Modeling the innovative component of sustainable development of oil and gas enterprises. The case of PJSC ROSNEFT

Nina Baranova*, and *Daria* Loginova

Peoples' Friendship University of Russia (RUDN University), Miklukho-Maklaya Str, 6, 117198 Moscow, Russia

Abstract. PJSC ROSNEFT is a member of the UN Global Compact since 2010 and supports the UN Sustainable Development Goals. In the Strategies-2022 (2030), important directions are recorded in which PJSC ROSNEFT will develop. A significant place in them is given to innovative development as an important component of sustainable development. The corporation set a new record in Russia for oil production in 2019 thanks to these developments – 560.3 million tons – and did not go broke in 2020. In our work, we will conduct a study of the innovative component of the corporation's sustainable development in 2004-2020. To this end, the materials of annual and consolidated reports, programs of sustainable and innovative development for 2004-2020 were studied. The Eviews10 econometrics software was used to carry out econometric modeling. The work shows that the obtained linear model is adequate and can be used for predictive calculations for the short term. The exponential model turned out to be inadequate for calculations. The article notes that epidemics, oil and gas wars, geopolitical contradictions have significantly reduced the rate of economic growth of PJSC ROSNEFT. The corporation will have to adjust its sustainable and innovative development programs to reduce costs, stop falling income and return to the previous level of development.

1 Introduction

PJSC ROSNEFT is one of the largest companies in the Russian and world oil and gas market. PJSC ROSNEFT entered the Top-10 Russian oil companies (3rd place) in extraction and processing of oil in 2013 as a result of the takeover of TNK-BP plc and the acquisition of Bashneft (2016). The revenue and profit of PJSC ROSNEFT amounted to 6,850 billion rubles and 549 billion rubles in 2018. PJSC ROSNEFT took 1st place in this rating (revenue of 8676 billion rubles, profit of 708 billion rubles) in 2019 [22].

PJSC ROSNEFT ranked 158th in 2016 (revenue of $ 56.553 billion), 115th place in 2017 (revenue of $ 72.028 billion), 86th place in 2018 (revenue of $ 90.055 billion), 76th place in 2019 (revenue of $ 96.313 billion) [23] according to the Fortune Global 500 magazine.

PJSC ROSNEFT has formed a competitive portfolio of gas projects and ranked 3rd in gas production in Russia. The corporation has developed and is actively implementing this

portfolio [1] in various regions of Russia and the world: Germany, Norway, Italy, Spain, Japan, China, Mongolia, Vietnam, India, etc.

PJSC ROSNEFT is a member of the UN Global Compact and supports the UN Sustainable Development Goals since 2010. In the Strategies-2022 (2030) [2-3] important directions in which the company will develop are recorded. A significant place in them is given to innovative development as an important component of sustainable development [3-4]. The corporation set a new record in Russia for oil production in 2019 thanks to these developments – 560.3 million tons.

2 Innovative activity of PJSC ROSNEFT

In their works Russian and foreign scientists [4-12] have proved that innovative technologies are the main component of the competitiveness of both an enterprise and a country. PJSC ROSNEFT pays special attention to the innovation and the introduction of breakthrough technologies in production. A certified audit in the field of innovation management and international standards have determined the company's innovative activities of sustainable development. These directions are formulated in the PJSC ROSNEFT Innovative and Sustainable Development Program for 2016-2020 with a vision to 2030 [3, 13].

PJSC ROSNEFT develops its own scientific research complex (27 Research and Design Institutes), cooperates with industry research institutes, universities, small and medium-sized innovative enterprises. The scope of work of the corporate research and development complex has more than doubled since 2016.

Advanced inventions, unique innovative projects of PJSC ROSNEFT are significant both for the corporation and for the entire oil and gas industry in Russia and abroad. 4,274 patent applications were filed in 2017, of which 1,355 were implemented, and the economic effect from the use of patent rights was more than 3.8 billion rubles; 700 million rubles were allocated for the implementation and distribution of innovative technologies in 2018. The share of the Company's projects implemented in its own software has doubled. The confirmed economic effect from the implemented targeted innovative projects for 2017-2019 amounted to more than 36 billion rubles.

The unique innovative R&D of the Company, comparable or unparalleled abroad, were carried out in the field of exploration and production, high-tech technological software, oil refining and petrochemicals, development of polymer materials for oil production, production of equipment and services, environmental protection, etc.

According to annual reports, reports in the field of sustainable development and press releases [14-15], PJSC ROSNEFT has recently increased its costs for innovative development. Total investments in innovative projects for 2016-2019 amounted to 250 billion rubles, of which R&D costs were 92 billion rubles: R&D costs increased by 48% (29.9 billion rubles) in 2017, by 7.4% (32.1 billion rubles) in 2018 and decreased to 30 billion rubles in 2019. The share of patent applications increased by 30%, and the economic effect from the use of patent rights amounted to 16.7 billion rubles. More than 640 patents were developed, 279 new technologies were tested (78 were introduced), and the economic effect from the introduction of new technologies amounted to 659 million rubles in 2019.

3 Econometric modeling of innovation activity of PJSC ROSNEFT

In the long-term development program of PJSC ROSNEFT until 2030 [2-3], the indicator of innovative activity, among the main indicators aimed at solving the company's strategic objectives, is indicated.

The statistical data of the annual reports of PJSC ROSNEFT for 2004-2020[3, 13-16] were used to determine the level of the development of the company's innovative activity, its competitiveness. Linear, exponential models were built using the Eviews10 software package [17-20]. These models are necessary to calculate the forecast of innovative development of PJSC ROSNEFT for the short term.

Variables were entered. Y(R_D) is the R&D costs (billion rubles) and characterizes the level of innovation activity of the corporation. Variables X_1(CAP) is the market capitalization of the corporation (billion rubles), X_2(NATUR) is environmental costs (billion rubles), X_3(REV)is sales revenue (billion rubles) have the power to change Y(R_D). The modeling will be carried out using statistical data for 2005-2019 (n = 15).

Covariance Analysis: Ordinary
Date: 11/29/20 Time: 14:53
Sample: 2005 2019
Included observations: 15

Correlation t-Statistic Probability	R_D	CAP	NATUR	REV
R_D	1.000000			

CAP	0.951277	1.000000		
	1.723519	-----		
	0.1085	-----		
NATUR	0.919513	0.476337	1.000000	
	8.434725	3.310611	-----	
	0.0000	0.0056	-----	
REV	0.899996	0.577882	0.437144	1.000000
	7.444367	3.718033	11.91605	-----
	0.0000	0.0026	0.0000	-----

Fig. 1. Covariance analysis

A matrix of pairwise correlations is built (Fig. 1) to determine the strength of relationships between variables X_1(CAP), X_2(NATUR), X_3(REV) and variable Y(R_D). Here the correlation is established between Y(R_D) and X_1(CAP), X_2(NATUR), X_3(REV) as follows: r_{yx1}=0.95; r_{yx2}=0.912; r_{yx3}=0.9. There is a slight multicollinearity between the variables X_1(CAP), X_2(NATUR), X_3(REV) (r_{x1x2}=0.48; r_{x1x3}=0.58, r_{x2x3}=0.44), so it could be happened a bit wrong result. Therefore, the parameters are studied, and the desired equation is estimated.

Dependent Variable: R_D
Method: Least Squares
Date: 11/29/20 Time: 14:52
Sample: 2005 2019
Included observations: 15

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CAP	-0.005780	0.001441	-4.011513	0.0020
NATUR	0.698288	0.281665	2.479141	0.0306
REV	0.002852	0.001298	2.198007	0.0503
C	11.88991	3.280191	3.624762	0.0040

R-squared	0.939187	Mean dependent var	16.66400
Adjusted R-squared	0.922601	S.D. dependent var	12.84708
S.E. of regression	3.574145	Akaike info criterion	5.608507
Sum squared resid	140.5196	Schwarz criterion	5.797321
Log likelihood	-38.06381	Hannan-Quinn criter.	5.606496
F-statistic	56.62699	Durbin-Watson stat	1.818801
Prob(F-statistic)	0.000001		

Fig. 2. The coefficients and estimates of the linear equation (1)

The Eviews10 software package is used to obtain the coefficients of the linear model and estimate the parameters of the equation. The coefficients and parameter estimates show (Fig. 2) that the equation is significant (F_{stat}=56.63, p-value=0.000) and can be used for forecasting for the short term. The coefficient of determination is R^2=0.939 Thus, the obtained linear model is adequate according to the formal criterion. The equation for analysis and forecast is as follows:

$$Y^{\wedge}(R\_D) = -0.0058 \cdot X_1(CAP) + 0.7 \cdot X_2(NATUR) + 0.0029 \cdot X_3(REV) + 11.89 \quad (1)$$

Further, the regression coefficients are examined: an increase in the market capitalization of an enterprise by 1 billion rubles will lead to a change in R&D by an average of 5.8 million rubles per year; an increase in environmental projects costs by 1 billion rubles will lead to an increase in R&D by an average of 700 million rubles per year; an increase in sales revenue by 1 billion rubles will lead to an increase in R&D by an average of 2.9 million rubles per year, other things being equal. If X_1(CAP) = X_2(NATUR) = X_3(REV) = 0, then Y^(R_D) = 11.89.

The T-statistic of each variable and their Prob are adequate (Fig. 2), therefore, the obtained components can be used for further analysis and forecast. The fitted values of Y^(R_D), on average, approximate well the dependence of Y(R_D) on the variables X_1(CAP), X_2(NATUR), X_3(REV). Considering the Jacques-Bera test (Fig. 3), it can be argued that the residuals of the equation (1) have normal distribution (0.35), and the probability of accepting the null hypothesis H_0 is 84% (P-value=0.84).

Series: Residuals
Sample 2005 2019
Observations 15

Mean	4.03e-15
Median	0.202608
Maximum	6.064469
Minimum	-5.375159
Std. Dev.	3.168141
Skewness	-0.038810
Kurtosis	2.260723
Jarque-Bera	0.345347
Probability	0.841412

Fig. 3. Jarque-Bera test

Theil's coefficient (0 <0.074 <1) and the mean absolute percent error of the equation (12.89%) show the high accuracy of the model (1) (Fig. 4).

Forecast: R_DF	
Actual: R_D	
Forecast sample: 2005 2019	
Included observations: 15	
Root Mean Squared Error	3.060715
Mean Absolute Error	2.556900
Mean Abs. Percent Error	12.89569
Theil Inequality Coefficient	0.074056
Bias Proportion	0.000000
Variance Proportion	0.015684
Covariance Proportion	0.984316
Theil U2 Coefficient	0.936025
Symmetric MAPE	37.02978

Fig. 4. Parameters of the model (1)

The White test investigates the model (1) for the absence of heteroscedasticity. Hypothesis H_0: the proposition that the residuals of the equation (1) are not homoscedastic, H_1 is the opposite hypothesis. According to White test (Fig. 5), it can be argued that the value oftheObs*R^2 = 12.5, and the corresponding P-value is 0.19, i.e. the hypothesis H_0 about the heteroscedasticity of the residuals (1) is rejected, the residuals have constant variance.

Heteroskedasticity Test: White

F-statistic	2.783580	Prob. F(9,5)	0.1360
Obs*R-squared	12.50434	Prob. Chi-Square(9)	0.1863
Scaled explained SS	4.238903	Prob. Chi-Square(9)	0.8950

Fig. 5. White test for the model (1)

The Durbin–Watson statistic (DW=1.82) shows the absence of autocorrelation of the residuals and the adequacy of the model (Fig. 2). The upper bound of the DW statistics (d_u<1.82<4-d_u) is 1.46 at 1% significance level with 3 regressors and n = 15, and less than 2 (1.46<1.82<4-1.46), therefore, there is no autocorrelation of residuals (r≈0).

Thus, the model (1) is adequate and can be used to forecast Y^(R_D) for the short term.

It was noted during the study of the parameters and their estimates (Prob and T-stat) for building the exponential equation that the model is not adequate (Fig. 6). Therefore, this model cannot be used for research and forecast.

Dependent Variable: LOG(R_D)
Method: Least Squares
Date: 11/29/20 Time: 14:56
Sample: 2005 2019
Included observations: 15

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(CAP)	-1.175301	0.529681	-2.218883	0.0485
LOG(NATUR)	0.371590	0.553965	0.670783	0.5162
LOG(REV)	0.781568	0.619953	1.260688	0.2335
C	4.703603	5.008943	0.939041	0.3679

R-squared	0.818370	Mean dependent var	2.433209
Adjusted R-squared	0.768834	S.D. dependent var	0.978765
S.E. of regression	0.470587	Akaike info criterion	1.553508
Sum squared resid	2.435976	Schwarz criterion	1.742321
Log likelihood	-7.651309	Hannan-Quinn criter.	1.551497
F-statistic	16.52088	Durbin-Watson stat	0.534363
Prob(F-statistic)	0.000219		

Fig. 6. The coefficients and estimates of the nonlinear equation

4 Results

It was found during the consideration of the actual Y*i*(R_D) and fitted Y*i*^(R_D) values (*i*=1,...,15) for 2005-2019 that these indicators on average slightly differ from each other. According to the annual reports of PJSC ROSNEFT [13-15] Y(R_D) = 5.58 billion rubles, Y^(R_D) = 5.9 billion rubles in 2005, Y(R_D) = 32.1 billion rubles, Y^(R_D) = 31.4 billion rubles in 2018, Y(R_D) = 30 billion rubles, Y^(R_D) = 31.6 billion rubles in 2020.

It is possible to check the correctness of the constructed linear model (1) according to the PJSC ROSNEFT report for 2020, which will be received and refined only in March 2021.

5 Conclusions

PJSC ROSNEFT presented the corporation's Sustainable Development Program [2-3, 13] in April 2019. The company plans to continue its course towards sustainable and innovative development, to develop projects for environmental protection.

PJSC ROSNEFT cleared a profit of 708 billion rubles according to the reports of 2019 [18-20] (the profit of 649 billion rubles in 2018, the dividend amount of 274.5 billion rubles). Sales revenue increased by 5.3% to 8,676 billion rubles.

The financial performance of PJSC ROSNEFT was expected to continue to grow in 2020–2022, and the dividend yield on equities would be around 10%. However, the crisis due to COVID-19, the global decline in energy demand, cut in OPEC oil production, the partial loss of the Belarusian oil market, the termination of the corporation's participation in Venezuela projects, etc. led to significant financial losses for PJSC ROSNEFT for all the indicators in 2020.

If the consolidated financial performance of PJSC ROSNEFT for Q3 2019 is compared with that for 2020 [16], it can be noted that sales proceeds and income decreased by 37.8%, net profit fell by 3 times, capital costs was down by 17.1%, etc. This trend has been observed in all Russian oil and gas companies. According to the forecasts of the consulting company McKinsey&Company, Russia's GDP will decline by 3.8% at best and 10.2% at worst in 2020.

The pandemic, oil and gas «wars», geopolitical contradictions have significantly reduced the rate of economic growth of PJSC ROSNEFT. The corporation will have to

adjust its Programs for Sustainable and Innovative Development in order to keep costs down, stop income crash and return to at least the previous level of development [2-3, 5, 7, 9, 21].

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