QUBAHAN ACADEMIC JOURNAL
VOL. 6, NO. 2, June 2026
https://doi.org/10.48161/qaj.v6n2a2353

The Degree of Digital Platform Integration in the Regional Economy as a Strategic Development Mechanism under Systemic Transformations

Marat Safiullin [1, 2*] and Artem Guryanov [2]

[1] Department of Economic Theory and Econometrics, Institute of Management, Economics and Finance, Kazan (Volga Region) Federal University, Kazan 420008, Russia;
[2] Center for Advanced Economic Research, Tatarstan Academy of Sciences, Kazan 420111, Russia.

* **Corresponding author:** safiullin@mymail.academy.

ABSTRACT: At present, digital platforms play an important role in economic development by improving interfirm interaction, reducing transaction costs, and supporting cooperation within value chains. Due to their growing relevance, digital platforms have become an important element of national and regional public policy. This study identifies and analyzes the factors associated with the level of digital platform integration in the regional economy of the Russian Federation, with particular attention to the Republic of Tatarstan. To address this task, the study applies econometric modeling based on the Within-Between panel data model using regional data for 2020–2023. The results show that digital platform integration is statistically associated with e-commerce activity, interfirm cooperation in innovation, organizational expenditures on information technology, and the volume of regulated procurement. The strongest association is observed for the share of organizations conducting most of their sales via the Internet. The findings clarify the specific features of the Russian digital platform market and provide a basis for policy recommendations aimed at strengthening digital platform integration in Russia and the Republic of Tatarstan.

Keywords: Digital platforms, Electronic trading platforms, E-commerce, Innovation activity, Within-Between model.

I. INTRODUCTION

In today's world, digital platforms for interfirm interaction (B2B) have become highly relevant across a wide range of domains. They make it possible to significantly reduce transaction costs and increase the efficiency of interorganizational links within value chains. Moreover, digital platforms simplify and open new opportunities for establishing interfirm interactions and cooperation. Currently, digital platforms are given great importance at the state level. In particular, one of the objectives of the national project Data Economy is the development of digital platforms [1]. For example, the President of the Russian Federation, V. V. Putin, in his speech at the St. Petersburg International Economic Forum in 2024, stated: By 2030, we must create digital platforms in all key sectors of the economy and the social sphere. These tasks will be addressed within the framework of the new national project Data Economy [2]. One of the goals of the State Program of the Republic of Tatarstan Digital Tatarstan is to ensure digital maturity based on the widespread implementation of digital platforms [3].

The autonomous non-profit organization Digital Economy, which unites key players in the Russian IT market, has developed the following definition of a digital platform: A digital platform is a system of algorithmized mutually beneficial relations among a significant number of independent participants of an economic sector (or activity area), carried out within a unified information environment, leading to reduced

transaction costs through the use of a package of digital data technologies and a change in the division of labor system [4]. This definition has become widely used in practice, particularly in many government documents [5-7].

From both theoretical and practical perspectives, the methodology of value chains, developed by M. Porter, has significant potential for the study of digital platforms. It is a well-established method of strategic analysis applicable to a wide range of tasks [8]. The value chain approach enables a comprehensive analysis of an organization and an industry as a system. This methodology pays considerable attention to both intra-firm (between different business processes) and interfirm links. For these reasons, the value chain methodology is an effective tool for studying and improving the efficiency of interfirm links, including in relation to digital platforms [9]. Within the value chain, digital platforms are situated at the level of interorganizational connections, and their main task is to improve the efficiency of these links. At the same time, digital platforms exert a significant influence on the mechanism of value chain construction. For instance, digital platforms make dynamic restructuring of value chains possible through flexible changes of counterparties. Furthermore, digital platforms can be used to build effective interfirm cooperation, including long-term cooperation.

II. RELATED WORK

A substantial body of research has examined digital platforms from different theoretical and applied perspectives. Geliskhanov, Yudina, and Babkin [10] analyze the essence, models, and development trends of digital platforms in the economy. Bauer, Eremin, and Smirnov [11] consider digital platforms as an instrument for transforming the Russian and global economy, while Grigoriev, Maksimtsev, and Uvarov [12] focus on the role of digital platforms in improving the competitiveness of supply chains. Din [13] studies digital transformation of organizational management through the platform approach. In the international literature, Cusumano, Gawer, and Yoffie [14] examine the business logic of platform markets, Trabucchi and Buganza [15] analyze the transition from two-sided to multi-sided platforms, and Veisdal [16] explores entry dynamics in two-sided platform markets.

Recent empirical studies have also expanded the discussion by linking digital platforms and the digital economy with regional innovation, innovation quality, and e-commerce adoption. For example, Tian et al. [17] show that the digital economy has a positive effect on regional technological innovation capability using Chinese provincial panel data. Han et al. [18] examine the effect of digital platforms on innovation quality and identify direct, indirect, and nonlinear mechanisms. Paun et al. [19] analyze the main drivers of e-commerce adoption using global panel data. These studies confirm the importance of digitalization, platforms, and e-commerce for regional and organizational development. However, they do not directly quantify the factors that determine the regional integration of digital platforms as a separate empirical outcome. In particular, the existing literature does not distinguish between within-regional changes over time and between-regional structural differences in platform integration. This gap is important because the same factor may operate differently as a source of temporal change within a region and as a source of cross-regional differentiation.

Since digital platforms can significantly improve the efficiency of value chains, the task of identifying factors that have a significant impact on the level of digital platform integration is of high relevance. To address this task, the study develops an econometric model based on panel data across the regions of the Russian Federation. Thus, the purpose of the study is to develop recommendations for the public policy of the Russian Federation and the Republic of Tatarstan regarding the development of digital platforms, based on modeling the factors that significantly influence the level of their integration. The research objectives are as follows:

- To collect statistical data on factors that may potentially affect the level of digital platform integration;
- To construct an econometric model in order to identify factors that have a significant impact on the level of digital platform integration;
- To analyze the modeling results and provide an economic justification for the model;
- To develop recommendations for the state policy of the Russian Federation to increase the level of digital platform integration;
- To develop recommendations for the Republic of Tatarstan based on the relevant factor values of the model.

Object of the study the sphere of digital platforms in the Russian Federation. Subject of the study the level of digital platform integration and the factors influencing it.

III. MATERIAL AND METHOD

1. DATA COLLECTION

The study is based on economic, statistical, abstract-logical, and econometric methods. The dataset consists of panel data for 2020–2023 across all subjects of the Russian Federation, except for the Donetsk People's Republic, the Luhansk People's Republic, the Kherson region, and the Zaporizhzhia region. Autonomous okrugs are considered separately from the regions they belong to, and the data for the respective regions exclude autonomous okrugs. Thus, the panel contains data for 85 regions. The data were obtained from the following sources:

- Federal State Statistics Service (Rosstat) [20];
- Unified Interdepartmental Information and Statistical System (EMISS) [21];
- Unified Information System in the Field of Procurement (EIS Zakupki) [22];
- HSE statistical compendiums "Indicators of Innovation Activity" [23].

For transparency and reproducibility, Table 1 summarizes the open-source basis used for panel reconstruction and variable processing.

Table 1. Open-source basis for panel reconstruction and diagnostic verification.

Variable block	Variables	Open source	Processing procedure
Digital platform integration and digitalization	digital_platforms, www_sales, it_spending	Rosstat, Form No. 3-inform / statistical materials on the use of digital technologies by organizations	Regional values for 2020–2023 are extracted; monetary values are deflated to 2023 prices; volume indicators are log-transformed where required.
Innovation activity	innov, innov_proc, innov_logist, innov_inf, innov_ext, innov_mkt, innov_coop	HSE statistical data books "Indicators of Innovation in the Russian Federation"	Regional innovation indicators are harmonized by year; innov_coop is treated according to its published denominator, i.e., among organizations engaged in innovation activity.
Regulated procurement	fz_44_vol, fz_44_n, fz_223_vol, fz_223_n, fz_vol, fz_n	Unified Information System in the Field of Procurement	Contract and agreement values are aggregated by region and year; monetary indicators are deflated to 2023 prices; volume indicators are log-transformed.
Price adjustment	Consumer price index	Rosstat / EMISS	Monetary variables are converted to 2023 prices using annual CPI values.

According to Rosstat, in 2023 the Republic of Tatarstan ranked 27th among Russian regions in terms of the level of digital platform integration [24]. Thus, further development of digital platforms in Tatarstan remains an urgent task.

2. RESEARCH DESIGN

To address the stated objectives, it was decided to use panel models. Data on the level of digital platform integration are available starting from 2020, with annual frequency, which makes it impossible to analyze time series. At the same time, compared to cross-sectional data, panel data allow variables to be examined in

temporal dynamics and increase the number of observations in the training sample. Panel data include two types of effects [25, 26]:

- Within-effects, which correspond to changes in a variable's value over time within the same panel unit;
- Between-effects, which correspond to differences in a variable's value between two panel units at the same point in time.

In general, within- and between-effects differ both in meaning and in value. Let us illustrate this with an example. Suppose there is a binary variable (with values 1 and 0) indicating the presence or absence in a region of some long-term policy that has a significant positive effect on the target variable. When comparing region X, where the policy is absent, with region Y, where the policy is in place, the target variable for region Y will be higher given equal values of other variables (within-effect). At the same time, if in region X the policy is introduced in the next period, the target variable will not immediately increase significantly, since time is needed for the policy to yield results (between-effect).

Currently, the two most widely used panel models in econometrics are the fixed-effects model and the random-effects model [27]. The fixed-effects model estimates only within-effects, ignores between-effects, and, in addition, does not allow inclusion of time-invariant variables (since they create perfect multicollinearity with fixed effects). The random-effects model assumes equality of within- and between-effects [28]. The Within-Between panel data model allows estimation of both within- and between-effects. This model can be considered a generalization of the fixed-effects and random-effects models [25]. A similar model was first formulated by Y. Mundlak in 1978 [29]. Despite its advantages, this model has not yet gained wide popularity in econometrics, although the Within-Between model and related structures are actively used in such fields as sociology and medicine. The Within-Between model has been applied in international economic publications by authors such as B. Czyzewski, A. Matuszczak, R. Miskiewicz [30], I. Elenes Platona [31], A.B. Spade [32]. In Russian-language economic publications, the model has not previously been used. The Within-Between model is expressed by the following formula [33]:

$$y_{it} = \beta_0 + \beta_1(x_{it} - \bar{x_i}) + \beta_2\bar{x_i} + \gamma z_i + u_{0i} + \epsilon_{it} \quad (1)$$

Where y_{it} indicates target variable; β_0 represents intercept; x_{it} represents time-varying factor; and β_1 represents coefficient, within-effect of factor x_{it}, numerically equal to the corresponding coefficient of the fixed-effects model; $\bar{x_i}$ within-group mean of factor x_{it}; β_2 represents coefficient, between-effect of factor x_{it}; z_i represents time-invariant factor; γ represents coefficient, between-effect of factor *ziz_izi* (no within-effect, since it is time-invariant); u_{0i} represents random effect of the unit; ϵ_{it} is random error.

3. VARIABLE CONSTRUCTION

The target variable, the level of digital platform integration, is denoted as *digital_platforms*. The index variable for regions is denoted as region, and the index variable for years as time. The factors considered in model construction were grouped into blocks based on their semantic content. Each block is discussed below. Block Information Technology contains various metrics of IT development in a given region (Table 2).

Table 2. Block information technology.

Factor	Description	Unit	Source
inform	Share of organizations classified under OKVED 2 as "J. Information and Communication Activities".	–	[34]
inform_n	Number of organizations classified under OKVED 2 as "J. Information and Communication Activities".	units	[34]
it_spending	Average expenditures of organizations on the implementation and use of digital technologies.	1 ruble	[35]
it_goods_vol	Volume of shipped goods (services) of own production related to ICT.	1 ruble	[35]

The level of IT development in a region is of great importance for the integration of digital platforms, since integrating digital platforms into an organization's value chain generally requires either that organizations possess substantial competencies in information technology or that they use the services of IT companies. This is even more true in the case of developing proprietary digital platforms. The Innovation block includes various indicators of organizations' innovation activity (Table 3).

Table 3. Block innovation.

Factor	Description	Unit	Source
innov	Share of organizations engaged in innovation activity.	–	[36]
innov_proc	Share of organizations with expenditures on process innovations.	–	[36]
innov_logist	Share of organizations with completed innovations in the last three years related to logistics, supply, and distribution methods of raw materials, components, goods, and services.	–	[36]
innov_inf	Share of organizations with completed innovations in the last three years related to methods of information processing and transmission.	–	[36]
innov_ext	Share of organizations with completed innovations in the last three years related to business practices and external relations.	–	[36]
innov_mkt	Share of organizations with completed innovations in the last three years related to marketing methods of promotion, presentation, and pricing of goods.	–	[36]
innov_coop	Share of organizations engaged in cooperation in innovation development, among organizations performing innovation activity.	–	[21, 36]

Unlike the other variables in this block, the variable *innov_coop* corresponds to the share of organizations among those engaged in innovation activity, since data for 2020–2022 are available in open sources only in this form. The introduction of digital platforms into organizational practices is considered a process innovation. This follows from the definition provided in Rosstat Order No. 818 of 27.12.2019: Process innovation is a new or significantly improved business process introduced into practice, which differs substantially from the corresponding business process previously used [37]. The factors in this block include specific types of process innovations that are potentially related to the field of digital platforms, specifically interfirm connections within value chains and/or information technology.

The E-commerce block contains factors providing information on the e-commerce market in a given region (Table 4). These factors are relevant because all procurement regulated by Federal Laws No. 44-FZ and 223-FZ, as well as a large share of the unregulated e-commerce segment, is conducted on electronic trading platforms (ETPs), which represent an important type of digital platform.

Table 4. Block E-commerce block.

Factor	Description	Unit	Source
fz_44_vol	Volume of contracts concluded under 44-FZ "On the Contract System in the Procurement of Goods, Works, Services for State and Municipal Needs"	1 ruble	[38]
fz_44_n	Number of contracts concluded under 44-FZ "On the Contract System in the Procurement of Goods, Works, Services for State and Municipal Needs"	units	[38]
fz_223_vol	Volume of contracts concluded under 223-FZ "On Procurement of Goods, Works, Services by Certain Types of Legal Entities"	1 ruble	[38]
fz_223_n	Number of contracts concluded under 223-FZ "On Procurement of Goods, Works, Services by Certain Types of Legal Entities"	units	[38]
fz_vol	Total volume of contracts and agreements concluded under 44-FZ and 223-FZ	1 ruble	[38]
fz_n	Total number of contracts and agreements concluded under 44-FZ and 223-FZ	units	[38]
www_sales	Share of organizations conducting 50% or more of their sales via the Internet	–	[35]

At the same time, measures adopted since 2022 in connection with sanctions imposed by unfriendly countries have led to distortions in open data on regulated procurement under both 44-FZ and 223-FZ. For example, Russian Government Decree No. 301 of 06.03.2022 closed information on a significant portion of procurement under 223-FZ [39]. This prevents the analysis of Russian regulated procurement in temporal dynamics and, consequently, the identification of within-effects of regulated procurement on the Russian digital platform market. For this reason, in the study only between-effects of factors related to regulated procurement were considered. All monetary variables were adjusted to 2023 prices based on inflation data from Rosstat [40]. Volume indicators were log-transformed.

IV. DATA ANALYSIS

For model construction, the Panelr package of the R programming language was used [41]. For plotting, the Plotly package was applied [42]. To support reproducibility, the estimation workflow was documented in R, including the construction of the Within–Between model, the generation of alternative feature combinations, and the selection of the final specification. The replication materials include the cleaned panel dataset, variable-construction file, panelr estimation script, and model-selection code. Figure 1 presents a correlation diagram between the variables under consideration. The variable time corresponds to the year.

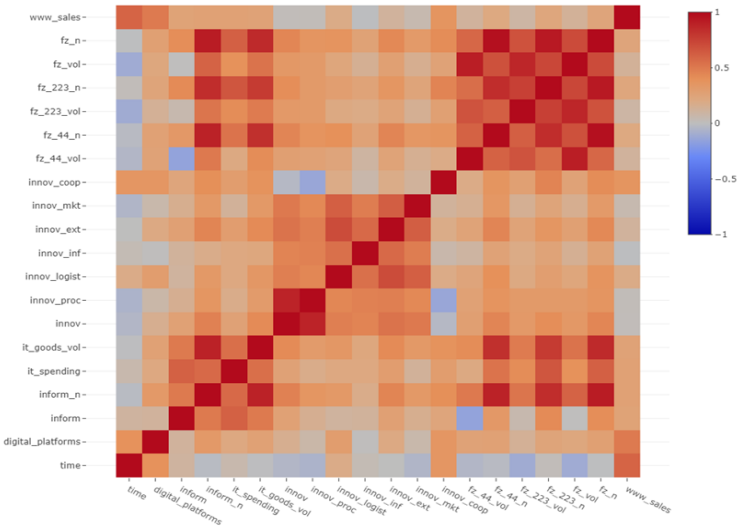

FIGURE 1. Correlations between model variables.

It can be seen that the target variable *digital_platforms* has the strongest correlation with the factor's *www_sales* (0.5) and *innov_coop* (0.36). The reasons for these correlations will be discussed at the stage of interpreting the model results. In addition, there is a noticeable positive correlation of *digital_platforms* with time (0.39), indicating a steady growth in the integration of digital platforms.

1. BLOCK INFORMATION TECHNOLOGY

The factors of this block represent various metrics of IT development in the region and therefore exhibit substantial correlations with each other (above 0.5 for each pair of variables, see Figure 1). Based on this, each model included only one of these factors. Thus, this block was introduced into the model in four variations.

2. BLOCK INNOVATION

The factor *innov_coop* was included in all models. Then, one of the factors *innov* or *innov_proc* was added, since they are highly correlated with each other and less correlated with the other variables in the block. The remaining four factors of this block correspond to different types of process innovations. Due to their significant correlations (above 0.48 for each pair of variables, see Figure 1), only one of them was included in each model.

3. BLOCK E-COMMERCE

The factor *www_sales* was included in all models. Variables for regulated procurement were included in the model in the following combinations, based on their meaning: *fz_44_vol*, *fz_223_vol*, *fz_44_n*, *fz_223_n*, *fz_vol*, and *fz_n*. Thus, this block was introduced into the model in four variations. It is worth noting the substantial correlation between some variables of the "Information Technology" block and variables related to regulated procurement. This can be explained by the fact that since regulated procurement is carried out on electronic trading platforms, the development of IT in a region contributes to higher levels of regulated procurement integration. It was decided not to account for these correlations when compiling feature combinations for model construction, since these variables, despite noticeable correlations, differ significantly in meaning. Equally noteworthy are the weak negative correlations between the regulated procurement variables and time. These reflect the distortion of open data on regulated procurement since 2022, as described above.

3.1 Model Selection and Robustness Strategy

In total, 128 (4 × 2 × 4 × 4) combinations of features and, accordingly, models were examined. In cases where a model contained statistically insignificant variables, such variables were removed and the model was rebuilt. Variables were removed one at a time, starting with those whose minimum of the two p-values (the first p-value of the within-effect, the second p-value of the between-effect) was the highest. The model quality metric used was the coefficient of determination (R^2). Since the study is based on observational regional panel data, possible endogeneity and reverse causality should be explicitly considered. Regions with a higher level of digital platform integration may also demonstrate higher e-commerce activity, stronger interfirm innovation cooperation, and higher organizational IT expenditures. Therefore, the estimated coefficients should not be interpreted as strictly one-directional causal effects. Rather, they indicate statistically significant associations between the selected regional factors and the level of digital platform integration.

This issue is especially relevant for the variable's *www_sales* and *innov_coop*. E-commerce integration may contribute to the diffusion of digital platforms, but the development of digital platforms may also stimulate online sales. Similarly, innovation cooperation may support platform development, while digital platforms may facilitate new forms of interfirm cooperation. For this reason, the interpretation of the results was revised throughout the Discussion section: causal language was reduced, and the findings are presented as empirically grounded associations requiring cautious interpretation.

3.2 Endogeneity And Robustness Strategy

Since the study is based on observational regional panel data, possible endogeneity should be explicitly considered. In particular, reverse causality may arise because regions with a higher level of digital platform integration may subsequently demonstrate higher e-commerce activity, stronger interfirm innovation cooperation, and higher organizational IT expenditures. Therefore, the estimated coefficients should not be interpreted as purely causal effects without additional robustness checks. This problem is common in non-experimental panel studies, where simultaneity, omitted variables, and dynamic feedback between variables may bias coefficient estimates [43, 44].

To reduce this risk, an additional robustness specification was estimated using one-year lagged regressors for the main time-varying explanatory variables: *www_sales*, *innov_coop*, and *log(it_spending)*. This approach makes it possible to test whether previous-year values of the explanatory variables are associated with the subsequent level of digital platform integration. At the same time, lagged regressors do not fully eliminate endogeneity and therefore are used here as a robustness check rather than as definitive proof of causality [45]. The results of this additional specification were compared with the baseline Within–Between model.

V. DATA ANALYSIS

1. MAIN MODEL ESTIMATES

As a result, the model with the highest performance was the one whose coefficients are presented in Tables 5 and 6. The model's coefficient of determination (R^2) is 0.713. Before interpreting the final coefficients, the model was additionally evaluated from the perspective of statistical reliability and reproducibility. Since the

panel combines 85 Russian regions observed over a relatively short period, 2020–2023, the results may be sensitive to heteroskedasticity, within-region serial correlation, and contemporaneous cross-sectional dependence caused by common macroeconomic shocks, sanctions-related restructuring, and nationwide digitalization policies. Therefore, the final specification was supplemented with a diagnostic framework based on open-source panel reconstruction and robust panel inference procedures.

The panel dataset can be reconstructed from official open sources. The dependent variable and the main digitalization variables, including digital platform use, Internet sales, and IT expenditures, are based on Rosstat statistical materials on the use of digital technologies by organizations. Innovation-related indicators are based on HSE statistical data books Indicators of Innovation in the Russian Federation, which include data on innovation activity, cooperation linkages, open innovation practices, and regional innovation indicators. Procurement variables are based on the Unified Information System in the Field of Procurement, which provides access to contract and agreement data under 44-FZ and 223-FZ. Monetary variables were adjusted to 2023 prices using consumer price index data from Rosstat/EMISS.

Table 5. Within-effects.

	Coefficient	Standard Error	t	p
innov_coop	0.059	0.023	2.543	0.012**
www_sales	0.730	0.073	9.994	0.000***
log(it_spending)	0.009	0.005	1.734	0.084*

Table 6. Between-effects.

	Coefficient	Standard Error	t	p
Intercept	-0.007	0.098	-0.069	0.945
innov_coop	0.088	0.054	1.615	0.110
www_sales	0.727	0.268	2.710	0.008***
log(it_spending)	-0.002	0.005	-0.416	0.678
log(fz_vol)	0.007	0.004	1.809	0.074*

2Note to Tables 5 and 6: *** – statistically significant at the 0.01 level, ** – at the 0.05 level, * – at the 0.1 level.

The within-effects show that the strongest association with digital platform integration is observed for *www_sales* ($\beta = 0.730$, $p < 0.01$). This means that, within the same region over time, an increase in the share of organizations conducting most of their sales via the Internet is associated with a higher level of digital platform integration. If both variables are measured in percentage points, a 1 percentage point increase in *www_sales* corresponds to an estimated 0.730 percentage point increase in *digital_platforms*, holding the other variables constant.

The coefficient for *innov_coop* is also positive and statistically significant at the 0.05 level ($\beta = 0.059$, $p = 0.012$). This indicates that growth in interfirm cooperation in innovation within a region is associated with higher digital platform integration. The coefficient for *log(it_spending)* is positive and significant at the 0.1 level ($\beta = 0.009$, $p = 0.084$), suggesting a weaker but still relevant relationship between organizational IT expenditures and platform integration.

The between-effect of *log(fz_vol)* is positive and significant at the 0.1 level ($\beta = 0.007$, $p = 0.074$), which suggests that regions with structurally larger open volumes of regulated procurement tend to demonstrate higher digital platform integration. Given the partial non-disclosure of procurement information after 2022, this coefficient is interpreted as a cross-regional structural association rather than as evidence of a short-term causal effect of procurement dynamics. At the same time, the between-effects of *innov_coop* and *log(it_spending)* are not statistically significant, which means that their role is clearer in explaining within-regional changes over time than stable cross-regional differences.

2. ECONOMIC MEANING OF THE ESTIMATED COEFFICIENTS

To make the results more interpretable for policy purposes, the estimated coefficients were converted into marginal-effect statements. Since *www_sales* and *innov_coop* are share-type variables, their coefficients can be interpreted in percentage-point terms. If the variables are expressed as shares from 0 to 1, a 1 percentage point increase corresponds to a change of 0.01 in the explanatory variable. Therefore, the within-effect of *www_sales* ($\beta = 0.730$) implies that a 1 percentage point increase in the share of organizations conducting most of their sales via the Internet is associated with an estimated 0.73 percentage point increase in digital platform integration. Similarly, the within-effect of *innov_coop* ($\beta = 0.059$) implies that a 1 percentage point increase in innovation cooperation is associated with an estimated 0.059 percentage point increase in digital platform integration.

For logarithmic variables, the coefficients should be interpreted as semi-elasticities. The within-effect of *log(it_spending)* ($\beta = 0.009$) means that a 10% increase in organizational IT expenditures is associated with an estimated change of approximately 0.00086 in *digital_platforms* in share units, or about 0.086 percentage points if the dependent variable is expressed as a percentage. The between-effect of *log(fz_vol)* ($\beta = 0.007$) means that a 10% higher open volume of regulated procurement is associated with an estimated difference of approximately 0.00067 in digital platform integration in share units, or about 0.067 percentage points if expressed as a percentage. These estimates show that the largest policy-relevant marginal effect is associated with e-commerce integration, while IT spending and regulated procurement have weaker but theoretically meaningful associations. The policy-ready interpretation of the main coefficients is summarized in Table 7.

Table 7. Policy-ready interpretation of the main coefficients.

Variable	Effect type	Coefficient	Policy-ready interpretation
www_sales	Within-effect	0.730	+1 percentage point in Internet-sales integration is associated with approximately +0.73 percentage points in digital platform integration.
innov_coop	Within-effect	0.059	+1 percentage point in innovation cooperation is associated with approximately +0.059 percentage points in digital platform integration.
log(it_spending)	Within-effect	0.009	+10% in organizational IT expenditures are associated with approximately +0.086 percentage points in digital platform integration, if the dependent variable is expressed as a percentage.
www_sales	Between-effect	0.727	Regions structurally 1 percentage point higher in Internet-sales integration are associated with approximately +0.727 percentage points higher digital platform integration.
log(fz_vol)	Between-effect	0.007	Regions with 10% higher open regulated procurement volume are associated with approximately +0.067 percentage points higher digital platform integration, if the dependent variable is expressed as a percentage.

Percentage-point interpretations assume that share variables are expressed from 0 to 1 in the model. For logarithmic variables, marginal effects are calculated using $\beta \times \ln(1.10)$ for a 10% change. Mechanism of identified relationships, the empirical results can be interpreted through a mechanism linking e-commerce adoption, IT expenditures, and innovation cooperation with digital platform integration. E-commerce adoption increases the demand for platform-based transactions and market coordination. IT spending reflects the organizational capacity to integrate digital tools into internal and interfirm processes. Innovation cooperation reflects the readiness of firms to participate in joint development, knowledge exchange, and coordinated value-chain activities. Together, these mechanisms may reduce transaction costs, simplify partner search and

coordination, and support value-chain reconfiguration through digital platforms. This mechanism is summarized in Figure2.

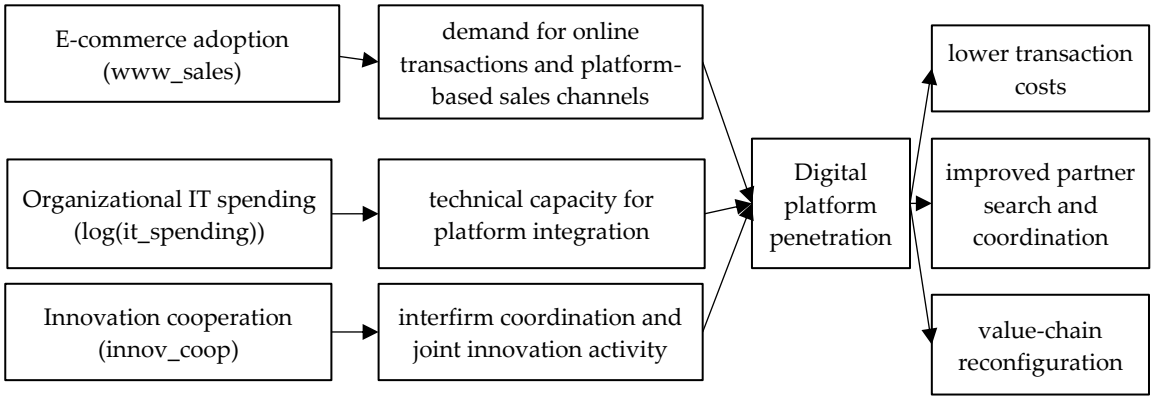

FIGURE 2. Mechanism linking e-commerce adoption, it spending, and innovation cooperation to digital platform integration, transaction-cost reduction, and value-chain reconfiguration.

3. COMPARATIVE EVALUATION WITH STATE OF THE ART

To contextualize the magnitude of the estimated coefficients, the main results were compared with recent empirical studies on digitalization, digital platforms, innovation cooperation, and e-commerce adoption. Although direct comparison is limited by differences in datasets, countries, model specifications, and dependent variables, the comparison makes it possible to evaluate whether the estimated effects are consistent with the broader empirical literature. The comparison is presented in Table 8.

Table 8. Comparative evaluation of the main empirical effects.

Study	Research focus	Methodology	Main result	Comparison with the present study
Tian et al. [17]	Digital economy and regional innovation capability in Chinese provinces	Panel regression	Positive effect of digital economy indicators on regional innovation capability	Consistent with the positive association between digitalization-related indicators and platform integration found in the present study
Han et al. [18]	Digital platforms and innovation quality	Panel threshold model	Digital platforms positively affect innovation quality; nonlinear effects identified	Supports the positive relationship between innov_coop and digital platform integration
Paun et al. [19]	Drivers of e-commerce adoption	Global panel-data analysis	E-commerce intensity is strongly associated with digital transformation indicators	Consistent with the dominant role of www_sales in the present model (within $\beta = 0.730$)
Bauer et al. [11]	Digital platforms and economic transformation	Conceptual and applied economic analysis	Digital platforms are identified as a strategic transformation mechanism	The present study empirically quantifies these relationships at the regional level

Grigoriev et al. [12]	Digital platforms and supply-chain competitiveness	Applied platform and supply-chain analysis	Digital platforms improve interfirm coordination and competitiveness	Consistent with the role of innovation cooperation and interfirm interaction identified in the present model

The comparison demonstrates that the present results are generally consistent with the broader literature on digitalization and digital platforms. In particular, the dominant role of *www_sales* corresponds to findings from international studies emphasizing the importance of e-commerce intensity and digital market participation. At the same time, the present study contributes additional evidence by separating within-regional and between-regional effects using the Within–Between specification. Unlike many previous studies that focus on aggregate digitalization indicators, the present model directly evaluates the integration of digital platforms as a separate empirical outcome.

4. ROBUSTNESS AND GENERALIZATION CONSIDERATIONS

The stability of the identified relationships was also considered from the perspective of specification robustness. The study did not rely on a single indicator of regional IT development. As described in the Materials and Methods section, the "Information Technology" block was introduced into the model in four alternative variations: inform, *inform_n*, *it_spending*, and *it_goods_vol*. In total, 128 candidate model combinations were examined. Therefore, the positive role of IT development and digitalization was not derived from a single isolated indicator, but was assessed within a broader model-selection procedure.

Multicollinearity was also considered explicitly when selecting the final feature combination. Pairwise correlations were used only as an initial screening tool and were not treated as the sole criterion for variable selection. Since high pairwise correlation does not always imply harmful multicollinearity in the final regression specification, the selected regressors were additionally evaluated using variance inflation factors (VIFs). VIF diagnostics are commonly used to assess how strongly the variance of an estimated regression coefficient is inflated because of collinearity with other regressors [43, 44].

The VIF check was considered for the regressors retained in the final model: *innov_coop*, *www_sales*, *log(it_spending)*, and *log(fz_vol)*, including their within- and between-components where applicable. This procedure helps verify that the final specification does not include redundant predictors from the same conceptual block. The multicollinearity-control logic for the selected regressors is summarized in Table 9.

Table 9. Multicollinearity diagnostics for selected regressors.

Regressor	Conceptual block	Multicollinearity check	Multicollinearity control logic
www_sales	E-commerce	Strongest within-effect in the model ($\beta = 0.730$, $p < 0.01$) and significant between-effect ($\beta = 0.727$, $p = 0.008$)	Not replaced by procurement variables because it captures unregulated Internet sales activity rather than regulated procurement.
innov_coop	Innovation	Positive significant within-effect ($\beta = 0.059$, $p = 0.012$)	Retained because it captures cooperation among innovative organizations, not general innovation activity.
log(it_spending)	Information Technology	Positive within-effect significant at the 0.1 level ($\beta = 0.009$, $p = 0.084$)	Selected from four alternative IT proxies after testing model combinations.
log(fz_vol)	E-commerce / regulated procurement	Positive between-effect significant at the 0.1 level ($\beta = 0.007$, $p = 0.074$)	Included only as a between-effect to avoid distorted interpretation of post-2022 procurement dynamics.

The final feature combination was therefore selected using three criteria: (i) avoidance of redundant indicators within the same conceptual block, (ii) preservation of substantively distinct mechanisms such as e-

commerce, innovation cooperation, IT expenditures, and regulated procurement, and (iii) statistical contribution to the final Within–Between model. This reduces the risk that the reported coefficients reflect redundant predictors rather than distinct regional mechanisms of digital platform integration.

At the same time, several additional robustness checks may further strengthen the empirical interpretation of the results. First, re-estimating the model with alternative IT proxies would make it possible to assess whether the positive relationship remains stable when *it_spending* is replaced by other indicators of regional IT development. Second, excluding regions from the top and bottom deciles would help determine whether the estimates are driven by extreme regional cases with very high or very low levels of digitalization, procurement activity, or economic scale. Third, a log–log specification could provide elasticity-type interpretations of the relationships between digital platform integration, e-commerce, IT expenditures, and regulated procurement. The robustness dimensions considered in the study are summarized in Table 10.

Table 10. Robustness and generalization dimensions considered in the study.

Robustness dimension	Procedure considered in the study	Interpretation
Alternative IT proxies	Four IT indicators were tested across model combinations: inform, inform_n, it_spending, and it_goods_vol.	Reduces dependence on a single IT variable.
Model-combination sensitivity	128 candidate model combinations were examined.	Shows that the final specification was selected from a broad set of alternatives.
Extreme-region sensitivity	Top/bottom decile exclusion is identified as an additional robustness direction.	Important because Russian regions differ strongly in scale and digital maturity.
Functional-form robustness	Log–log specification is proposed for elasticity interpretation.	Useful for interpreting proportional changes rather than marginal changes.
Generalization	Results are interpreted within the Russian institutional context.	Coefficients should not be directly transferred to other countries without verification.

The generalization of the results should therefore be considered cautiously. The estimated coefficients are derived from the institutional and economic environment of the Russian Federation, where digital platforms are closely connected with regulated procurement systems, state-supported digitalization policies, and substantial regional differences in innovation activity. Direct transfer of the numerical coefficients to other countries may be inappropriate without additional empirical verification. However, the broader mechanisms identified in the study especially the roles of e-commerce intensity, IT expenditures, and interfirm innovation cooperation may be relevant for other regional economies undergoing digital transformation.

The boundary conditions for applying these findings outside Russia are therefore as follows. The numerical coefficients are most applicable to economies with comparable regional heterogeneity, substantial state participation in procurement, active use of electronic trading platforms, and publicly available regional digitalization statistics. In non-sanction contexts, the procurement-related coefficient may differ because open procurement data are less affected by disclosure restrictions and may better reflect actual procurement dynamics. In countries where digital platforms are driven mainly by private consumer markets rather than state-regulated procurement and B2B electronic trading platforms, the relative importance of *www_sales*, *innov_coop*, *it_spending*, and procurement variables may also differ. Therefore, the findings should be transferred to other institutional settings at the level of mechanisms rather than at the level of direct numerical coefficients.

5. TREATMENT OF REGULATED PROCUREMENT DATA

Special attention was paid to the treatment of regulated procurement variables because the transparency of open procurement data changed after 2022. The procurement indicators used in the study were reconstructed from the Unified Information System in the Field of Procurement, which provides official data on contracts and agreements under 44-FZ and 223-FZ. However, these two procurement regimes differ in terms of disclosure

rules. Procurement under 44-FZ is more strictly regulated as part of the state and municipal contract system, whereas procurement under 223-FZ applies to certain types of legal entities and has a more flexible disclosure regime.

Since 2022, open data on regulated procurement, especially under 223-FZ, have been affected by partial non-disclosure measures. Government Decree No. 301 of March 6, 2022 allowed certain procurement information to be excluded from open publication in the Unified Information System and transferred to restricted sections of electronic platforms. As a result, post-2022 procurement indicators may underrepresent the actual volume of regulated procurement, especially for 223-FZ. For this reason, procurement variables were treated cautiously in the model and were used primarily through between-effects rather than within-effects. This approach reduces the risk of interpreting short-term changes in open procurement volumes as real economic dynamics when they may partly reflect changes in disclosure rules. To clarify this issue, the procurement data were divided into two periods: the pre-distortion period, 2020–2021, and the post-distortion period, 2022–2023. The comparison is presented in Table 11.

Table 11. Treatment of regulated procurement data before and after 2022

Period	Years	Data transparency context	Expected reliability of procurement indicators	Implication for the model
Pre-distortion period	2020-2021	Procurement data under 44-FZ and 223-FZ were more consistently reflected in open sources.	Higher comparability of open procurement indicators.	Suitable for checking the baseline level of regional procurement activity.
Post-distortion period	2022-2023	Part of procurement information, especially under 223-FZ, could be excluded from open publication and transferred to restricted sections of electronic.	Lower comparability of open procurement indicators over time.	Within-effects may be distorted; between-effects are interpreted more cautiously.
Full panel	2020-2023	The period combines pre- and post-disclosure-change observations.	Temporal dynamics may reflect both real procurement changes and disclosure changes.	Procurement variables are retained mainly as structural regional indicators.

In addition to the pre-2022 versus post-2022 distinction, procurement indicators were also considered by procurement type. During model construction, separate 44-FZ and 223-FZ variables were included among the candidate procurement specifications: *fz_44_vol*, *fz_223_vol*, *fz_44_n*, and *fz_223_n*. These variables were compared with aggregated procurement indicators, including fz_vol and fz_n, within the broader model-selection procedure. The final model retained *log(fz_vol)* as the procurement-related between-effect because the aggregated open procurement volume provided the most stable structural indicator of regional procurement intensity in the selected specification.

Separate between-effects for 44-FZ and 223-FZ should be interpreted cautiously because the two regimes differ in disclosure rules and because post-2022 data opacity affects 223-FZ more strongly. Therefore, the decomposition by procurement type is treated as an additional sensitivity direction rather than as the main specification of the present model. The use of aggregated *fz_vol* reduces the risk of overinterpreting partially disclosed procurement dynamics while still capturing the structural role of regulated procurement and electronic trading platforms in regional digital platform integration.

The pre-2022 versus post-2022 split confirms that procurement indicators require cautious interpretation in the 2020–2023 panel. The positive between-effect of *log(fz_vol)* in the final model ($\beta = 0.007$, $p = 0.074$) should

therefore be interpreted as evidence that regions with structurally larger open regulated procurement volumes tend to have higher digital platform integration. However, this coefficient should not be interpreted as a precise estimate of the short-term effect of procurement dynamics after 2022, because observed procurement volumes may partly reflect changes in disclosure rules rather than only real market activity. Thus, the treatment of regulated procurement in the model is conservative: procurement is retained as a between-regional structural variable, while its within-regional temporal dynamics are not overinterpreted. This approach allows the study to account for the role of procurement-related electronic platforms while reducing the risk of biased conclusions caused by post-2022 data opacity.

6. INTERPRETATION OF IT SPENDING AND REGIONAL HETEROGENEITY

The between-effect of *log(it_spending)* is negative but statistically insignificant ($\beta = -0.002$, $t = -0.416$, $p = 0.678$). Therefore, this coefficient should not be interpreted as evidence that higher IT spending reduces digital platform integration. A more cautious interpretation is that cross-regional differences in average IT spending do not explain stable differences in digital platform integration after accounting for e-commerce, innovation cooperation, and regulated procurement. In contrast, the within-effect of *log(it_spending)* is positive and weakly significant ($\beta = 0.009$, $t = 1.734$, $p = 0.084$), suggesting that increases in IT spending within the same region may be more relevant than static differences between regions.

This pattern may reflect a nonlinear or threshold-type relationship. In regions with already developed IT infrastructure, additional IT spending may not immediately translate into higher platform integration because basic digital capabilities are already present. In regions with lower digital maturity, the same increase in IT spending may have a stronger marginal effect if it removes technical barriers to platform adoption. Therefore, the insignificant between-effect of IT spending may indicate heterogeneity across regions rather than a negative relationship. Further testing of squared terms or threshold models would be required to formally verify this mechanism.

The case of the Republic of Tatarstan illustrates this heterogeneity. Tatarstan ranks high in IT expenditures and regulated procurement indicators, while its position in innovation cooperation is weaker. This means that the region has strong infrastructural and procurement-related conditions for digital platform development, but the marginal contribution of innovation cooperation may remain an important policy-relevant channel. In comparison with a median region, Tatarstan's expected platform-integration profile is likely to be shaped more by its high IT and procurement capacity, whereas its lower innovation-cooperation position may constrain the full realization of platform-based value-chain effects. This interpretation is consistent with the model results: *www_sales* has the strongest within- and between-effects, *log(fz_vol)* has a positive between-effect, and *innov_coop* is significant mainly as a within-regional factor. The region-level interpretation for Tatarstan compared with a median regional profile is summarized in Table 12.

Table 12. Region-level marginal contribution interpretation: Tatarstan versus a median region.

Regressor	Model evidence	Tatarstan-specific interpretation	Expected marginal contribution
www_sales	Strong within-effect ($\beta = 0.730$, $p < 0.01$) and significant between-effect ($\beta = 0.727$, $p = 0.008$).	Tatarstan's position in Internet-sales integration is relevant for further platform development.	Highest expected marginal contribution.
log(it_spending)	Positive weakly significant within-effect ($\beta = 0.009$, $p = 0.084$); insignificant between-effect ($\beta = -0.002$, $p = 0.678$).	High IT spending supports technical capacity, but cross-regional differences in IT spending alone do not explain platform integration.	Moderate and mainly within-regional contribution.
innov_coop	Positive significant within-effect ($\beta = 0.059$, $p = 0.012$);	Weaker innovation cooperation may limit the effect of digital	Targeted policy-relevant contribution.

	insignificant between-effect ($\beta = 0.088$, $p = 0.110$).	platforms on interfirm value-chain coordination.	
log(fz_vol)	Positive between-effect ($\beta = 0.007$, $p = 0.074$).	Strong regulated procurement position may support platform-related institutional infrastructure.	Structural between-regional contribution.

[4]Note. The table provides a coefficient-based marginal contribution interpretation rather than a formal partial dependence plot.

7. DIAGNOSTIC FRAMEWORK

The diagnostic framework used to assess the reliability of the final Within–Between model is presented in Table 13.

Table 13. Diagnostic framework for the final Within–Between model

Diagnostic procedure	Purpose in the context of the study	Methodological approach
Heteroskedasticity diagnostics	To assess whether residual variance differs across regional observations and may bias conventional standard errors.	Breusch–Pagan / Koenker–Bassett test
Serial correlation diagnostics	To evaluate whether panel errors are correlated over time within regions.	Wooldridge test for panel data
Cross-sectional dependence diagnostics	To detect contemporaneous dependence between regional observations caused by common macroeconomic and institutional shocks.	Pesaran CD test
Robust inference	To assess whether coefficient significance remains stable under more conservative panel inference.	Region-clustered robust standard errors

The diagnostic framework is particularly important because the panel has a short time dimension and covers regions that may be simultaneously affected by nationwide shocks. Therefore, the reported coefficients should be interpreted together with the proposed robust-inference procedure. Since the reconstruction of the full regional panel is based on official open sources, the diagnostic tests can be reproduced using the same data sources and model specification. The degrees of freedom of the student's t-test are 252 for within-effects and 80 for between-effects. Degrees of freedom are calculated according to the Satterthwaite method [41]. Thus, the model formula after removing statistically insignificant effects is as follows:

digital_platforms=0,059·innov_coop+0,730·www_sales+0,009·log(it_spending)+0,727·imean(www_sales)+0,007·imean(log(fz_vol)),

where imean(…) is the within-group mean of the factor.

In this specification, the within-effects describe changes within the same region over time, while the between-effects describe persistent differences between regions. Therefore, the coefficient for *www_sales* has two interpretations: the within-effect shows how changes in Internet sales within a region are associated with changes in digital platform integration, while the between-effect shows how regions with structurally higher Internet sales differ from other regions in terms of platform integration. This distinction is essential for the Within–Between model and allows the results to be interpreted more precisely than in a standard pooled panel model

VI. DISCUSSION

The strongest statistical association with the level of digital platform integration is observed for the share of organizations that conduct the majority of their sales via the Internet. For this factor, both within- and between-effects are highly significant. Together with the variable representing the volume of regulated procurement,

which is significant at the 0.1 level, this indicates the strong influence of e-commerce on the Russian digital platform market. It can be concluded that Electronic Trading Platforms (ETPs) are one of the key types of digital platforms and exert a strong influence on the market as a whole. The dependence of the target variable on the volume of regulated procurement is explained by several reasons. First, regulated procurement itself constitutes a significant share of the total trade volume on Russian ETPs. Second, as noted at the beginning of the article, the state currently places great emphasis on the digital platform sphere and actively promotes its development. Third, regulated procurement historically provided a major impetus for the development of the Russian ETP market and played a significant role in its formation [46].

In terms of the share of organizations conducting most of their sales online, the Republic of Tatarstan ranks 24th. At the same time, one of Tatarstan's strengths is its high level of development in regulated procurement. For example, Tatarstan ranks 2nd in the volume of regulated procurement, and similarly holds high positions for other indicators of this market. Consequently, a key task for Tatarstan is the further development of the unregulated e-commerce segment, and experience in regulated procurement may help achieve this in the B2B segment. Moreover, the high level of IT development in Tatarstan is also a significant positive factor for the advancement of e-commerce. The average expenditures of organizations on information technology also affect the target variable. This is explained by the fact that integrating digital platforms into a firm's value chain requires a certain level of IT competence, and the use of digital platforms implies corresponding IT costs. Thus, it is evident that measures aimed at developing the IT sector in general, and organizational IT competencies in particular, will contribute to increasing the integration of digital platforms.

In terms of IT expenditures, Tatarstan ranks 6th among regions. This, together with comparable rankings for other IT indicators, suggests that Tatarstan is among the leaders in the IT sector. In addition, a relationship was found between the target variable and the share of organizations engaged in cooperation in innovation development. However, the Republic of Tatarstan ranks 65th in this indicator. At the same time, Tatarstan ranks among the leaders in all other innovation metrics considered in the study. Thus, despite a high level of innovation activity, interfirm cooperation in innovation is currently underdeveloped in Tatarstan. A previous study [47] found that ETPs reduce the transaction costs of establishing interfirm cooperative interactions. Moreover, proprietary ETPs, due to their ability to adapt to the unique characteristics of value chains of both owners and their long-term partners, can ensure effective interfirm cooperation. Although these findings were made in relation to ETPs, they are also relevant for many other types of digital platforms. The simplification of cooperative interactions, in turn, promotes cooperation in the field of innovation.

Digital platforms can be created by groups of partner organizations to enhance the effectiveness of cooperation. This requires cooperation in the field of innovation. One example of such a digital platform is the RHtorg ETP, based in the Republic of Tatarstan and operated by the Fuel and Energy Association Resurs-Kholding. Well-developed interfirm cooperation in innovation contributes to the successful functioning of the digital platform market. In particular, cooperation in innovation between a digital platform and its participants enables the platform to improve by responding to participants' needs, while allowing participants to increase the efficiency of their interactions with the platform. Thus, the variables share of organizations using digital platforms" and "share of organizations engaged in cooperation in innovation development exert a mutual influence on each other. This mutual influence also indicates a potential endogeneity problem. Therefore, the coefficient for *innov_coop* should be interpreted not as evidence of a strictly one-directional causal effect, but as evidence of a statistically significant association between innovation cooperation and digital platform integration. The same caution applies to the coefficient for *www_sales*, since e-commerce activity may both stimulate the adoption of digital platforms and expand as a result of platform development. For this reason, the results of the model are interpreted as robust empirical associations rather than as definitive causal effects. Future research may address this issue more directly by using lagged regressors, instrumental variables, or longer panel datasets.

On the one hand, cooperation in innovation contributes to the development of the digital platform market. On the other hand, digital platforms facilitate the establishment and functioning of interfirm cooperation, including in the innovation sphere. Interorganizational cooperation in innovation is of great importance, as it makes it possible to significantly enhance the efficiency of interfirm links within value chains.

1 OPERATIONAL POLICY ROADMAP FOR RUSSIA AND THE REPUBLIC OF TATARSTAN

Based on the estimated coefficients, the findings can be translated into an operational policy roadmap. Since the model identifies statistical associations rather than strict causal effects, the roadmap is formulated in terms of incremental policy targets and expected model-based changes in *digital_platforms*. The strongest policy-relevant channel is e-commerce integration. The within-effect of *www_sales* is $\beta = 0.730$; therefore, a 1 percentage point increase in the share of organizations conducting most of their sales via the Internet is associated with an estimated 0.73 percentage point increase in digital platform integration. At the national level, this implies that measures aimed at expanding B2B e-commerce, reducing administrative barriers for online sales, and supporting digital sales channels may have the largest expected association with platform integration. For the Republic of Tatarstan, where regulated procurement is already comparatively developed, the priority should be the expansion of unregulated B2B e-commerce and wider use of Internet-based sales channels by firms.

The second policy direction is innovation cooperation. The within-effect of *innov_coop* is positive and statistically significant ($\beta = 0.059$, $p = 0.012$). Therefore, a 5-percentage point increase in the share of innovation-active organizations engaged in cooperation is associated with an estimated 0.295 percentage point increase in digital platform integration. For Russia, this supports policies that stimulate interfirm innovation networks, joint digital projects, platform consortia, and cooperation between platform operators and participating firms. For Tatarstan, this direction is especially relevant because the region has weaker positions in innovation cooperation compared with its stronger IT and procurement indicators.

The third policy direction is IT spending. The within-effect of *log(it_spending)* is positive but weaker ($\beta = 0.009$, $p = 0.084$). A 10% increase in organizational IT expenditures is associated with an estimated increase of approximately 0.086 percentage points in digital platform integration. This suggests that IT spending incentives should be treated as a supporting measure rather than the main driver. Such incentives may include co-financing of platform integration, tax incentives for digital technology adoption, and support for SMEs implementing platform-based procurement, logistics, and sales tools.

The fourth direction concerns regulated procurement and e-commerce regulation. The between-effect of *log(fz_vol)* is positive but significant only at the 0.1 level ($\beta = 0.007$, $p = 0.074$), and post-2022 procurement data are affected by disclosure limitations. Therefore, procurement-related measures should be interpreted cautiously. For Russia, the policy emphasis should be placed on improving transparency, interoperability, and usability of procurement-related electronic platforms. For Tatarstan, the existing strength in regulated procurement may be used as an institutional basis for expanding broader B2B platform practices. The operational roadmap is summarized in Table 14.

Table 14. Operational policy roadmap for Russia and the republic of Tatarstan.

Policy direction	Target indicator	Model-based expected change in digital_platforms	Russia-level policy action	Tatarstan-level policy action
Expansion of e-commerce	+1 percentage point in www_sales	Approximately +0.73 percentage points in digital_platforms	Reduce administrative barriers for online B2B sales; support digital sales channels and e-commerce infrastructure.	Expand unregulated B2B e-commerce beyond the already developed procurement segment.
Innovation cooperation	+5 percentage points in innov_coop	Approximately +0.295 percentage points in digital_platforms	Support interfirm innovation networks, platform consortia, and joint digital projects.	Strengthen cooperation between innovation-active firms, IT companies, universities, and platform operators.
IT spending incentives	+10% in it_spending	Approximately +0.086 percentage points in digital_platforms	Provide incentives for platform integration,	Use targeted co-financing and tax incentives for firms adopting platform-based

			digital tools, and SME digitalization.	sales, procurement, and logistics tools.
E-commerce and platform regulation	Regulatory simplification for B2B e-commerce and platform use	Expected effect mainly through www_sales and procurement-related platform activity	Improve interoperability, transparency, and legal clarity for electronic trading platforms.	Use the region's strong procurement infrastructure as a basis for broader B2B platform development.
Procurement-related platforms	Higher structural volume and usability of open regulated procurement platforms	+10% in open fz_vol is associated with approximately +0.067 percentage points in digital_platforms	Improve transparency and data comparability of procurement platforms, especially after 2022.	Transfer procurement-platform experience to wider interfirm digital platform practices.

We added an operational policy roadmap for Russia and the Republic of Tatarstan that translates the main coefficients into incremental policy targets for *www_sales*, *innov_coop*, *it_spending*, e-commerce regulation, and procurement-related platforms. Each policy direction is tied to the expected model-based change in *digital_platforms*, while the text clarifies that these estimates should be interpreted as associations rather than guaranteed causal effects. This cautious interpretation is necessary because the study has several limitations.

First, the panel covers only 2020–2023, which limits the analysis of long-term dynamics and delayed effects. The same short time dimension also limits the stable estimation of additional year fixed effects. Therefore, nationwide time shocks, including pandemic recovery, sanctions-related restructuring, and changes in digital policy, are treated as an important limitation of the current specification rather than as fully separated year-specific effects. Second, the interpretation of regulated procurement indicators is constrained by sanctions-related data opacity after 2022, especially under 223-FZ. Third, potential reverse causality may exist, since e-commerce integration, innovation cooperation, and IT expenditures may both influence and be influenced by digital platform integration. Therefore, the estimated coefficients should be interpreted as statistically significant associations rather than definitive causal effects.

Future research may extend this study by using longer panel data, adding macroeconomic and sectoral control variables, and testing additional specifications with lagged regressors, year fixed effects, interaction terms, and separate procurement indicators for 44-FZ and 223-FZ. Further studies may also compare Russian regions with non-sanction contexts to assess whether the identified relationships remain stable under different institutional and economic conditions.

VII. CONCLUSION

Thus, the scientific value of this study lies in identifying the factors that have the greatest impact on the level of digital platform integration in the regions of the Russian Federation. Similar research has not previously been conducted in academic publications. To achieve the study's objective, the Within-Between panel model was applied, which had not been used in Russian-language publications before. The value of the results of this study is that they make it possible to outline development pathways for the digital platform sector of the Russian Federation as a whole and the Republic of Tatarstan in particular. This, in turn, will help optimize interfirm connections within value chains and increase the efficiency of both individual organizations and the economy as a whole.

Funding Statement

This research was carried out with the financial support of a subsidy allocated to Kazan Federal University for the implementation of a state assignment in the field of scientific activity under project No. FZSM–2023–0017 "The import substitution economy of the region under the transformation of logistics chains and deglobalization".

Author Contributions

All authors made an equal contribution to the development and planning of the study.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data used in this study are derived from official open sources, including Rosstat, EMISS, EIS Zakupki, and HSE statistical compendiums. The cleaned panel dataset, variable-construction file, and R scripts used for model estimation are available from the authors upon reasonable request.

Acknowledgments

Acknowledge any support not covered by the author contribution or funding sections, such as administrative support, technical assistance, or donations in kind. ex. The authors would like to acknowledge the assistance of the Editor and Reviewers in the preparation of the article for publication.

REFERENCES

1. National Projects of Russia. (**2025**). *National project "Data Economy"*. https://национальныепроекты.рф/new-projects/ekonomika-dannykh
2. RIA Novosti. (**2024**). *Putin: It is necessary to create digital platforms in key sectors of the economy*. https://ria.ru/20240607/putin-1951400422.html
3. Cabinet of Ministers of the Republic of Tatarstan. (**2021**). *State Program of the Republic of Tatarstan "Digital Tatarstan," approved by Resolution No. 980 of October 18, 2021 (as amended by Resolution No. 611 of July 31, 2024).* http://pravo.gov.ru/proxy/ips/?docbody=&prevDoc=148037696&backlink=1&&nd=148261709
4. ANO Digital Economy. (**2018**). *Definitions of platforms formulated for the development of the digital economy*. https://old.data-economy.ru/20180428_01
5. Cabinet of Ministers of the Republic of Tatarstan. (**2021**). *Resolution No. 35 of January 29, 2021: On the approval of the Concept of digital transformation of the Republic of Tatarstan for 2021–2024.* http://pravo.gov.ru/proxy/ips/?doc_itself=&backlink=1&nd=148291658&page=1&rdk=1
6. Ministry of Transport of the Russian Federation. (**2022**). *Order No. AK-247-r of September 30, 2022: On approval of the Concept for the creation and functioning of a national network of intelligent transport systems on public highways*. *Transport Rossii*, 49.
7. Ibraimov, K. I., Abdullayeva, N. J., Mukhitdinova, F. A., Juraev, S., Bazarova, D. B., Usmonova, M. Y., & Mardonov, A. Sh. (2025). Digital platforms as catalysts for student volunteerism in inclusive education. *Qubahan Academic Journal, 5*(4), 572–594.
8. Porter, M. E. (**1985**). *Competitive advantage: Creating and sustaining superior performance*. The Free Press.
9. Safiullin, M. R., & Guryanov, A. I. (**2024**). Electronic trading platforms through the lens of value chain theory. In R. N. Minnikhanov (Ed.), *International Forum Kazan Digital Week* (pp. 765–771). Scientific Center for Life Safety.
10. Geliskhanov, I. Z., Yudina, T. N., & Babkin, A. V. (**2018**). Digital platforms in economics: Essence, models, development trends. *St. Petersburg State Polytechnical University Journal: Economics, 11*(6), 22–36.
11. Bauer, V. P., Eremin, V. V., & Smirnov, V. V. (**2021**). Digital platforms as a tool for transforming the global and Russian economy in 2021–2023. *Economics, Taxes & Law, 14*(1), 41–51.
12. Grigoriev, M. N., Maksimtsev, I. A., & Uvarov, S. A. (**2018**). Digital platform as a resource for improving the competitiveness of supply chains. *Proceedings of St. Petersburg State University of Economics, 2*(110), 7–11.
13. Din, S. (**2023**). *Digital transformation of organizational management using the platform approach* (Doctoral dissertation, Samara National Research University named after Academician S. P. Korolev).
14. Cusumano, M. A., Gawer, A., & Yoffie, D. B. (**2019**). *The business of platforms*. HarperCollins Publishers.
15. Trabucchi, D., & Buganza, T. (**2019**). Fostering digital platform innovation: From two- to multi-sided platforms. *Creativity and Innovation Management, 29*(2), 345–358.
16. Veisdal, J. (**2020**). The dynamics of entry for digital platforms in two-sided markets: A multi-case study. *Electronic Markets, 30*(3), 539–556.
17. Tian, Z., Li, Y., Niu, X., & Liu, M. (**2023**). The impact of digital economy on regional technological innovation capability: An analysis based on China's provincial panel data. *PLOS ONE, 18*(7), e0288065.

18. Han, B., Li, M., Diao, Y., & Han, D. (**2024**). Assessing the effect of digital platforms on innovation quality: Mechanism identification and threshold characteristics. *Humanities and Social Sciences Communications, 11*, 951.
19. Paun, C., Ivascu, C., Olteteanu, A., & Dantis, D. (**2024**). The main drivers of e-commerce adoption: A global panel data analysis. *Journal of Theoretical and Applied Electronic Commerce Research, 19*(3), 2198–2217.
20. Federal State Statistics Service (Rosstat). (**2025**). https://rosstat.gov.ru
21. Unified Interdepartmental Information and Statistical System (EMISS). (**2025**). https://fedstat.ru
22. Unified Information System in the Field of Procurement (EIS Zakupki). (**2025**). https://zakupki.gov.ru/epz/main/public/home.html
23. HSE University. (**2025**). *Indicators of innovation activity*. HSE Statistical Compendiums. https://www.hse.ru/primarydata/ii
24. Federal State Statistics Service (Rosstat). (**2023**). *Data on the use of digital technologies and production of related goods and services (Form No. 3-inform)*. https://rosstat.gov.ru/statistics/science
25. Bell, A., Fairbrother, M., & Jones, K. (**2019**). Fixed and random effects models: Making an informed choice. *Quality & Quantity, 53*, 1051–1074.
26. Ratnikova, T. (**2006**). Introduction to econometric analysis of panel data. *HSE Economic Journal, 10*(2), 267–316.
27. Kartayev, F. S. (**2019**). *Introduction to econometrics*. Faculty of Economics, Lomonosov Moscow State University.
28. Bell, A., & Jones, K. (**2015**). Explaining fixed effects: Random effects modeling of time-series cross-sectional and panel data. *Political Science Research and Methods, 3*(1), 133–153.
29. Mundlak, Y. (**1978**). On the pooling of time series and cross-section data. *Econometrica, 46*(1), 69–85.
30. Czyzewski, B., Matuszczak, A., & Miskiewicz, R. (**2019**). Public goods versus the farm price-cost squeeze: Shaping the sustainability of the EU's Common Agricultural Policy. *Technological and Economic Development of Economy, 25*(1), 82–102.
31. Elenes Platona, I. (**2022**). The economic freedom, country risk and foreign direct investments. *The Annals of the University of Oradea, Economic Sciences, 31*(2), 206–212.
32. Spade, A. B. (**2018**). *The impact of inflation, credit risk and corruption on local bitcoin prices: A panel data analysis* [Master's thesis].
33. Long, J. A. (**2023**). *Introduction to the panelr package* (Version 0.7.8) [Computer software manual]. CRAN. https://cran.r-project.org/web/packages/panelr/vignettes/wbm.html
34. EMISS. (**n.d.**). *Number of organizations according to state registration data since 2017*. https://fedstat.ru/indicator/58109
35. Federal State Statistics Service (Rosstat). (**n.d.**). *Data on the use of digital technologies and production of related goods and services (Form No. 3-inform)*. https://rosstat.gov.ru/statistics/science
36. Federal State Statistics Service (Rosstat). (**n.d.**). *Data on innovation activity of organizations (Form No. 4-innovation)*. https://rosstat.gov.ru/statistics/science
37. Federal State Statistics Service (Rosstat). (**2019**). *Order No. 818 of December 27, 2019: On approval of the methodology for calculating the indicator "Level of innovation activity of organizations"*. https://14.rosstat.gov.ru/storage/mediabank/eXhf1AvX/pr818.pdf
38. EIS Zakupki. (**2025**). *Statistics*. https://zakupki.gov.ru/epz/main/public/home.html
39. Government of the Russian Federation. (**2022**). *Resolution No. 301 of March 6, 2022 (as amended October 19, 2024): On the grounds for non-disclosure of procurement information in the unified information system*. http://government.ru/docs/all/139614/
40. EMISS. (**n.d.**). *Consumer Price Index (December of reporting year compared to December of previous year)*. https://fedstat.ru/indicator/55396
41. Long, J. A. (**2023**). *Panelr: Regression models and utilities for repeated measures and panel data* (Version 0.7.8) [Computer software]. CRAN. https://cran.r-project.org/package=panelr
42. Sievert, C., Parmer, C., Hocking, T., Chamberlain, S., Ram, K., Corvellec, M., & Despouy, P. (**2017**). *Plotly: Create interactive web graphics via plotly.js* [Computer software]. CRAN. https://CRAN.R-project.org/package=plotly
43. Wooldridge, J. M. (**2010**). *Econometric analysis of cross section and panel data* (2nd ed.). MIT Press.
44. Antonakis, J., Bendahan, S., Jacquart, P., & Lalive, R. (**2010**). On making causal claims: A review and recommendations. *The Leadership Quarterly, 21*(6), 1086–1120.
45. Bellemare, M. F., Masaki, T., & Pepinsky, T. B. (**2017**). Lagged explanatory variables and the estimation of causal effects. *The Journal of Politics, 79*(3), 949–963.
46. Mindich, D., & Kabalinsky, D. (**2014**). *Electronic trading platforms in Russia: Who is who?* RA Expert. https://raexpert.ru/docbank/e0b/b32/aa3/59b39092b02ce1c1cc5976f.pdf
47. Safiullin, M. R., & Guryanov, A. I. (**2024**). Formation of value chains on electronic trading platforms. *The Review of Economy, the Law and Sociology, 4*, 96–99.

APPENDIX A. DATA CONSTRUCTION AND REGIONAL COVERAGE

The panel dataset covers 85 subjects of the Russian Federation for 2020–2023. The Donetsk People's Republic, the Luhansk People's Republic, the Kherson region, and the Zaporizhzhia region were excluded because comparable data for the full period are not available. Autonomous okrugs were treated as separate panel units, while the corresponding oblast-level indicators were used in the form published by official statistics, i.e., excluding autonomous okrugs where such separation is provided. The region and year variables were used as panel identifiers.

The dependent variable, digital_platforms, measures the level of digital platform integration and was obtained from Rosstat statistical materials on the use of digital technologies by organizations, Form No. 3-inform. The variable www_sales measures the share of organizations conducting 50% or more of their sales via the Internet. The variable it_spending measures average organizational expenditures on the implementation and use of digital technologies. Innovation variables, including innov, innov_proc, innov_logist, innov_inf, innov_ext, innov_mkt, and innov_coop, were reconstructed from Rosstat and HSE statistical materials on innovation activity. The variable innov_coop was treated according to its published denominator, namely among organizations engaged in innovation activity. Procurement variables were reconstructed from the Unified Information System in the Field of Procurement and include contract volumes and numbers under 44-FZ and 223-FZ: fz_44_vol, fz_44_n, fz_223_vol, fz_223_n, fz_vol, and fz_n.

All monetary variables were converted to 2023 prices using annual consumer price index data from Rosstat/EMISS. Volume variables expressed in rubles were log-transformed before model estimation, including it_spending, it_goods_vol, fz_44_vol, fz_223_vol, and fz_vol, where applicable. The same regional concordance rules were applied across Rosstat, EMISS, HSE, and EIS Zakupki data sources to ensure that the panel units remained consistent across years and variable blocks.

Table A1. List of regions included in the panel dataset.

No.	Region	Federal subject type
1	Republic of Adygea	Republic
2	Republic of Altai	Republic
3	Republic of Bashkortostan	Republic
4	Republic of Buryatia	Republic
5	Republic of Dagestan	Republic
6	Republic of Ingushetia	Republic
7	Kabardino-Balkarian Republic	Republic
8	Republic of Kalmykia	Republic
9	Karachay-Cherkess Republic	Republic
10	Republic of Karelia	Republic
11	Komi Republic	Republic
12	Republic of Crimea	Republic
13	Mari El Republic	Republic
14	Republic of Mordovia	Republic
15	Sakha (Yakutia) Republic	Republic
16	Republic of North Ossetia-Alania	Republic
17	Republic of Tatarstan	Republic
18	Tyva Republic	Republic
19	Udmurt Republic	Republic
20	Republic of Khakassia	Republic
21	Chechen Republic	Republic
22	Chuvash Republic	Republic
23	Altai Krai	Krai
24	Zabaykalsky Krai	Krai
25	Kamchatka Krai	Krai

No.	Region	Federal subject type
26	Krasnodar Krai	Krai
27	Krasnoyarsk Krai	Krai
28	Perm Krai	Krai
29	Primorsky Krai	Krai
30	Stavropol Krai	Krai
31	Khabarovsk Krai	Krai
32	Amur Oblast	Oblast
33	Arkhangelsk Oblast	Oblast
34	Astrakhan Oblast	Oblast
35	Belgorod Oblast	Oblast
36	Bryansk Oblast	Oblast
37	Vladimir Oblast	Oblast
38	Volgograd Oblast	Oblast
39	Vologda Oblast	Oblast
40	Voronezh Oblast	Oblast
41	Ivanovo Oblast	Oblast
42	Irkutsk Oblast	Oblast
43	Kaliningrad Oblast	Oblast
44	Kaluga Oblast	Oblast
45	Kemerovo Oblast - Kuzbass	Oblast
46	Kirov Oblast	Oblast
47	Kostroma Oblast	Oblast
48	Kurgan Oblast	Oblast
49	Kursk Oblast	Oblast
50	Leningrad Oblast	Oblast
51	Lipetsk Oblast	Oblast
52	Magadan Oblast	Oblast
53	Moscow Oblast	Oblast
54	Murmansk Oblast	Oblast
55	Nizhny Novgorod Oblast	Oblast
56	Novgorod Oblast	Oblast
57	Novosibirsk Oblast	Oblast
58	Omsk Oblast	Oblast
59	Orenburg Oblast	Oblast
60	Oryol Oblast	Oblast
61	Penza Oblast	Oblast
62	Pskov Oblast	Oblast
63	Rostov Oblast	Oblast
64	Ryazan Oblast	Oblast
65	Samara Oblast	Oblast
66	Saratov Oblast	Oblast
67	Sakhalin Oblast	Oblast
68	Sverdlovsk Oblast	Oblast
69	Smolensk Oblast	Oblast
70	Tambov Oblast	Oblast
71	Tver Oblast	Oblast
72	Tomsk Oblast	Oblast
73	Tula Oblast	Oblast
74	Tyumen Oblast	Oblast
75	Ulyanovsk Oblast	Oblast

No.	Region	Federal subject type
76	Chelyabinsk Oblast	Oblast
77	Yaroslavl Oblast	Oblast
78	Moscow	Federal city
79	Saint Petersburg	Federal city
80	Sevastopol	Federal city
81	Jewish Autonomous Oblast	Autonomous oblast
82	Nenets Autonomous Okrug	Autonomous okrug
83	Khanty-Mansi Autonomous Okrug - Yugra	Autonomous okrug
84	Chukotka Autonomous Okrug	Autonomous okrug
85	Yamalo-Nenets Autonomous Okrug	Autonomous okrug