



RESEARCH ARTICLE

Classification of Scenario Models for Diversifying the Architecture of Tax Policy to Ensure Regional Budgetary Sustainability

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ABSTRACT

The article is devoted to developing a classification of scenario models for diversifying the architecture of regional tax policy as a tool for ensuring budgetary sustainability. Based on the primary processing of data from the Federal Tax Service and reports of the Accounts Chamber of the Russian Federation for 2020–2024 for three representative regions (Khanty-Mansi Autonomous Okrug–Yugra, Samara Region, and the Republic of Kalmykia), the structural features of tax systems were identified: strong inertia with an autocorrelation coefficient of 0.74; differentiated correlations between tax revenues and macroeconomic factors, ranging from 0.89 for corporate profit tax and oil prices in a resource-based region to 0.11 in a subsidized region; and the presence of structural shifts in 2022 and 2023. Using multidimensional clustering through the k-means method and decision-tree construction, three types of diversification scenarios were identified: an evolutionary, or structural-compositional, scenario with property- and consumption-oriented models; a modernization, or tax-incentive, scenario with legalization, investment, and digital models; and a force-majeure, or redistributive, scenario with models of centralization with return transfers and excise decentralization. The influence of each scenario on regional budgets was analyzed, and key risks were identified, including legal challenges to cadastral valuation, a fiscal trap, shifting the tax burden onto end consumers, taxpayers moving to foreign jurisdictions, and misuse of interbudgetary transfers. A quantitative assessment of budgetary consequences for the federal and regional levels was carried out for three scenarios. It was established that the modernization legalization model produces the greatest systemic effect, amounting to +81.6 billion rubles per year when extrapolated to all subsidized regions; the evolutionary model produces a local effect of 2–3% of a region's own revenues; and the force-majeure model creates a paradoxical situation in which regions' disposable resources increase while their tax autonomy simultaneously decreases. Recommendations are formulated for selecting scenarios depending on the type of region.

INTRODUCTION

The issue of ensuring the budgetary sustainability of regional public-law entities has become particularly acute in recent years (Grundel, Cherepishnikova, 2025, p. 450; Smirnova, Grundel, 2025). The traditional model of tax policy, based on the dominance of several major taxpayers or one or two budget-forming taxes, such as corporate profit tax and personal income tax, has demonstrated its vulnerability under external shocks, sanctions pressure, and cyclical fluctuations in the economic environment (Kurbanalieva, 2025, p. 411). Regions with a narrow tax base, when commodity prices fall or major corporations withdraw from their territory, face a sharp decline in own-source revenues (Sinenko, 2023b, p. 239), an increase in the deficit, and, consequently, the accumulation of public debt (Sinenko, 2023a, p. 466).

In this logic, diversification of the architecture of tax policy is viewed not merely as a set of tools for increasing revenues, but as a systemic change in the structure of tax sources, the distribution of the

tax burden, and tax administration mechanisms aimed at reducing the dependence of regional budgets on market-driven factors (Alferova, 2022, p. 220; Muzalev et al., 2025). However, the implementation of such diversification requires a well-grounded choice from among many possible scenarios, each of which has its own prerequisites, limitations, and budgetary consequences (Kosobutskaya et al., 2025, p. 61).

The purpose of this study is to develop and substantiate a classification of scenario models for diversifying the architecture of regional tax policy, to assess their impact on budgetary sustainability with due regard to the identified risks, and to calculate the quantitative budgetary consequences for the federal and regional levels.

MATERIALS AND METHODS

The information base of the study consisted of data from the Federal Tax Service of the Russian Federation, reports of the Accounts Chamber of the Russian Federation on the execution of consolidated budgets of constituent entities of the Russian Federation, and indicators of budgetary provision and debt burden published by the Ministry of Finance of the Russian Federation. For in-depth analysis, three regions representing different types of tax architecture were selected: a resource-extracting region, namely Khanty-Mansi Autonomous Okrug–Yugra; an industrially developed region with a high share of manufacturing, namely Samara Region; and a subsidized agrarian-oriented region, namely the Republic of Kalmykia.

The methodological framework of the study included several interconnected blocks.

The primary data processing block involved removing the inflationary factor from time series through deflation using the GDP deflator index, normalizing indicators for interregional comparisons, and identifying structural breaks using the Chow test. To support the diversification models, a correlation matrix was constructed between changes in the volume of regional tax revenues and the following macroeconomic indicators: the industrial production index, real disposable income of the population, and the price of Urals crude oil.

The classification modeling block was based on multidimensional clustering methods, specifically k-means with Euclidean distance, and decision-tree construction using CART. This made it possible to identify stable types of diversification scenarios based on two key features: the depth of change in the tax structure and the implementation horizon.

The risk analysis block included the calculation of the coefficient of variation of tax revenues, cumulative budgetary sustainability according to the methodology of L. I. Pronina, and stress testing of scenarios for sensitivity to a 20% decline in the basic tax.

The block for calculating budgetary consequences involved constructing a simulation model using finite-difference equations, in which changes in regional revenues were represented as a function of changes in rates for individual taxes, expansion of the tax base through legalization of the “shadow” sector, and redistribution of deductions between levels of the budgetary system.

RESULTS

At the first stage, primary data processing was carried out, which revealed a number of critical features determining the limits of applicability of the future models.

Monthly series of tax revenues for 2020–2024 were taken for the three regions. Each series contains regular peaks in March, June, September, and December, corresponding to the payment deadlines for corporate profit tax and mineral extraction tax. The trend was removed using a 12-month moving average. Based on deviations from the trend, the first-order autocorrelation coefficient was calculated. The obtained value was 0.74. This means that the current deviation of tax revenues is determined by the deviation of the previous month by 74%. Inertia is high. Any change in the tax architecture will produce a measurable shift in revenues no earlier than after two or three tax periods, that is, quarters.

For each region, the pairwise correlation between monthly corporate profit tax revenues and the average monthly price of Urals crude oil was calculated. The results are presented in Table 1.

Table 1: Correlation coefficients of tax revenues with key factors, 2020–2025

Region	Corporate profit tax / oil price	Personal income tax / household income	Property taxes / price index
Khanty-Mansi Autonomous Okrug–Yugra	0.89	0.34	0.21
Samara Region	0.42	0.68	0.35
Republic of Kalmykia	0.11	0.72	0.54

The range of coefficients shows that the same “anchor” tax, namely profit tax, is linked to the external price-forming factor in different ways. For a resource-based region, the oil price is a direct driver of profits for extractive companies. For a manufacturing region, the relationship is weaker: profit is determined by demand, costs, and the exchange rate. For a subsidized region, the correlation is practically absent, since profit tax is small in absolute terms and is paid by enterprises not related to raw-material exports. Therefore, for each type of region, the scenario model of diversification should select its own anchor tax. In a resource-based region, this is profit tax, although it cannot be diversified without changing the region’s specialization; in a manufacturing region, these are personal income tax and property taxes; and in a subsidized region, these are excise taxes and taxes on small businesses.

Testing for structural changes was performed using the Chow test. Two dates were identified at which the null hypothesis of no structural break was rejected.

The first date is the first quarter of 2022. The factor behind the shift was the introduction of sanctions restrictions against the Russian Federation. The second date is the fourth quarter of 2023. The factor behind the shift was a change in the procedure for crediting profit tax paid by consolidated groups of taxpayers.

For both points, the F-statistic exceeds the critical value at the 0.05 significance level. Therefore, a single regression model for the entire period of 2020–2024 is not applicable. Scenario models of diversification must account for coefficient breaks at the indicated thresholds.

This imposes a requirement on diversification models: they must be adaptive, with the ability to switch regimes depending on external conditions.

Finally, to eliminate the scale effect when comparing regions, the indicators were normalized using the following formula:

$$X_{norm} = \frac{X - \min(X)}{\max(X) - \min(X)} \quad (1)$$

This made it possible to move from absolute values of tax revenues to dimensionless indices suitable for clustering.

Based on the processed data and using the k-means method with Euclidean distance, three stable types of scenarios for diversifying the architecture of tax policy were identified, which in turn are divided into seven specific models.

Type A. Evolutionary (structural-compositional) diversification involves a gradual change in the weights of taxes in the revenue structure without a sharp increase in rates. It includes two models:

- *Model A1 (property emphasis)*: increasing the share of corporate property tax and land tax through the revision of cadastral value and the reduction of benefits. It is applicable in regions with developed real estate and industrial assets.
- *Model A2 (consumer emphasis)*: increasing revenues from excise taxes and VAT, in the part credited to regions, through stricter administration of retail sales of excisable goods, primarily tobacco and nicotine-containing products.

Type B. Modernization (tax-incentive) diversification. The change in architecture is aimed not at the fiscal result as such, but at expanding the tax base by stimulating entrepreneurial activity. It includes three models.

Model B1 (legalization). A reduction in the effective rate under the simplified taxation system and a simultaneous expansion of the patent system are envisaged. The goal is to bring small and

medium-sized businesses out of the shadow sector. According to estimates, the number of registered taxpayers increases by 15–20%.

Model B2 (investment). A regional investment tax deduction for profit tax is introduced. The reciprocal obligation of companies is to increase the payroll fund subject to personal income tax.

Model B3 (digital rent). A tax on automated settlements, referred to in the literature as a robot tax, is introduced, or the professional income tax, namely the self-employed regime, is expanded to new types of activity: crowd platforms and remote employment.

Type C. Force-majeure (redistributive) diversification. This type is used during an acute budget crisis, when rapid redistribution of financial flows between levels of the budgetary system is required. It includes two models.

Model C1 (centralization with return). The standard rate of profit tax allocation to the federal budget is temporarily increased from 3% to 5%. Regional losses are compensated through targeted interbudgetary transfers. The condition for receiving transfers is the implementation of structural reforms.

Model C2 (decentralization of excise taxes). Part of the excise taxes on strong alcohol, up to 50% of revenues, is transferred from the federal to the regional level. At the same time, a “tax mandate” is introduced: the region is obliged to allocate these funds to the road fund and social infrastructure.

In existing approaches, for example, when dividing models into extensive and intensive ones, the system-forming feature is the instrument. In the proposed classification, the basis is different: the method of changing the architecture:

- Evolutionary, involving the recomposition of existing elements;
- Modernization, involving the creation of new elements to replace old ones;
- Force-majeure, involving the redistribution of flows without changing the composition of elements.

For each of the seven scenarios, an analysis of the impact on regional budgets was carried out. The key criterion was the cumulative budgetary sustainability index (CBS), calculated as the ratio of the sum of own-source revenues to the sum of expenditure obligations, weighted by the elasticity coefficient. The normative value of CBS is above 1.05.

For type A scenarios, that is, evolutionary diversification, the impact was moderately positive, but extended over time. For example, model A1, or property emphasis, two years after implementation increases the share of property taxes from 12% to 19% in the revenue structure of Khanty-Mansi Autonomous Okrug–Yugra; however, it is associated with the risk of legal challenges to cadastral value by major taxpayers. In Samara Region, the implementation of model A1 faced the risk of shifting the tax burden onto tenants through higher rental rates, which ultimately reduces consumer demand and indirectly undermines the personal income tax base.

For type B scenarios, the most significant positive impact was recorded for model B1, or the legalization model. The calculation for the Republic of Kalmykia showed that when the simplified taxation system rate is reduced from 6% to 4% and the patent system is simultaneously expanded, the number of newly registered individual entrepreneurs increases by 22%, while the volume of legalized revenue increases by 34%. However, the risk of a fiscal trap was also identified here: if the benefit is not accompanied by stronger control measures, most of the increase comes from those who were already paying taxes, while no real movement out of the shadow sector occurs.

The risk associated with model B3, or digital rent, was recognized as the most dangerous. In the absence of a unified methodology for accounting for income from platform employment, the introduction of the tax leads either to double counting or, conversely, to a mass relocation of platforms to foreign jurisdictions. For the federal budget, this risk is insignificant, but for regions focused on the development of IT clusters, such as Novosibirsk Region, it is critical.

For type C scenarios, the analysis showed that model C1, or centralization with return, reduces regional budgetary sustainability by 12–15% in the short term. However, if return transfers are earmarked for investment purposes, sustainability recovers within three years to a level 7–8%

above the initial level. Model C2, or decentralization of excise taxes, by contrast, provides a rapid increase in own-source revenues, by 8–10% in the first year, but creates the risk of misuse: regions may allocate excise revenues to current expenditures instead of road construction, which in the long term reduces transport accessibility and economic activity.

The summary risk analysis made it possible to construct a “probability–consequences” map. The most probable risks, with a probability above 0.4, were legal challenges, shifting the burden onto end consumers, and the fiscal trap. The most severe in terms of consequences, with damage exceeding 5% of regional gross regional product, were the risks of taxpayers moving to foreign jurisdictions and misuse of excise revenues.

For quantitative assessment, three contrasting scenarios were selected, each tested on data from representative regions with subsequent extrapolation to the federal level.

Scenario 1, evolutionary, model A1 + A2, was implemented for Samara Region. The calculation was performed using the formula:

$$\Delta TR_{\text{reg}} = 0,12 \times \Delta \text{Cad}_{\text{value}} + 0,08 \times \Delta \text{Excise}_{\text{retail}} \quad (2)$$

where

$\Delta \text{Cad}_{\text{value}}$ — the revision of cadastral value (+15 %),

$\Delta \text{Excise}_{\text{retail}}$ — the strengthening of retail excise administration (+20% in collections).

The result showed that additional revenues of the consolidated budget of the region amounted to 4.7 billion rubles per year, or 2.3% of own-source revenues. For the federal budget, this scenario is neutral, since property taxes and retail excise taxes remain at the regional level.

Scenario 2, modernization, model B1, was implemented for the Republic of Kalmykia, with subsequent extrapolation to all subsidized regions, 23 regions with a total population of 8.2 million people. The calculation included three effects: direct, through growth in the number of taxpayers; indirect, through reduction of the shadow sector; and secondary, through growth in personal income tax due to wage legalization. The final integral effect according to the formula:

$$\Delta TR_{\text{reg}}^{\text{total}} = \Delta N_{\text{taxpayers}} \times \text{AverageTax}_{\text{USN}} + \Delta \text{Shadow} \times 0,13 + \Delta \text{Payroll}_{\text{legal}} \times 0,13 \quad (3)$$

showed that the total increase in tax revenues of all subsidized regions would amount to 62.3 billion rubles per year. At the same time, the federal budget loses simplified taxation system revenues, since the rate is reduced, in the amount of 9.1 billion rubles, but gains additional personal income tax revenues, due to growth in the payroll fund of the legalized sector, in the amount of 28.4 billion rubles. The net effect for the federal budget is positive, at +19.3 billion rubles.

Scenario 3, force-majeure, model C1, is centralization with return. The calculation was carried out for the condition of an acute crisis, when the federal budget needs to quickly mobilize 500 billion rubles. If the standard rate of profit tax allocation is increased from 3% to 5% for a period of two years, the federal budget receives an additional 620 billion rubles per year, provided that the tax base remains unchanged. However, regions lose 310 billion rubles annually. If 400 billion rubles of return transfers are allocated to regions from the collected 620 billion rubles, leaving 220 billion rubles to the federal center, the budgetary consequences are distributed as follows: the federal budget receives a net gain of 220 billion rubles; regions as a whole incur a net loss of 310 billion rubles but receive 400 billion rubles in transfers, meaning that their disposable resources increase by 90 billion rubles. The paradox is that while formally losing tax revenues, regions gain in terms of the volume of financial assistance, but at the same time lose financial autonomy.

Table 2: Summary budgetary consequences of the three scenarios, billion rubles per year

Scenario	Effect for regions, consolidated	Effect for the federal budget	Systemic effect, FB + RB
Scenario 1, evolutionary	+4.7	0	+4.7
Scenario 2, modernization	+62.3	+19.3	+81.6
Scenario 3, force-majeure	+90* (but with loss of autonomy)	+220	+310

Source: compiled by the authors

Note: disposable resources taking transfers into account.

The calculations show that the greatest systemic budgetary effect is produced by the modernization legalization model, B1; however, it requires strong administrative capacity and a lag of one and a half to two years. The evolutionary model is safe but insignificant. The force-majeure model is effective in the short term, but undermines regional incentives to develop their own tax base.

As a result of the study, the following main results were obtained.

1. A three-level classification of scenario models for diversifying the architecture of tax policy was developed and empirically substantiated. It includes three types, evolutionary, modernization, and force-majeure, and seven specific models. For the first time, the classification uses not the fiscal instrument but the method of changing the architecture of the tax system as the system-forming feature, which makes it possible to account for institutional constraints.
2. Risks were identified and quantitatively assessed for each type of scenario. The most significant set of risks was found to be associated with shifting the tax burden, for property-based models; the fiscal trap, for legalization models; and the misuse of interbudgetary transfers, for redistributive models. It is shown that legalization models are a priority for subsidized regions, property-based models for industrial regions, and excise decentralization models for resource-extracting regions.
3. A quantitative assessment of budgetary consequences was carried out for three scenarios. It was established that the modernization legalization model, B1, produces the greatest systemic effect, amounting to +81.6 billion rubles per year when extrapolated to all subsidized regions, whereas evolutionary models produce a local but immediate effect of up to 2–3% of a region's own-source revenues. The paradox of the force-majeure model is demonstrated: an increase in regions' disposable resources occurs simultaneously with the loss of their tax autonomy.

The discussion of the results requires several reservations. First, the calculations presented are based on data for 2020–2024, which include two shock periods, the pandemic and the beginning of the sanctions crisis. This means that the elasticity coefficients may be overestimated due to the volatility of the base. Second, the study did not consider the social consequences of diversification, such as an increase in the tax burden on small businesses in model A1 through rent payments, which may change the assessment of scenario suitability from the perspective of regional socioeconomic policy. Third, the proposed classification requires further testing on data from regions with a high share of mineral extraction tax, where diversification is objectively difficult.

Comparison with the results of other researchers shows that the proposed approach to classification through the method of changing the architecture is more flexible than the traditional division into tax and non-tax methods of diversification. However, it is less simple in practical application for the operational management of the budget process.

CONCLUSION

Diversification of the architecture of regional tax policy is not an alternative to expanding the tax base, but rather an architectural change, that is, a restructuring of the links between taxes, levels of the budgetary system, and economic agents. The study made it possible to classify scenario models of such diversification into three types: evolutionary, involving the recomposition of existing elements; modernization, involving the creation of new elements; and force-majeure, involving the redistribution of flows. Each type has its own advantages: the evolutionary type has low political costs, the modernization type produces the greatest systemic budgetary effect, up to 81.6 billion rubles per year, and the force-majeure type offers rapid implementation.

For practical tax policy, a combination of scenarios is recommended depending on the type of region: for subsidized regions, priority should be given to legalization model B1 with a delayed effect of 1.5–2 years; for industrial regions, to evolutionary model A1 with control over the shifting of the burden onto tenants; and for resource-based regions, to model C2 of excise decentralization with the introduction of a “tax mandate” for targeted use. When developing budgetary adjustments, the federal center should take into account that the centralization of profit tax, model C1, provides

a short-term fiscal gain but undermines incentives for regional diversification for a period of more than three years.

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