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The Impact of R&D on the Financial Performance of Russian Oil and Gas Companies

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Abstract

This study presents a comprehensive analysis of the impact of the intensity of research and development (R&D) costs on the financial performance of Russian oil and gas companies, including in the context of external sanctions pressure. To conduct an empirical analysis, a data panel was created covering 112 companies in the industry for the period from 2017 to 2023. For the econometric assessment, an improved two-step model based on the CDM approach (Crépon – Duguet – Mairesse) [1] is used, which allows solving the problem of endogeneity. At the first stage, the key determinants of the intensity of R&D costs, including return on assets, company size, and debt burden, are determined using a fixed-effect panel regression. At the second stage, the R&D intensity values predicted at the first step are used as an independent variable in the quantile regression model. This method allows us to analyze the impact of investments in innovation on the gross margin of companies with different levels of profitability (different distribution quantiles) and with time lags from 1 to 3 years. The results obtained demonstrate that an increase in the intensity of R&D costs has a statistically significant and positive impact on the financial performance of oil and gas companies within a year after investment, especially for firms with medium and high profitability. However, this effect does not persist in the medium term (with lags of 2 and 3 years). Such a rapid but short-term financial return indicates that until recently, R&D funds have been mainly used to purchase and implement ready-made imported technological solutions, rather than to create companies' own breakthrough technologies. In addition, it was discovered that the inclusion of a company in the list of sanctioned entities is statistically significant and has a positive effect on its financial performance in the short term in certain groups in terms of profitability. The article makes up for the lack of empirical research on the financial impact of R&D in the domestic economy and highlights the vulnerability of the current innovation model of the sector.

Keywords: innovation development, oil and gas sector, R&D expenditures, sanctions effect

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Introduction

Since 2022, after sanctions have been imposed on the Russian economy, domestic companies have faced major problems related to technological development. First, Russian companies were denied access to advanced foreign technologies. Second, they were forced to redirect a part of their resources to solve the current problems caused by the disruption of the usual supply and production chains. The oil and gas sector, which is of strategic importance for Russia, was one of the national industries most profoundly affected by the sanctions. The key foreign suppliers of oil and gas technology withdrew from the Russian market or significantly reduced the scale of their operations. Consequently, although the majority of companies had shown a steady growth of research and development (R&D) expenditures before 2022, in 2022–2023 investment in technological development was reduced. Analysis of companies' financial statements shows that oil and gas companies cut R&D expenses to a different extent: from partial diminishing of funding by PJSC Gazprom (a decline by 11% from RUB 35,440.9 million in 2022 to RUB 31,700 million in 2023) to a considerable slash in R&D funding by PJSC RussNeft, where R&D expenses in 2022 amounted to just RUB 341.7 million. It is important to emphasize that foreign technology is of critical significance for the Russian oil and gas industry: a considerable part of oil is currently extracted in the oil fields that are at the peak level of production. Enhanced oil recovery methods are necessary to further develop these fields, and they have been mainly implemented by the western companies, which have exited the Russian market (first and foremost, these technologies comprise hydraulic fracturing, lateral drilling and electromagnetic stimulation).

Against the background of forced disinvestment from technological development, two topical research issues arise. The purpose of this study is to solve them. The first issue is related to the strength of the effect produced by R&D expenditures on corporate financial performance. The second issue concerns the way in which the inclusion of Russian companies on the sanctions lists influences their innovation funding decisions and financial performance. It is of particular importance to examine these issues in the context of a discussion dedicated to the national policy priorities in the science and technology sphere in the new geopolitical environment. Despite the applied significance of the raised issues, there is a gap in the academic literature related to empirical research, which is partly caused by a time lag in submitting company reports. Our research makes a contribution to empirical literature dedicated to the study of the role of technology in the development of national industries in the period of sanctions [2; 3].

Traditionally, when modeling the full cycle of technology creation and adoption, it is assumed that investments in innovation adversely affect corporate financial performance in the short term, and a positive effect is achieved only in the long term [4; 5]. However, in this paper, first of all, the object of the research is the short-term effect of innovation investments, that is, the effect that emerges at the horizon of one to three years after the investment is made. Short-term effects have been chosen as the research object because of the specific nature of innovation expenditures in the Russian oil and gas industry. In the environment where foreign companies were the main source of technology innovation, the investment of Russian companies was mainly targeted at implementation of foreign companies' ready technologies in business processes instead of funding long-term projects to create their own breakthrough technologies [6]. Thus, due to the distinctive features of technological development, investments in the Russian oil and gas industry, which consist in spending a significant part of funds to purchase ready-made equipment and introduce it into production , the short-term planning horizon in particular is of special interest for the assessment of the effects of innovation investment.

The paper is structured as follows. The second section presents a literature review dedicated to two research issues: searching for the factors that influence the amount of R&D expenditures and defining the effect produced by R&D expenditures intensity on corporate financial performance. The third section describes data and the model used for the econometric assessment of the effects produced by R&D expenditures on company profitability. The fourth section shows the results of the performed empirical analysis. In the fifth section, we discuss the obtained results and draw the key conclusions. In the conclusion we sum up the results of the research and state the research limitations related to availability of statistics on R&D expenditures.

Literature Review

Uncertainty of the results of innovative activity is one of its important aspects. When companies make decisions to increase innovation investment, they face the risk that innovation activity will not provide positive results in the future. Current corporate profit is often used to increase innovation expenditures, but the gains from research and development expenditures are not apparent at the time of investment. Moreover, if R&D expenditures are of intangible nature, and their results are initially meant for implementation in the operational processes of a certain business [7]. Therefore, the availability of free financial resources is usually the most important factor that determines the scale of corporate innovative activity [8]. Companies with insufficient internal funds often encounter difficulties when they try to provide a continuous flow of innovation by means of maintaining a stable R&D expenditure level: internal uncertainty related to research and development results is a factor constraining the expenditures because companies may postpone decisions in order to collect additional information or to solve immediate operations-related problems [9]. Large companies often have more resources at their disposal to finance R&D, therefore, they may exhibit better results due to economies of scale [10]. On the contrary, as a rule, small companies encounter additional restrictions when creating and implementing innovation [11].

In spite of the uncertainty characteristic of innovative activities, empirical literature dedicated to analysis of the effects of innovation investments accumulated substantial evidence that research and development expenditures were a success and ensured high financial performance. Company profitability is most often used as a measure of financial performance. For instance, the paper by Bayraktaroglu et al. [12] detected a positive relationship between an increase in intangible assets and R&D expenditures and profit. In a similar way, research by Dimitropoulos [13] showed that R&D expenditures correlated with profit even in the times of crises while innovation-active companies turned to be more resilient during a recession. Moreover, the study by Roper and Turner [14] proves that high R&D expenditures not only ensured a business's resilience during a recession but also drove growth in the period of economic recovery.

Another financial indicator examined in order to evaluate the impact of R&D expenditures is the company market value. Studies show that in case of capitalization, R&D expenditures have a positive correlation with market value. This indicates that the market interprets this investment as an indicator of future economic benefits. In contrast, when R&D expenditures are taken into account as current expenses, a negative relationship is usually observed between innovation investment and market value because the market does not consider current R&D expenses a source of future benefits [15]. Capitalization of R&D expenditures may result in a more favourable evaluation of operating efficiency because it drives up the expected future benefits from the incurred expenses [16]. On the contrary, in companies that write off R&D expenditures, an increase in such R&D expenditures reduces the reported profit, as a consequence, changing the investors' attitude to their financial standing. Such a relationship is in line with the logic of signaling theory, which states that R&D expenditures are a signal to the market concerning the company's growth potential and innovative abilities. However, at the same time, company market value is not always the optimal indicator that may be used to assess the effects of innovation investments because the market often underestimates the potential of future income related to an increase in R&D expenditures. This results in a delay in adjustment of stock prices after R&D expenditures have been announced. In the future, the initial underestimation of an asset may entail significant changes in stock prices when market participants realize the potential of incurred innovation expenditures.

Apart from the total amount of innovation investment, empirical literature often uses the indicator of intensity of R&D expenditures defined as a ratio of R&D expenditures to total sales. Research by Reguera-Alvarado [17] revealed that an increase in intensity of R&D expenditures scales up innovation and enhances operating efficiency, and this, in its turn, exerts a positive impact on corporate profit. A study by Trump and Guenther [18] used a sample of manufacturing companies and confirmed that an increase in R&D intensity drives up the number of innovative products and services.

A number of studies showed that R&D expenditures and intensity of R&D expenditures may produce a positive impact on corporate operating results [19]. Research by Falk [20] revealed that intensity of R&D expenditures exerts a positive influence on growth in employment and sales. Vithessonthi and Racela offered in their paper [4] a more complicated interrelation between innovation investment and operating efficiency: they presume that the intensity of R&D expenditures is negatively associated with short-term operating efficiency, but makes a positive contribution to a company's long-term efficiency. Research by Leung and Sharma [5] confirms this conclusion and shows that intensity of R&D expenditures has a negative influence on profit in the short term, but a positive impact on company value over the long term. Some papers point out the impact of R&D expenditures on sales volume and company profitability [21].

Additional control variables are required to conduct an econometric study of the effects of innovation investment on financial performance of companies. A number of studies examine a set of independent variables that may be used as control variables when measuring the effect of intensity of R&D expenditures. Papers by Jefferson et al. [22] and Min and Lee [23] studied the interrelation between company size, market share, profitability and intensity of R&D expenditures. Similarly, Tyagi et al. [24] studied how company size and profit for the past year influence future profits. Besides, some papers emphasized that the returns on R&D expenditures were heavily reliant on the company's industry affiliation. Thus, companies involved in knowledge-intensive industries such as chemical industry, pharmaceuticals and computer manufacturing show higher rates of return on R&D as compared to firms from other industries [25–29]. Research [30] explains the dissimilarities between the benefits of R&D across industries by different levels of uncertainty of innovation results and a corresponding risk premium.

Methodology and Research Data

For modeling the impact of intensity of R&D expenditures on the financial performance of oil and gas companies, we used the approach underlying the CDM model (Crépon, Duguet, Mairesse) [1], which takes into consideration the structural relationships between research and development, company characteristics and its productivity. The most prominent feature of the CDM model is its attempt to eliminate the endogeneity problem caused by the interdependence of R&D expenditures and company performance. For this purpose, the authors of the CDM model used several equations: the first – to predict R&D expenditures, the second – to evaluate innovation results and the third – to assess productivity. Researchers have significantly modified the CDM model (changing the number of equations, variables, test methods) to solve various tasks [31; 32]. Similarly to the CDM model and its modifications, in this study we are going to use two equations. Empirical testing of the model implies a two-step procedure. Intensity of R&D expenditures defined at the first step serves

as the explanatory variable for the company gross profit at the second step. The advantage of the two-step procedure is that it allows to assess models with endogeneity in case of a bidirectional cause-and-effect relationship.

Variables were selected to develop equations. The relationship between return on assets (ROA), debt to equity ratio (D/E), company size and intensity of research and development expenditures in the oil and gas producing industry assumes distinctive characteristics based on high capital expenditures, nature-related constraints and dependence on oil and gas price fluctuations. ROA is indicative of the efficiency of company assets' use aimed at deriving profit from extraction, processing and transportation of hydrocarbons [33]. High ROA values usually imply a high efficiency of the production process, availability of modern equipment and advanced technology. As a result, companies have an opportunity to invest in long-term and capital-intensive projects, such as exploration of new deposits or implementation of innovative oil and gas recovery methods [34]. Such investments require significant funds and their payback period may be long, however, companies with high return on assets are more resilient to financial risks and can maintain a high R&D expenditure level. In the long term, this contributes to sustaining of competitive advantages [22; 23].

The D/E ratio in the oil and gas industry also exerts a significant impact on the opportunities for innovation project funding [35]. A high level of borrowed funds expands the company debt service obligations, which may be a significant constraining factor for solid R&D investment, especially taking into consideration the volatility of oil and gas prices [36]. Projects for exploration and development of new deposits are often costly and highly risky due to their technical complexity, infrastructure requirements and the need to comply with environmental standards. Companies with low D/E ratio have a wider margin of manoeuvre and may afford to invest actively in the development of new technologies or environment-friendly solutions. As a result, they are able to minimize the impact on the environment and enhance business resilience [37]. Under high debt burden, oil and gas companies are forced to limit R&D more often and prefer less risky short-term projects [38].

Company size in the oil and gas producing industry also has a significant influence on the ability to finance and manage risks related to research and development [22; 23]. Large companies, including international oil corporations, possess extensive resources and have better conditions for raising capital [39]. They may afford intensive investments in R&D, which is important both for exploration of new deposits and for the development of innovation extraction methods in hard-to-reach regions or ocean shelves. Large companies benefit from asset diversification and higher resilience to risks. This enables them to invest in long-term projects such as emissions reduction research or improvement of hydrocarbon processing efficiency [40]. At the same time, small companies that target niche segments or are at early development stages often demonstrate high R&D intensity relative to their revenues because for them innovation may be the only competitive advantage when access to resources is restricted [41].

Intensity of research and development expenditures in the oil and gas producing industry is determined as the ratio of R&D expenditures to corporate total revenue. This value provides an opportunity to define priorities concerning innovation and technology in strategic company development. With the current trend towards decarbonization and transition to cleaner energy, R&D becomes the key field of sustainable development for oil and gas producers. It ensures a competitive advantage and enables to adapt to future environmental standards [42]. A high intensity of R&D expenditures is in most cases observed in large, highly profitable companies with a stable cash flow and fewer debt obligations. This enables them to finance long-term research projects in the unstable oil market [43].

Influence of return on assets and the debt-to-equity ratio on R&D expenditures is of particular relevance for the oil and gas industry: high return on assets reduces the need for borrowed capital, thus supporting a low D/E ratio and providing an opportunity for the companies to actively develop innovation programs. With high ROA and low D/E, large oil and gas companies may invest more heavily in research and development, thus achieving economy of scale and enhancing efficiency of resource use [44]. In the long-term, the economic logic of this relationship in the oil and gas producing industry consists in maintaining a balance between company resilience to the market and financial risks and readiness to implement costly innovation projects.

Thus, in order to predict the amount of R&D expenditures for each company, we selected the following variables: the debt-to-equity ratio, return on assets and total asset value (company size). Additionally, we collected information on the price of Urals crude oil. Its influence on financial performance is indicative of the distinctive nature of oil and gas companies. At the second step, in order to model gross profit, we used predicted R&D expenditure values, company characteristics selected on the basis of the literature review (control variables) and oil prices, as well as information whether sanctions had been imposed on the company.

The following procedure was applied for econometric assessment of the model. At the first step, the model of intensity of R&D expenditures is evaluated by means of fixed-effect panel regression. At the second step, the predicted values of intensity of R&D expenditures are added to quantile regression where company financial effectiveness is the dependent variable (the share of gross profit in revenue). Quantile regression is used to evaluate the impact of independent variables on various quantiles of distribution of the dependent variable [45]. As a result, it is possible to work with data even in case of heteroscedasticity and heterogeneity [46]. Unlike standard regression models, quantile regression takes into consideration non-uniform effects and detects non-linear and asymmetric relationships [47].

In this paper, the two-step evaluation procedure allows to neutralize endogeneity of the key regressor – R&D expenditures. At the first step, in fixed-effect panel regression the variation in R&D expenditures is explained by return on assets and time-invariant company characteristics (fixed effects). Thus, the obtained ("purified") estimates of the expenditure values are indicative of only the part that is unrelated to the error of the second equation and eliminates the impact of hidden constant factors and the inverse correlation "profit → R&D expenditures". At the second step, the predicted values are used in quantile regression, thus providing robust estimators of the influence of R&D expenditures on efficiency for various quantiles of profit distribution already without endogeneity-caused bias. Moreover, the lag is used to calculate variables, which allows to address the probable endogeneity of variables.

Equations of the first and second steps of the model are described in formulas (1) and (2):

$$R\&D\ Intesity_t = b0 + b1 \cdot \frac{Debt}{Equity}_{t-1} + b2 \cdot ROA_{t-1} + \\ + b3 \cdot Firm\ Size_{t-1} + b4 \cdot Oil\ price_{t-1}; \quad (1)$$

$$GPmargin_{t+n} = b0 + b1 \cdot R\&D\ Intesity\_pred_t + \\ + b2 \cdot \frac{Debt}{Equity}_{t+n} + b3 \cdot Firm\ Size_{t+n} + b4 \cdot DummyUpst + \quad (2)$$
$$+ b5 \cdot DummySanc + b6 \cdot Oil\ price_{t+n}, n = 1,2,3,$$

where $GPmargin_{t+n}$ is the share of gross profit in company revenue expressed as the share of revenue at time $t+n$; n designates the lag between intensity of R&D expenditures and other variables in the equation;

$R\&D\ Intesity_t$ is the intensity of R&D expenditures at time t;

$\frac{Debt}{Equity}_{t+n}$ is the ratio of debt to equity, which is indicative of the company's financial structure at time $t+n$;

$Firm\ Size_{t+n}$ is the company size measured as the logarithm of total assets at time $t+n$;

$R\&D\ Intesity\_pred_t$ is the intensity of R&D expenditures at time t predicted at step 1;

$DummyUpst$ is a dummy variable that takes on the value of 1 if the company's core economic activity is extraction of crude oil and natural gas (Russian National Classifier of Types of Economic Activity (OKVED) 2: code 06);

$DummySanc$ is a dummy variable that takes on the value of 1 if sanctions are introduced against the group of companies to which the company in question pertains;

$Oil\ price_{t+n}$ is the control variable – Urals oil price at time $t+n$.

The binary indicator of sanctions imposed on the company is one of the research variables. The company is considered to be under sanctions when the parent company is on the US sanctions lists, namely Specially Designated Nationals and Blocked Persons (SDN), and/or corresponding sanctions lists of the European Union. This approach to identification allows to consider sanctions as a discrete event. This is in line with the purpose of our research, that is, to evaluate the cumulative financial effect produced by innovation-driven development of oil and gas companies under the sanctions pressure or without it. For this reason, in this empirical strategy, priority is placed on the very fact of being under sanctions.

For the research we collected a dataset using the SPARK-Interfax information and analysis system. The initial sample comprised all Russian oil and gas enterprises whose core economic activity corresponded to one of the following codes from the Russian National Classifier of Types of Economic Activity (OKVED 2):

- 06 – Extraction of crude oil and natural gas;
- 09.1 – Support activities for extraction of crude oil and natural gas;
- 19.2 – Manufacture of refined petroleum products;
- 20.11 – Industrial gas production.

We eliminated from the sample of oil and gas companies (4,248 companies) the holding companies with no financial statements and the companies that had not disclosed data on R&D expenditures (balance sheet item 1120 Research and Development Results) from 2017 to 2023. The final sample contains 112 companies with at least one non-zero value of R&D expenditures for 2017–2023. Thus, we preserve both positive and zero investments for certain years. First of all, the number of companies in the sample is so small because of the limited availability of data on R&D expenditures in the oil and gas industry: only 3% of companies disclose corresponding indicators according to art. 1120 of the Russian Accounting Standards [48]. This particular time period was selected primarily because since 2017, completeness of information disclosure has grown steeply in compliance with art. 1120.

The collected dataset was used for static test of the relationship between company characteristics, intensity of R&D expenditures and the share of gross profit in revenue. Descriptive statistics on each variable is presented in Table 1.

Results of Econometric Assessment

At the first step, when the model of fixed-effect panel regression was selected, the Breusch – Pagan and Hausman tests were conducted. The result of the Breusch – Pagan test intended to reveal random effects is statistically significant at the 1% significance level. Then the Hausman test with the 5% significance level confirmed the differences in the estimates of the fixed effects and random effects models. Therefore, the fixed effects model is preferable. Multicollinearity was not detected among the variables of equation 1. For econometric analysis, at the first stage, in order to ensure robust estimates when heteroscedasticity is potentially possible, we additionally calculated standard errors of coefficients in the model using White adjustments [49]. High values of F-statistics are indicative of the statistical significance of the equation 1 model and the possible use at the second step of intensity of R&D expenditures predicted by

Table 1. Descriptive statistics of used data

Variable	Mean value	St. deviation	Median
DummyUpst	0.230	0.421	0.000
DummySanc	0.467	0.499	0.000
R&D_intensity	0.005	0.069	0.000
Debt/Equity$_{t-1}$	0.380	0.690	0.031
ROA$_{t-1}$	0.463	0.112	0.434
Firm_size_(Sales)$_{t-1}$	0.479	0.117	0.482
Oil_price_LOG$_{t-1}$	0.406	0.317	0.346
GP_margin$_{t+1}$	0.597	0.082	0.584
Debt/Equity$_{t+1}$	0.318	0.038	0.318
Firm_size_(Sales)$_{t+1}$	0.362	0.154	0.331
Oil_price_LOG$_{t+1}$	0.372	0.239	0.399
GP_margin$_{t+2}$	0.566	0.075	0.553
Debt/Equity$_{t+2}$	0.696	0.046	0.696
Firm_size_(Sales)$_{t+2}$	0.299	0.184	0.341
Oil_price_LOG$_{t+2}$	0.662	0.334	0.824
GP_margin$_{t+3}$	0.550	0.066	0.524
Debt/Equity$_{t+3}$	0.172	0.040	0.170
Firm_size_(Sales)$_{t+3}$	0.220	0.213	0.300
Oil_price_LOG$_{t+3}$	0.477	0.411	0.743

Note: The sample comprises 448 observations.

means of such explanatory variables as financial leverage, ROA, company size and oil price.

The second step of empirical analysis consisted in the evaluation of models for the entire spectrum of quantiles (τ = 0.1, 0.25, 0.5, 0.75, 0.9) and lag specifications (one-three years) in order to detect heterogeneous effects of R&D expenditures on financial performance. The results of evaluation of the two-step model with a one-year lag are presented in Table 2. The variable of intensity of R&D expenditures shows statistically significant influence on the level of the corporate gross margin for quantiles 0.1, 0.5, 0.75 and 0.9. The coefficients of these quantiles are –0.0013, 0.0010, 0.0020 and 0.0015, respectively. This is indicative of the effect's multidirectionality: for the lower quantile (0.1) the influence is negative, while at the median level and higher (0.5–0.9) it is positive. So, we may assume that R&D investments are most profitable for highly remunerative companies. The fact of being sanctioned (DummySanc) turned out to be significant at the 1% level and positive for the median (0.5) and upper (0.75) quantiles. This may be indicative of the short-term effect of sanctions on successful companies.

Table 2. Evaluation Results. One-Year Lag

Equation 1. FE Panel Regression: Dependent Variable – Intensity of R&D Expenditures

Variable	Coefficient *(standard error)*
Debt/Equity	0.2791** *(0.1064)*
ROA	11.210 *(9.8861)*
Firm Size	–10.687* *(6.3580)*
Oil price	253.78* *(150.91)*

Equation 2. Quantile Regression: Dependent Variable – Share of Gross Profit in Revenue

Variable	Coefficients *(standard errors)*				
	Quantile 0.1	**Quantile 0.25**	**Quantile 0.5**	**Quantile 0.75**	**Quantile 0.9**
Intercept	0.7743***	–0.0626	–0.5480**	–1.3158***	–1.5928**
	(0.213)	*(0.170)*	*(0.217)*	*(0.420)*	*(0.776)*
R&D intensity	–0.0013***	0.0003	0.0010***	0.0020***	0,0015*
	(0.000)	*(0.000)*	*(0.000)*	*(0.001)*	*(0.001)*
Debt/Equity	0.0001**	0.0000	–0.0001	–0.0002	–0.0004
	(5.76e-05)	*(6.97e-05)*	*(0.000)*	*(0.000)*	*(0.001)*
Firm Size	0.0096*	0.0040	–0.0021	–0.0057	–0.0376*
	(0.006)	*(0.004)*	*(0.005)*	*(0.008)*	*(0.021)*
Oil price	–0.1882	0.0183	0.2037**	0.4767***	1.0659**
	(0.124)	*(0.092)*	*(0.103)*	*(0.173)*	*(0.429)*
DummyUpst	0.0309	0.0606**	0.1154***	0.1399***	0.0490
	(0.028)	*(0.025)*	*(0.029)*	*(0.043)*	*(0.089)*
DummySanc	0.0200	0.0272	0.0663***	0.1304***	0.0516
	(0.026)	*(0.022)*	*(0.025)*	*(0.037)*	*(0.078)*

Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

In the models with 2- and 3-year lags, the impact of the intensity of R&D expenditures predicted at the first step on the company's financial performance turned out to be statistically insignificant. Thus, according to the results of our research, the influence of R&D investments is observed only over a short-term horizon (one-year lag). Besides, highly profitable companies demonstrate a positive effect. The effect is not confirmed in the medium term (two-year and three-year lag). Also, the imposition of sanctions (DummySanc) turned out to be insignificant from the point of view of company financial performance for the models with the two-year and three-year lag: the results of the assessment confirm the impact of sanctions in the medium term similarly to the short term.

Research Conclusions

The purpose of the present research was to develop the model for assessing the effects of technology implementation on company financial performance for the Russian oil and gas industry in the period of sanctions. To sum up the obtained results of empirical estimators, we may make two conclusions.

First, the conducted modeling of the impact of R&D expenditures allowed to evaluate their efficiency in raising productiveness in the oil and gas industry. The results indicate that an increase in the intensity of R&D expenditures has a statistically significant and positive impact on the performance of oil and gas and oilfield service companies over the one-year horizon (1% significance level). At the same time, the two-year and three-year effect of the intensity of R&D expenditures was not confirmed.

Secondly, the research we have performed allows to draw conclusions regarding the impact of sanctions on investment activity and financial performance of Russian oil and gas and oilfield service companies. The geopolitical events of 2022 and subsequent sanctions delivered a heavy blow to Russian vertical-integrated oil companies, weakening their financial performance and restricting access to crucial technologies. The paper revealed a statistically significant deviation in the indicators of companies with a certain profitability level that are under sanctions from the indicators of companies on which sanctions have not been imposed. Thus, sanctions pressure influenced both the Russian oil and gas industry in general and the specific enterprises on sanctions lists.

The specific character of R&D expenditures of Russian oil and gas companies before sanctions consisted in launching a rapid search for ready solutions and their implementation in the current business processes. The present research revealed an advantage of this approach. It consists in the opportunity to rapidly achieve financial results by using the purchased technological equipment with no need to spend a long time for developing proprietary technologies. It is true that before 2022, oil and gas companies had obtained financial returns from R&D investment over a short-time horizon. At the same time, this innovation funding strategy turned out to be ineffective in the new geopolitical environment because restricted access to foreign equipment actually deprives companies of a key source of development. Absence of proprietary technologies causes an additional problem in times of a social and economic crisis: under the external pressure companies may be forced to focus on short-term goals and cut long-term investments even more.

The short-term nature of the effect of R&D expenditures within the analyzed period is largely due to the fact that a significant part of investment provides for the implementation of ready solutions and is in fact targeted at adaptation of imported ready-made equipment and software-based solutions. In particular, this refers to the purchase of foreign geological exploration and seismic interpretation systems, complex service packages for horizontal and multistage hydraulic fracturing, off-the-shelf technologies of enhanced oil recovery in mature fields and integrated digital platforms that manage the extraction and transportation of hydrocarbons. Such solutions ensure a noticeable productivity gain and financial results within the first two years after implementation. However, as the "rapid" effects of optimization wear off, the equipment becomes technologically obsolete and it is impossible to perform its in-depth modernization without access to the initial designs, the relative impact of these investments on company performance decreases rapidly and almost fades away over a three-year horizon.

The research detected that the influence of company size and its financial leverage in previous periods on R&D intensity is significant, as stated in the research by Tyagi et al. [24]. Moreover, the research confirms the relationship between R&D intensity and operating efficiency represented in this study by the share of gross profit in revenue [19]. Thus, using oil and gas companies as an example, we confirmed the moderating influence of the intensity of R&D expenditures on the financial performance of company operations described in the paper by Diéguez-Soto [21].

Conclusion

The companies' demand for innovation directly depends on the expected effects that novel technologies will produce on financial performance. Effective implementation of technologies may result in a significant productivity gain, cost reduction and improvement of product quality, which, in its turn, influences companies' competitiveness and financial performance. Besides, investment in technologies in Russian industries often implies the implementation of ready solutions in the production process rather than a complete cycle of development of proprietary innovations. The advantages of this strategy consist in rather low risks related to obtaining a certain result from innovation investment and the opportunity to get financial returns within a short-term period. The conducted empirical research using the sample of Russian oil and gas companies has demonstrated it.

The developed assessment model allows for a quantitative measurement of the impact of R&D investment on financial performance of Russian oil and gas and oilfield service companies under sanctions. First, it is demonstrated that an increase in R&D expenditures significantly improves the operating efficiency of companies over the one-year horizon (1% significance level). Besides, the lagged effect (for two or three years) turned out to be insignificant. Second, sanctions are a significant factor that exerts a considerable impact on the development of technologies by oil and gas companies. Finally, empirical estimators proved the significance of company size and financial leverage for R&D intensity, and also confirmed the relationship between the level of R&D expenditures and operating efficiency (share of gross profit in revenue), which is in line with the results obtained by Tyagi et al. [24], Hou et al. [19] and Diéguez-Soto [21]. Thus, to ensure the steady growth of profitability under external pressure, Russian oil and gas companies need to develop their own scientific and technical competences and revise the innovation investment strategy over the long-term horizon.

One of the key limitations of this research was availability of statistics on R&D expenditures of Russian enterprises. The international experience of successful government support of science and technology indicates that it is important to use data on R&D expenditures and intangible asset value to assess and encourage technological development. In Russia, the main practical impediment comprises the problems related to disclosure of data on R&D and intangible assets. Only about 0.2% of legal entities in Russia indicate R&D expenditures in their financial statements. Data on intangible assets is also reported by a small number of companies – approximately 1.7% of legal entities. After processing the data from SPARK-Interfax in the present research, a considerable part of oil and gas companies were left out of the final sample because they had not disclosed information on R&D results. Taking into account the crucial importance of technological development from the viewpoint of improving competitiveness of the national economy and the necessity to develop new government policies intended to encourage technological development of Russian companies, it is necessary to introduce additional changes related to submitting corporate reporting, in particular, detailing the manner of submitting data on R&D expenditures and intangible asset value [48].

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