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Tax sensitivity of the main industries of the Russian Federation

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Abstract : This paper examines the tax sensitivity of Russian industrial sectors as a key factor in the effectiveness of state tax and industrial policy. The study is based on the hypothesis that knowledge-intensive and innovation -driven industries are more sensitive to changes in the tax burden than traditional and resource-based ones. The objective of the paper is to empirically assess the impact of the tax burden on output and determine the differences in elasticity between knowledge-intensive and less knowledge-intensive sectors. The methodological basis of the study is represented by a regression analysis based on 2010-2022 data for five industrial sectors: mechanical engineering, metallurgy, food industry, electric power, and coal mining. The indicators used were the volume of shipped products and the tax burden, calculated as the ratio of total tax revenues to the volume of output. The results showed a stable negative relationship between the tax burden and output, with the greatest sensitivity observed in knowledge-intensive industries. This confirms the need to differentiate tax policy taking into account industry characteristics and innovation activity. The findings have practical implications for the development of targeted tax incentives aimed at accelerating technological innovation and ensuring industrial growth in the context of structural restructuring of the Russian economy.

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1 INTRODUCTION

Given the structural restructuring of the Russian economy and the need for accelerated technological development, issues of tax incentives for industry are particularly important. The industrial sector is a key driver of economic growth, providing employment, export potential, and technological sovereignty. However, the effectiveness of tax policy for industrial sectors is largely determined by their tax sensitivity—the change in output resulting from a change in the tax burden. Understanding the differences in tax sensitivity between industries allows for more targeted and balanced government support measures.

The current Russian tax system is largely focused on ensuring budget stability, while its incentive function is not fully realized. At the same time, to ensure technological sovereignty, support for knowledge-intensive and innovative industries—mechanical engineering, instrument making, information technology, pharmaceuticals, and biotechnology—is particularly important. These industries form the technological foundation of the new industrialization, but their development is constrained by high capital intensity, long investment payback periods, and increased dependence on the tax environment.

According to several studies, the tax sensitivity of industrial sectors varies depending on their technological level, cost structure, and share of value added. At the same time, less knowledge-intensive sectors are characterized by more stable financial flows and are less sensitive to changes in tax conditions. For them, natural resources, production scale, and export conditions are key factors of competitiveness, while tax incentives play a secondary role. Therefore, a uniform tax policy for all sectors distorts the industrial structure and hinders the development of the high-tech sector.

The relevance of this study is further enhanced by current trends in Russian tax policy. Since 2022, both tax regimes and the external economic conditions for industrial activity have changed significantly. Tax support measures introduced for specific industries (for example, the IT sector) require an empirical analysis of their effectiveness in terms of their actual sensitivity to tax changes. The lack of systematic research in this area means that decisions are often made without relying on a quantitative assessment of industry elasticity.

Furthermore, assessing the tax sensitivity of industry has direct practical implications for the implementation of structural policy and the achievement of national project goals related to technological sovereignty, import substitution, and increased labor productivity. The results of such analysis are important for developing differentiated tax mechanisms (for example, establishing preferential income tax rates, accelerated depreciation, or R&D tax deductions specifically in those industries where the impact of reducing the tax burden will be greatest).

2 LITERARY REVIEW

As noted earlier, the impact of tax policy on economic growth and enterprise production activity remains a key issue in modern economic literature. Of particular importance is the differentiated impact of the tax burden on different types of industries—in particular, knowledge-intensive and less knowledge-intensive ones. Empirical studies confirm that taxes not only generate government revenues but also directly influence investment decisions, innovation activity, and resource allocation across both sectors and regions.

The classic work by C. Romer and D. Romer confirms the macroeconomic impact of the tax burden: a tax increase of 1% of GDP leads to a decrease in real GDP by almost 3% (Romer et al., 2010). Investments show a sharp decline in response to tax increases. This is especially important for knowledge-intensive industries, where R&D investments account for a significant share of costs.

One area of research is analyzing the relationship between the direct tax burden, financial constraints, and innovative output. Lu's study, based on Chinese data and employing a quasi -experimental design, shows that reducing the direct tax burden significantly reduces the financial constraints of enterprises, which directly leads to an increase in innovative output (Lu et al., 2023). This mechanism can be formulated as "taxes → financing → innovation/output." The tax burden, by influencing operating expenses, is a critical factor determining the growth trajectory of enterprises. It is assumed that, with a reduced tax burden, enterprises are inclined to invest in less risky and more rapidly implemented innovations. The relationship between the tax burden and innovation performance has strengthened since the onset of the COVID-19 pandemic, highlighting the sensitivity of innovation activity to fiscal pressure during a crisis.

Another important aspect is the elasticity of tax revenues with respect to economic output, which allows us to assess the relationship between

production growth and fiscal revenues. Kazuki Hiraga (2012) uses a structural approach based on the dynamic stochastic general equilibrium (DSGE) model to calculate elasticity (Hiraga et al., 2012). The results show that in the short term, the output elasticity of tax revenues can be negative. However, in the medium term, it becomes strongly positive—from 2.3 to 4, indicating a high sensitivity of tax revenues to economic growth. In the long term, the elasticity decreases and reverses. This is because significant growth in output can lead to a reduction in the effective tax rate (for example, through progressive taxation or changes in the revenue structure), which in the long term constrains overall revenue growth.

For the purposes of sensitivity analysis, this is particularly important for knowledge-intensive industries, as they are more likely to experience long innovation development and implementation cycles, making them more susceptible to long-term tax conditions.

A number of studies have assessed how changes in tax rates affect economic activity (output, employment, capital). A study by Giroud and Rauh, based on data from US businesses, demonstrates that state-level corporate taxation has a significant impact on business activity (Giroud et al., 2015). The study demonstrates that taxation forms directly influence business sensitivity to taxes. More than half of the observed effects are due to the reallocation of resources between states where businesses are located, indicating high capital and labor mobility in response to changes in the tax climate. Capital is less elastic than labor, demonstrating similar trends, but with an elasticity 36% lower than that of labor, which is associated with higher costs of capital mobility. These findings support the hypothesis that knowledge-intensive industries, which often require highly skilled labor, may be particularly sensitive to regional differences in tax policy.

Russian researchers also assess the impact of the tax burden on industry output. E. Balatsky showed that high-tech industries tend to exhibit higher profit elasticity with respect to the tax burden than traditional ones (Balatsky et al., 2020). In other words, increasing tax pressure leads to a more significant decline in business activity and investment attractiveness for them. This is explained by the fact that innovative enterprises more often use intangible assets and human capital, which are more difficult to protect and amortize for tax purposes, and their profitability is more dependent on the volume of reinvestment. However, it should be noted that the tax sensitivity analysis of industries was conducted as an empirical fact, using data up to 2019 and with aggregated industries according to broad classifications (manufacturing, mining, etc.).

Thus, the conducted research suggests that knowledge-intensive industries are more sensitive to the tax burden, especially direct taxes, as their activities depend on internal financing, investment in intangible assets, and highly skilled labor—all components susceptible to tax distortions. The transmission mechanism of tax impact includes both a direct channel (reduced profits → reduced investment) and an indirect one through financial constraints and factor mobility.

Research confirms that the tax burden, by limiting funding, negatively affects innovative output, which likely makes knowledge-intensive industries more sensitive to changes in the tax burden, since their main output depends on investments in intangible assets.

Hypothesis: sensitivity to the tax burden depends on the type of industry: knowledge-intensive industries are more sensitive than less knowledge-intensive and less technologically advanced industries.

The aim of the study is to assess the impact of the tax burden on the performance of knowledge-intensive and less knowledge-intensive industries in the Russian Federation.

Tasks:

- To estimate the elasticity coefficients of the tax burden in knowledge-intensive and less knowledge-intensive industries and to analyze the relationship between knowledge intensity and the elasticity coefficient of the tax burden of selected industries in the Russian Federation as a whole,
- To assess the elasticity of the tax burden in the selected industries and compare it with the expenditure on innovation in these industries.

3 RESULTS

The following industries were considered for analysis:

coal mining;

- production of food products, including beverages, and tobacco (hereinafter referred to as food),
- metallurgical production and production of finished metal products, except for machinery

and equipment (hereinafter referred to as metallurgy),
- production of machinery and equipment not included in other groups (hereinafter referred to as mechanical engineering),
- production and distribution of electricity, gas and water (hereinafter referred to as electricity).

Based on Table 1, mechanical engineering and metallurgy with a share of expenditure on innovation of more than 5% can be classified as knowledge-intensive industries; the remaining industries can be classified as less knowledge-intensive.

Table 1: Average share of innovation expenditure in the volume of shipped products in industrial sectors in 2019–2022.

Industry	Average share of innovation expenditure in the volume of shipped products
Coal mining	1.2%
Food	2.1%
Metallurgy	5.7%
Mechanical engineering	5.4%
Electricity	2.9%

To assess the sensitivity of the industry's performance to the tax burden, it is proposed to use the following relationship (formula 1):

$$Y_t = AY_{t-1}^{\alpha} T_{t-1}^{\beta} \quad (1)$$

where Y_t is the output of the industry in the reporting period;

Y_{t-1} – output of the industry in the previous period;

T_{t-1} – tax burden of the industry in the previous period.

The indicator “Volume of shipped goods of own production” is used as the output of the industry from 2010 to 2022, the values of which are adjusted to 2017 using production indices.

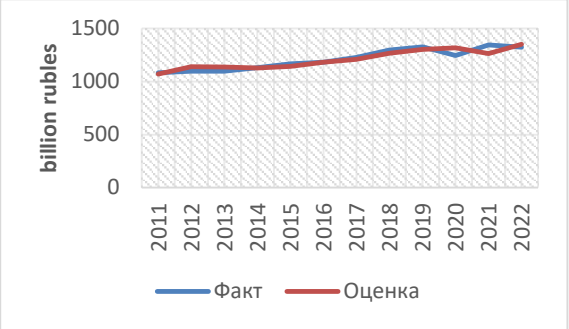
The tax burden is the ratio of tax and fee revenues to the consolidated budget of the Russian Federation to the volume of shipped goods of own production for the relevant period.

The results of a tax sensitivity analysis of Russian industrial sectors confirmed a correlation between the tax burden and output volumes in key industrial sectors. Moreover, the identified patterns vary in the direction and intensity of the impact depending on the technological level and innovative activity of the industry.

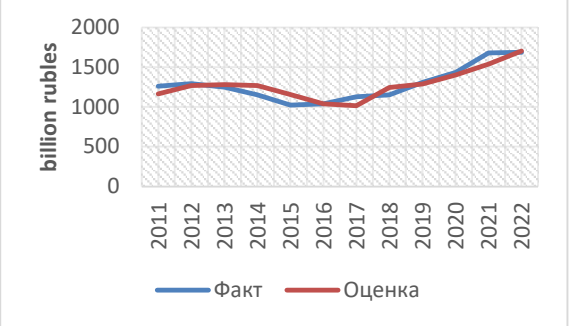
Regression analysis showed that the volume of shipped products in the previous period has a positive impact on output in the current period in all industries studied. This demonstrates the presence of production inertia and the important role of accumulated industrial potential. It can be noted that short-term industrial development is largely determined by the industry's current level of production capacity.

At the same time, the previous period's tax burden demonstrated a negative impact on output, reflecting the inverse relationship between the severity of fiscal pressure and the business activity of companies in the industry. Although the statistical significance of this effect varies across industries, the overall trend confirms the hypothesis that an increased tax burden limits the potential for production expansion, reduces investment activity, and increases companies' financial risks.

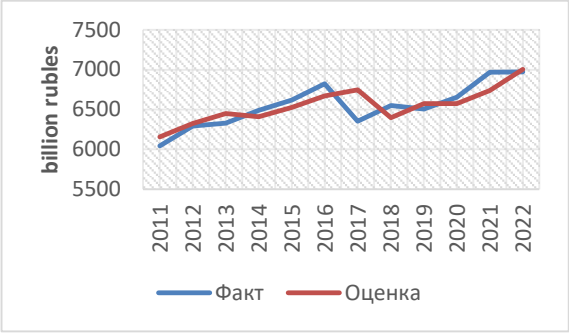
An analysis of the determination coefficients revealed a fairly high quality of the resulting equations (the determination coefficient exceeds 80% for most industries) (Figure 1). The most robust models were obtained for metallurgy, coal mining, and mechanical engineering, where the relationship between the tax burden and output is most pronounced.



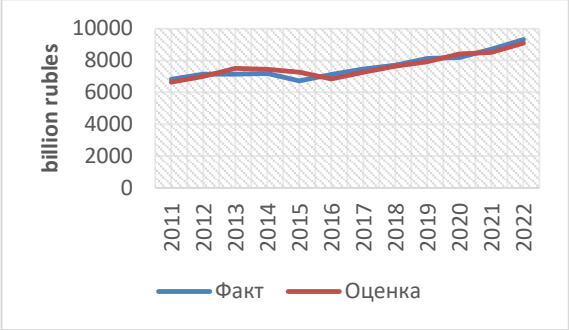
Coal mining



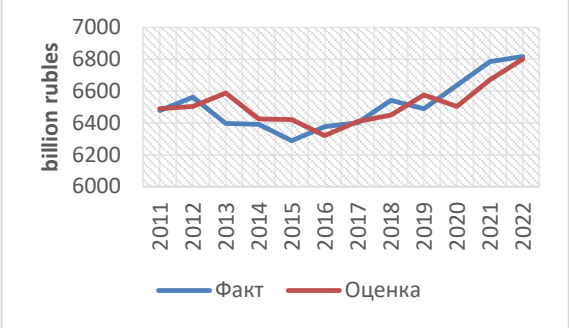
Mechanical engineering



Food



Metallurgy



Energy

Figure 1: Dynamics of actual and estimated values of the indicator "Volume of shipped goods of own production"

The difference in the response to tax changes between knowledge-intensive and traditional sectors deserves special attention. According to calculations, the highest absolute values of the coefficients for the variable tax burden are observed in mechanical engineering (-0.247) and metallurgy (-0.162), i.e., in industries with a high share of innovation expenditures (Appendix). This indicates increased tax sensitivity in these industries.

In less knowledge-intensive industries (coal mining, food processing, and electric power), the impact of the tax burden was weaker (coefficients within the range of -0.07 and -0.08). This indicates a lower elasticity of production activity to changes in the tax burden.

Thus, the obtained results confirm the hypothesis that innovative, capital-intensive and technologically complex industries demonstrate higher sensitivity to the state tax policy (Figure 2).

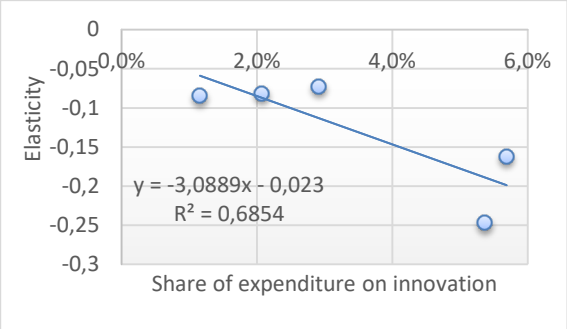


Figure 2: Relationship between the share of expenditure on innovation and the elasticity of the tax burden.

Certainly, the differences identified can be explained by the specific characteristics of knowledge-intensive industries. They are characterized by higher fixed costs, a significant share of R&D expenditures, long investment payback cycles, and a high dependence on macroeconomic stability. Under such conditions, even a slight increase in tax pressure can lead to a reallocation of resources from innovative projects to current expenses, reducing the pace of technological innovation.

In contrast, in industries with a low innovation component (such as extractive or resource-based industries) , market conditions and production costs, rather than tax incentives, play a key role. These industries often enjoy strong positions in both foreign and domestic markets, making them less sensitive to fiscal changes.

4 DISCUSSION

The results of the analysis confirmed the existence of a relationship between the tax burden and industrial output dynamics, as well as differences in the strength and direction of this relationship between knowledge-intensive and less knowledge-intensive industries. Interpretation of the results allows us to note the following.

The resulting regression coefficients show that the tax burden in previous periods has a negative impact on output in the current period in all the industries studied. This confirms the hypothesis that

the tax burden has a deterrent effect on business activity. Particularly high coefficient values (in absolute value) were recorded in mechanical engineering and metallurgy—sectors characterized by a high share of innovation expenditures and capital-intensive production processes.

This result is consistent with theoretical notions of the "increased sensitivity" of innovative industries to tax pressure. Under conditions of limited access to financing and long investment cycles, even a moderate increase in the tax burden leads to a slowdown in capital accumulation and a reallocation of resources from R&D to current expenses. This slows the adoption of new technologies and reduces the competitiveness of the industry.

At the same time, in traditional industries—coal mining, food processing, and electric power—the effect was weaker. This is explained by structural features: stable sources of demand, less reliance on investment in intangible assets, and a higher degree of monopolization, which reduces the sensitivity of output to fluctuations in the tax burden.

Thus, the obtained results confirm the conclusions of a number of domestic and foreign studies (Romer et al., 2010; Balatsky et al., 2020; Lu et al., 2023) that innovative activity and capital intensity of production increase the elasticity of output with respect to the tax burden. The study's results demonstrate that this effect persists in the Russian economy of the 2020s, when industry is experiencing simultaneous tax, structural, and foreign economic transformation.

Despite the statistical robustness of the resulting models, it is important to acknowledge a number of methodological limitations that may affect the accuracy and generalizability of the results.

The model used accounts for the impact of the tax burden and output only for a single prior period, which limits the ability to assess cumulative and long-term effects. For innovative industries, where R&D investments yield results over a 2-5-year period, the lag of a single-period regression may underestimate the true sensitivity. In future studies, it would be advisable to consider models with distributed lags or dynamic panels, which would allow for time lags in the tax impact.

It should be noted that the proposed model does not take into account the influence of external macroeconomic factors—demand dynamics, inflation, exchange rates, interest rates, government support, and sanctions. These factors can either amplify or offset the impact of the tax burden. For example, rising metal export prices can temporarily offset the effect of tax pressure, creating a false impression of low industry sensitivity.

A major limitation is the lack of regional differentiation. Regional context is crucial: specialization, differences in economic structure, and capital intensity determine the degree of response to tax changes. This confirms the need to conduct analysis not only at the aggregate level but also taking into account regional specialization. Thus, regional responses to federal tax changes are not uniform, which is crucial for regional analysis. Liu and Williams' work examines the impact of federal taxes on state output in the United States (Liu et al., 2019). The authors show that more than half of the states show no statistically significant response to tax cuts, highlighting the importance of accounting for interregional differences. Particularly noteworthy is that less capital-intensive states respond more strongly to tax cuts by increasing output and employment. This result contradicts the predictions of standard single-sector models but is well explained by a two-sector model with corporate and non-corporate sectors. Because knowledge-intensive industries often combine elements of both sectors, their behavior may differ significantly from traditional capital-intensive industries. Thus, regional specialization—in particular, the share of knowledge-intensive industries in a region's economy—can serve as an important predictor of tax sensitivity.

Similarly, a study by Lagravinese, Liberati and Sacchi is devoted to the dynamics of regional taxes in Italy (Lagravinese et al., 2016). The authors show that tax bases (in particular, regional income tax and production tax) are procyclical, especially during recessions. This creates additional risks for knowledge-intensive industries, whose revenues may be unstable in the short term but are critical for long-term growth. The procyclicality of regional taxes reduces their effectiveness as a source of funding for public services during periods of crisis, when demand for them increases, while simultaneously increasing the financial vulnerability of innovative enterprises.

It should be emphasized that Russian industry is extremely unevenly distributed, and tax regimes vary in structure and rates across the federal subjects. This is particularly relevant for assessing the sensitivity of the energy and extractive industries, which are concentrated in specific regions. A regional-level analysis would identify which territories are most vulnerable to changes in tax conditions and where tax incentives are most effective.

Finally, when interpreting the results, the endogeneity of the tax burden should be taken into account: a decrease in output itself can reduce tax revenue, creating a feedback effect. This is a typical problem in econometric models where variables are interdependent. Instrumental variables or panel data methods with fixed effects can be used to address this.

It is important to note that, as in E. Balatsky's study, the main correlation—the higher tax sensitivity of high-tech industries—was confirmed. However, unlike earlier estimates based on data prior to 2019, the new results reflect the situation under sanctions, rising budget expenditures, and the active redistribution of fiscal resources. Furthermore, unlike E. Balatsky's study, which examined aggregated industries, this paper analyzes them at a more granular level, including mechanical engineering, metallurgy, food processing, electric power, and coal mining. This allowed for a more precise identification of differences in sensitivity between sectors with different shares of innovation expenditure.

It should also be noted that, on the one hand, the coefficients obtained for mechanical engineering and metallurgy turned out to be somewhat lower in magnitude than in similar foreign studies (Giroud et al., 2015; Lu et al., 2023). This may indicate more stringent institutional constraints affecting enterprises' responses to tax incentives, or the influence of compensating factors—for example, direct government support for investment.

On the other hand, coal mining and electricity production exhibit extremely low elasticity, consistent with Romer & Romer's findings on the weak response of capital-intensive but non-innovative industries to tax incentives. This underscores that Russian industry is replicating global patterns of tax behavior, despite its unique institutional characteristics.

Despite these limitations, the results of the analysis may have some practical implications. The higher sensitivity found in knowledge-intensive industries demonstrates the importance of taking this factor into account. A one-size-fits-all approach based on uniform rates and tax conditions may lead to an uneven distribution of the fiscal burden and reduce the effectiveness and efficiency of tax incentives.

For knowledge-intensive industries, it would be appropriate to use special tax regimes, including tax deductions for R&D, accelerated depreciation, and reduced income taxes when reinvesting profits in technology development. At the same time, it would be logical to avoid excessively increasing tax breaks for low-elasticity industries, where tax incentives do not lead to output growth.

The obtained results confirm the usefulness of the concept of tax sensitivity as an indicator of industrial structural stability. The higher the sensitivity, the greater the industry's dependence on the external economic environment and the more important the institutional predictability of fiscal policy is for it.

Further development of the study could involve expanding the database to include the period after 2023, when new instruments were introduced into the Russian tax system—investment tax deductions, regional profit tax incentives, and new conditions for industrial cluster participants. Assessing these instruments in terms of industry sensitivity will help clarify the actual incentives operating in industry. Additionally, experiments could be conducted that take into account the procyclical nature of tax revenues to eliminate the influence of their cyclical component (Sinelnikov-Murylev et al., 2025).

An equally promising area is studying the spatial heterogeneity of tax sensitivity—identifying regions and clusters where tax policy has the greatest impact on output. This will allow for a shift from sectoral to territorial-sectoral analysis, which is particularly important for the practical implementation of industrial policy measures.

5 CONCLUSIONS

A study of the tax sensitivity of key industrial sectors in the Russian Federation confirmed the hypothesis that there are significant differences in the response to changes in the tax burden between knowledge-intensive and less knowledge-intensive sectors. The findings are important for understanding the interactions between tax policy and industrial development, as well as for improving government support instruments in the context of structural economic transformation.

A regression analysis based on data from 2010 to 2022 revealed a strong inverse relationship between the tax burden and industrial output. An increase in the tax burden in the previous period is accompanied by a decrease in output in the current period, reflecting the limiting effect of taxes on investment and production activity by enterprises.

The strongest negative impact is observed in knowledge-intensive industries—mechanical engineering and metallurgy—where the coefficients for the variable tax burden are (-0.247) and (-0.162),

respectively. These industries are characterized by a high share of innovation expenditures, significant fixed costs, long payback periods for capital investments, and dependence on profit reinvestment. Under these conditions, any increase in the tax burden leads to a reduction in financial resources available for innovative and technological projects, which hinders modernization in the long term.

In less knowledge-intensive industries (coal mining, food processing, and electric power), the elasticity was significantly lower (-0.07 to -0.08), indicating that their production indicators are less dependent on tax conditions. For these industries, market conditions, raw material prices, energy intensity, and export opportunities are key factors, not tax incentives.

Thus, the obtained results confirm the hypothesis that knowledge-intensive industries are more sensitive to the tax burden than traditional and resource-based sectors. This pattern is consistent with the findings of foreign studies (Romer & Romer; Giroud & Rauh; Lu et al.) and with the results obtained by E. Balatsky for the Russian industrial complex, but clarifies them in relation to the new economic environment of the 2020s.

The increased sensitivity of mechanical engineering and metallurgy is explained by the fact that the profitability of innovative enterprises is more dependent on the reinvestment of profits, which makes them more sensitive to changes in income taxes and to restrictions on working capital.

The impact of the tax burden is not immediate, but rather occurs with a time lag, reflecting the cyclical nature of investment decisions. Therefore, short-term estimates may underestimate the cumulative effect of fiscal changes, and the actual tax sensitivity of knowledge-intensive industries is likely higher than indicated in the baseline model.

For less knowledge-intensive industries, tax incentives are secondary: they are more resilient to fluctuations in the tax environment due to the scale of production and the relatively low share of innovation costs. This is one of the arguments for moving away from a universal tax policy implementing the principle of tax neutrality in favor of a more differentiated "smart" approach that takes into account the specifics and particular importance of modern knowledge-intensive development.

The results of the study confirm that tax instruments should not be used in isolation, but in conjunction with programs to support industry and scientific and technological development.

The regional aspect deserves special attention: regions with a high concentration of knowledge-intensive industries (e.g., Moscow, St. Petersburg, Tatarstan, and the Sverdlovsk region) may exhibit different sensitivity to the tax burden than regions with a resource-based specialization. A comparative analysis of regional differences would allow tax incentives to be tailored to the specifics of the territorial industrial structure.

Thus, tax policy is a crucial element of industrial development and the structural adaptation of the economy. Effective management of the tax burden—provided that the right priorities for such development are identified and updated—can not only ensure budget revenues but also stimulate technological innovation, increased investment, and the development of high-tech industries.

The analysis revealed that a unified tax policy does not always ensure a balance between fiscal and incentive objectives. Achieving stable, sustainable economic growth based on innovation requires a transition to a more finely tuned tax policy that takes into account the specific characteristics of knowledge-intensive industries and their strategic role in ensuring Russia's technological sovereignty.

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APPENDIX

Results of regression analysis

	Coal mining	Mechanical engineering	Food	Metallurgy	Electricity
Multiple R	0.911	0.901	0.802	0.927	0.792
R-squared	0.831	0.812	0.643	0.860	0.628
Normalized R-squared	0.793	0.770	0.564	0.829	0.545
Standard error	0.037	0.079	0.028	0.042	0.017
Observations	12	12	12	12	12
F-criterion	22,061	19,373	8,123	27,605	7,585
Significance of F	0.0003	0.0005	0.0096	0.0001	0.0117
Y-intersection	2,195	2,266	4,289	-0.256	0.050
Issue of the previous period	0.820	0.804	0.719	0.984	0.987
Tax burden of the previous period	-0.084	-0.247	-0.081	-0.162	-0.072
Standard error					
Y-intersection	1,858	2,727	2,837	2,217	4,367
Issue of the previous period	0.124	0.205	0.178	0.149	0.262
Tax burden of the previous period	0.081	0.133	0.078	0.187	0.312
t-statistics					
Y-intersection	1,181	0.831	1,511	-0.115	0.011
Issue of the previous period	6,592	3,931	4,029	6,595	3,769
Tax burden of the previous period	-1,043	-1,849	-1,034	-0.867	-0.232
P-Value					
Y-intersection	0.268	0.428	0.165	0.911	0.991
Issue of the previous period	0.0001	0.0035	0.0030	0.0001	0.0044
Tax burden of the previous period	0.324	0.098	0.328	0.409	0.822