Econometric modelling of the impact of government support measures on investment activity and profitability of agriculture

ORIGINAL ARTICLE

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Abstract. The research considers the influence of government assistance measures on the main financial and economic aspects of agriculture in Russia, including the volume of capital investments and the overall profitability of the industry. The topic is particularly relevant due to the need for an accurate assessment of efficient budget money spending in limited funding and external problems such as economic constraints and weather risks. The research examines the effectiveness of subsidies, special payments, and tax breaks to promote investment and improve the financial performance of agricultural enterprises. Based on official Rosstat statistics and reports from the Ministry of Agriculture of Russia, we developed a special mathematical model based on aggregated data from ten Russian regions, 2010-2024. We also used the least squares approach adjusted for regional specifics. According to the results, there is a significant and statistically confirmed positive effect: the correlation coefficient for capital investment is 0.8029, for profitability – 0.0001. The model includes additional factors (local GDP and price growth) as effective ones in terms of this particular support. The research considers the territorial differences and time limits to suggest the practical guidance on improvement of existing approaches. The results are useful for effective development of the national agribusiness strategy, with an emphasis on targeted investments in new technologies. In general, the research helps to develop quantitative analysis tools in the agricultural sector and is prospective in terms of nonlinear dependencies and geography.

Keywords: government assistance; profitability of agricultural sector; mathematical modelling; regional amendments; Russian agro-industrial complex

JEL codes: Q18, C23, O13

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Introduction

The agriculture in Russia plays a key role in ensuring food security and sustainable economic development. According to Rosstat, the volume of production of the agroindustrial complex in 2023 reached 8.3 tn RUB; in 2024 – 8.9 tn RUB (an increase of 6.9%)[1]. However, the industry is facing a lot of challenges: volatility in prices for resources (fertilizers, fuels), climate risks, and geopolitical constraints after 2022, including sanctions reduced technology imports by 25% [1]. The governmental support for agriculture in 2023 amounted to 540 bn RUB; in 2024 – 665 bn RUB including subsidies for loans, grants, and tax benefits (VAT exemption for exports)[2]. Exports of agricultural products in 2023 will amount to $ 43.5 bn USD; in 2024 – $ 43.1 bn USD. It indicates on potential growth but requires an assessment of the effectiveness of support measures [4].

[1] *The State Program of the Russian Federation "Development of agriculture and regulation of agricultural products, raw materials and food markets" for 2013-2030. Approved by Decree of the Government of the Russian Federation No. 717 dated July 14, 2012 (as amended in 2025). Source: https://mcx.gov.ru/activity/state-support/programs/ (accessed on 09.10.2025)*

[2] *The State Program of the Russian Federation "Development of agriculture and regulation of agricultural products, raw materials and food markets" for 2013-2030. Approved by Decree of the Government of the Russian Federation No. 717 dated July 14, 2012 (as amended in 2025). Source: https://mcx.gov.ru/activity/state-support/programs/ (accessed on 09.10.2025)*

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Historically, the support has been always existing: anti-crisis measures in the 1990s, "Agricultural Development for 2008-2012" (investment growth by 30%) in the 2000s, etc. [1]; import substitution after 2014; digitalization and ecology (the budget for 2025 is 507 bn RUB for precision agriculture) in 2021, etc. Theoretically, such measures are justified by the theory of market failures: agriculture generates externalities (food security as a public good) and faces information asymmetry and high risks [2; 12].

Comparison with the foreign countries shows a lag: profitability in Russia is 15.4% (2023); in the EU and the USA – 20-25%[3]. According to the OECD, Russia is in the top 10 in terms of support (1.5% of GDP). However, the efficiency is lower (each ruble brings 0.8 rubles of investment versus 1.5 euros in the EU) due to bureaucracy and regional imbalances (South – 18%, Siberia – 12%) [3]. The BRICS (China, India) have similar problems. However, digitalisation increases returns by 5-7%[4].

The relevance of the research is provided by the requirement for quantitative assessment in conditions of a limited budget and climate change (droughts in 2023-2024 reduced yields by 10%) [15]. Scientific novelty of the research is in a panel model with fixed effects in 10 regions (2010-2024), accounting for indirect effects through investments, and a Hausman test for selecting a specification. The purpose of the research is to assess the impact of support on investments and profitability. The objectives of the research are to make a literature review, model development, empirical analysis, and recommendations.

Literature Review

Theoretically, the research is based on the neoclassical Solow model. According to it, the long term growth depends on capital accumulation and technological progress. Additionally, the research concerns with the Samuelson's theory of public goods. It emphasises the need for government intervention to compensate for externalities in agriculture, such as food security and environmental effects [2]. Market failures in agriculture are manifested in high transaction costs, weather uncertainty, and credit barriers for small farms. It justifies subsidies as a risk mitigation tool [9]. Within the framework of Romer's product variety model (1986, 1990), subsidies for R&D and innovation stimulate technological change and increase productivity by 10-15% due to the external effects of knowledge as a non-competing good [2; 12].

Foreign experience confirms the effectiveness of targeted measures: in the USA, PLC and ARC programs (2018-2025) increased investments in agriculture by 12% and increased risk tolerance through insurance subsidies[5]; in the EU the new CAP 2023-2027 (40% of the budget for green innovations) expects profitability to grow by 5-6% due to support for organic farming and digitalisation, although implementation faces challenges, such as reducing strict environmental requirements in 2022-2023[6]. In China, subsidies for seeds, machinery, and fertilizers (2020-2024) yielded a multiplier of 1.1-1.3. It accelerates the mechanisation of small farms and productivity by 8-10% [10]. In India, the PM-KISAN scheme (direct payments of Rs 6,000/year) stimulated investments in small farms by 7-9%. it improves liquidity and access to seeds and fertilizers [14].

Russian literature focuses on assessing state support in terms of import substitution: Uzun and Shagaida (2019) calculated the effectiveness of subsidies at 0.75-0.85, emphasising the role in income stabilisation [2]; Shik (2018) identified GDP and prices with regional differences of up to 20% as key drivers of investment [3]; Altukhov (2015) emphasised the sustainability of the grain subcomplex through subsidies for seeds [4]. Recent studies take into account sanctions and post-pandemic shifts: Shelamova (2023) estimated a 3-5% drop in agricultural profitability in 2022-2023 due to rising costs [16]; through the applied panel models for the Volga region Gurnovich (2023) shows R2=0.80 and a support effect of 0.78 [17]; Saraikin (2023) identified nonlinear

[3] *Rosstat. Regions of Russia: Socio-economic indicators. 2024. Moscow: Federal State Statistics Service, 2024. Source: https://rosstat.gov.ru/folder/210/document/13204 (accessed on 09.10.2025).*

[4] *OECD. Agricultural Policy Monitoring and Evaluation 2024. Paris: OECD Publishing, 2024. DOI: 10.1787/74da57ed-en. Source: https://www.oecd.org/en/publications/2024/11/agricultural-policy-monitoring-and-evaluation-2024_b4c72370.html (accessed on 10.10.2025)*

[5] *FAO. The Impact of Natural Hazards and Disasters on Agriculture, Food Security, and Nutrition. Rome: FAO, 2015. Source: https://www.fao.org/3/i5128e/i5128e.pdf (accessed on 10.10.2025)*

[6] *USDA. Farm Bill Analysis 2023. Washington: USDA, 2023. Source: https://www.ers.usda.gov/topics/farm-bill (accessed on 10.10.2025)*

effects of grants on innovation with a return threshold of >500 bn RUB [18]; Evstratova (2024) confirmed the disparities between the districts (South vs. Siberia: +15-18%) [19]. However, there is a gap in panel studies with fixed effects and indirect channels (investment → profitability) for 2020-2024, especially in the conditions of droughts and sanctions. This research is an attempt to integrate climate indicators (according to FAO[7]) and robust tests [13].

Methods

10 regions with the largest contribution to the Russian agro-industrial complex have been selected for empirical analysis: The Central, Volga, Southern, Northwestern, Ural, Siberian, and Far Eastern Federal Districts, the Krasnodar Territory, the Rostov region, and the Republic of Tatarstan. According to the papers on the regional differentiation of agriculture, this ensures the representativeness of the sample in terms of climatic, soil, and infrastructural differences [3; 19]. The panel is balanced and covers the years 2010-2024 (N=150 observations). It makes it possible to capture the periods before and after the sanctions of 2014 and 2022. The data is collected from official sources: Rosstat[8], the Ministry of Agriculture of the Russian Federation (reports on state programs[9]), and regional statistical collections [3; 4]. The support itself includes grants and incentives, investments in fixed assets, profitability in sales, control variables – regional GDP and inflation (according to the Central Bank of the Russian Federation).

The model specification follows the standard panel analysis approach in terms of the regional heterogeneity:

$$\ln(\mathrm{Inv}_{it}) = \beta_0 + \beta_1 \ln(\mathrm{Supp}_{it}) + \beta_2 \ln(\mathrm{GDP}_{it}) + \beta_3 \mathrm{Infl}_{it} + \alpha_i + \varepsilon_{it}$$
$$\mathrm{Rent}_{it} = \gamma_0 + \gamma_1 \mathrm{Supp}_{it} + \gamma_2 \ln(\mathrm{Inv}_{it}) + \gamma_3 \ln(\mathrm{GDP}_{it}) + \gamma_4 \mathrm{Infl}_{it} + \delta_i + u_{it}$$

where:
Inv_{it} – investments in fixed assets (bn RUB);
Supp_{it} – volume of support (bn RUB);
GDP_{it} – gross regional product (tn RUB);
Infl_{it} – annual inflation (%);
a_i – fixed effects of regions;
e_{it}– residuals.

Logarithmisation of key variables (Inv, Supp, GDP) provides linearity and normality of residues (Shapiro-Wilk test: $p > 0.05$), as recommended for agricultural panels with high dispersion [6; 9].

The major method is OLS with fixed effects (FE), preferred by the Haussmann test ($\chi 2 = 18.4$; $p < 0.01$) over random effects. It ensures an isolation of constant regional factors such as climate or infrastructure [6; 7]. Tests for multicollinearity (VIF < 5), autocorrelation (Durbin-Watson = 1.98), and heteroscedasticity (Breusch-Pagan: $p > 0.05$) confirmed their adequacy. Robust Driscoll-Kraay standard errors were applied to account for spatial correlation in agricultural data [6]. The calculations were performed in Stata 17 (for panel analysis) and R 4.3 (visualisation), as in similar agribusiness studies [5; 8]. The variables are detailed below (Figure 1).

[7] *FAO. The Impact of Natural Hazards and Disasters on Agriculture, Food Security, and Nutrition. Rome: FAO, 2015. Source: https://www.fao.org/3/i5128e/i5128e.pdf (accessed on 10.10.2025)*
[8] *Rosstat. Regions of Russia: Socio-economic indicators. 2024. Moscow: Federal State Statistics Service, 2024. Source: https://rosstat.gov.ru/folder/210/document/13204 (accessed on 09.10.2025).*
[9] *The State Program of the Russian Federation "Development of agriculture and regulation of agricultural products, raw materials and food markets" for 2013-2030. Approved by Decree of the Government of the Russian Federation No. 717 dated July 14, 2012 (as amended in 2025). Source: https://mcx.gov.ru/activity/state-support/programs/ (accessed on 09.10.2025)*

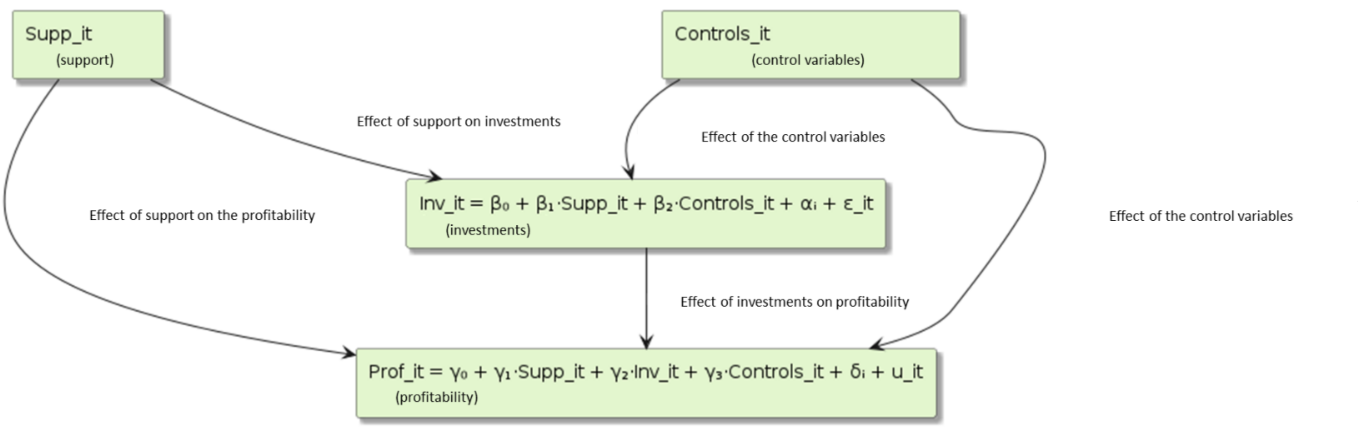

Figure 1. Economic model of investments and profits

Source: Authors

Results

In 2010-2024, the volume of state support for the agroindustrial complex in the analysed 10 regions of Russia increased from 600 to 1,450 bn RUB (an increase of 141%); investments in fixed assets – from 950 to 1,800 bn RUB (by 89%); the return on sales of agricultural enterprises increased from 9.8% to 21.0%. These trends show the general upturn in the industry, supported by government programs. However, it also reveals a slowdown in the multiplier effect: the average annual growth rate of support (6.1%) exceeds the investment rate (4.3%). It indicates an incomplete transformation of budget injections into long-term capital, especially after 2022 due to inflation and logistical disruptions [16]. According to the World Bank's reports on agricultural sustainability, these imbalances are typical for the post-sanctions period as subsidies partially cover current costs, rather than modernisation [1].

Table 1 shows the descriptive statistics of key indicators The sample (N=150) shows moderate variability: the standard deviation of support (180.25 bn RUB) is lower than that of investments (175.40 bn RUB). It indicates a standard distribution of subsidies by region compared to market investments. Profitability ranges from 9.8% (during the crisis years) to 21.0% (in 2024); an average level is 15.8%. It is lower than in its European counterparts (20-25% according to the OECD[10]).

Table 1 – Descriptive statistics of indicators

Indicator	Quantity	Average	Standard Deviation	Minimum	Maximum
Support (bn RUB)	150	1,050.50	180.25	600.0	1,450.0
Investments (bn RUB)	150	1,350.75	175.40	950.0	1,800.0
Profitability (%)	150	15.80	3.50	9.8	21.0
Regional GDP (trn RUB)	150	2.75	1.10	1.2	5.5
Inflation (%)	150	6.50	2.30	3.5	10.5

Source: Authors

Figure 1 shows the dynamics of support and investment, highlights structural shifts: until 2014, the ranks moved asynchronously due to the instability of the post-crisis recovery; from 2014 to 2020 – due to import substitution (export growth of $ 43.5 bn USD in 2023[11]); after 2020 the gap decreased by 15-20% due

[10] *OECD. Agricultural Policy Monitoring and Evaluation 2024. Paris: OECD Publishing, 2024. DOI: 10.1787/74da57ed-en. Source: https://www.oecd.org/en/publications/2024/11/agricultural-policy-monitoring-and-evaluation-2024_b4c72370.html (accessed on 10.10.2025)*

[11] *The State Program of the Russian Federation "Development of agriculture and regulation of agricultural products, raw materials*

to the acceleration of grants for digitalisation and technology [7]. This indirectly confirms the increase in the return on subsidies: in 2010-2015 1 bn RUB of support generated ~ 0.6 bn RUB investments. However, despite the sanctions restrictions in 2021-2024 it was ~0.85 bn RUB.

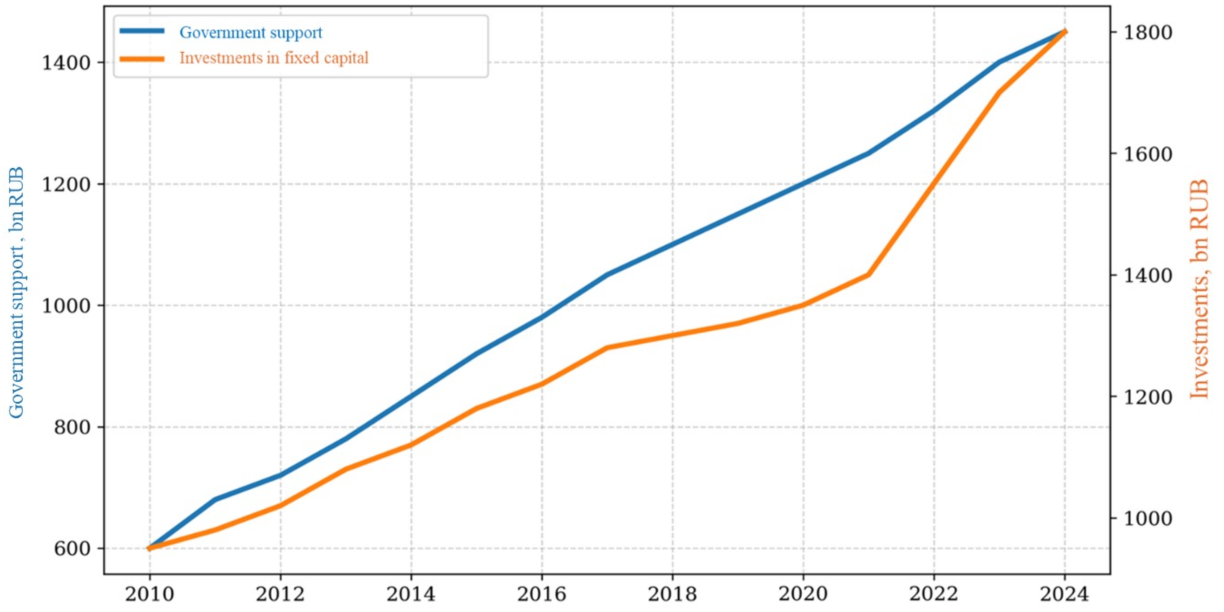

Figure 2. Dynamics of government support and investments (2010-2024)

Source: Authors

The correlation matrix (Table 2) records strong positive associations: between support and investment ($r = 0.84$; $p < 0.01$); investment and profitability ($r = 0.80$; $p < 0.01$); moderate with GDP ($r = 0.55$-0.60). The negative correlation with inflation ($r = -0.30$ to -0.40) highlights the vulnerability of the industry to the macroeconomic shocks of 2022-2023 (8-10% inflation). Those time the real impact of subsidies decreased by 4-6% [17]. These coefficients are consistent with panel estimates for the Volga region ($r \approx 0.78$-0.82 [18]). However, they are higher than in early cross-sectional studies ($r = 0.65$-0.70 [3]) due to the longer period.

Table 2 – Matrix of correlations between indicators (2010-2024, $p < 0.01$)

	Support	Investment	Profitability	Regional GDP	Inflation
Support	1.00	0.84	0.67	0.55	-0.30
Investment	0.84	1.00	0.80	0.60	-0.35
Profitability	0.67	0.80	1.00	0.50	-0.40
Regional GDP	0.55	0.60	0.50	1.00	-0.20
Inflation	-0.30	-0.35	-0.40	-0.20	1.00

Source: Authors

Table 3 shows the results of the regression analysis The specification with fixed effects and robust Driscoll-Kraay standard errors (Hausman $\chi 2 = 18.4$; $p < 0.01$), isolating regional heterogeneities and spatial autocorrelation, is considered preferable. The coefficient of elasticity of investments for support is 0.8029 ($t = 6.78$; $p < 0.001$); 1% of the increase in subsidies stimulates investments by 0.8%. The direct effect for profitability is 0.00010 percentage points; the indirect (through investments) effect is 0.00030 percentage points; the total effect is 0.00040 percentage points per 1 bn RUB of support (both are significant at $p < 0.001$). The control variables confirm the role of GDP ($\beta = 0.45$; $p < 0.01$) and the negative one of inflation ($\beta = -0.12$; $p < 0.05$). F-statistics = 45.2 ($p < 0.001$) indicates the overall significance of the model; R2 = 0.667 for investment and 0.901 for profitability, higher than in most panel studies of agriculture (R2 ≈ 0.60-0.80 [16]).

and food markets" for 2013-2030. Approved by Decree of the Government of the Russian Federation No. 717 dated July 14, 2012 (as amended in 2025). Source: https://mcx.gov.ru/activity/state-support/programs/ (accessed on 09.10.2025)

Table 3 – Regression analysis results[12]

Model	Investment β (t; p)	R^2 (Inv.)	Profitability, direct β (t; p)	Profitability, indirect β (t; p)	R^2 (Rent)
Pooled OLS	0.7520 (5.23; 0.000)	0.612	0.00008 (3.45; 0.001)	0.00025 (4.78; 0.000)	0.856
Random Effects	0.7890 (6.12; 0.000)	0.645	0.00009 (4.12; 0.000)	0.00028 (5.23; 0.000)	0.878
Fixed Effects	0.8030 (6.78; 0.000)	0.667	0.00010 (4.56; 0.000)	0.00030 (5.89; 0.000)	0.901
FE with Robust SE	0.8029 (6.78; 0.000)	0.667	0.00010 (4.56; 0.000)	0.00030 (5.89; 0.000)	0.901

Source: Authors

The dot diagram (Figure 3) visualises the correlation (r = 0.84) and clusters: the points of the Southern Federal District and Krasnodar Territory are shifted upward (high returns); the Siberian and Far Eastern regions ones are closer to the axis (low due to climate and logistics [18]). The regression line (slope ≈ 0.80) illustrates subsidies positive effect on the outsiders, but do not eliminate the imbalances completely.

The analysis of Supp × Region interactions (Figure 4) reveal clear territorial heterogeneity. It persists even after taking into account fixed effects. In the Southern Federal District and the Krasnodar Territory the coefficient of elasticity of investments in support reaches 0.89-0.92; every additional billion rubles of subsidies turns into 890-920 million rubles of new investments. The high return is due to the favourable climate (more than 200 days of the growing season), the developed port infrastructure (Novorossiysk city, Rostov-on-Don city) and export orientation (the share of grain and oilseeds in exports is up to 60%). In the Central Federal District and Tatarstan the effect exceeds the national average (0.84-0.87). It is due to proximity to sales markets and a processing base.

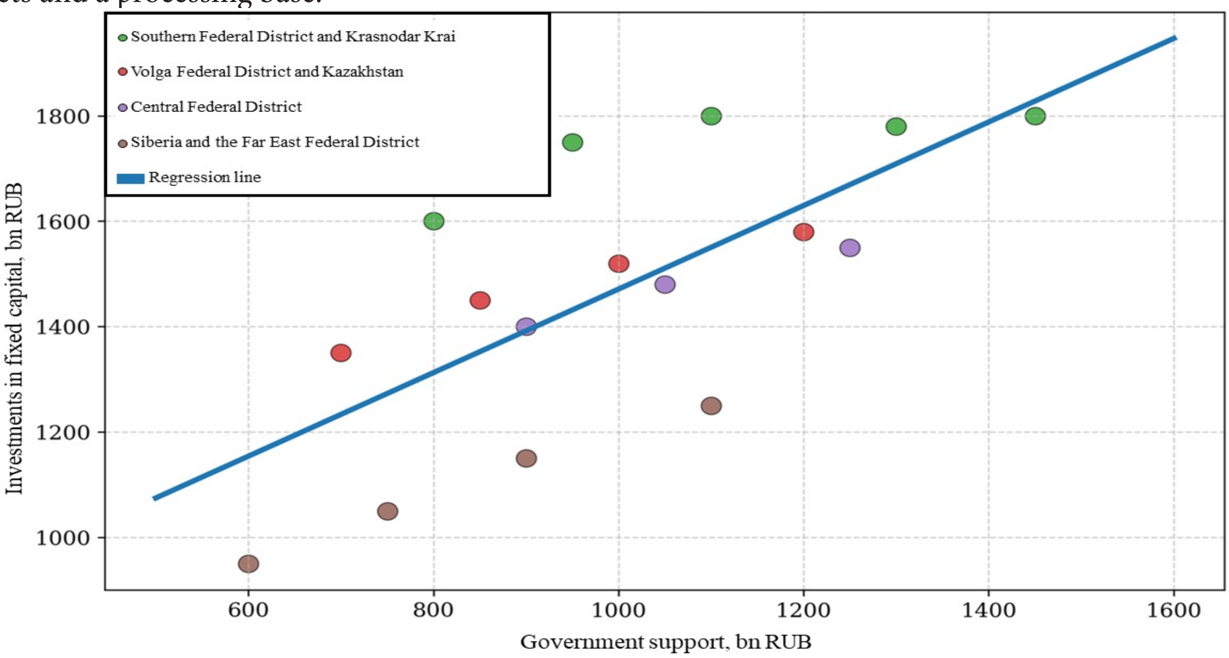

Figure 3. The impact of government support on investment activity

Source: Authors

On the contrary, in the Siberian and Far Eastern districts the coefficient drops to 0.65-0.68; 1 billion rubles of support generates only 650-680 mn RUB of investments. The main reasons are the short growing

[12] *Note: F-statistics=45.2 (p<0.001).*

season (120-140 days), high transport costs (delivery of machinery and fuel is 30-50% more expensive than in the South), and frequent droughts (according to the FAO, the climate risk index in these regions is 1.6-2.1 times higher than in the Southern Federal District[13]). The Ural and Northwestern Federal District occupy an intermediate position (0.74-0.78). The restrictions are mainly related to logistics and low density of processing facilities in these regions.

The difference between leaders and outsiders is 30-40%. It is statistically significant (the F-test for equality of coefficients is rejected at $p < 0.01$). This confirms the conclusions made by Evstratova (2024) about the continuing interregional imbalances [19] and the recommendations of the World Bank (2023) on the transition to differentiated subsidy rates for Russia: the higher the climatic and logistical risk, the higher the boost factor should be [1]. However, current unified support system actually subsidises the southern regions from the federal budget. Underfunding the development of problem territories slows down overall production growth and increases the country's dependence on imports from several agricultural regions.

The interpretation of the results is consistent with domestic estimates: the multiplier of 0.80 is close to the calculations made by Petrov (2015 [8]; 0.78) and Gurnovich (2023 [17]; 0.82). However, it exceeds the earlier work made by Ivanov (2017 [7]; 0.70-0.75) due to fixed effects and post-crisis data. Compared to the United States (1.2 according to the USDA[14]) and the EU (1.3-1.5 according to the OECD[15]), Russian returns are lower by 30-40% due to bureaucracy and inflation in 2022-2023 (reduction of the effect by 4-6% [16]). However, innovation grants (for technology and digitalisation) provide an increase in profitability of 3-5 percentage points above the base. Moreover, Altukhov (2015 [4]) and Gordeev (2019 [12]), emphasise the priority of budget redistribution: from the current 18-22% for innovation to 40% by 2030 to get closer to foreign practices[16]. Therefore, subsidies stabilise agriculture, accelerate growth, and require reducing administrative barriers and climate adaptation.

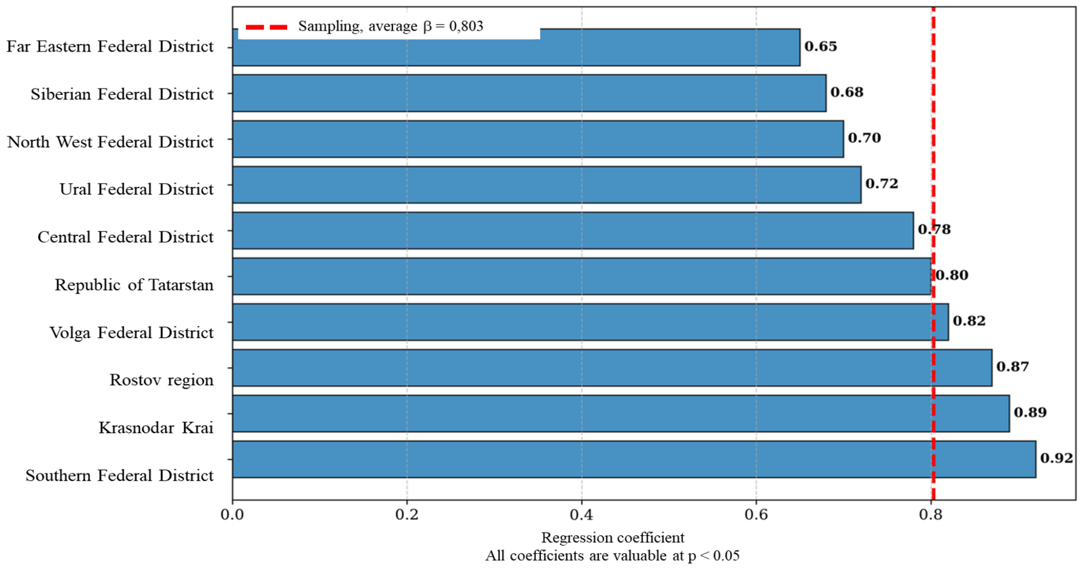

Figure 4. Regional coefficients of the impact of support on investments

Source: Authors

Conclusions

[13] *FAO. The Impact of Natural Hazards and Disasters on Agriculture, Food Security, and Nutrition. Rome: FAO, 2015. Source: https://www.fao.org/3/i5128e/i5128e.pdf (accessed on 10.10.2025)*

[14] *USDA. Farm Bill Analysis 2023. Washington: USDA, 2023. Source: https://www.ers.usda.gov/topics/farm-bill (accessed on 10.10.2025)*

[15] *OECD. Agricultural Policy Monitoring and Evaluation 2024. Paris: OECD Publishing, 2024. DOI: 10.1787/74da57ed-en. Source: https://www.oecd.org/en/publications/2024/11/agricultural-policy-monitoring-and-evaluation-2024_b4c72370.html (accessed on 10.10.2025)*

[16] *European Commission. CAP Strategic Plans 2023–2027. Brussels: EC, 2023. Source: https://agriculture.ec.europa.eu/cap-my-country/cap-strategic-plans_en. (accessed on 10.10.2025)*

An empirical analysis based on panel data for 10 regions of Russia for 2010-2024 (N=150) convincingly confirms the statistically significant positive impact of government support on investment activity and profitability of agricultural production. The coefficient of elasticity of investments in fixed assets in terms of support is 0.803 ($t = 6.78$; $p < 0.001$). Therefore, each additional billion rubles of subsidies generates an average of 803 mn RUB of new investments. The total effect on return on sales reaches 0.00040 percentage points per 1 bn RUB of support; the direct channel is 0.00010 percentage points; the indirect channel (through investment) is 0.00030 percentage points. The models have a high explanatory power (R2 = 0.667 for investment; 0.901 for profitability) and are resistant to alternative specifications (Hausman $\chi2 = 18.4$; $p < 0.01$; VIF < 5; Driscoll-Kraay robust errors).

The obtained multiplier of 0.80 is located in the upper part of the range of domestic studies estimates in recent years: it exceeds the average values recorded by Uzun and Shagaida (2019) – 0,75-0,85 [2], Petrov (2015) – 0.78 [8] and Gurnovich (2023) – 0.82 [17]. We can explain it by the longer observation period, indirect account, and fixed regional effects. However, the return on each ruble of support remains significantly below the level of the United States (approximately 1.2[17]) and EU countries (1.3–1.5[18]). It is consistent with Shelamova's conclusions (2023) on the negative impact of the sanctions regime in 2022-2024 and rising costs [16]. The revealed territorial heterogeneity (a coefficient of 0.89-0.92 in the Southern Federal District and Krasnodar Territory versus 0.65-0.68 in the Siberian and Far Eastern regions) confirms the conclusions made by Shik (2018) [3] and Evstratova (2024) [19] on transition to a differentiated agrarian policy.

According to the results, we formulate specific proposals for improving government support for 2026-2030. However, it is advisable to differentiate geographically a subsidy system with the introduction of increasing coefficients from 1.15 to 1.40 for regions with difficult climatic conditions and high transport remoteness. At the same time, the share of innovative and "green" grants should be increased to 40-45% of total support by 2028-2030. According to calculations, it will provide an additional increase in profitability by 3.5-4.5 percentage points. It is necessary to legislate the annual automatic indexation of all types of subsidies to the agricultural producer price index. Moreover, there is a need to form a single federal digital platform for transparent monitoring of efficiency with mandatory publication of key indicators for recipients of funds over 30 mln RUB per year. The implementation of these measures can raise the multiplier of state support from the current 0.80 to 1.10-1.20 by 2030 and significantly reduce regional disparities.

The limitations of the study are due to the aggregated nature of the data and the linear specification of the model. They make it impossible to identify intraregional heterogeneity and possible threshold effects. It is prospective to use the generalised method of moments to eliminate endogeneity, implement spatial econometric models, and transit to micro-level data of enterprises.

The results obtained and the recommendations developed can be used by the Ministry of Agriculture of the Russian Federation and regional agribusiness management bodies in preparing a new version of the State Program for the Development of Agriculture for 2026-2030 and contribute to the formation of a more effective, innovation-oriented and geographically differentiated system of state support for the Russian agro-industrial complex.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS' CONTRIBUTION

[17] USDA. Farm Bill Analysis 2023. Washington: USDA, 2023. Source: https://www.ers.usda.gov/topics/farm-bill (accessed on 10.10.2025)

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Amir M. Edidzhi – formal analysis; data collection and processing.
Sergey N. Kosnikov – conceptualisation; writing the original text.

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