European Research Studies Journal
Volume XXIV, Special Issue 1, 2021

pp. 53-68

Default Risk of Listed Companies in the Context of the Threat to Commodity Markets in the Times of COVID-19 Pandemic

Submitted 05/02/21, 1st revision 103/02/21, 2nd revision 05/03/21, accepted 20/03/21

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Abstract:

Purpose: *The purpose of this study was to identify the threat of default risk among commodity-related companies in European equity markets.*
Design/Methodology/Approach: *Determination of the default risk of companies listed on several stock exchanges followed the Merton model by comparing the probability of bankruptcy in the time intervals from 1 January 2019 to 30 June 2019, and from 1 January 2020 to 30 June 2020. The calculations were based on data from the Wall Street Journal database. The companies selected for the study represent the main indexes of five European stock exchanges. In total, the analysis covers 40 commodity-related companies and 20 companies from the control groups.*
Findings: *It was observed that commodity-related companies stood out against the control group in terms of default risk in the times of Covid-19 pandemic. The growing risk of default among stock market companies from significant European stock exchanges is a threat which - if unrecognized - may lead to a new financial crisis that can undermine the foundations of European economy.*
Practical Implications: *The research results can be used by financial institutions in the process of creating a more customized approach to the modeling of credit risk of commodity-related companies. This will enable rationalization of risk management costs.*
Originality/Value: *This study lies in the research area orientated towards exploration of relations between types of risks, which is an original aspect of this paper. More broadly, the research seeks to build risk assessment models that will be more adaptable to actual market situations in the times of Covid-19 pandemic.*

Keywords: *Market risk, default risk, commodity market, equity market, coronavirus pandemic.*

JEL classifications: *Q02, Q40, Q41, G14, C12.*
Paper Type: *Research paper.*

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1. Introduction

The justification for raising the issue of default risk among companies exposed to the commodity market is the growing importance of economic processes initiated in this market for global economy (Nissanke, 2010; Algieri and Leccadito, 2017; Maizels, 2003). First and foremost, the wide reach of commodity market risk affects not only economic conditions but also institutions and societies. The impact of this risk on economy is reflected through changes in levels of prices of raw materials and commodities, which shape the financial standing of households, companies, and states, especially for economies with less developed financial markets (Céspedes and Velasco, 2012).

Companies whose operations rely on commodity markets are exposed to market risk comprising the price risk of bought or sold raw materials and commodities and exchange risk of the currencies in which purchase/sale transactions for raw materials are settled (Akram, 2009; Hegerty, 2016).

A vital question for companies is the risk of their financial condition (financial performance, cash flows, balance sheet structure) deteriorating due to unfavorable currency exchange rates and prices of raw materials, which have bearing on all component assets and liabilities as well as incomes and expenses (Achzet and Helbig, 2013; Thalassinos and Politis, 2011). An example is a decline in the value of revenues and receivables resulting from depreciation of the clearing currency or prices of commodities, or else an increase in costs and liabilities caused by appreciation of the currency or higher raw material prices. In extreme cases, such developments can lead to the bankruptcy of an affected company. For banks and lending institutions providing capital to companies, the risk of default of commodity-related companies, being a consequence of developments stimulated by price risk and currency exchange risk, is a significant issue (Varangis and Larson, 1996).

In view of the above considerations, the following research objective was to identify the threat of default risk arising from price risk and exchange rate risk among commodity-related companies active in European stock exchange markets.

It is not easy to capture the dependence between market risk and default risk of capital companies, as this is a complex relationship. Above all, it is difficult to exclude the impact of other factors, such as trends in the demand for companies' products and services, changes in the demand for raw materials driven by technological progress, etc. Thus, the identification of the default risk among commodity-related companies (hence, companies whose operations are linked to commodity markets) arising from disturbances in commodity markets is possible to capture during shock periods caused by a crisis (Kablan *et al.*, 2017; Grima *et al.*, 2020; Khan *et al.*, 2020). This is the type of situation we are observing now, namely the lockdown due to the COVID-19 pandemic. Resulting perturbations in prices in stock exchange markets and

commodity markets enable us to try and identify the vulnerability of commodity-related companies to default risks caused by the market risk in commodity markets.

2. Economic Consequences of the COVID-19 Pandemic to Commodity-Related Companies and Markets

There are several factors affecting the commodity market and investment risk, of which the most important ones are the demand and supply for raw materials, as the demand generates an economic growth while the supply depends on the extraction or production of raw materials. The market mechanisms and demand and supply adaptations determine prices of raw materials. The main price-shaping factors on the commodity market are macroeconomic determinants, factors associated with the chain of supplies and geopolitical conditions (Schofield, 2007). The economic consequences of the coronavirus pandemic are revealed through direct and indirect manifestations in global raw materials markets (Ahmad *et al.*, 2020; Nicola *et al.*, 2020; Baker *et al.*, 2020; Rajput *et al.*, 2020). The condition of a commodity market is correlated with the condition of economy.

Rapid declines in the crude oil market have been mainly caused by restrictions imposed on production and on international air and road transport. However, if the epidemic persists for more than half a year, the influence on the price of crude oil as a raw material will continue to be felt in the coming year 2021, and the price of this commodity should not exceed $60 per barrel (Marszałkowski, 2020). The price for Brent Crude Oil fell from $66.3 in the first quarter of 2020 to $26.0, and the price of American WTI oil decreased from over $61 to $20 per barrel. The worst situation in the crude oil market occurred on 20 April 2020, when the price of WTI for the futures for May was nearly minus $40 dollars per barrel. The reason was that the May futures concerned deliveries of crude oil during the lockdown of the US economy, when the demand for fuels from refineries was low and the storage tanks were already filled to much of their capacity. In line with the agreement between the OPEC and its allies, the producers decided to cut down on crude oil production by 9.7 million barrels per day starting on 1 May 2020.

According to forecasts made by OPEC+ experts, if the Covid-2 pandemic continues for more than half a year, the demand for this raw material could decline by 0.21 million barrels per day compared to the predicted growth by 1.22 million barrels. In the first three months of 2021 an increase in the demand is expected to reach 0.8 m compared to the previously planned rise by 1.17 m barrels a day. In the second quarter, it can slow down to 0.77 m barrels daily in comparison with the previous prediction of 1.18 m barrels. Exxon Mobil Corp., Chevron Corp. and ConocoPhilips in the USA are planning to reduce production until the end of June by a total of 600,000 barrels a day. Due to the crisis caused by the coronavirus pandemic and plummeting prices of crude oil, the number of oil drills in the USA decreased from 624 to 292 within a month. However, the stocks of crude oil in China are decreasing. The SIA Energy data show that the stocks of this raw material in April decreased by 9.5 m barrels, whereas

in the first quarter of 2020 they rose by as much as 161 m barrels. The giant state company PetroChina Co has recently increased production. The rapid depreciation of crude oil prices badly hit the economies based on crude oil exports, especially those of the Russian Federation and Saudi Arabia. The budget of the Russian Federation is based on a year-average price of crude oil equal $42.4 per barrel (Borkowska, 2020). Saudi Arabia is pursuing an enormous project of transforming its economy from being based on production and export of crude oil to the one reliant on oil processing and on other sectors of economy. New investments entail high outlays, and therefore low crude oil prices are undesirable. Saudi Arabia has suspended the investments projects implemented under the Vision 2030 programme, while raising VAT from 5 to 15%.

The situation in international crude oil markets is slowly stabilizing, which has been aided by the resumed domestic and international road and air transport. It is predicted that the US extraction of crude oil may reach as much as 17 m barrels per day in 2040. Saudi Arabia is now mining 9.5 m barrels a day. Canada might possess as much as 175 billion barrels of petroleum in Alberta's oil sands. The development of export supported using Trans Mountain, Keystone XL and Line 3 pipelines will contribute to a further growth in supply. Canada is expected to provide 25% of new supplies in 2020, and its production output is to increase by 85% to the year 2040 (nearly 10 million barrels a day) (Biznes Alert, 2020). The global restrictions have restrained broadly understood mobility, which generates 57% of the world's demand for petroleum. Road transport in the regions subjected to lockdowns fell by 50% to 75%, and the average road transport activity decreased by 50% compared to its level in 2019. The air transport in some European states fell by over 90%. In consequence, the global demand for petroleum decreased rapidly by a record 10.8 m barrels/year-to-year. It is estimated that the demand for crude oil in the OECD states has declined in Europe by 0.9 m barrels/d, in America by 0.8 m barrels/d, and in Asia by 0.6 m barrels/d. The total demand for petroleum in the first quarter of 2020 decreased by 5.6 m barrels/d (IEA, 2020b).

Another consequence of the sanitary regime and associated restrictions is a decrease in the demand for other petroleum products (Norouzi *et al.*, 2020), such as LPG, ethane, petrol, and residual fuel. The impact of the lowered demand for these products will probably be less severe than that of petrol, diesel oil and jet fuel. Moreover, the demand for some petrochemical products is growing due to the higher demand for individual protective equipment.

Consequences of the coronavirus pandemic are also observed in the gas market (Walsh and Boys, 2020; Babatope and Audu, 2020). Obligatory quarantine means a higher demand for gas for household use, while the economic situation of industrial plants leads to a lower demand in the industrial, transportation and commerce sectors. Even if the demand for industrial gas is growing quite rapidly, the commercial demand may remain low. There is a much higher risk to the demand for gas, which arises from the collapse of regional supply chains, as factories have started to inform clients of their inability to meet their supply obligations. LNG traders are making attempts to redirect

or to find new markets for the supplies allocated to the Chinese market. China is the second largest LNG importer in the world, and its immediate purchase of supercooled natural gas and other energy products has nearly halted. Thus, the Covid-2 epidemic in China creates a threat of reducing the demand for natural gas (Perzyński, 2020).

The demand for gas is also decreasing in Germany, France, and Italy. A consequence of the decreased import in Europe to Asian clients and the global production and increased export of LNG is the oversupply of this commodity. In March 2020, the supplies of LNG to Europe reached a record high volume of around 15 billion m^3. Prices of gas on stock exchanges plummeted. The market situation adversely affects exporters, as well as investments and gas supplies. The LNG suppliers from the USA suffer the most, but the traditional exporters of gas to European markets, such as Russia or Norway, are also affected. The decrease in gas demand is indirectly connected with the effectiveness of implemented pandemic restrictions, and with the structure of gas consumption in every country. The highest decrease in the demand for gas was noted in France (a decrease in consumption by 25%), Italy (24%), Belgium (18%) and Germany (12%) (Łoskot-Strachota, 2020).

Decreases in the demand for gas occur in a situation of the oversupply of this commodity on global markets persisting since 2019. Prices of gas have been noted to decrease on most stock exchanges. The EU TTF noted the lowest ever recorded prices of gas, 6.95 euro/MWh, and the LNG DES (delivery ex-ship) supplies to north-western Europe were valued below 2 US dollars/ MMBtu (IEA, 2020a). High temperatures, oversupply of the raw material and the growing competition for market shares have resulted in exceptionally low prices in the world and in European markets. Low prices of gas make it a more appealing choice as a transient fuel, able to play an important role in the energy transformation to climate neutral economy. On the other hand, maintaining low prices of gas and petroleum over a long-time horizon can contribute to the weakening of the dynamic or temporary inhibition of the process of shifting towards green sources of energy, which require additional investments (Frydenberg, 2020). Deceleration of the economic activity in European countries causes a decline in demand and greater uncertainty about the scale of consumption of raw materials by industries, services, heat, and power generation plants, etc. The power and range of the negative influence of the pandemic on prices of gas will depend on how effectively and quickly the authorities will combat the Covid-19 threat.

The coronavirus pandemic has had a significant impact on operational and logistic activities pursued by many economic enterprises across the world. Reduced activity is seen mainly among companies seated in Europe and the United States of America which depend on supplies of raw materials from Australia, China, and South America. The pandemic has induced changes in prices of industrial metals and prices of lithium, used for production of batteries used in electric cars. The sale of lithium carbonate by Oracobre has fallen by 20% year-to-year and by 23% compared to the sale volumes in October and December 2019 (Rapacka, 2020). In the first quarter of 2020, the situation in the copper market was the worst since 2011. The price of copper fell by

over 23%, down to $ 4,758.5$ per tonne. At present, a tonne of copper sells for approximately $ 5,260.00. This somewhat improved situation in the copper market and higher prices of copper are a consequence of the gradual reopening of global economies as well as better international and trade relations between Washington and Beijing. In mid-June this year, major trade negotiators from the USA and China declared they would elaborate proper conditions for the implementation of a bilateral trade agreement and cooperation in commerce and in health care between these two countries. The copper market is also affected by the decline in global stocks of this metal, which is due to the limited supplies of copper provided by Chinese producers and certain disturbances in copper productions that have occurred in mines all over the world when the COVID-19 virus spread among miners. Copper is used broadly in construction of buildings and elements of infrastructure. Hence, prices of copper are significantly influenced by the condition of the building sector. Considering the global scale of the COVID-19 epidemic and the extent of consequences it causes, it can be suspected that raw materials markets will be experiencing strong fluctuations.

The situation in the global commodity market is reflected by the Thomson Reuters/CoreCommodity CRB (TR/CC CRB) index. Looking at historical data, CRB Commodity Index reached the highest value equal 470.17 in July 2008. Since January 2020, the CRB index has decreased by 27.21% (53.51 points). It is predicted that the CRB Commodity Index should be trading at a level of 140.10 points until the end of this quarter of the year, and the value of transactions will reach 131.42 for 12 months. The negative impact of the SARS-CoV-2 pandemic is also manifested by the poorer condition of national economies as well as the global equity market. The following indexes decreased between 31 December 2019 and 23 April 2020: FTSE – (-) 23.3%, Dow Jones – (-) 17.7%, CAC – (-25.8%), Nikkei – (-) 17.8%. The WIG 20 index has decreased by 12.9% since the first case of coronavirus infection was recorded (a decrease from 1860.95 points on 4 March to 1620.91 on 23 April; on 14 January 2020, the WIG-20 was 2182.96 points, that is by 34.5% more than now) (European Commission, 2020).

According to the forecasts by the World Bank, the COVID-19 pandemic can depress the global GDP by as much as 4.8% in the worst-case scenario (a pandemic like that of the Spanish flu), 3.1% in a moderate case scenario (a pandemic resembling that of the 1958 flu pandemic), or 0.7% in a mild case scenario (a pandemic like the flu pandemic in 1968) (Jonas, 2020; Sieroń, 2020). It can therefore be concluded that the coronavirus pandemic will have an adverse effect on the world economy, the willingness to invest and or plans to make pension and savings investments (van Dalen and Henkens, 2020), which can stimulate aversion to high-risk stock market investments in favor of locating capital in less risky treasure markets, like gold or precious stones (Brabenec *et al.*, 2020).

To recapitulate, the economic situation affected by the lockdown caused by the coronavirus pandemic has resulted in a crisis in raw materials markets (mainly petroleum and gas) (Ghazanfari, 2020). This contributes to higher default risk among

stock-listed companies with exposure to raw materials or connected with these markets. The identification of the scale of this risk in the purpose of our study.

3. Methodology and Data

The determination of default risk of stock market companies followed the Merton's model (Merton, 1974) by comparing the probability of bankruptcy for the periods: from 1 January 2019 to 30 June 2019 and from 1 January 2020 to 30 June 2020. The default scenario referred to a company's share price (company's value), which was adopted to be a 50-interval moving average. Data about the companies' total debt as well as number of shares traded as of 30 June 2019 and 30 June 2020 were included in the study, when the coronavirus disease (COVID-19) was declared by the WHO as a global emergency (February 2020) and later as a pandemic (March, 2020; Rajput *et al.*, 2020; WHO, 2020).

The calculations were based on data originating from the website The Wall Street Journal (https://www.wsj.com/market-data, accessed on 12.10.2020). The companies chosen for the study are included in the major indexes of five European stock exchanges: Borsa Italiana, Euronex, Deutsche Börse, London Stock Exchange and Warsaw Stock Exchange.

The targeted selection of companies was based on the economic branches they represent, and the core group consisted of commodity-related companies. Additionally, for comparative purposes, a control sample of companies having no operational links to commodity markets was created. The composition of both samples, including the indication of their operational scope, is presented in Table 1.

Table 1. *Listed companies composing the researched and control sample*

No.	Company	Scope of business activity	Stock exchange
1.	Saipem	Infrastructure, crude oil, gas	Borsa Italiana
2.	Eni	Mining, processing, sale of crude oil and gas	
3.	Italgas	Distribution of gas	
4.	Snam	Gas, storage and transmission	
5.	Tenaris	Manufacturer of steel pipes and crude oil infrastructure	
6.	Prysmian	Manufacturer of cables and equipment for electric power transmission	
7.	Enel	Production and transmission of electric power and gas	
8.	Telecom Italia	Control sample	
9.	Garofalo Health Care		
10.	Rai Way		
11.	DiaSorin		
12.	EDF Electricite de France	Generation and transmission of electric power	Euronex
13.	Eramet	Mining and metallurgy of metal ores	

No.	Company	Scope of business activity	Stock exchange
14.	Total SE	Mining and processing of petroleum, sale of fuels	
15.	Solvay	Producer of chemical compounds for industrial purposes	
16.	Arkema	Producer of chemical compounds for industrial purposes	
17.	GTT Gaztransport & Technigaz SA	Selling technology for gas transport	
18.	Euro Ressources SA	Excavation of noble metals	
19.	Esso SAF	Producer and distributor of crude oil and fuels in the French market	
20.	Carrefour	Control sample	
21.	UCB Pharma		
22.	Dassault Systèmes		
23.	Iliad SA		
24	K+S AG	Chemical industry, producer of mineral fertilizer components	Deutsche Börse
25.	E.ON	Producer of electric power	
26.	BASF	Chemical industry, producer of chemical compounds for industrial purposes	
27.	Evonik Industries	Chemical industry, producer of energy	
28.	Aurubis	Processing of copper ore, production of copper products	
29.	RWE	Generation of electric power	
30.	Fuchs Petrolub	Chemical industry, products for the car industry, lubricants, oils, silicones	
31.	Symrise	Chemical industry, producer of concentrated fragrances and aromas	
32.	Uniper	Generation of electric power	
33.	Deutsche Telekom	Control sample	
34.	Merck Group		
35.	SAP		
36.	Fresenius Medical Care		
37.	Glencore	Extraction and trading of minerals and metal ores	London Stock Exchange
38.	BP	Mining and processing of crude oil, sale of fuels	
39.	Royal Dutch Shell	Mining and processing of crude oil, sale of fuels	
40.	Anglo American	Mining of noble metals and diamonds	
41.	BHP Group	Mining of raw materials, industrial metals and noble metals	
42.	Rio Tinto	Mining of raw materials, metal ores and coal	
43.	Fresnillo	Mining of noble metals	
44.	Polymetal International	Mining of noble metals	
45.	SSE Scottish and Southern Energy	Producer and distributor of energy from renewable sources	
46.	Kingfisher	Control sample	
47.	ITV		
48.	Avast		

No.	Company	Scope of business activity	Stock exchange
49.	GlaxoSmithKline		
50.	Azoty SA	Chemical industry, producer of mineral fertilizer components	Warsaw Stock Exchange
51.	Enea	Producer of electric power	
52.	PKN Orlen	Processing of crude oil, sale of fuels	
53.	Tauron	Producer of electric power	
54.	KGHM	Mining of raw materials, industrial and noble metals	
55.	Grupa Kęty	Processing of aluminum	
56.	Energa	Producer of electric power	
57.	Cyfrowy Polsat	Control sample	
58.	Comarch		
59.	Bioton		
60.	Enelmed		

Source: *Own research.*

4. Results

The data collated in the following tables identify default risk of the companies selected for the research and listed on major European stock exchanges and on a large local stock exchange, such as Warsaw Stock Exchange. The probability of default was estimated according to the Merton's model, which reflects the position of companies in terms of their perception by potential creditors. While analyzing relationships between the situation on commodity markets and the financial standing of the stock market companies whose operational activity relates to commodities, a control group of companies was set up, composed of such businesses whose operations are not determined by commodities (gray boxes in the tables). The risk of default was estimated with reference to the data originating from two comparable time periods: first half year of 2019 and first half year of 2020. In the latter period, the global economy experienced lockdown due to the COVID pandemic. This allowed us to observe how the risk of default was shaped in a situation characterized by extreme circumstances.

In the Italian market (Table 2), the four companies with the consecutively highest increase in the probability of default were ones connected with the petroleum and gas markets (Saipem, Eni, Italgas and Snam). All these companies were additionally characterized by stronger deterioration of their financial standing than the control companies (gray color). The remaining commodity-related companies included in the study noted either slight worsening of their financial situation (Tenaris) or even some improvement, that is a decrease in default risk (Prysmian and Enel, producers of equipment and infrastructure for extraction and transport of gas and petroleum).

Table 2. *Probability of default for selected companies listed on Borsa Italiana*

No.	Company	First half of 2019	First half of 2020 (Covid pandemic)	Gain in probability of default
		Probability of default	Probability of default	
1	Saipem	0.105239753	0.337725275	0.232485522
2	Eni	0.03954889	0.208373555	0.168824665
3	Italgas	0.110291155	0.251806211	0.141515056
4	Snam	0.146068006	0.251427599	0.105359593
5	Telecom Italia	0.669209055	0.752112132	0.082903077
6	Garofalo Health Care	0.002077833	0.004195876	0.002118043
7	Rai Way	1.73639E-06	2.16565E-05	1.99201E-05
8	Tenaris	2.41465E-05	0.00018187	0.000157723
9	DiaSorin	1.43468E-08	2.46853E-12	-1.43444E-08
10	Prysmian	0.082516339	0.052444666	-0.030071673
11	Enel	0.180377136	0.140005945	-0.04037119

Source: *Own research.*

Companies associated with the commodity markets land isted on Euronex can be divided into several groups in terms of their financial standing (Table 3). The first group, with the highest increase in the probability of default (the risk of financial standing getting worse), comprised two companies: Electricite de France (producer and distributor of electricity) and Eramet (extraction and processing of metal ores).

Table 3. *Probability of default for selected companies listed on Euronex (Paris and Brussels).*

No.	Company	First half of 2019	First half of 2020 (Covid pandemic)	Gain in probability of default
		Probability of default	Probability of default	
1	Electricite de France	0.367855735	0.666268203	0.298412468
2	Eramet	0.504711258	0.745723473	0.241012215
3	Carrefour	0.303267875	0.382317433	0.079049558
4	Total SE	0.014522285	0.08846771	0.073945425
5	Solvay	0.071970651	0.08577261	0.013801958
6	Arkema	0.027852258	0.03983566	0.011983403
7	UCB Pharma	0.000108957	0.00063771	0.000528753
8	Dassault Systèmes	4.3278E-07	0.000192292	0.00019186
9	GTT Gaztransport & Technigaz SA	3.04949E-16	1.15776E-12	1.15745E-12
10	Euro Ressources SA	2.15842E-12	3.91918E-15	-2.1545E-12
11	Esso SAF	0.00308718	0.000980766	-0.002106414
12	Iliad SA	0,237811757	0,115198829	-0,122612927

Source: *Own research.*

The second group, with a moderate rise in default risk, consisted of a company from the petrochemical industry (Total SE) and two other companies from the chemical industry (Solvay and Arkema). There was a third distinguishable group, with companies whose financial situation did not deteriorate distinctly (GTT Gaztransport

& Technigaz SA – technologies and infrastructure for transport of gas) or even improved slightly (Euro Ressources – extraction of noble metals, Esso SA-distribution of fuels, a company dependent on the US concern Exxon Mobile). No clear polarization was observed regarding financial standing between the companies bound with commodity markets and control group companies.

In Deutsche Börse (Table 4), the highest rise in default risk was noted for two of the analyzed companies (K+S AG producer of fertilizers and chemical components, and E.ON – electric power producer). The average level of the probability of default during the lockdown period was 0.61 for the former and 0.32 for the latter company. Slight deterioration in the financial situation was noted in the case of such large chemical companies as BASF and Evonik Industries, as well as for Aurubis, copper producer and processor. With its financial situation almost unaffected, the company RWE stands in certain contrast to the company E.ON, which represents the same energy generation sector but whose default risk has risen. A decreasing risk of default was noted for the company Uniper, producer of renewable energy. In two chemical companies, Petrolub and Symrise, changes in their financial standing were less obvious.

Table 4. *Probability of default for selected companies listed on Deutsche Börse (Frankfurt)*

No.	Company	First half of 2019	First half of 2020 (Covid pandemic)	Gain in probability of default
		Probability of default	Probability of default	
1	K+S AG	0.181935137	0.612006306	0.430071169
2	E.ON	0.012156497	0.328607896	0.316451398
3	Deutsche Telekom	0.229226819	0.516583403	0.287356584
4	BASF	0.007631405	0.036266367	0.028634962
5	Evonik Industries	0.011486995	0.016660303	0.005173308
6	Aurubis	0.001022832	0.002700398	0.001677566
7	Merck Group	0.003728096	0.005012761	0.001284664
8	RWE	0.0048677	0.005910064	0.001042364
9	SAP	0.000183299	0.000217374	3.40751E-05
10	Fuchs Petrolub	1.02317E-09	3.05298E-07	3.04275E-07
11	Symrise	0.001391669	0.000443594	-0.000948075
12	Uniper	0.00307959	0.001601577	-0.001478013
13	Fresenius Medical Care	0.045890207	0.038979899	-0.006910308

Source: *Own research.*

In the London market (Table 5), the financial situation of the company mining mineral raw materials and metal ores (Glencore) and the petrochemical companies (BP and Royal Dutch Shell) suffered relatively the most (an increase in default risk). The other companies, including the control group ones (gray color), were characterized by a small increase or even by a small decrease in the probability of default. They comprised the mining companies Anglo American (extraction of noble metals), BHP Group (extraction of industrial and noble metals), Rio Tinto (extraction of coal and

metal ores) and Fresnillo (extraction of noble metals). The financial situation of two companies, such as Polymetal International (mining of noble metals) and SSE (producer of renewable energy) improved during the lockdown period (a decrease in the probability of default).

Table 5. *Probability of default for selected companies listed on London Stock Exchange*

No.	Company	First half of 2019	First half of 2020 (Covid pandemic)	Gain in probability of default
		Probability of default	Probability of default	
1	Glencore	0.075999408	0.369209098	0.29320969
2	BP	0.030336888	0.208960336	0.178623448
3	Royal Dutch Shell	0.008903452	0.106843204	0.097939752
4	Kingfisher	0.03441282	0.094949166	0.060536346
5	Anglo American	0.004265402	0.02410391	0.019838508
6	ITV	0.004939742	0.014687931	0.009748189
7	BHP	0.001322705	0.003803026	0.002480321
8	Rio Tinto	0.001318396	0.001550665	0.000232269
9	Fresnillo	0.000134975	0.000169881	3.49058E-05
10	Avast	0.004875636	0.000476753	-0.004398884
11	GlaxoSmithKline	0.013935414	0.009590877	-0.004344537
12	Polymetal International	0.009545976	0.00166204	-0.007883937
13	SSE	0.109476423	0.072351639	-0.037124783

Source: *Own research.*

The commodity-related companies listed on the stock exchange in Warsaw (Table 6) were distinguished by a relatively small increase in default risk in comparison with the situation found in the other analyzed markets.

Table 6. *Probability of default for selected companies listed on Warsaw Stock Exchange*

No.	Company	First half of 2019	First half of 2020 (Covid pandemic)	Gain in probability of default
		Probability of default	Probability of default	
1	Azoty SA	0.14829724	0.325525443	0.177228203
2	Enea	0.593029379	0.675984759	0.08295538
3	PKN Orlen	0.004676298	0.05837239	0.053696093
4	Tauron	0.749615915	0.793523556	0.04390764
5	Cyfrowy Polsat	0.057966706	0.089812531	0.031845825
6	KGHM	0.016542584	0.03951705	0.022974466
7	Comarch	0.000706611	0.000501221	-0.000205391
8	Grupa Kęty	0.003474961	0.000809636	-0.002665325
9	Bioton	0.01050927	0.004613799	-0.005895471
10	Energa	0.554782947	0.512816905	-0.041966042
11	Enelmed	0.195330301	0.136418529	-0.058911772

Source: *Own research.*

The most severe deterioration of the financial standing was observed for the companies Azoty SA (fertilizer producer), Enea and Tauron (producers of electric power), PKN Orlen (petrochemical industry) and KGHM (mining and processing of copper and silver). The other companies, Grupa Kety (aluminum processing) and Energa (producer of electric power) noted a decrease in the probability of default during the lockdown in 2020. The polarization was observed regarding the distribution of changes in default risk within the researched group of companies against the background of the control group (the first four companies).

5. Conclusions

This comparative study of the default risk among commodity-related companies listed on the biggest European stock exchanges produced the following findings:

1. The commodity-related companies stood out against the background of the control group in terms of default risk. The differences in the Italian and Polish markets were large enough to verify the presence of polarization, with most commodity-related companies forming a group of business enterprises with a higher default risk and the control group companies with a lower probability of default.
2. On Euronex, Deutsche Börse and London Stock Exchange, large differences were observed among commodity-related companies and control companies (not connected with commodity markets) in terms of changes in default risk. It was possible to distinguish a group of companies with a stronger increase in the probability of default and a group of companies when the said increase was milder.
3. Considering the situation on commodity markets in the first half of 2020, it can be claimed that it did not fully reflect itself by a rise in the risk of default of the analyzed commodity-related companies. These companies were highly diverse (energy producers, producers of equipment for the mining of petroleum and gas, the chemical industry).
4. The commodity-related companies which experienced a considerable increase in default risk during the analyzed time period represented the following branches: petrochemical industry (BP, Royal Dutch Shell, Eni, PKN Orlen), electric power industry (E.ON, Electricite de France, Enea, Tauron), mining companies (Eramet, Glencore) and chemical industry (K+S AG, Azoty SA). In this group of companies, it is possible to suggest the presence of causal links between trends in prices in commodity markets and the probability of default.
5. When comparing Warsaw Stock Exchange with the dominant European stock exchanges, it can be concluded that a rise in default risk among commodity-related companies listed in this stock market was weaker than detected for companies whose shares are traded on large European stock exchanges. This could be associated with a relatively weaker exposure of Polish companies to the risk inherent in commodity markets and a lower level of total debt relative to their capitalization.

The growing risk of default of companies listed on major European stock exchanges is a threat which - if left unrecognized - may lead to a new financial crisis that could shake the foundations of European economy. This scenario is even more likely due to the unprecedented COVID-19 pandemic, which in a relatively short time can bring major sectors of European economy to the brink of bankruptcy. Hence, the situation of commodity-related companies heralds more serious disturbances and should therefore become the subject of more in-depth research.

References:

Ahmad, T., Haroon, M.B.., Hui, J. 2020. The condition of a commodity market is correlated with the condition of economy. Pakistan Journal of Medical Sciences, 36, S73-S78, 10.12669/pjms.36.COVID19-S4.2638.

Achzet, B., Helbig, C. 2013. How to evaluate raw material supply risks-an overview. Resources Policy, 38(4), 435-447, https://doi.org/10.1016/j.resourpol.2013.06.003.

Akram, F. 2009. Commodity prices, interest rates and the dollar. Energy Economics, 31(6), 838-851, https://doi.org/10.1016/j.eneco.2009.05.016.

Algieri, B., Leccadito, A. 2017. Assessing contagion risk from energy and non-energy commodity markets. Energy Economics, 62, 312-322, https://doi.org/10.1016/j.eneco.2017.01.006.

Babatope, B.B., Audu, S.I. 2020. Overview of the Effect of Covid-19 on Nigeria's Energy Sector. CPEEL's Covid-19 Volume II Discussion Papers Series.

Baker, S.R., Bloom, N., Davis, S.J., Kost, K., Sammon, M., Viratyosin, T. 2020. The Unprecedented Stock Market Reaction to COVID-19. The Review of Asset Pricing Studies, 0, 1-17, doi:10.1093/rapstu/raaa008.

Biznes Alert, https://biznesalert.pl/koronawirus-epidemia-chiny-ropa-gaz-energetyka/.

Borkowska, M. 2020. Energetyka przyszłości, https://biznes.interia.pl/raporty/raport-energetyka-przyszlosci/aktualnosci/news-to-nie-koniec-wahan-na-surowcach,nId,4495475.

Brabenec, T., Suler, P., Horak, J., Petras, M. 2020. Prediction of the Future Development of Gold Price. Acta Montanistica Slovaca, 25(2), 250-262.

Céspedes, L.F., Velasco, A. 2012. Macroeconomic Performance During Commodity Price Booms and Busts. IMF Economic Review, 60, 570, https://doi.org/10.1057/imfer.2012.22.

European Commission. 2020. Coronavirus: Commission stands ready to continue supporting EU's agri-food sector. Press Release, Brussels, 25 March.

Frydenberg, J. 2020. Changes to foreign investment framework. Melbourne, 30 March, https://ministers.treasury.gov.au/ministers/josh-frydenberg-2018/media-releases/changes-foreign-investment-framework.

Ghazanfari, A. 2020. The Impact of the COVID-19 Pandemic and Crude Oil PriceCrisis on the Price of Automobile Fuels in European Countries. Diverse Journal of Interdisciplinary Research, 2(6), 10-19.

Grima, S., Dalli Gonzi, R., Thalassinos, I.E. 2020. The Impact of COVID-19 on Malta and its Economy and Sustainable Strategies. Available at: SSRN: https://ssrn.com/abstract=3644833

Hegerty, S.W. 2016. Commodity-price volatility and macroeconomic spillovers: Evidence from nine emerging markets. The North American Journal of Economics and Finance, 35, 23-37, https://doi.org/10.1016/j.najef.2015.10.014.

IEA. 2020a. Change in monthly oil demand in selected countries, 2020 relative to 2019, https://www.iea.org/data-and-statistics/charts/change-in-monthly-oil-demand-in-selected-countries-2020-relative-to-2019.

IEA. 2020b. Global Energy Review 2020, First quarter of 2020 – compared with first quarter of 2019, https://www.iea.org/reports/global-energy-review-2020/oil#abstract.

Jonas, O.B. 2020. Pandemic Risk. The World Bank.

Kablan, S., Ftiti, S., Guesmi, K. 2017. Commodity price cycles and financial pressures in African commodities exporters. Emerging Market Review, 30, 215-231, https://doi.org/10.1016/j.ememar.2016.05.005.

Khan, S., Rabbani, R.M., Thalassinos, I.E., Atif, M. 2020. Corona Virus Pandemic Paving Ways to Next Generation of Learning and Teaching: Futuristic Cloud Based Educational Model. Available at SSRN: https://ssrn.com/abstract=3669832.

Łoskot-Strachota, A. 2020. Wzburzone wody – europejski rynek gazu w czasie pandemii. Ośrodek Studiów Wschodnich, 326, 2-3.

Maizels, A. 2003. Economic dependence on commodities. In: Toye, J. (eds.). Trade and Development: Directions for the 21st Century. Edward Elgar, Cheltenham, Northampton, 169.

Marszałkowski, M. 2020. Alert. https://biznesalert.pl/porozumienie-naftowe-opec-nowe-ciecia-koronawirus/.

Merton, R.C. 1974. On the pricing of corporate debt: the risk structure of interest rates. Journal of Finance, 29, 449-470.

Nicola, M., Alsafi, Z., Sohrabi, C., Kerwan, A., Al.-Jabir, A., Iosifidis, C., Agha, M., Agha, R. 2020. The socio-economic implications of the coronavirus pandemic (COVID-19): A review. International Journal of Surgery, 78, 185-193, https://doi.org/10.1016/j.ijsu.2020.04.018.

Nissanke, N. 2010. Issues and Challenges for Commodity Markets in the Global Economy: An Overview. In: Nissanke, M., Mavrotas, G. (eds.). Commodities, Governance and Economic Development under Globalization. Palgrave Macmillan, London, 39-63, https://doi.org/10.1057/9780230274020_3.

Norouzi, N., de Rubens, G.Z., Choupanpiesheh, S., Enevoldsen, P. 2020. When pandemics impact economies and climate change: Exploring the impacts of COVID-19 on oil and electricity demand in China. Energy Research & Social Science, 68, 101564, doi: 10.1016/j.erss.2020.101654.

Perzyński, M., 2020. Raport: koronawirus uderza w surowce, https://biznesalert.pl/koronawirus-epidemia-chiny-ropa-gaz-energetyka/.

Rajput, H. Changotra, R., Rajput, P., Gautam, S., Gollakota, A.R.K., Arora, A.S. 2020. A shock like no other: coronavirus rattles commodity markets. Environment, Development and Sustainability, https://doi.org/10.1007/s10668-020-00934-4.

Rapacka, P. 2020. Orocobre: rynek litu i baterii unormuje się dopiero w 2021 roku, https://biznesalert.pl/orocobre-rynek-lit-baterie-norma-koronawirus-logistyka-elektromobilnosc-surowce-energetyka/.

Schofield, N.C. 2007. Commodity Derivatives. Markets and Applications. John Wiley & Sons Ltd.

Sieroń, A. 2020. Czy pandemia COVID-19 spowoduje zapaść globalnej gospodarki? Instytut Misesa.

Thalassinos, I.E. and Politis, D.E. 2011. International Stock Markets: A Co-integration Analysis. European Research Studies Journal, 14(4), 113-129, DOI: 10.35808/ersj/338.

van Dalen, H.P., Henkens, K. 2020. The COVID-19 Pandemic: Lessons for Financially Fragile and Aging Societies. Aging and Retirement, 6(4), 229-232, doi:10.1093/workar/waaa011.

Varangis, P., Larson, D. 1996. Dealing with Commodity Price Uncertainty. Policy Research Working Paper, The World Bank, 1667, DOI:10.1596/1813-9450-1667.

Walsh, A., Boys, J. 2020. The political economy of fossil fuel subsidies in the Middle East and North Africa. Helpdesk Report. K4D. Knowledge, evidence and learning for development, https://opendocs.ids.ac.uk/opendocs/bitstream/handle/20.500.12413/15493/835_%20Political_economy_fossil_fuel_subsidies_in_MENA.pdf?sequence=1.

WHO. 2020. Naming the coronavirus disease (COVID-19) and the virus that causes it. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/naming-the-coronavirus-disease-(covid-2019)-and-the-virus-that-causes-it.