

**Błażej Lepczyński,
Małgorzata Siemionek-Ruskań,
Mariusz Chmielewski,
Joanna Pioch**

THE IMPACT OF THE PANDEMIC AND WAR CRISES ON THE FINANCIAL RISK OF ENERGY SECTOR COMPANIES IN POLAND

Abstract

The article analyzes the impact of the pandemic and war crises on the risk of selected energy sector companies in Poland listed on the Warsaw Stock Exchange and listed in the WIG-Energy. The main research concerns the COVID-19 pandemic and the war in Ukraine, both of which had a significant impact on the energy market. The analysis uses both traditional financial analysis metrics used to assess risk in companies and a multivariate comparative analysis methodology. The research covers the period 2019–2023, assessing changes in debt service capacity, leverage, liquidity and return on sales. The results indicate high financial risk, however, with a downward trend over the analyzed period. However, the impact of external factors (pandemics and war) was not clear for all entities. Operational, financial and structural indicators were analyzed, indicating the varying impact of crises on individual companies. The analysis indicates that the indicated crises did not have a uniformly negative impact, and the methods used allowed for a comprehensive risk assessment. The results obtained during the analysis can be useful to decision-makers and managers in better preparing for future unforeseen events, and should be the basis for investigating the reasons for the diverse impact of events in the economic environment on the level of risk in the analyzed entities.

Keywords: enterprise risk, financial crisis, pandemic crisis, energy sector, multivariate analysis.

WPŁYW PANDEMII I KRYZYSU WOJENNEGO NA RYZYKO FINANSOWE SPÓŁEK SEKTORA ENERGETYCZNEGO W POLSCE

Streszczenie

Artykuł analizuje wpływ kryzysu pandemicznego i wojennego na ryzyko finansowe wybranych przedsiębiorstw sektora energetycznego w Polsce, notowanych na Giełdzie Papierów Wartościowych w Warszawie i notowanych w WIG-Energia. Główne badania dotyczą pandemii COVID-19 oraz wojny na Ukrainie, które wywarły znaczący wpływ na rynek energii. W analizie zastosowano zarówno tradycyjne mierniki z zakresu analizy finansowej, wykorzystywane do oceny ryzyka w przedsiębiorstwach, jak i metodologię wielowymiarowej analizy porównawczej. Badania obejmują lata 2019–2023, oceniając zmiany w zdolności do obsługi długu, poziomie dźwigni finansowej, płynności i rentowności sprzedaży. Wyniki wskazują na wyso-



kie ryzyko finansowe, jednakże z tendencją spadkową w analizowanym okresie. Jednak wpływ czynników zewnętrznych (pandemii i wojny) nie był jednoznaczny dla wszystkich podmiotów. Wskaźniki operacyjne, finansowe oraz strukturalne były analizowane, wskazując na zróżnicowany wpływ kryzysów na poszczególne spółki. Przeprowadzona analiza wskazuje, że wskazane kryzysy nie miały jednolicie negatywnego wpływu, a zastosowane metody pozwoliły na kompleksową ocenę ryzyka. Otrzymane w trakcie analizy wyniki mogą być użyteczne dla decydentów i menedżerów w lepszym przygotowaniu się na przyszłe nieprzewidziane wydarzenia oraz powinny być podstawą do zbadania przyczyn różnorodnego wpływu zdarzeń z otoczenia gospodarczego na poziom ryzyka w analizowanych podmiotach.

Słowa kluczowe: ryzyko w przedsiębiorstwie, kryzys finansowy, kryzys pandemiczny, sektor energetyczny, analiza wielowymiarowa.

Introduction

In recent years, energy companies in Poland have faced exceptionally challenging situations resulting from the global pandemic and war crises. The COVID-19 pandemic, which began in the first quarter of 2020, caused significant disruptions in supply and demand and forced governments to implement various forms of support for businesses. Conversely, the armed conflict in Ukraine, which erupted in the first quarter of 2022, led to an increase in energy prices and a deterioration in economic stability. This article attempts to assess how these external crisis factors have impacted the level of financial risk in energy companies. The analysis aims to understand changes in debt service capacity, the level of financial leverage, and the liquidity of these companies from 2019 to the first half of 2023. The study's results may provide valuable insights for decision-makers and managers in the energy sector, enabling better preparation for future unforeseen events.

To determine the extent of this impact, two approaches were applied. The first approach is based on the analysis of selected financial indicators used to assess risk levels, such as financial leverage, current liquidity, and sales profitability. The second approach relies on multivariate comparative analysis using synthetic financial indicators that allow for a comprehensive assessment of risk. The conducted analysis aims to indicate the influence of external events on the risk levels in the analyzed energy companies. This analysis covers the period from 2019 to the first half of 2023 and aims to provide valuable insights for decision-makers and managers in the energy sector, enabling better preparation for future unforeseen events. The study's results may also contribute to a better understanding of risk dynamics in the context of sudden economic changes.

Literature review

Changes in any economy are cyclical, and crisis is an inherent feature of a market economy¹. After a period of prosperity due to changing conditions in the environment, there is a period of marked deterioration in the key financial parameters of enterprises. It should be noted that the crisis affects various industries operating in the economy to different degrees and at different times. The reasons for the appearance of the crisis can be diverse and depend on the industry in which the entity operates. In the literature one can find four main groups of causes of crises: financial². According to Nobel laureate Shiller, crises are usually the result of inappropriate financial behaviour and excessive speculation³. During periods of growth, people pay less attention to risk, which can consequently lead to disastrous consequences. However, recent crises that significantly affected companies (the 2020 pandemic crisis and the 2022 war crisis) from various industries were due to global causes.

Neuhauser investigated the reasons for the global financial crisis, which took place in 2007–2009 period, its effects on different aspects of the financial system, and the effectiveness of regulatory measures undertaken to rebuild the financial system. The main causes were a housing bubble that was driven in part by boosted subprime lending and an OTD lending model that depended severely upon the ability of originators to securitize loans and a failure by the credit rating agencies to correctly evaluate the risk of mortgage-backed securities⁴. Blum and Raviv conducted a textual analysis of the effects of the financial crisis and Basel III on the content of the financial reports of banks in Israel. The authors found that the reports focused on the new regulations of leverage and liquidity coverage ratios, while ignoring market risk and value at risk methods⁵.

¹ Friedman M., *Kapitalizm i wolność*, Onepress, Warszawa 2022, p. 25; Stiglitz J.E., *Freefall: America, Free Markets, and the Sinking of the World Economy*, W.W. Norton, 2010, p. 56.

² Bouvatier V., *Częstotliwość kryzysów bankowych w dynamicznym otoczeniu: podejście oparte na czasie dyskretnym*, „Oxford Economic Papers” 2017, 69(4), 1078–1100. <https://www.jstor.org/stable/48691504>.p. 1078–1100; Schiller R.J., *Irrational Exuberance*, Princeton University Press, Princeton 2016, p. 86; Todaro M.P., Smith S.C., *Economic Development*, E-book Pearson, 2020; Klein M.C., *Trade Wars Are Class Wars: How Rising Inequality Distorts the Global Economy and Threatens International Peace*, Yale University Press, 2021, p. 43.

³ Schiller R.J., *Irrational Exuberance*, Princeton University Press, Princeton 2016, p. 58.

⁴ Neuhauser K.L., *The Global Financial Crisis: what have we learned so far?*, “International Journal of Managerial Finance” 2015, 11(2), doi: 10.1108/IJMF-02-2015-0014.

⁵ Blum A., Raviv A., *The effects of the financial crisis and Basel III on banks’ risk disclosure: A textual analysis*, „Finance Research Letters” 2023, 53, doi: 10.1016/j.frl.2023.103680.

The research conducted by Mensi, Hanif and others examined the effects of the pandemic outbreak, recent oil price fall, and both global and European financial crises on dependence structure and asymmetric risk spillovers between crude oil and stock sectors in China. They found out that the risk spillovers from sectors to oil are considerably larger than those from oil to sectors during pandemic⁶. Studies conducted by Lei, Aziz and other indicated that after pandemic and the Russian–Ukraine war, investors should purchase oil assets to hedge their portfolios against the ensuing any disaster. Their study was based on the data between 2001 and 2022 having into consideration the link between the volatility of the Karachi Stock Exchange and West Texas Intermediate. They demonstrated that “lagged volatility, rather than lagged shocks, is a better predictor of market volatility for the future”⁷.

Verberi, Volz and Sugoza conducted a study to analyze the link between capital account liberalization and economic growth throughout the 2008 global crisis in 105 countries, incorporating moral hazard. The authors looked at the link concerning capital account liberalization and economic growth. The authors found that “capital inflows encourage growth, with portfolio equity flows having more contribution and stability than portfolio debt flows”. They pointed out the excessive risk-taking behavior of financial institutions led to the above mentioned crisis, while credit expansion and capital accumulation alone have a positive impact on economic growth⁸.

Willet in his article pinpointed guidelines for everybody interested in finding out about the causes and results of the crisis and what lessons we can take for the future. From his perspective we should focus on the “imperfections in the operation of both markets and governments, drawing on insights from behavioral and neuro economics and finance and political economy analysis”. Furthermore, financial decision makers should pay more attention to macroeconomic analysis and financial risk analysis needs when they make their economic choices⁹.

Wu, Shen and others in their study compared banks' performance under shareholder orientated and stakeholder orientated governance models during and

⁶ Mensi W., Hanif W., Vo X., Choi K., Yoooun S., *Upside/Downside spillovers between oil and Chinese stock sectors: From the global financial crisis to global pandemic*, “North American Journal of Economics and Finance” 2023, doi: 10.1016/j.najef.2023.101925.

⁷ Lei L., Aziz G., Sawrawr S., Waheed R., Tiwari A., *Spillover and portfolio analysis for oil and stock market: A new insight across financial crisis, COVID-19 and Russian-Ukraine war*, “Resources Policy” 2023, 85, doi: 10.1016/j.resourpol.2023.103645.

⁸ Verberi C., Yasar S., Sugoza I.H., *Capital liberalization, growth and moral hazard: Lessons from the global financial crisis*, “International Review of Financial Analysis” 2023, 90, doi: 10.1016/j.irfa.2023.102901.

⁹ Willet T., *Some lessons for economists from the financial crisis*, „Indian Growth and Development Review” 2010, 3, doi: 10.1108/17538251011084482.

before the 2008 crisis on the sample of 84 big and 21 medium banks. Authors created a stakeholder-friendly index and compare it to a shareholder-friendly index to analyze their relations with banks' profits and risks in selected time frame¹⁰.

Risk is understood as "uncertainty concerning the occurrence of a loss"¹¹. Financial Risk refers to "the uncertainty of loss because of adverse changes in commodity prices, interest rates, foreign exchange rates, and the value of money"¹². There are many risks in business operations. There are basic financial risks such as market risk, operational risk, liquidity risk, credit risk, legal risk, business risk. In specific the cases of certain companies there are sector-specific risks¹³.

Moore, Felton and Wright examined the link between the political orientation of investors and their financial risk tolerance on a group of 129 undergraduates at Central Michigan University during one academic year. They found out that financial risk tolerance was higher for the group with more conservative economic political views and the same can be noticed for those with more centrist social political views¹⁴.

Consumers' financial risk-taking attitude plays a significant role on making their financial decisions. People have two options, in terms of the risk, when they make their economic decisions. They can be characterized as "those who tolerate risk (risk-takers) or those who avoid risk (risk-averse)"¹⁵.

Schularick and Taylor found that the "global crisis was preceded by excessive financial risk taking by banks, in particular with regard to home mortgage loans"¹⁶. Jansson and others conducted a study on banks' risk taking in credit decisions. They discovered that "loan officers' credit risk taking is associated with bank-contextual factors, directly with perceived organizational credit risk

¹⁰ Wu M., Shen C., Hsu H., Chiu P., *Why did a bank with good governance perform worse during the financial crisis? The views of shareholder and stakeholder orientations*, "Pacific-Basin Finance Journal" 2023, 82, doi:10.1016/j.pacfin.2023.102127.

¹¹ Rejda G., Macnamara M., *Principles of risk management and insurance*, Pearson, Global edition, 2016, p. 39–45.

¹² Ibidem.

¹³ Jajuga K., *Zarządzanie ryzykiem*, PWN, Warszawa 2007.

¹⁴ Moore J., Felton J. and Wright C., *The Influence of Political Orientation on Financial Risk Taking*, "American Journal of Business" 2010, Vol. 1(25), doi:10.1108/19355181201000003.

¹⁵ Tahir M., Richard D., Ahmed A., *The role of financial risk-taking attitude in personal finances and consumer satisfaction: evidence from Australia*, "International Journal of Bank Marketing" 2020, 41 (4), doi: 10.1108/IJBM-09-2022-0431.

¹⁶ Schularick M., Taylor A., *Credit booms gone bust: monetary policy, leverage cycles and financial crisis*, "American Economic Review" 2009, Vol. 102 No. 2.

norms and indirectly with self-confidence in assessing credit risks through attitude to credit risk taking”¹⁷.

Haque and Varghese investigated the interconnected relationships between the choice of leverage, growth expectation, firm risk and default probability in the situation of Covid- 19 crisis¹⁸. The first objective of their research was to calculate the financial risk by determining a causal liquidity channel during the COVID-19. The research group was publicly-held active firms in the period from 1st of January 2018 to end of December 2020. The results indicated that companies “with large share of long term debt maturing in the post-COVID sample reduced leverage by approximately 4 percentage points more than less-exposed firms”¹⁹. Clemente-Almendros, Boldeanu, Segui-Amortegui investigated the impact of COVID-19 on listed European electricity companies from both sectors renewable and traditional one. The authors noticed a larger impact of COVID-19 announcement for renewable companies due to their riskier investment profile, rather than traditional ones. On the other side, they found out that after the national lockdowns were put in action, the recovery in the financial markets return was smaller for renewable companies²⁰.

Solopova, Karpovich and others examined major risk- forming factors for the energy sector.²¹ In terms of macro level, the authors identified following types of financial risk: currency fluctuations, inflation, change in the refinancing rate, tightening of the tax system, insolvency of counterparties, portfolio risk and financial losses from investment activities . In terms of micro level, they indicated as internal financial risks such as: ineffective distribution of financial flows within the corporate structure, loss of liquidity, an increase in the volume of net debt, transactional risk and wrong choice of object for investment²². Based on the expert ranking it can be noticed that “financial and political risk increase the negative dynamics of the market”²³. One of the areas of the literature to which this study is linked is the study of enterprises using synthetic measures or, more broadly, methods of multivariate comparative analysis.

¹⁷ Jansson M., Roos M., Garling T., *Banks’ risk taking in credit decisions: influences of loan officers’ personality traits and financial risk preference versus bank-contextual factors*, “Managerial Finance” 2022, 79 (8), doi: 0.1108/MF-10-2021-0487.

¹⁸ Haque S.M., Varghese R., *The Covid-19 Impact on Corporate Leverage and Financial Fragility*, “International Monetary Fund” 2021, 265.

¹⁹ Ibidem.

²⁰ Clemente-Almendros J.S., Boldeanu F.D., Segui-Amortegui L.A., *Impact of COVID-19 on listed European electricity companies: a comparative analysis of investment in renewable and traditional electricity*, “Journal of Economic Studies” 2022, Vol. 49, doi 10.1108/JES-09-2021-0448.

²¹ Solopova N., Karpovich O., Minnullina A., Minnullin A., *Assessment of the impact of risks of energy companies in a pandemic*, E3 web of Conferences. 217 <https://doi.org/10.1051/e3sconf/202021707002>. 2020.

²² Ibidem.

²³ Ibidem.

A review of the literature has identified a relatively large number of studies of companies that have used synthetic measures. Synthetic measures have been used in studies of the investment attractiveness of companies²⁴ and in assessing the financial condition of companies including multidimensional fundamental analysis of companies²⁵.

In the literature, financial risk is variously defined by several authors. Frank J. Fabozzi defines financial risk as the uncertainty regarding future returns and the possibility that outcomes will significantly differ from what investors expect²⁶. Financial risk can arise as a consequence of various causes, including changes in asset prices, interest rates, and other market factors. A narrower definition of financial risk was provided by A. Damodaran, who indicates that it is associated with the uncertainty of future financial results or liquidity of an entity resulting from the uncertainty regarding cash flows and their value²⁷. According to J.C. Hull, financial risk is the probability of losses resulting from the inability to settle various financial obligations of the entity²⁸. Based on such definitions, the following types of financial risk are presented in the literature:

1. Market risk – the risk of losses resulting from market changes, such as changes in asset prices, interest rates, exchange rates, or commodity prices²⁹.
2. Credit risk – the risk that a counterparty will not fulfill its financial obligations³⁰.
3. Liquidity risk – the risk that an entity will not be able to meet its short-term financial obligations³¹.

²⁴ Dmitruk J., *Taksonomiczna miara atrakcyjności inwestowania (TMAI) na przykładzie spółek giełdowych*, „Zeszyty Naukowe SGGW - Ekonomika i Organizacja Gospodarki Żywnościowej” 2012, (99); Lisek S., Luty L., *Propozycja wskaźnika atrakcyjności inwestycyjnej przedsiębiorstwa*, „Wiadomości statystyczne” 2019, vol. 64.

²⁵ Skoczylas W., Batóg B., *Wykorzystanie taksonomicznego miernika rozwoju w ocenie sytuacji finansowej przedsiębiorstw*, „Prace Naukowe Uniwersytetu Wrocławskiego we Wrocławiu” 2017, nr 472; Bąk I., Szczecińska B., *Wykorzystanie analizy taksonomicznej do wyznaczania rankingu spółek sektora spożywczego notowanych na Giełdzie Papierów Wartościowych w Warszawie*, „Ekonometria” 2013, 4(42), Warszawa.

²⁶ Fabozzi F.J., *Handbook of Finance, Volume 1: Financial Markets and Instruments*, John Wiley & Sons, 2008, p. 87.

²⁷ Damodaran A., *Investment Valuation - Tools and Techniques for Determining the Value of any Asset*, University Edition, John Wiley & Sons Inc, 2012, p. 83.

²⁸ Hull J.C., *Zarządzanie ryzykiem instytucji finansowych*, PWN, Warszawa 2022, p. 25.

²⁹ Jorion P., *Value at Risk: The New Benchmark for Managing Financial Risk*, 3rd Edition, McGraw-Hill, 2006, p. 34.

³⁰ Hull J.C., *Options, Futures, and Other Derivatives*, 10th Edition, Pearson, 2017.

4. Operational risk – the risk of losses resulting from failures in internal processes, people, systems, or external events³².
5. Strategic risk – the risk related to decisions regarding the direction of the company's development³³.

All these types of financial risk are interrelated and result from both external environmental factors and the operational activities conducted by different companies. The level of financial risk in a given enterprise significantly impacts on its operations. The literature provides various tools for estimating the magnitude of financial risk within an economic entity. The most commonly used tools for estimating financial risk are financial analysis tools based on financial statement parameters and financial ratios. In the case of financial statements, various measures are used to analyze the structure of the entity's financing, using parameters from both the balance sheet and the income statement. The financial ratios most commonly used to measure the level of financial risk include liquidity ratios³⁴, debt and capital structure ratios³⁵, profitability ratios, earnings variability ratio, and financial leverage ratio³⁶. This study focuses mainly on the risk associated with liabilities arising from the use of external financing by the economic entity. This approach directly influenced the tools used to assess the magnitude of financial risk in the analyzed companies.

Research methods

In the first stage of the study, selected energy companies listed on the Warsaw Stock Exchange (6 companies: CEZ, Kogenera, PEP, Enea, PGE, Tauron) were examined in terms of operational and financial risk using selected financial indicators. According to the literature, the indicators directly related to the level of operational and financial risk chosen for this study were: degree of operating leverage, degree of financial leverage, the share of long-term liabilities in asset financing, current liquidity ratio, and profitability of sales revenue.

Financial risk for the purposes of this study is understood broadly in three fundamental dimensions: 1) financial stability of the enterprise; 2) solvency; 3) liquidity.

³¹ Armour J., Awrey D., Davies P., Enriques L., Gordon J.N., Mayer C., & Payne J., *Principles of Financial Regulation*, Oxford University Press, Oxford 2016, p. 132.

³² Hubbard D.W., *The Failure of Risk Management: Why It's Broken and How to Fix It*, Wiley, 2009, p. 49.

³³ Kaplan R.S., Norton D.P., *The Execution Premium: Linking Strategy to Operations for Competitive Advantage*, Harvard Business Press, 2008, p. 98.

³⁴ Gołębiowski G., Grycuk A., Tłaczała A., Wiśniewski P., *Financial Analysis of the Enterprise*, Difin, Warszawa 2020, p. 68.

³⁵ Sierpińska M., Jachna T., *Evaluation of the Enterprise According to World Standards*, PWN, Warszawa 1993, p. 48.

³⁶ Ibidem, p. 67.

The choice of the operating leverage indicator for the study was dictated by the fact that a too high level of this leverage increases the financial risk of the enterprise. High leverage causes even small fluctuations in sales to lead to significant changes in profit, which in turn could lead to the destabilization of the enterprise. The level of financial leverage is closely related to the risk of the enterprise's bankruptcy. The growing share of long-term liabilities in the structure of liabilities has a negative impact on financial risk. A too high share of debt in the structure of liabilities increases the risk of bankruptcy. The use of the profitability indicator is related to the fact that low profitability (especially if it lasts for an extended period) weakens the financial stability of the enterprise, its ability to repay debt, and negatively affects liquidity, limiting the ability to generate cash.

The values of the proposed risk assessment indicators were determined in the second quarter of 2019, 2020, 2021, 2022, and the first quarter of 2023. The external factors generating potential crises were identified as the second quarter of 2020 (COVID-19 pandemic – which started in Poland in the first quarter of 2020) and the second quarter of 2022 (the war in Ukraine – which began in the first quarter of 2022). The values of the analyzed indicators were compared with the values obtained by the companies a year earlier. If the indicator's value improved, the change was marked in green. Conversely, if the indicator's value deteriorated, it was marked in yellow.

Multivariate comparative analysis was used to multidimensionally assess the financial risk of energy companies operating in Poland. Among the many methods of multivariate comparative analysis, the synthetic indicator (synthetic measure of development) Z. Hellwig was selected for the study³⁷. This indicator is included in the group of taxonomic indicators of development (synthetic measures of development³⁸, aggregate measures³⁹ and linear ordering methods, The basis of linear ordering is a synthetic variable whose values are estimated on the basis of observations of diagnostic variables describing the ob-

³⁷ Hellwig Z., *Zastosowanie metody taksonomicznej do typologicznego podziału krajów ze względu na poziom ich rozwoju oraz zasoby i strukturę wykwalifikowanych kadr*, „Przegląd Statystyczny” 1968, nr 4.

³⁸ Walesiak M., *Syntetyczne badania porównawcze w świetle teorii pomiaru*, „Przegląd Statystyczny” 1990, R. XXXVII, zeszyt 1-2, Warszawa.

³⁹ Witkowska K., *Budowa mierników syntetycznych do oceny efektywności europejskich funduszy inwestycyjnych*, „Metody ilościowe w badaniach ekonomicznych” 2012, Tom XIII/3.

jects under study⁴⁰. It makes it possible to determine the object and against other objects by comparing its values⁴¹.

The procedure for creating the Hellwig measure has several stages and is counted among the benchmark formulas. Walesiak⁴² pointed out that the shortcoming of benchmark formulas, which are different types of distances, is limited interpretation. Without denying this disadvantage, it is worth emphasizing that it is a measure that is transparent in terms of its construction and that makes it possible to capture changes in the situation of the objects under study (in our case, power companies).

In the case of the study of financial risk of energy companies using a synthetic indicator based on the concept originally proposed by Z. Hellwig, its construction will consist of the following stages⁴³:

1. establishing a set of diagnostic characteristics for assessing the financial risk of energy companies,
2. determining the nature of indicators and their division into stimulants and destimulants,
3. carry out standardization of indicators for measuring financial risk,
4. to determine the parameters of the positive and negative benchmark,
5. to determine the distance of individual energy companies from the positive benchmark,
6. determining the standard
7. calculation of the synthetic indicator as a quotient of the distance of a particular enterprise from the positive benchmark to the
8. interpretation of the results obtained.

To carry out standardization, the study used normalization of variable values. Diagnostic features were not given weights, thus assuming that each of the selected features has the same significance.

To carry out standardization, the study used normalization of variable values. Diagnostic features were not given weights, thus assuming that each of the selected features has the same significance.

For the purposes of the study, authors called this index the synthetic financial risk ratio (SFRR). It was determined according to the formula:

⁴⁰ Bąk A., *Porządkowanie liniowe obiektów metodą Hellwiga i Topsis – analiza porównawcza*, „Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu, Taksonomia” 26, nr 426, Wrocław 2016.

⁴¹ Kompa K., *Budowa mierników agregatowych do oceny poziomu rozwoju społeczno-gospodarczego*, „Zeszyty Naukowe SGGW w Warszawie. Ekonomika i Organizacja Gospodarki Żywnościowej” 2009, 74.

⁴² Walesiak, op. cit.

⁴³ Bąk A., *Porządkowanie liniowe obiektów...*

$$SFRR = a_i/a_0 * 100$$

Where:

a_i - distance of the i -th power company in terms of financial risk from the benchmark

a_0 - the standard

According to the approach proposed by Z. Hellwig, the norm is calculated according to the formula:

$$a_0 = a + 2 Sa$$

Where:

a - arithmetic mean a_i

Sa - standard deviation a_i

The value of the synthetic index ranges from 0 to 100. The interpretation of the SFRR index is intuitive and consistent with the nature of the problem under study. The lower the value, the lower the financial risk of the company under study. For the purposes of the study, the following ranges of the indicator were adopted:

0-20 - very low financial risk,

20-40 - low financial risk

40-60 - average financial risk,

60-80 - high financial risk,

80-100 - very high financial risk.

The authors of this paper calculated the SFRR synthetic index for the surveyed companies in each year. In addition, a dynamic survey was conducted. This type of study was aimed at capturing the paths of change in the level of financial risk of individual energy companies during the period under study.

Results

The first analyzed indicator related to operational risk was the degree of operating leverage. The obtained values of the indicator for each of the analyzed companies are presented in Table 1.

Table 1. Changes in the degree of operating leverage during the analyzed periods (DOL – degree of operating leverage)

Enterprise	II 2019	II 2020	II 2021	II 2022	I 2023
CEZ	3,36	5,29	- 2,16	2,71	1,85
Kogenera	- 2,21	37,45	5,64	- 20,95	1,98
PEP	8,80	4,47	2,65	68,34	3,22
Enea	2,92	- 32,00	4,72	6,40	35,09
PGE	2,44	- 5,39	2,21	2,44	4,18
Tauron	6,55	2,69	- 2,68	- 9,19	3,50

Source: own elaboration based on www.biznesradar.pl [Access: 2024.06.10].

For the majority of the analyzed energy companies, both the pandemic crisis (Q2 2020) and the war crisis (Q2 2022) led to a deterioration in the value of the degree of operating leverage. During the pandemic crisis, only two companies (PEP and Tauron) recorded an improvement in the degree of operating leverage, while during the war crisis, only one company (CEZ) showed an improvement in this indicator.

The next analyzed indicator related to financial risk was the degree of financial leverage. The values of the indicators for each period for all the examined entities are presented in Table 2.

Table 2. Changes in the degree of financial leverage during the analyzed periods (DFL – degree of financial leverage)

Enterprise	II 2019	II 2020	II 2021	II 2022	I 2023
CEZ	1,75	4,52	0,83	1,24	1,19
Kogenera	0,89	2,25	1,03	0,66	1,01
PEP	2,36	1,68	1,14	-0,46	1,16
Enea	1,35	0,04	1,20	1,24	-4,37
PGE	1,01	0,82	0,91	1,04	0,99
Tauron	1,29	1,12	0,84	0,63	1,14

Source: own elaboration based on www.biznesradar.pl [Access: 2024.06.10].

For the majority of the analyzed energy companies, both the pandemic crisis and the war crisis led to a deterioration in the value of the degree of financial leverage. This was observed in the same entities that experienced a deterioration in the degree of operating leverage. An improvement in the degree of financial leverage occurred in the same entities that showed an improvement in the degree of operating leverage. An additional entity that showed an improvement in the degree of operating leverage during the war crisis was PGE.

The third financial indicator analyzed, related to the risk present in the entity, was the financial structure, defined as the ratio of long-term liabilities to total liabilities. The values of this structural indicator are presented in Table 3.

Table 3. The ratio of long-term liabilities to total liabilities

Enterprise	II 2019	II 2020	II 2021	II 2022	I 2023
CEZ	34,59%	38,74%	28,76%	21,89%	35,07%
Kogenera	29,64%	25,62%	24,61%	23,03%	14,18%
PEP	37,29%	36,11%	32,74%	27,81%	28,85%
Enea	31,89%	34,26%	28,32%	21,94%	25,91%
PGE	1,61%	31,72%	25,85%	17,48%	16,27%

Source: own elaboration based on www.biznesradar.pl [Access: 2024.06.10].

For the majority of entities, the value of this financial indicator improved. A deterioration in the value of the indicator (an increase in the share of external capital) occurred only in the first of the analyzed crisis periods and affected two entities (Enea and CEZ). During the war crisis, the value of the structural indicator improved for all entities (the share of debt decreased compared to the previous period).

The next analyzed financial indicator directly related to the risk present in the analyzed entity was the current liquidity ratio. The values of this indicator for all analyzed entities in individual years are presented in Table 4.

Table 4. Current liquidity ratio for the analyzed entities

Enterprise	II 2019	II 2020	II 2021	II 2022	I 2023
CEZ	0,987	1,153	0,987	0,947	1,342
Kogenera	3,190	3,227	3,232	1,990	1,140
PEP	1,738	2,356	1,513	1,369	1,754
Enea	1,342	1,424	1,100	1,160	1,236
PGE	1,274	1,128	1,105	1,237	1,067
Tauron	0,896	1,292	0,894	0,775	3,672

Source: own elaboration based on www.biznesradar.pl [Access: 2024.06.10].

For the current liquidity ratio, most entities saw an improvement in the value of the analyzed indicator during the pandemic crisis (Q2 2020) – only PGE experienced a deterioration in the indicator's value. A deterioration in liquidity occurred during the war crisis (Q2 2022) – for 4 out of the 6 analyzed entities, the value of the indicator decreased.

The fifth analyzed indicator related to the level of risk born by energy companies was sales profitability, defined as the ratio of operating profit to sales revenue. The value of the indicator for the analyzed years is presented in Table 5.

Table 5. Sales profitability of the analyzed entities

Enterprise	II 2019	II 2020	II 2021	II 2022	I 2023
CEZ	11,29%	6,54%	-10,49%	14,94%	26,19%
Kogenera	-12,81%	0,82%	6,08%	-1,39%	23,36%
PEP	3,70%	7,97%	15,39%	0,44%	11,91%
Enea	12,08%	-0,07%	7,39%	5,15%	4,88%
PGE	17,24%	-4,93%	19,92%	17,19%	8,61%
Tauron	5,13%	15,05%	-8,89%	-3,03%	10,70%

Source: own elaboration based on www.biznesradar.pl [Access: 2024.06.10].

Regarding the profitability indicator, the war crisis had a greater impact on the deterioration of profitability for the analyzed entities (a larger number of entities experienced a decrease in the value of the analyzed profitability indicator – only two entities improved the value of the analyzed indicator). During the pandemic crisis, three entities experienced a decrease in profitability compared to the previous period, while three entities improved their profitability compared to the previous period.

The analyzed external events (the pandemic crisis and the war in Ukraine) affected the values of the analyzed indicators in various ways. However, for most entities, the impact was negative – the values of the analyzed indicators deteriorated.

In the next stage of the research, a multivariate analysis was conducted based on the determined financial indicators.

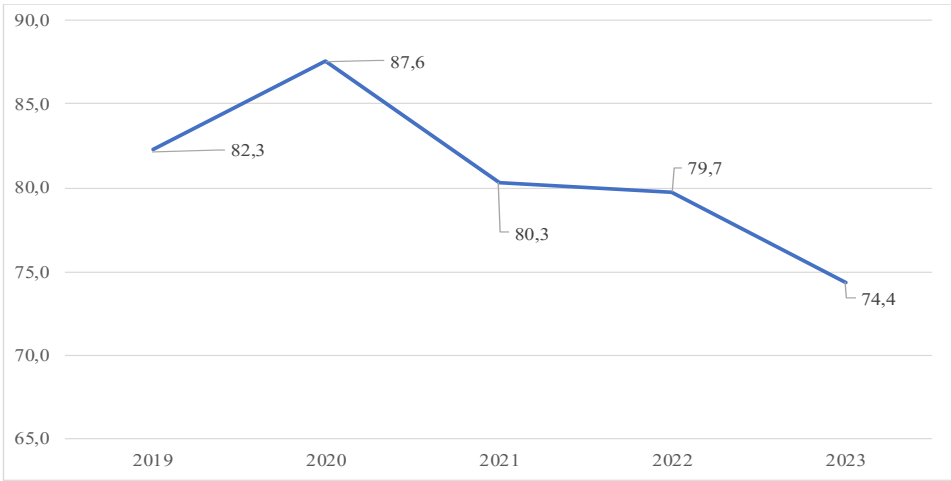
As part of the multivariate comparative analysis, the first step involved establishing a feature vector consisting of five diagnostic indicators. In the second step, the diagnostic indicators were divided into stimulants and destimulants. The operating profitability ratio and liquidity ratio were classified as stimulants. Three indicators (DOL, DFL⁴⁴, and the share of long-term debt) were classified as destimulants. The advantage of using multivariate methods is the ability to resolve the frequently occurring problem of conflicting indications from individual partial indicators when using a larger number of them. By using a synthetic indicator for the study, the Authors of this paper obtained specific indications (in the form of a number) for the examined objects.

⁴⁴ For the purposes of the multivariate study, authors of this paper transformed DOL and DFL in such a way that the interpretation of these indicators from the perspective of the studied phenomenon would be unambiguous.

This study covered the years 2019–2023. Therefore, for the purposes of the study, a two-dimensional matrix was created in the second step. The rows of the matrix represented the analyzed companies in the five studied years, while the columns of the matrix were the diagnostic indicators.

The average level of synthetic indicators for the analyzed energy companies in the five studied years ranged between 87.6 and 74.4. The evolution of the average synthetic indicator in individual years for the analyzed energy companies is presented in the chart below.

Chart 1. The average level of the synthetic index for the surveyed companies in the electricity sector in 2019–2020



Source: own elaboration based on www.biznesradar.pl [Access: 2024.06.10].

The obtained results indicate a relatively high level of financial risk in the analyzed energy companies. At the same time, a decrease in the level of risk can be observed. While in 2020, the average level of the SFRR indicator was 87.6, it was calculated at only 74.4 based on financial data for 2023.

The paths of changes in the synthetic indicator for the analyzed energy companies in the years 2019–2023 are presented in table 6.

Table 6. Changes in the level of financial risk for the analyzed energy companies in the years 2019–2023

Enterprise/Years	2019	2020	2021	2022	2023	Average synthetic indicator for years 2019–2023
CEZ	87,5	108,2	87,4	76,0	80,0	87,8
Kogenera	80,5	89,2	68,5	69,0	68,3	75,1
PEP	92,1	82,1	78,0	97,4	74,9	84,9
Enea	80,6	75,9	80,8	78,3	72,4	77,6
PGE	65,9	84,5	74,1	69,9	73,2	73,5
Tauron	87,2	85,5	93,0	87,9	77,3	86,2
Standard deviation	9,2	11,0	8,9	11,0	4,0	8,8
Arithmetic average	82,3	87,6	80,3	79,7	74,4	80,9
Coefficient of variation	11,1	12,6	11,1	13,8	5,4	10,8

Source: own elaboration based on www.biznesradar.pl [Access: 2024.06.10].

When analyzing the information presented in the table 6, it is useful to refer to the coefficient of variation. In the studied years, it was relatively low, amounting to 11.1% in 2019, 12.6% in 2020, 11.1% in 2021, 13.8% in 2022, and 5.4% in 2023. The low coefficient of variation indicates that there was relatively little variation in financial risk among the analyzed companies during the studied years. This would suggest that during the analyzed period, there was a relatively high similarity in financial risk among the studied companies.

Considering all the studied years, the lowest financial risk in the analyzed set of energy sector companies was characterized by the PGE group (the average synthetic indicator calculated for all years was 73.5), while the highest was CEZ (87.8).

Conclusions

The conducted studies allow for formulating several key conclusions regarding the impact of the pandemic and war crises on the level on financial risk in energy companies in Poland. Firstly, the results indicate a relatively high level of financial risk in the analyzed companies, but with a noticeable downward trend from 2020 to 2023. The average level of the synthetic indicator decreased from 87.6 in 2020 to 74.4 in 2023, indicating an improvement in the financial situation for most of the analyzed entities.

The analysis showed that the impact of both external factors – the COVID-19 pandemic and the war in Ukraine – was not uniformly negative for all the analyzed entities. Despite challenging external conditions, some companies managed to maintain or even improve selected financial indicators.

A positive aspect of using multivariate analysis compared to single indicators is the ability to resolve the frequently occurring problem of conflicting indications from individual partial indicators. Multivariate analysis provides a more comprehensive and balanced view of financial risk by integrating multiple dimensions into a single synthetic indicator.

It is also important to note certain limitations of risk assessment using synthetic indicators based on distance metrics. Firstly, the results are influenced by the selection of partial indicators and the companies included in the study. Another significant limitation of such methods is linearization. It is possible for companies with different levels of partial indicators to have the same level of the synthetic indicator. Despite these limitations, the proposed synthetic measure of financial risk can serve as a practical tool for assessing the level of financial risk and warning against adverse developments in risk.

In conclusion, study conducted by the authors of this paper have shown that while the pandemic and war crises have affected the level of financial risk in the energy sector, their impact was not uniformly negative. Additionally, the use of synthetic indicators allows for a more complex and multidimensional risk assessment, which is particularly important in the context of dynamic economic changes. These results can provide valuable insights for decision-makers and managers in better preparing for future unforeseen events.

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Information about the authors:

dr Błażej Lepczyński,
Katedra Finansów i Bankowości, Wydział Zarządzania,
Uniwersytet Gdański, Polska
ORCID ID: <https://orcid.org/0000-0002-1954-1144>
e-mail: blazej.lepczynski@ug.edu.pl

dr Małgorzata Siemionek-Ruskań,
Katedra Finansów i Bankowości, Wydział Zarządzania,
Uniwersytet Gdański, Polska,
ORCID ID: <https://orcid.org/0000-0002-0733-456X>
e-mail: malgorzata.siemionek-ruskan@ug.edu.pl,

dr Mariusz Chmielewski,
Katedra Strategicznego Rozwoju, Wydział Zarządzania,
Uniwersytet Gdański, Polska,
ORCID ID: <https://orcid.org/0000-0002-0775-621X>
e-mail: mariusz.chmielewski@ug.edu.pl

dr Joanna Pioch,
Sopocka Akademia Nauk Stosowanych,
Wydział Ekonomii i Finansów, Polska,
ORCID ID: <https://orcid.org/0000-0002-7895-1696>
e-mail: joanna.pioch@ssw-sopot.pl