky Krai has noticeably lower tax yield rate compared to the country level (15% against 21.8% to GRP), it also demonstrates the largest value of the coefficient of variation (0.648) among all Russian regions. Transport and telecommunication activity accounting for the largest share in this region GRP, namely 23.63%, generates as much as 25.92% of total tax revenues and 28.61% of tax system risk. Meanwhile, the mining and quarrying industry
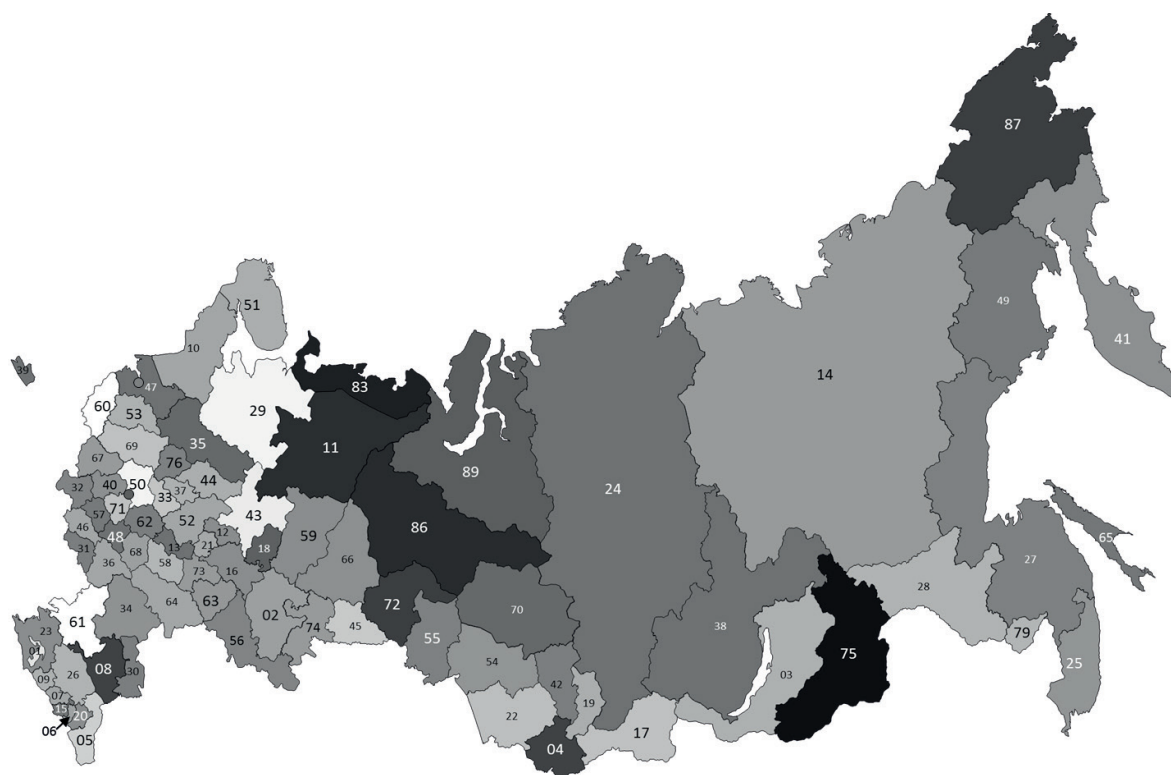
1: *The risk level of Russian regions' tax systems (logarithmic scale)*
Note: The subjects of Russian Federation are designated by administrative codes explained in the text
Source: The author's own calculations based on data provided by Federal Tax Service of Russia (https://www.nalog.ru/
eng/) and Russian Federation Federal State Statistics Service (http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/
en/main/).

proves to be the most risk increasing for the tax system of this region. Whereas it produces only 8.32 % of GRP and provides 9.35 % of tax revenues, it generates as much as 21.48 % of total tax system risk in the region. A significant excess of the share in tax risk over the share in GRP is also typical for Electricity, gas and water activity in Zabaykalsky Krai. Obviously, extraction of minerals and non-ferrous metals, power generation and provision of freight traffic are complementary activities in this region, sharing common risks.

The riskiest tax systems are also peculiar to other Russian regions specializing in minerals extraction. Thus, the second and third highest risky ranking territories are Nenets (No. 83) and Khanty-Mansi (86) Autonomous Districts, where the Mining and quarrying industry, mainly represented by oil and gas production, provides 71.82 % and 67.13 % of total GRP, accordingly. In Nenets Autonomous District the tax system demonstrates risk at the level of 8.28 % compared to the mean value of tax yield rate at 25.78 %. In Khanty-Mansi Autonomous District it is 7.29 % compared to 57.93 % tax yield rate. Two other leading mining regions are: Yamal-Nenets Autonomous District (No. 89), where the share of mining industry, again presented by gas and oil extraction, reaches 51.31 % of its GRP, and Sakhalin Oblast (65) with the industry share of 54.85 %. They are ranked 10th and 22nd accordingly by risk level

of tax systems and 61st and 17th by tax system risk/return ratio. Among other mining territories with increased risk of tax system we would mention Komi Republic, No. 11 (7.07 %/27.84 %), and Chukotka Autonomous District, No. 87 (5.77 %/21.35 %).

Nevertheless, in the group of mining territories we have some exclusion, first of all, Republic of Sakha (Yakutia) (14) and Orenburg Oblast (56). In these regions mining industry provides 37.19 % and 31.91 % of GRP respectively, but total risks of their tax systems are only 1.67 %/15.61 % and 2.32 %/27.36 %. This outcome is resulted mainly from relatively lower risk of mining industry in these territories and smoothing effects provided by other industries such as Wholesale, Retail Trade & Repair and Real Estate, Leasing & Services.

Among the regions with high risky tax systems we can also identify some underdeveloped southern border territories, namely Republic of Kalmykia (08) and Altai Republic (04). In their industrial structure the agriculture dominates, providing 32.33 % and 19.24 % of total GRP, respectively in two Republics. About one fourth of population of Kalmykia is engaged in agricultural production, mainly beef cattle, meat and fine-wooled sheep breeding. Altai Republic specializes in animal husbandry and horticulture, cultivation of fodder crops, buckwheat. But actually agriculture in both republics ensures smoothing of tax revenues volatility. The largest
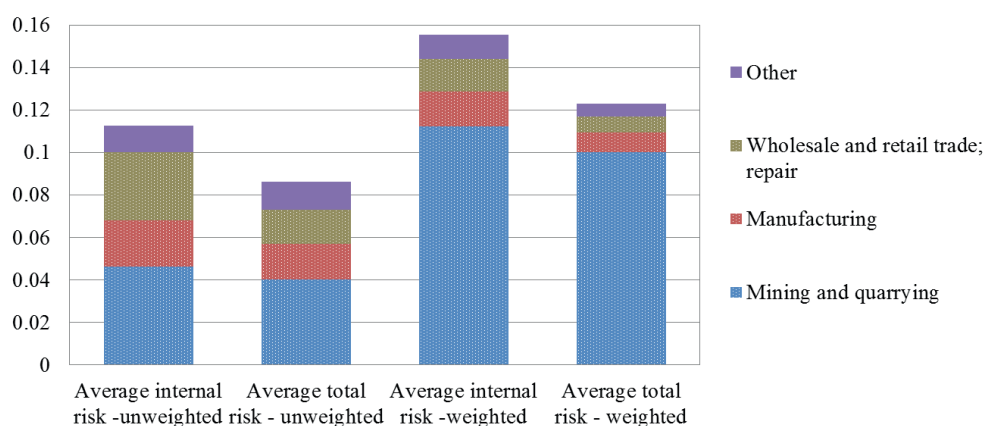
2: *Average internal and total risk of tax portfolio of Russian regions assessed by means of variance-covariance unweighted and weighted approaches*
Source: The author's own calculations based on data provided by Federal Tax Service of Russia and Russian Federation Federal State Statistics Service.

part of tax risk here originates from trade industry (159.7% and 63.49% of total risk value). Evidently, this is the result of both low level of development and unstable incomes of population inhabited these backward territories.

Now we have to turn our attention to the regions with the lowest tax system risk level. The leading position among them belongs to Rostov Oblast (61), the subject of Southern Federal District. Rostov Oblast has a highly diversified economy. Here the shares of the most productive industries, manufacturing and trade, amounting to 18.84% and 19.81% in the regional GRP are very similar to average shares of these industries in Russia (18.12% and 19.83%). Agriculture showing an increased proportion of GRP (11.58% against 4.58% nation-wide) provides only 2.25% of total tax revenues. Among other lower risky territories we can find a number of regions with well-balanced economies, such as Pskov (60), Moscow (50), Arkhangelsk (29) and Kirov (43) Oblasts. All of them are characterized by high level of economy diversification, albeit not the highest among all the regions. In the five mentioned regions the risk/return ratio of tax systems, i.e. the coefficient of variation of tax yield rate, is below 0.05. It means that tax yield rate may deviate from its mean value by less than 5%.

Additionally, in other 27 regions (from 83 total number) risk/return ratio does not exceed 10%. These regions either have highly diversified economies, e.g. Samara Oblast (63) and Republic of Bashkortostan (02), both in the Volga Federal District, or demonstrate increased share of manufacturing in GRP. Among the territories with moderately risky tax systems we can find the following highly industrial Russian regions: Tula (71), Kaluga (40), Vladimir (33), Yaroslavl (76), Ryazan (62) and Kostroma (44) Oblasts, the subjects of the Central Federal District; Perm Krai (59), Nizhni Novgorod Oblast (52) and Chuvash Republic (21), belonging to the Volga

Federal District; and Novgorod oblast (53), located in the Northwestern Federal District.

Meanwhile, other highly developed regions with an even larger share of manufacturing in GRP, on the contrary, demonstrate a higher risk of tax systems. The most typical examples of them are Lipetsk (48), Vologda (35) and Chelyabinsk (74) Oblasts, where the share of manufacturing activity in GRP reaches 43.48%, 40.31% and 36.31% respectively. Manufacturing provides 33.52%, 36.97% and 42.86% of total tax revenues in these regions and creates 121.93%, 119.06% and 106.72% of total tax system risk accordingly, while many other industries mitigate it. In Lipetsk Oblast a special economic zone with a preferential taxation regime operates which reduces the volume and possibly increases the volatility of tax revenues. The main role in manufacturing structure of the above three regions belongs to ferrous metallurgy which performance, obviously, depends on global market scope. In other regions with a predominant share of the manufacturing industry in GRP and increased risk/return ratio different industries may become a source of tax volatility. For instance, in Omsk Oblast (55), where manufacturing accounts for 40.31% of total GRP, generates 37.6% of total tax revenues and 128.84% of total tax system risk, the refining and petrochemicals production prevails in its structure.

After the detailed regional analysis we can proceed to the overall picture review. The Fig. 2 demonstrates average tax system risk in Russian regions. The so-called internal risk is assessed by tax yield rate variance (formula 2), and total risk – by adding covariances to it (formulas 3 and 4). Besides, when calculated average values we used two alternative approaches: unweighted and weighted. The unweighted approach is based on the simple regional mean, whereas the weighted approach takes into account the scale of regional economies and outlines the nation-wide position.

According to the results obtained, the overall risk of regional tax systems is on average lower than their internal risk, which is due to the multidirectional changes in tax yield rates in various industries. Additionally, a weighted risk score appears higher than unweighted ones, which means that larger regional economies contribute relatively more to nation-wide risk. However, the dependency between the risk and the share of regional economy in total GRP is statistically insignificant and visible heteroscedasticity is observed. Finally, Fig. 2 shows that the largest contribution to the average risk of the region's tax systems is made by three industries: Mining and quarrying, Wholesale and retail trade and Manufacturing.

The Tab. I represents the results of decomposition of average inter-regional tax system risk and tax yield rate by economic activities. Both approaches witness relatively higher tax risk in Mining & Quarrying industry compared to its tax return. According to inter-regional simple mean, this activity generates 41.13% of internal risk and 46.65% of total risk, providing only 22.48% of the tax system total return. Nation-wide, the contribution of mining industry to tax system risk and return is noticeably higher, which is due to allocation of mining industry in relatively larger regional economies and positive covariance of its tax yield rate with that in other industries.

Manufacturing, the industry secondly ranked by tax return and total tax risk, on the contrary, demonstrates their reduction when moving from unweighted to weighted assessments and from internal to overall risk. Apparently, this result is explained by a relatively lower level of the tax risk of manufacturing in regions with larger economies.

Wholesale and retail trade and repair activity, the thirdly ranked, ensures 11–12% of total tax revenues and demonstrates steady decrease in tax risk when interacting with other industries and weighting by scale of economy. An increased tax risk/return ratio is also observed in the Russian fishing industry, but its share in the country total production is almost imperceptible. Eventually, excess of the total risk over internal risk in Transport and telecommunications activity is resulted from positive covariance of its tax yield rate with the rates in other industries.

Both unweighted and weighted approaches evidence smoothing role of some activities in total tax systems risk. Firstly, we would mention significant contribution made by Construction, Transport and telecommunications and Real estate, leasing and services activities to the tax systems stability. According to the weighted approach, their total share in tax return surpasses their share in internal tax system risk by 18.52% and exceeds their share in overall risk by 19.36%. Secondly, we can establish the positive influence of Public Administration & Defense and the entire social sphere (Education, Health & Social Services, Public Utilities) on mitigating the risk of tax system. These four activities altogether ensure 13.76% of positive difference between tax system return and tax system risk, when evaluated unweighted, and 10.00% of it – based on weighted estimations. The observed negative contribution of the above three activities to the total risk is mainly due to their tax rates change in the opposite direction to the rates of other activities. However, this is an average pattern, which may vary from region to region.

I: *Average industrial structure of tax yield rate and tax portfolio risk of Russian regions based on unweighted and weighted approaches (%)*

Industries	Unweighted approach			GRP-weighted approach		
	return	internal risk	total risk	return	internal risk	total risk
Agriculture, hunting and forestry	0.91	0.22	0.05	0.57	0.08	0.06
Fishing, fish farming	0.39	0.31	0.61	0.13	0.06	0.09
Mining and quarrying	22.48	41.13	46.65	30.95	72.27	81.44
Manufacturing	23.49	19.41	19.24	19.24	10.44	7.77
Electricity, gas and water	5.05	0.98	2.13	3.44	0.37	0.85
Construction	6.20	2.13	1.93	5.82	0.63	–0.59
Wholesale and retail trade; repair	10.90	28.52	18.68	11.58	9.97	6.04
Accommodation and food service activities	0.57	0.01	–0.04	0.71	0.02	–0.27
Transport and telecommunications	8.67	3.91	8.51	8.11	1.99	4.07
Real estate, leasing and services	7.98	2.55	2.64	11.08	3.87	2.17
Public administration and defense	6.00	0.60	–0.47	2.93	0.12	–0.75
Education	3.30	0.11	–0.19	2.10	0.05	–0.81
Health and social services	2.69	0.06	–0.06	1.72	0.02	–0.49
Public utilities	1.37	0.06	0.32	1.62	0.11	0.42
Total	100.00	100.00	100.00	100.00	100.00	100.00

Source: The author's own calculations based on data provided by Federal Tax Service of Russia and Russian Federation Federal State Statistics Service.

Thus, the share of Public Administration activity in GRP is usually higher in lagging territories appreciably subsidized from the federal budget. In Republic of Ingushetia (No. 06) it accounts for 25.72%, in Chechen Republic (20) – 23.21%, in Republic of Tyva (17) – 21.93%, when country average is just 5.09%. Moreover, this activity provides 37.34%, 32.56% and 29.20% of total tax revenues in these republics, respectively. However, its impact on the risks of regional tax systems differs significantly, largely depending on the volatility of intergovernmental transfers supporting them.

Republic of Ingushetia shows the highest among all Russian regions contribution of public administration activity to tax system risk – 26.61% (the internal part of which is 22.64%). Jewish Autonomous Oblast (79) engages the second position in this ranking. Here the share of Public Administration in tax system revenues amounts to 13.22%, while its share in total tax risk is 16.6%, and in internal risk – 9.27%. On the contrary, Republic of Dagestan (05) may be an example of a region where positive internal risk is not amplified, but is greatly overlapped by negative inter-temporal covariances of tax yield rates. In our opinion, such fiscal policy, essentially countercyclical, may be appraised as exceptionally positive.

In the poorer republics there is also a large share of education and health activities in GRP, but this does not indicate a high level of social policy there, since per capita spending is relatively lower. At last we can establish that in 56 out of 83 regions the contribution of the education activity to total tax system risk is negative and the same is observed in 55 regions for Public Administration and Health & Social Services activities. This verifies a generally positive impact of these spheres on the regions' tax systems risks.

The Tab. II demonstrates the ratio of average internal and total risk of regional tax systems to average return in them for main economic activities. Its examining allows us to conclude that the most relatively enhancing tax risk activities are Fishing and Agriculture, although their total contribution to tax system risk is low due to their small share in GRP and small tax yield rate. Additionally, the Tab. II represents the inter-regional coefficients of correlation between internal and total risk in main economic activities, on the one hand, and their return, on the other hand.

In general, the estimates confirm the basic law of economic theory, which establishes a positive relationship between profitability and risk. Meanwhile, only fishing, mining and manufacturing industries demonstrate a strong direct dependency. For Transport and telecommunications it is medium by strength, for Construction it is observed only under an unweighted approach and for Public utilities – vise versa – under a weighted one. For some activities, e.g. Electricity, gas and water, Transport and Public utilities, the relationship between tax system risk and return is enhancing when moving from internal to total risk. For many other activities it is weakening because of negative covariance of their tax yield rates with the rates in other activities. Ultimately, in Construction, Accommodation and food services, Public administration and defense, Education and Health care, the dependencies

II: *Coefficients of variation and Pearson correlation between risk and return in main economic activities*

Industries	Unweighted approach				GRP-weighted approach			
	CV_{in}	CV_t	Cor_{in}	Cor_t	CV_{in}	CV_t	Cor_{in}	Cor_t
Agriculture	1.159	0.500	0.073	−0.365	1.062	0.866	0.204	−0.234
Fishing	3.219	3.921	0.932	0.894	4.138	4.464	0.861	0.734
Mining	0.636	0.593	0.642	0.680	0.599	0.565	0.591	0.652
Manufacturing	0.418	0.365	0.642	0.581	0.366	0.281	0.612	0.550
Electricity	0.436	0.564	0.449	0.084	0.387	0.517	0.480	−0.175
Construction	0.525	0.437	0.555	0.400	0.296	−0.254	0.211	0.054
Trade	1.091	0.774	0.128	0.100	0.594	0.411	−0.025	−0.208
Accommodation	0.466	−0.667	0.721	0.069	0.487	−1.427	0.744	−0.218
Transport	0.508	0.657	0.485	0.397	0.379	0.482	0.374	0.396
Real estate	0.446	0.397	0.199	0.059	0.387	0.258	0.456	0.206
Public admin.	0.288	−0.222	0.362	0.056	0.258	−0.571	0.465	0.199
Education	0.220	−0.256	0.304	0.106	0.234	−0.831	0.117	0.428
Health	0.197	−0.184	0.276	0.186	0.201	−0.789	0.139	0.430
Public utilities	0.396	0.804	0.189	0.214	0.438	0.773	0.846	0.445
Total	0.223	0.195	0.239	0.350	0.218	0.194	0.448	0.594

Note: CV_{in} and CV_t – coefficient of variation, estimated as the ratio of average internal or total risk to average tax yield rate, when regional risk is calculated as the square root of tax yield rate variance with sign rendered; Cor_{in} and Cor_t – the Pearson coefficients of correlation between internal (total) tax risk and return.
Source: The author's own calculations based on data provided by Federal Tax Service of Russia and Russian Federation Federal State Statistics Service.

change their sign from positive into negative when passing to total risk for the same reason.

Further, using the Gretl software package we attempted to construct econometric regressions, where the tax system risk assessed by inter-temporal standard deviation of tax yield rate might depend on the level of diversification of regional economy. The latter was measured on the basis of special SD, making comparison of regional industrial structure with the average structure nation-wide (formula 6). To eliminate visible heteroscedasticity we employed the weighted least squares method (WLS), where the regions' shares in total GRP served as weights for estimated variables. To improve the quality of the developed models, we tested additional control variables for inclusion into them, avoiding multicollinearity:

- the overall tax yield rate in regional economy (assessed by formula 1), which showed moderately positive dependency with tax system risk;
- the shares of most productive albeit volatile taxes in the total tax revenues of the regions, such as: value added tax, mineral extraction tax, corporate income tax;
- the share of tax revenues allocated to the federal budget in total tax revenues collected in the regions. As our previous research has shown (Malkina and Balakin, 2016), regions are less interested in the proper administration of those taxes that are remitted to the center, they are more prone to use various kinds of tax breaks and exemptions for such taxes. For that reason taxes allocated to the federal center might demonstrate more volatility;
- a number of indicators, directly or indirectly reflecting the level of tax discipline in the regions: the share of desk and field audits by tax authorities that revealed violations in their total amount; the ratio of additional tax accruals as a result of inspections to the total tax revenues of the regions; the ratio of tax arrears to tax receipts; the number of crimes per 100 thousand of the population (an indicator of the general state of the legal environment in the regions);

- the presence of a special economic zone with preferential taxation regime in the period under consideration, introduced as a dummy variable with values of 0 and 1;
- the instability of industrial structure of the regions' economy assessed by means of its inter-temporal standard deviation (formula 7), the inter-industrial equality of tax yield rates in the regions' economy estimated on the basis of the Hachman index (formula 8);
- the short-term and long-term economic growth rates in the regions and their inter-temporal standard deviation, wherein the period of 2006–2014 was considered as the short run, and 1998–2015 was regarded as the long run.

Ultimately, we developed two models that meet the Fisher and Student criteria and demonstrate significant R-square (the Tabs. III and IV). By means of the Darbin-Watson test we have confirmed that there is no autocorrelation of residuals in both of them.

Both models testify that the level of economy diversification positively affects the stability of tax yield rate, although it is not the only factor of the tax portfolio risk. The positive dependency found between total tax yield rate and tax system risk is quite expected according to economic theory. The inter-industrial unevenness of tax yield rate obviously contributes to its inter-temporal volatility. The increased share of one of the most volatile taxes – corporate income tax (CIT) – creates additional risk. Evidently, this share is higher in

III: *Model 1 - Weighted OLS estimates using 83 observations, dependent variable: RISK_SD*

Variable	Coefficient	Std. Error	t-statistic	P-value	
const	0.0969	0.0485	1.9997	0.04906	**
HI_equal	–0.0214	0.0048	–4.4354	0.00003	***
Yield	0.1169	0.0162	7.2143	<0.00001	***
Divers	–0.1141	0.0477	–2.3902	0.01929	**
Crimes_per_100	8.4e–06	2.7e–06	3.1478	0.00234	***
Share_CIT	0.0477	0.0146	3.2677	0.00162	***
Statistics obtained from weighted data:					
Sum of squared residuals	0.000077	Standard model error		0.000999	
R-squared	0.768270	Adjusted R- squared		0.753223	
F(6, 76)	51.05677	P-value (F)		4.57e-23	
Statistics obtained from initial data:					
Mean of dependent variable	0.023555	S.D. of dependent variable		0.017661	
Sum of squared residuals	0.013898	Standard model error		0.013435	

Note: HI_equal – the level of inter-industrial equality in tax yield rates, Yield – the total tax yield rate, Divers – the level of diversification of economy (based on unit minus standard deviation), Crimes_per_100 - the number of crimes per 100 thousand of the population, Share_CIT – the share of corporate income tax in total tax revenues.
Source: authoring.

regions where more profitable industries are located. Therefore, this factor also embodies influence of the regional industrial structure.

According to the first model, the crime level in the regions negatively affects tax behavior of their residents and enhances tax system risk. The second model demonstrates negative influence of the short-term rates of economic growth and positive influence of their inter-temporal volatility on the risk levels of the regional tax systems. Altogether the selected factors explain 75% of the average risk of the Russian regions tax portfolio – according to the first model, and 71% of it – according to the second model.

DISCUSSION

The obtained results do not have direct analogues for comparison. In general, we developed a portfolio approach to assessment of the risk of tax systems earlier proposed in a range of our works (Malkina and Balakin, 2015; Malkina and Balakin, 2016). The novelty of the present study is in composing of tax portfolio of industries (economic activities) generating tax revenues. The instability of tax revenues in industries depends on sectorial, macroeconomic and global factors influencing their development, as well as on the peculiarities of taxation and tax administration in industries and regions. Therefore, tax volatility derives from both taxable economy and the taxation system per se. A certain part of volatility is indeed originated from industrial structure, while the other is connected with different characteristics of a particular region. In reality, it is extremely difficult to discern their influence.

Our models prove that more diversified economies ceteris paribus generate lower risks of tax systems because of negative interaction of industrial risks in them. They ensure robustness to previously found a positive, albeit heterogeneous, relationship between diversification and the inherent tax risk system, estimated from unstructured variance of tax yield rates (Malkina, 2017). Besides, they support results earlier obtained by (Ankudinov *et al.*, 2012) and (Mikheeva, 2013) who detected positive influence of diversification of economy on main indicators of regional economies including growth and employment. But they apparently contradict to (Kravchenko, 2016) who used other indicators and measured diversification by means of Herfindahl-Hirschman index which suggests uniform distribution as benchmark, unlike the overall structure of Russian economy.

Apparently, the analysis conducted has some limitations indicating the directions of its further elaboration.

First of all, we considered aggregated groups of industries, and even at this level we revealed that influence of certain branches within manufacturing activity on tax yield rate and its volatility is quite different. Likewise, the levels of diversification and specialization of economy are designed for aggregated data and therefore give rough estimations. In future we intend to itemize the structure of our industrial portfolio. Obviously, the higher the level of portfolio specification, the more precise inter-regional comparisons would be made, but the smaller values of the tax system risk would be obtained due to its greater diversification.

Secondly, we assessed tax yield rate as the ratio of tax revenue from each industry to total regional GRP, whereas it may seem to be more substantiated

IV: *Weighted OLS estimates using 83 observations, dependent variable: RISK_SD*

Variable	Coefficient	Std. Error	t-statistic	P-value	
const	0.1164	0.0138	8.4357	<0.00001	***
LN_Yield	0.0265	0.0042	6.3110	<0.00001	***
LN_Special	0.0060	0.0016	3.8034	0.00029	***
HI_equal	–0.0143	0.0053	–2.7063	0.00840	***
SR_real_growth	–0.1463	0.0840	–1.7420	0.08555	*
Share_CIT	0.0400	0.0154	2.5923	0.01143	**
LN_SR_SD_real_growth	0.0076	0.0030	2.5155	0.01400	**
Statistics obtained from weighted data:					
Sum of squared residuals	0.000089	Standard model error		0.001083	
R-squared	0.731412	Adjusted R- squared		0.710208	
F(6, 76)	34.49362	P-value (F)		8.59e-20	
Statistics obtained from initial data:					
Mean of dependent variable	0.023555	S.D. of dependent variable		0.017661	
Sum of squared residuals	0.012426	Standard model error		0.012787	

Note: LN_Special – natural logarithm of the level of specialization of economy assessed by variance, SD squared – formula 6, SR_real_growth – the short-term economic growth rates; LN_SR_SD_real_growth - natural logarithm of the standard deviation of short-term economic growth rates.
Source: authoring.

to relate them to the gross value added in correspondent industry. However, application of this more meaningful approach to Russian regional data may lead to paradoxical results, because the legal addresses of enterprises where they really pay taxes do not always coincide with their spatial locations. This is typical for the mining industry and agriculture in some regions and for almost entire financial sphere. For this reason the latter was totally excluded from our analysis. The mining industry in the city of Moscow represents another example of discrepancy between production and taxation. The gross added value of this industry in Moscow was zero over years, while its tax revenues varied greatly during the period under consideration. In 2007 they accounted for almost 36 % of all tax payments. It impacted noticeably on risk assessment in this region overstating it. Division of this activity's tax revenue to the total GRP of the region, which is a non-zero, allowed us to partially smooth out these distortions.

Thirdly, employed indicator of diversification in fact measure the similarity of the two structures, one of those is the aggregated structure of Russian economy. In this connection, the question arises, how much is it justified to consider the economic structure of Russia as a benchmark of diversification for its regions? Our doubts are supported by (Gnidchenko, 2011) who highlighted the problem of standard or reference to perfect diversity and stressed the impact of aggregation level on the measurement of diversification (op cit, p. 46).

Ideally, it is desirable in future to analyze data on all taxpayers or their clusters belonging to the same branch and grouped by similar reactions to economic shocks. However, collection of detailed data is labor intensive, and the necessary information is not always available. Therefore, we leave all these improvements for the future research.

CONCLUSION

We explored the relationship between industrial structure of economy and tax system risk level based on the panel data of 83 Russian regions in 2006–2014. The regional tax system risk level was assessed using the portfolio approach by H. Markowitz. In this approach regional portfolio consists of economic activities brining tax revenues and imposing system with tax risk. It allowed us to evaluate total tax system risk of 83 Russian regions, divide it into internal and external component in each economic activity and explain the interregional differences in tax system risk level by diversity of industrial structures and the levels of economy diversification in the regions.

According to the results obtained, mining industry is relatively more risky on average; thereby economies incorporating it have more vulnerable tax systems. At the same time Public Administration and social sphere are relatively less risky, but in underdeveloped regions, where they bring larger part of tax revenues, it may be vice versa. The risk of manufacturing depends on certain branches located in the region. We found that the overall contribution of some activity to total tax system risk level depends on its share in GRP, its tax yield rate and the connection of this rate to own volatility and to volatility of rates in other industries.

Two developed alternative WLS regressions evidence positive influence of economic diversification on the Russian regions' tax system stability, while tax yield rate is negatively related to it. Additionally, our models demonstrate that more stable tax systems are characterized by the lower level of inter-industrial tax yield rate inequality and the higher short-term economic growth. Other factors, such as the level of crimes in regions, the share of corporate income tax in regional tax revenues and the volatility of short-term growth rates, generally increase tax system risk level.

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