Casual analysis of financial and operational risks of oil and gas companies in condition of emergent economy

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Abstract. The need to control the risk that accompanies businesses in their day-to-day operations, and at the same time changing economic conditions make risk management an almost indispensable element of economic life. Selection of the main aspects of the selected phases of the risk management process: risk identification and risk assessment are related to their direct relationship with the subject matter (risk identification to be managed; risk analysis leading to the establishment of a risk hierarchy, and, consequently, the definition of risk control' methods) and its purpose (bringing the risk to acceptable level). It is impossible to identify the basic patterns of development of the oil and gas industry without exploring the relationship between economic processes and enterprise risks. The latter are subject to simulation, and based on models it is possible to determine with certain probability whether there have been qualitative and quantitative changes in the processes, in their mutual influence on each other, etc. The work is devoted to exploring the possibilities of applying the Granger test to examine the causal relationship between the risks and obligations of oil and gas companies. The analysis is based on statistical tests and the use of linear regression models.

Keywords: risk, risk identification, casual analysis, causality.

1 Introduction

One of the most important factors that accompany any business activity, including production and commercial activity, is risk. This is because every business operates in a volatile and uncertain environment, in which unforeseen events can occur. Currently, many businesses manage risk by using an early warning system that allows early detection of the threat and initiation of appropriate corrective processes. For businesses, this is a signal to take action to improve the situation [9]. Today, risk is associated with every decision, whether operational, investment or financial. The planning's nature shows that the predicted future values of the variables taken into account are not certain but only probable. Different quantitative parameters assume values only under certain assumptions. The need to monitor risk performance is an indispensable element in achieving the objective of business entities, as the entity, as a market-oriented, earnings-oriented entity, is subject to any management and casual events. Risks that threaten the capital used by the owner or owners mean that the costs associated with realizing that risk, unless they can be transferred to someone else, are borne by the enterprise. Therefore, for the continuity of the company, it is crucial to determine the impact of the adverse event of a casual event on the value of assets and to take appropriate measures to transfer this burden to other entities.

The processes occurring in the operations of oil and gas companies are related to the various forms, frequency and nature of the risks involved and necessitate the study of their cause and effect relationships. Given that risk is an integral part of business entities and a necessary element of economic decision making, the risk of which increases significantly in the conditions of dynamism and instability of the business environment, there is a need to consider risk as an object of managerial influence and its complex analysis.

The purpose of the article is to present the role of identification and measurement of financial risk in the process of managing enterprises of the oil and gas industry by establishing interdependencies between its elements.

2 Background

Risk research has recently received considerable attention. A lot of work is devoted to examining the role and importance of risk for practice. The main issues of the theory and practice of economic risk assessment are outlined in the works of Mohamed Abdel-Basset [1], Bamikole Amigun [2], Vanessa E. Daniel [5], Luca Salvati [32], Qianqian Zhou [35] and others. A wide range of issues related to risk assessment and forecasting are investigated by Olga O. Degtiareva [6], Oleh G. Dzoba [3], Iryna Yu. Ivchenko [12], Oleh Ye. Kuzmin [17; 18], Valentyna V. Lukianova [19], Nazar Yu. Podolchak [31], Liliia I. Rishchuk [25], O. V. Shcherbak [33], Halyna I. Velikoivanenko [21], Valdemar V. Vitlinskyi [4] and others. It is worth noting that most scientists in their scientific work focus on the study of classical methods of risk assessment, while the latest methods, which are the most promising for the functioning of enterprises in a dynamic business environment, remain underutilized.

One of the methods to reduce the risk of an enterprise is its insurance [16]. This method of risk management must be considered in conjunction with other methods of risk diversification. For optimal risk management at an enterprise it is necessary to use portfolio theory [24]. Economic, financial and other parameters of the enterprise's operation act as constraints, and minimization of the enterprise's risk can be used as an optimization criterion.

For the analysis of financial and economic sustainability of the enterprises are used as classical statistical modeling techniques and advanced mathematical tools such as fractal analysis [20] as well as the methods of artificial intelligence [14; 22].

To predict financial time series, artificial intelligence tools are often used, which include as machine learning methods [7; 15].

The works [8; 34] are devoted to a comparative analysis of the complexity of traditional stock indices and social responsibility indices using the example of Dow Jones Sustainability Indices and Dow Jones Industrial Average and opens up new opportunities for investor risk management. A scientific approach to risk assessment taking into account the manifestation of emergent properties and using the method of taxonomy and factor analysis for oil and gas companies is proposed in [13].

In [11], an approach is proposed for assessing the financial efficiency of a business model of an industrial enterprise, where the integral indicator of the financial components of a business model is modeled using the method of fuzzy sets and taxonomic analysis, which will help to more objectively assess the level of financial standing of an industrial enterprise.

3 Methodology

The oil and gas industry of Ukraine is one of the most important components of the fuel and energy complex, but the needs of the domestic economy in oil and gas are only partially met at the expense of its own production. This issue is becoming increasingly relevant today. In order to increase the economic potential of oil and gas companies, it is necessary to infuse investment resources. However, the instability of tax legislation is one of the most significant shortcomings of Ukraine's current tax system, which deter investors. Inconsistency in the application, interpretation and implementation of tax law can lead to litigation, which can ultimately lead to additional taxes, penalties and penalties, and these amounts can be significant. All the above clearly indicates that the oil and gas companies of Ukraine operate in an emergent economy and this fact largely determines the high relevance of our study.

In the ordinary course of business, certain claims are raised against oil and gas companies. If the risk of an outflow of financial resources related to such claims is considered probable, a liability is recognized in the provisions for litigation. If management estimates that the risk of an outflow of financial resources related to such claims is probable or the amount of expenses cannot be estimated reliably, the provision is not recognized and the corresponding amount disclosed in the consolidated financial statements.

There is a claim between businesses and some natural gas suppliers about the volume or prices of the natural gas being supplied and other claims. Management estimates its potential liabilities for such claims at UAH 5890 million (2016: UAH 1380 million; 2017: UAH 3928 million; 2018: UAH 4246 million) [29; 28; 30; 27; 26]. Management cannot reliably estimate the amount of potential losses on these liabilities, if any.

The activities of the oil and gas industry are characterized by a number of financial risks: market risk (including foreign exchange and interest rate risk), concentration risk, credit risk and liquidity risk. Management reviews and aligns its risk management policies to minimize the adverse impact of these risks on the Group's financial performance.

The main categories of financial instruments are presented by structure of financial assets and financial liabilities.

Market risk. Market risks arise from open positions in (a) foreign currencies, (b) interest-bearing assets and liabilities, and (c) investments, all of which are affected by general and specific market changes in condition of emergent economy.

Currency risk. Oil and gas companies operate in Ukraine, and their dependence on foreign exchange risk is mainly determined by the need to purchase natural gas from foreign suppliers, which is denominated in US dollars. The Group also receives foreign currency loans and does not hedge its foreign currency positions.

Dependence on currency risk is presented on the basis of the carrying amount of the respective currency assets and liabilities.

Table 1 provides information on the sensitivity of profit or loss to reasonably possible changes in the exchange rates applied at the reporting date, provided that all other variables remain stable. The risk was calculated only for monetary denominations denominated in currencies other than the functional currency.

Table 1. Profit or loss sensitivity to reasonably possible changes in exchange rates [29; 28; 30; 27; 26]

In millions of Ukrainian Hryvnias	December 31, 2019	December 31, 2018	December 31, 2017	December 31, 2016
US dollar Strengthening by 10%	(2540)	(2865)	(3 400)	(4 957)
US dollar weakening by 10%	2540	2865	3 400	4 957
Euro Strengthening by 10%	225	239	251	299
Euro weakening by 10%	(225)	(239)	(251)	(299)

Granger causality is applied to components of a stationary vector random process. At the heart of the definition is a well-known postulate that the future cannot affect the past.

The essence of the Granger test is that the variable x is causal for the variable y, that is, under the influence of $x \rightarrow y$ changes of x must precede changes of y, not vice versa. Therefore, under the above conditions, it is necessary that the following actions be performed at the same time: the variable x makes a significant contribution to the forecast of y, while the variable does not significantly contribute to the forecast of the variable x [10]. To determine whether x is the cause of y, determine what proportion of the variance of the current value of variable y can be explained by past values of the variable y itself, and whether adding past values of variable x can increase the proportion of explanatory variance. The variable x is the cause of y if x contributes to the prediction of y. In the regression analysis, the variable x will be the cause of y when the coefficients at logs x are statistically significant, but the most commonly investigated cause and effect relationships are two-sided. In other words, the variable x_t is not a Granger cause for the variable u_t if excluding from the model information about the past values of the variable x_t does not impair the predicted value of u_t when used to construct models of both time series. The quality of the forecast in this case is estimated by the standard error. The scheme of model analysis for the presence and direction of causality is shown in figure 1.

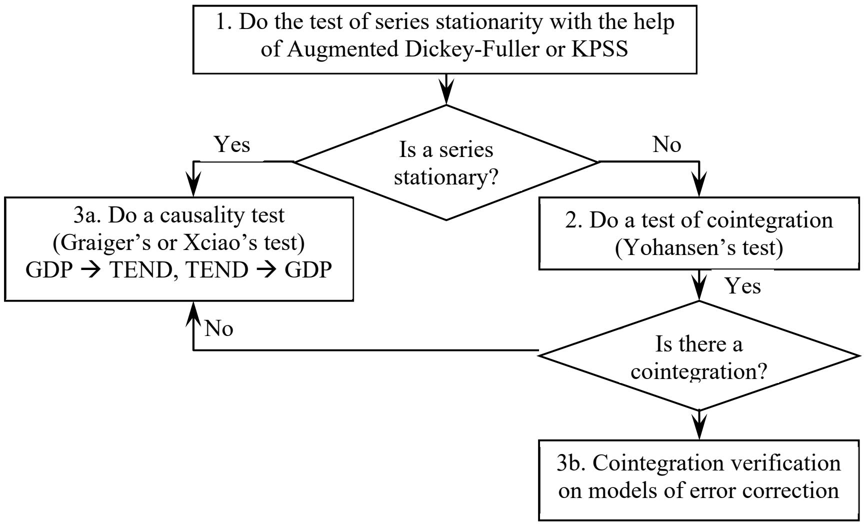


Fig. 1. The scheme of analysis of the model for the presence and direction of causality

To perform this test, three indicators were selected for six NGSUs and Ukrnafa Public Joint-Stock Company (PJSC) for the six months 2016-2019. These include financial risk, operational risk, and contingent and contractual commitments under Chernihivnaftogaz, Poltavanaftogaz, Okhtyrkanaftogaz, Dolynaftogaz, Borislavnaftogaz, Nadvirnaftogaz and Ukrnafa PJSC. Causality testing involves the use of stationary time series. Stationarity is verified in Eviews software, which automatically calculates the required metrics. The functionality of the program proposes to use the Dickey-Fuller and Phillips-Perron test to check the stationarity of a number of selected indicators.

The Dickey-Fuller test is based on the estimation of the parameter $\lambda = \alpha_1 - 1$ of the equation $\Delta Y_t = \lambda Y_{t-1} + \varepsilon_t$, equivalent to the autoregression equation. If the value of the Student's t-statistic for the parameter λ is less than the lower threshold of the DF-statistic, then the null hypothesis $\lambda = 0$ (about the presence of a single root $\alpha_1 = 1$) should be rejected and the alternative about the stationarity of the process Y_t should be accepted [23]. As a result of the Dickey-Fuller test, it was found that even at a significance level of 10%, the hypothesis of stationarity of series should be rejected. To bring the original variables to the stationary form, the transition to the analysis of the second differences of these series was performed. The calculations revealed that the hypothesis of stationarity of a series should be accepted (figure 2).

Null Hypothesis: D(X1,2) has a unit root			
Exogenous: None			
Lag Length: 0 (Automatic - based on SIC, maxlag=1)			
		t-Statistic	Prob.
Augmented Dickey-Fuller test statistic		-3.3939	0.0067
Test critical values:	1% level	-3.1095	
	5% level	-2.0439	
	10% level	-1.5973	
Null Hypothesis: D(X2,2) has a unit root			
Exogenous: None			
Lag Length: 1 (Automatic - based on SIC, maxlag=1)			
		t-Statistic	Prob.
Augmented Dickey-Fuller test statistic		-2.402	0.0319
Test critical values:	1% level	-3.271	
	5% level	-2.082	
	10% level	-1.599	
Null Hypothesis: D(X3,2) has a unit root			
Exogenous: None			
Lag Length: 1 (Automatic - based on SIC, maxlag=1)			
		t-Statistic	Prob.
Augmented Dickey-Fuller test statistic		-4.072	0.0042
Test critical values:	1% level	-3.271	
	5% level	-2.082	
	10% level	-1.599	

Fig. 2. Investigation into the stationarity of the second series differences using the Dickey-Fuller test (series X1 – Financial risk, series X2 – Operational risk, series X3 – Contingent and contractual obligations (Ukrnafta PJSC))

However, there are other tests to check the series for stationarity. Given that the random components of the ADF test can be autocorrelated, have different variances (i.e., heteroskedasticity may be present) and not necessarily normal distributions, compared to the ADF test, the Phillips-Perron test can be used to consider wider classes time series.

Conducting the Phillips-Perron test, which is also present in the Eviews software, shows the same results: the investigated series are non-stationary and the other series differences are stationary (figure 3).

Null Hypothesis: D(X1,2) has a unit root Exogenous: Constant Bandwidth: 4 (Newey-West automatic) using Bartlett kernel			
		Adj. t-Stat	Prob
Phillips-Perron test statistic		-6.614176	0.0049
Test critical values:	1% level	-5.604618	
	5% level	-3.694851	
	10% level	-2.982813	

Null Hypothesis: D(X2,2) has a unit root Exogenous: Constant Bandwidth: 4 (Newey-West automatic) using Bartlett kernel			
		Adj. t-Stat	Prob
Phillips-Perron test statistic		-4.209688	0.0315
Test critical values:	1% level	-5.604618	
	5% level	-3.694851	
	10% level	-2.982813	

Null Hypothesis: D(X3,2) has a unit root Exogenous: Constant Bandwidth: 4 (Newey-West automatic) using Bartlett kernel			
		Adj. t-Stat	Prob
Phillips-Perron test statistic		-4.103371	0.0346
Test critical values:	1% level	-5.604618	
	5% level	-3.694851	
	10% level	-2.982813	

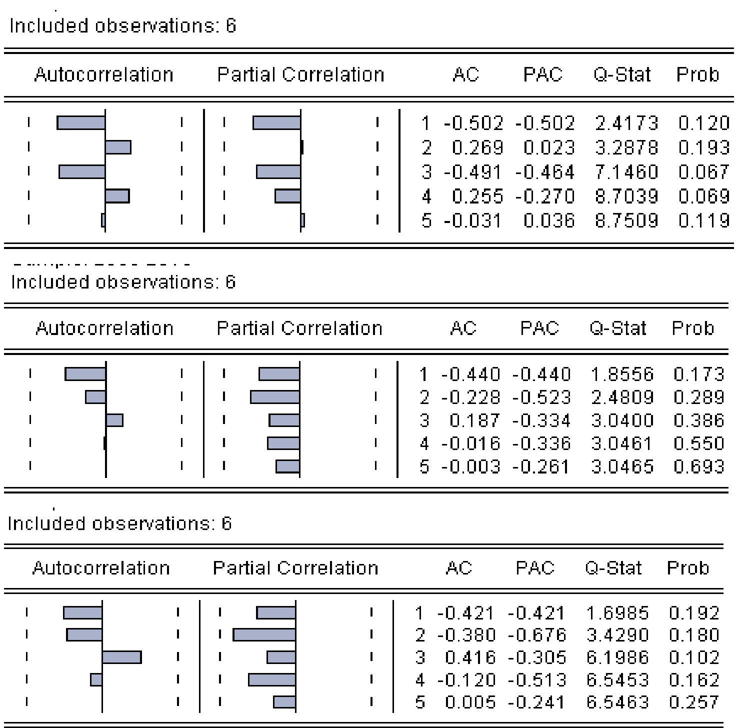
Fig. 3. Investigation into the stationarity of the second series differences using the Phillips-Perron test (series X1 – Financial risk, series X2 – Operational risk, series X3 – Contingent and contractual obligations (Ukrnafta PJSC))

The results obtained by the ADF test can also be verified by visual analysis of the autocorrelogram and partial autocorrelogram (figure 4).

Let's do a Granger causality test. The length of lag p should be chosen from the longest lag, which can still help in predicting. Analysis of the cross correlograms indicates the choice of $p = 2$. In addition, it is confirmed by the well-known rule that the number of lags should not exceed the number of observations divided by 4. Consider the Granger causality for two variables. The model form below is:

$$E_d = \sum_{i=1}^{n} e_{ij} \tag{1}$$

$$E_d = \sum_{i=1}^{n} e_{ij} \tag{2}$$



a) b) c)

Fig. 4. Self-correlates of the second time series differences: a) Financial risk, b) Operational risk, c) Contingent and contractual obligations (Ukrnafta PJSC)

The absence of a causal relationship from *x* to *y* means that when $c_j = 0$ at $j = 1, ..., p$ that is, past values of *x* do not affect *y*. The absence of causality from y to x means that $b_j = 0$ at $j = 1, ..., p$.

When the process is stationary, then hypotheses about causality can be tested using F-statistics. The null hypothesis is that one variable is not a Granger cause for another variable.

The results of the test are presented in table 2. Recall that the hypothesis about the causality of this factor is accepted (and the null hypothesis, respectively, is rejected) at a probability of less than 0.05, with a probability greater than 0.05 is accepted null hypothesis.

Table 2. Granger test results

Company	Indicator		
	Financial risk (X1)	**Operational risk (X2)**	**Contingent and contractual obligations (X3)**
Chernihivnaftogaz	The hypothesis is accepted	The hypothesis is accepted	The hypothesis is accepted
Nadvirnaftogaz	The hypothesis is accepted	The hypothesis is rejected (X2→X3)	The hypothesis is accepted
Borislavnaftogaz	The hypothesis is accepted	The hypothesis is accepted	The hypothesis is accepted
Poltavanaftogaz	The hypothesis is accepted	The hypothesis is accepted	The hypothesis is accepted
Dolinanaftogaz	The hypothesis is accepted	The hypothesis is accepted	The hypothesis is rejected (X3→X1)
Okhtyrkanaftogaz	The hypothesis is rejected (X1→X2)	The hypothesis is accepted	The hypothesis is accepted
Ukrnafta	The hypothesis is accepted	The hypothesis is accepted	The hypothesis is accepted

As a result of the causal analysis, it was found that the change in operational risk at Nadvirnanaftogaz is the cause of contingent and contractual obligations, but not vice versa; at Dolynaftogaz a number of contingent and contractual dynamics are the cause of a number of financial risks for Granger; at Okhtyrkanaftogaz financial risk is the cause of operational risk, and the connection is also one-sided. Other hypotheses regarding causality are not accepted.

4 Results

Effective and integrated risk management requires the integration of risk management into the enterprise management process. The market economy creates both opportunities to achieve planned profits, as well as the risk of losses due to adverse changes in the environment of the company and mistakes within the organization.

Many methods and approaches to the risk management process indicate that an important aspect of the company is to look for optimal solutions to existing threats. Decisions on this issue should be taken as a result of the risk management process, in which the placement and awareness of the importance of the risk that threatens the company become a very important starting point.

Risk identification and measurement are important here because they determine the choice of risk control method, which means specific decisions and financial costs. In assessing this, particular attention should be paid to the importance of contingent and contractual obligations, which often go unnoticed and neglected, and omissions of which can be significant.

The obtained results allow us to adjust the policy of activity of oil and gas enterprises for 2 years in advance (lag length) depending on the risks involved and the peculiarities of the socio-economic status of the territories.

The scientific novelty of the study is to formalize the areas of relationships between the risk of oil and gas companies and its elements on the basis of testing by the Granger method. Using the results of the proposed testing allows to determine the direction of causal links between financial risk, which depends on currency risk, that is determined by the need to purchase natural gas from foreign suppliers, operational risk of concentration on revenues from gas transportation and trade payables, as well as contingent and contractual obligations that pose the risk that one party to a financial instrument will cause a financial loss to the other party as a result of a default. This contributes to the definition and coordination of risk management policies to minimize their negative impact on the financial performance of oil and gas companies.

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