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Data: 24/09/2026 18:12:39

DOI:10.17951/h.2023.57.3.123-138

A N N A L E S
UNIVERSITATIS MARIAE CURIE-SKŁODOWSKA
LUBLIN – POLONIA
VOL. LVII, 3 SECTIO H 2023

MAGDALENA JASINIAK

magdalena.jasiniak@uni.lodz.pl
University of Łódź. Faculty of Economics and Sociology
39 Rewolucji 1905 r. St., 90-001 Łódź, Poland
ORCID ID: https://orcid.org/0000-0002-1658-320X

OLGA KRZECZEWSKA

olga.krzeczewska@uni.lodz.pl
University of Łódź. Faculty of Economics and Sociology
39 Rewolucji 1905 r. St., 90-001 Łódź, Poland
ORCID ID: https://orcid.org/0000-0003-3650-2152

ANNA PLUSKOTA

anna.pluskota@uni.lodz.pl
University of Łódź. Faculty of Economics and Sociology
39 Rewolucji 1905 r. St., 90-001 Łódź, Poland
ORCID ID: https://orcid.org/0000-0002-2566-3420

Is It a Real COVID-19 Fear? A Cross-Industry Study of Fear on the Stock Market

Keywords: COVID-19; capital market; negative sentiment; implied volatility

JEL: G11; G18; G41

How to quote this paper: Jasiniak, M., Krzeczewska, O., & Pluskota, A. (2023). Is It a Real COVID-19 Fear? A Cross-Industry Study of Fear on the Stock Market. *Annales Universitatis Mariae Curie-Skłodowska, sectio H – Oeconomia*, *57*(3), 123–138.

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Abstract

Theoretical background: According to many behavioural studies, emotions (e.g. fear, greed, overenthusiasm) strongly influence investment decisions and are one of the main sources of irrational behaviour.
Purpose of the article: The study aims at investigating the impact of fear related to the COVID-19 crisis on sector indices on the stock market, in the face of anticipatory restrictions imposed by the authorities. The paper illustrates the investors' decisions affected by fear.
Research methods: The empirical study includes statistical analyses, in particular an analysis of the coefficient of variation.
Main findings: The highest increase in the implied volatility index, which is used as a proxy of fear, is noted for the period of uncertainty (before the decisive reactions of government), during which, investors' reactions are the most strongly related to fear and the negative sentiment affects all the sectors.

Introduction

The outbreak of COVID-19 and its rapid spread strongly influenced the global economy and financial markets all over the world. The economy was developing in conditions that were difficult to define and are unpredictable. The sudden pandemic shock was translated into the anxiety about survival and forced actions aimed at mitigating the negative consequences of the crisis (Domańska et al., 2022). The pandemic created an unprecedented level of fear and economy risk which influenced many investment decisions.

The impact of the COVID-19 crisis on stock markets has become a key point in many studies. It seems that the COVID-19 outbreak affects stock markets by "the rational channel" related to portfolio restructuring caused by changes in prospects for future economic conditions and "the irrational channel" which is of a behavioural nature (Zaremba et al., 2020).

The following study aims at investigating the impact of fear related to the COVID-19 crisis on sector indices in the context of restrictions imposed on the economy. The main emphasis is put on fear growth that is expected to come from the COVID-19 new cases and deaths, which is a novelty in currently conducted studies. We analyze the investment decision in the context of pandemic evolution and related government decisions. The study was conducted between 2 January 2017 and 19 April 2020. To measure fear, we use two indexes: the WIV20, that is created for Polish capital market and illustrates fear locally, and the VIX that is commonly used and describes the fear level globally. The investors' sentiment was illustrated by changes in the WIG20 and WIG indices for individual industries.

The main hypothesis was formulated as follows:

H0: Fear is significantly related to the behaviour of investors as shown in the value of stock indices and the depth of sell-off (fear, proxied by WIV20 and VIX indexes, is strongly and significantly correlated to the value of stock indices).

According to many behavioural studies, emotions (e.g. fear, greed, overenthusiasm) strongly influence investment decisions and are one of the main sources of irrational behaviour. Here we expect that the fear illustrated by WIV20 and VIX

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indexes is related to WIG index, however, this relation might be different. Due to the fact that fear has the strongest impact on a person in the initial phase, partial hypotheses with the following content were also determined:

H1: The growing fear index was associated in the short term with a negative reaction from investors in all sectors of the market (in the short term there is a negative correlation between the fear proxied by WIV20 and VIX indexes and the value of sectoral indices).

In the initial phase of the impact of fear, human reactions are not rational. Acting under the influence of such strong emotions as fear causes that, regardless of rational premises, decisions are made chaotically, quickly, without thinking. Therefore, it should be expected that in the period of dynamic growth of the WIV20 index, investors' reactions will be different than in the later phase, when the strongest emotions subside. In the case of VIX index, we expect that the relation will be stronger in the later phase, as the pandemic was developing.

In connection with the above, a second partial hypothesis was formulated:

H2: The negative impact of fear on the value of stock exchange indices in the long term is conditioned by a given industry to which the analyzed stock index relates.

Due to the fact that the COVID-19 pandemic affects individual industries in different ways and there are areas in which its positive effects can be seen, it can be expected that after the wave of the strongest impact of fear, there will be a period of more rational decision-making, and the changes in indexes will be dictated by changes in the development of individual industries in the economy.

The article fits in with the current research trends. The added value of this article, apart from assessing the impact of current economic events on the Polish capital market, is an attempt to indicate how fear and its intensity affect investors' decisions. Poland was chosen due to the specificity of the course of the pandemic. Compared to other outbreaks, it was not a significant disease center. Poland was one of the last countries in Europe to record the first coronavirus infections. At the time when the government introduced restrictions, the percentage of people infected with the virus and fatalities was relatively low compared to other countries. In this context, the decisions of the authorities introducing restrictions to the economy were anticipatory, in line with global trends. Therefore, the emotions and anxiety related to the pandemic have eased relatively quickly and although the virus is still active and the number of cases is increasing, the level of uncertainty and fear has become socially acceptable. The results show that the highest increase in fear is noted for the period of uncertainty (before the decisive reactions of government), during which investors' reactions are the most strongly related to fear and the negative sentiment affects all the sectors.

The first part of the article covers the most important conclusions resulting from the research on the impact of COVID-19 on the economy and changes in selected capital markets conducted so far. Then, the research methodology, results and conclusions were presented. The article ends with a discussion and summary.

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The impact of negative sentiment (fear) on stock markets

The crises on financial markets highlight the impact of investors' sentiment on market efficiency (Economou et al., 2018). The investors exhibit biases, which can be attributed to psychological factors, e.g. fear, greed, and other psychological responses (Lo et al., 2005). The final investment decision is the outcome of many factors, such as knowledge, experience, and psychological determinants (Pastusiak, 2013; Keller et al., 2013).

From the perspective of this paper, we are particularly interested in negative sentiment. Fear is a primary emotional state. In the face of the unknown, people tend to focus on adverse scenarios while evaluating defections from the *status quo* (Cao et al., 2011). There is evidence that fear affects market participants' behaviour, e.g. managers' finance reporting choices (Gassen & Markarian, 2009) or investors' trading performance (Lo et al., 2005) and the returns of companies (Iyer & Harper, 2017). Furthermore, fear can spread across markets (Smales, 2019). Although investors' sentiment cannot be easily and accurately measured, in the economic literature the volatility of stock markets is commonly used as a proxy of fear. The Volatility Index (VIX), which is created by the Chicago Board Options Exchange, is considered a fear gauge (see Smales, 2014; Lalancette & Simonato, 2017). Furthermore, there is evidence that some macroeconomic announcements are significant signals affecting the VIX index (Markowski & Keller, 2020).

The VIX has a negative correlation with stock market returns (Smales, 2017) – the higher the VIX, the greater the investors' fear. However, the stock prices seem to react more negatively to an increase in VIX, then to react positively when VIX falls (Sarwar, 2012). Sarwar (2012) points out that asymmetry and explain that VIX is more related to fear than to positive excitement (greed). In our opinion, this phenomenon can be also attributed to the theory of perspective. According to Kahneman, "losses loom larger than the corresponding gains" (1991), so the reaction to the losses is more pronounced.

An interesting issue is also how different industries respond to fear and uncertainty. It seems that different industries exhibit different sentiment effects (Dash & Mahakud, 2013). Copeland et al. (2018) prove that industry sensitivity to the change in VIX as a proxy of investors' sentiment varies in time. According to their study, different events and VIX regimes alter industry sensitivity. Smales (2015) shows that there is a significant relationship between news sentiment and stock market returns, which fluctuates over time and by industry. He identifies a link between the time variation of news sentiment impact and industry beta, and highlights the role of VIX in explaining this variation. In his further study, Smales (2017) points out that fear affects returns to shares across firm size, value and across industries. According to his study, the most responsive to changes in investors' sentiment are small-cap stocks and firms operating in technology or telecom industries. On the other hand, taking Polish stock market under consideration, the telecom sector is described as a defensive one

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(Czyżycki, 2012; Wiśniewski, 2019). It is said that defensive (non-cyclical) stocks perform relatively well in times of uncertainty and their profits fall relatively slowly or do not fall down at all even during the economic breakdown (Krzeczewski, 2016).

Baker et al. (2020) quantify the role of COVID-19 and other diseases in the US to market volatility by applying the textual analysis of news published by media. They indicate that it had a much larger impact on market volatility than other similar diseases, which led to modest, short-lived spikes in volatility or were hardly registered. Onali (2020) investigates the impact of COVID-19 on US stock market returns. According to his study, the changes in the number of cases and deaths in the US and six other countries do not have an impact on US stock market returns, apart from the number of cases reported for China. In turn, Albulescu (2020) searches for the effect of new cases of infection announcements and deaths ratio on the volatility index (VIX). The results of his study suggest that whereas the new cases of infection have a mixed effect on volatility, the death ratio positively affects VIX. Moreover, the spread of COVID-19 among countries can increase the volatility. Zaremba et al. (2020) investigate the impact of social restrictions imposed by governments on stock market volatility and determine that COVID-19 information campaigns and public events cancellations increase volatility the most.

There is also evidence of the impact of coronavirus crisis on different industries. Fernandes (2020) indicates that no sector is left untouched by the crisis. On the basis of year-to-date returns derived from Reuters Eikon for industries on the world stock markets, he shows that even the sectors considered traditionally to be stable, like utilities, pharmaceuticals, and tobacco, have recorded a drop in share prices. According to his study, the collapse in stock prices has been particularly hard for the following sectors: oil, gas and coal, travel and leisure, aerospace, mining, banking, and media. Moreover, the volatility of equity markets reached historically high levels.

Rameli and Wagner (2020) divide the COVID-19 crisis into three periods – incubation, outbreak, and fever – based on the dates of key events. Their study concerns US public equity market. In the whole period considered, energy and consumer services exhibit the worst situation when industry-level returns are concerned. Telecom services, food and staples retailing, and semiconductors performed relatively well. The study highlights the importance of corporate debt and cash holding in stocks valuation. In the fever period, highly leveraged firms and those with little cash holdings suffered more.

Research methods

The first concern of this study is how to measure fear on the Polish stock market. The Warsaw Stock Exchange is not publishing any implied volatility index derived from the WIG20 index option prices. The reason is the low level of liquidity on this market (Rudzki, 2008). However, there are some theoretical concepts of the volatility

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indexes for Polish stock market (see Rudzki, 2008). One of the concepts is WIV20, which is proposed by Rudzki (2008).

The WIV20 is a volatility index implied by the option prices on WIG20 index and it has been published since 22 September 2003 on artim.waw.pl. The value of WIV20 illustrates the investors' expectations according to volatility trends in the near future and might be treated as a measure of investors' sentiment in the stock market. The WIV20 implied volatility index for a given trading session is calculated as the weighted average of the obtained parameter values for all out-of-the-money options, according to the following formula:

$$WIV20 = \frac{\Sigma \sigma_i z_i v_i}{\Sigma z_i v_i} * 100\%$$

where:
σ_i – implied variability of the *i*-th option,
z_i – the price of the *i*-th option *P* or *C* as in determining the implied volatility,
v_i – trading volume for the *i*-th option on a given trading session.

The calculation of implied volatility for a single option is based on the option pricing model for European options of Black and Scholes with Merton's extension to the model, which takes into account the dividend yield (Rudzki, 2008). Thus, this index is based on data describing Polish capital market, in our study we use WIV20 index as a proxy of local investors' fear.

Additionally, we also used VIX index created by Whaley (1993). It is a measure of expected stock market volatility derived from option prices on the S&P 500 index. Currently, it is based on a static replication of a variance swap that uses all available options on the S&P 500 index with a specified expiry date. VIX is commonly used as a measure of fear not only in US market but also in other economies, which is explained by the connections between these markets in the global economy, thus, changes in one country influence the economy in others by market relations. We treat VIX index as an illustration of the global fear that Poland is part of on the one hand and is influenced on the other.

The research period is established between 2 January 2017 and 19 April 2020. Taking into account the course of the epidemic in Poland and the WIV20 trends, the following research sub-periods have been specified:

- 4–15 March 2020 – "the period of uncertainty", the highest increase in the WIV20 index value, started by the announcement of the first case of infection,
- 16–20 March 2020 – "a state of epidemic emergency", with a lockdown and decreasing tendency of WIV20,
- 21 March – 19 April 2020 – "a state of the epidemic", stabilization in the fear level.

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Figure 1 presents the WIV20 and VIX indexes and new daily cases of COVID-19 infection in Poland during the period analyzed. This shows the relation between epidemic growth in Poland and increasing fear in the local and global context.

Figure 1. WIV20 and VIX indexes (a proxy of fear) and new daily cases of COVID-19 infection in Poland

Source: Authors' own study on the basis of: https://www.worldometers.info/coronavirus/country/poland/; http://artim.waw.pl/wiv20/; http://www.tradingview.com

Note that there may be unconfirmed cases that were never reported to the public health authorities.

For several months before the COVID-19 crisis began, the level of WIV20 and VIX indexes had been relatively stable over time. The level of the indexes at that time (nearly 20%) is a reference point for further analyzes and may be considered a normal feature of the Polish economy. The fear began to increase after the occurrence of the first case of infection in Poland, which is naturally strongly expressed by WIV20. From the first COVID-19 death in Poland (4 March 2020), a sharp increase in the index was recorded. However, the upward trend was observed only until the introduction of the first restrictions.

The crucial point is around 16 March 2020 when the lockdown is announced (not only in Poland). This moment is highly pointed by both WIV20 and VIX, which illustrates the global sentiment. This confirms that the local fear does not come from the increasing number of new cases but rather from the government decisions in Poland and other countries. The growing fear was in effect "a fear of the unknown", not related to the health hazard. In this context, it is not surprising that despite the growing number of new infections and deaths, the indexes value fell.

From 20 March 2020, i.e. the day of the state of the epidemic announcement, the stabilization in the level of fear is observed. Although the epidemiological situation

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has not been improved and the number of infections is increasing, the index value is gradually returning to the pre-pandemic level. It can be assumed that the main cause of fear was the uncertainty caused by the epidemiological situation in the world. During this period in Poland, there were no other events, comparable in scale, that could increase anxiety. After the dynamically growing fear, there was a period of gradual accustoming to the new situation. The index value has been decreasing since the implementation of the first restrictions. Thus, we analyze the market reactions not in the context of a growing pandemic but in the context of fear that has occurred in the early beginning.

For the research period, we analyze the sector indices (the study also included risk analysis in the form of a beta sector) and the major stock indices (WIG[1] index and WIG20[2] index) noted on the Warsaw Stock Exchange (WSE) Main Market. The data is obtained from the stooq.pl portal (2020). Table 1 presents the descriptive statistics and a correlation coefficient between the selected indices and the fear index.

Table 1. Descriptive statistics and correlation in the period January 2017 – April 2020

	Mean	Standard deviation	Minimum	Maximum	Correlation with WIV20	Correlation with VIX
WIG – banking	7247.76	1031.75	3647.91	9205.47	-0.70879 ***	-0.6896 ***
WIG – construction	2509.68	560.25	1847.67	3724.92	-0.14723 ***	-0.3510 ***
WIG – chemical	11932.46	3089.87	4969.56	16814.67	-0.38476 ***	-0.5830 ***
WIG – energy	2443.33	546.62	999.33	3687.96	-0.48407 ***	-0.6391 ***
WIG – mining	3642.24	722.55	1567.96	5000.41	-0.50289 ***	-0.6571 ***
WIG – IT	2298.79	331.42	1861.75	3461.98	0.338073 ***	0.3879 ***
WIG – pharmaceuticals	5433.88	663.09	2461.49	6757.19	-0.68237 ***	-0.8010 ***
WIG – media	4979.34	369.02	3777.03	6550.02	-0.35062 ***	-0.2624 ***
WIG – automobiles & parts	4293.40	871.84	2297.59	5950.11	-0.38672 ***	-0.5909 ***
WIG – real estate	2147.74	158.74	1834.45	2618.68	-0.2902 ***	-0.1268 ***
WIG – clothes	6040.96	1086.94	2573.37	8234.44	-0.62129 ***	-0.6208 ***
WIG – oil & gas	6819.97	957.13	3287.44	8678.64	-0.61491 ***	-0.6349 ***
WIG – food	3648.93	538.14	2401.54	4919.98	-0.3277 ***	-0.5317 ***

[1] WIG index comprises all companies listed at the WSE Main List that meet base eligibility criteria.
[2] WIG20 index comprises 20 major and most liquid companies in the WSE Main List.

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	Mean	Standard deviation	Minimum	Maximum	Correlation with WIV20	Correlation with VIX
WIG – telecom	730.99	79.19	567.60	921.11	-0.02733	0.0354
WIG	58414.30	4936.19	37164.02	67529.39	-0.77364 ***	-0.8079 ***
VIW20	0.1994	0.0652	0.1413	0.9969	1.0000 ***	0.8585 ***
WIG20	2227.28	224.45	1305.73	2630.37	-0.74937 ***	-0.7769 ***
VIX	16.64	9.49	9.14	82.69	0.858515 ***	1.0000 ***

It is assumed that the parameter is statistically significant for every *p*-value smaller than 0.1, for increasing confidence intervals of 1% (***), 5% (**), and 10% (*), respectively.

Source: Authors' own study.

Descriptive statistics show that the main industries in Poland are correlated in a statistically significant manner with the fear index, except for the telecommunications sector. For all sector indices, except for WIG – IT, there is a negative correlation with WIV20, which means that the increase in the fear index is related to the fall in the prices of industry indices (and *vice versa*). The WIG – IT index has a positive correlation with WIV20, which means that the increase in implied volatility is related to the increase in WIG – IT quotations (and *vice versa*). The same conclusions may be formulated in relation to VIX. In addition, the correlation is strong, which means that the IT sector is affected by the fear of pandemic in local and global scale.

The relatively strong correlation is also observed between WIG – clothes, WIG – pharmaceuticals and WIG – oil & gas and WIV20 and VIX. These sectors also react strongly to the level of fear locally and globally, however this relation is negative. In the case of WIG – media and WIG – real estate, we may observe a very weak correlation with the fear index, VIX especially. It seems that these sectors are resistant to negative investors' sentiment and are characterized by some level of independence from the capital market. Only one sector – WIG telecom – is not correlated with fear measured by WIG20 and VIX indicators. The strong relation with VIX index might be a reason for the participation of foreign capital in particular sectors and strong market relations in the area of products and service deliveries.

Additionally, there was analyzed the correlation of fear, proxied by WIV20 and VIX, and mean changes in sector indices in particular periods: uncertainty, epidemic emergency, and epidemic. Based on the results, which are presented in Table 2, it can be concluded that there is a general evidence of a very strong and negative correlation between all stock market indices and fear indexes.

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Table 2. Correlation analysis in selected sub-periods for WIV20 and VIX

Selected indices	WIV20			VIX		
	uncertainty	epidemic emergency	epidemic	uncertainty	epidemic emergency	epidemic
WIG – banking	-0.9771	-0.8158	-0.2210	-0.3298	-0.9498	**0.2162**
WIG – construction	-0.9771	-0.4662	-0.6080	-0.3898	-0.3280	-0.9108
WIG – chemical	-0.9753	-0.5086	-0.6330	-0.5027	-0.7848	-0.8905
WIG – energy	-0.9853	-0.6200	-0.6062	-0.4914	-0.8988	-0.9009
WIG – mining	-0.9605	-0.8083	-0.6715	-0.5177	-0.9374	-0.8867
WIG – IT	-0.9531	-0.2375	-0.6239	**0.1162**	-0.3478	-0.8847
WIG – pharmaceuticals	-0.9517	-0.5205	-0.3999	-0.6618	-0.1745	-0.7999
WIG – media	-0.9667	-0.8436	-0.5465	-0.0280	-0.9781	-0.7104
WIG – automobiles & parts	-0.9955	-0.0609	-0.5724	-0.4817	-0.3958	-0.9139
WIG – real estate	-0.9632	**0.3226**	-0.6094	**0.1117**	**0.7476**	-0.6756
WIG – clothes	-0.9825	-0.9486	-0.6619	-0.2952	-0.8498	-0.7054
WIG – oil & gas	-0.9216	-0.7069	-0.4808	-0.3703	-0.9510	-0.9424
WIG – food	-0.9088	-0.8594	-0.6197	-0.4082	-0.9155	-0.9280
WIG – telecom	-0.9882	-0.6895	-0.5264	-0.0941	-0.9089	-0.7856
WIG	**-0.9762**	**-0.7495**	**-0.6404**	**-0.5932**	**-0.9361**	**-0.9243**
WIG20	-0.9724	-0.7881	-0.6182	-0.5395	-0.9608	-0.9223
WIV20	1	1	1	0.6461	0.8133	0.4852

Source: Authors' own study.

The strongest correlation is noted in the case of WIV20 during the sub-period 4–15 March 2020 (the period of uncertainty), during which the value of the correlation coefficient varies between -0.91 (WIG – food) and -0.99 (WIG – automobiles & parts). The negative correlation means that the increase of the WIV20 index is related to the drop in price levels of the analyzed stock market indices. Hence, one may conclude that during the period of uncertainty, when the implied volatility increases rapidly, investors' reactions are most strongly related to fear. In the remaining sub-periods, the correlation between the fear index and selected stock market indices is weaker.

VIX also negatively correlates with particular sectors (except for WIG – IT, and WIG – real estate), however, the correlation is much weaker in comparison to WIV20 in the period of uncertainty. WIV20 is better adjusted to changes in the capital market in the first period of uncertainty, what is visible in sectors correlations but also in WIG. The sensitivity to the first changes is greater, almost immediate, which results from the structure of the indicator itself, based on the variables describing the local stock market. The correlation with VIX at that time is much worse. In next sub-periods, changes in Polish capital market are better adjusted to VIX. This is a premise for further conclusion that it is important to use local indexes that describe investors' sentiment to have a quick response about changes in short-time perspectives (in our case it is two week sub-periods) which is especially important in times of uncertainty and very rapid changes that are taking place now during the pandemic. Unfortunately, this area of capital market indicators is not developed. Further results are presented below.

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Results

We conducted the analysis of the mean for all analyzed indices for the three sub-periods of the crisis (period of uncertainty, the state of epidemic emergency, and the state of the epidemic). The means for these sub-periods are compared with the means for the period preceding the COVID-19 pandemic (2 January 2017 – 3 March 2020) (Table 3).

Table 3. Comparison of means for the period before the pandemic and in sub-periods with a particular intensity of fear

Selected indices	Mean for the period				% change		
	The period preceding the COVID-19 crisis	The period of uncertainty	The state of epidemic emergency	The state of the epidemic	(B-A)/A	(C-A)/A	(D-A)/A
	2 January 2017 – 3 March 2020	4–15 March 2020	16–20 March 2020	21 March – 19 April 2020			
	A	B	C	D	E	F	G
WIG – banking	7511.09	5300.51	4211.58	4115.42	-29%	-44%	-45%
WIG – construction	2530.05	2135.83	1862.80	1999.42	-16%	-26%	-21%
WIG – chemical	12331.56	6048.50	5639.24	6417.24	-51%	-54%	-48%
WIG – energy	2537.12	1221.51	1175.05	1278.48	-52%	-54%	-50%
WIG – mining	3759.43	1999.23	1771.21	2023.45	-47%	-53%	-46%
WIG – IT	2238.87	2732.17	2608.45	2738.76	22%	17%	22%
WIG – pharmaceuticals	5581.90	3443.12	3240.33	3610.74	-38%	-42%	-35%
WIG – media	5000.02	5081.38	4133.32	4352.14	2%	-17%	-13%
WIG – automobiles & parts	4412.42	3070.91	2541.54	2596.47	-30%	-42%	-41%
WIG – real estate	2155.21	2330.60	2023.47	1911.25	8%	-6%	-11%
WIG – clothes	6255.51	3749.60	2742.96	3072.85	-40%	-56%	-51%
WIG – oil & gas	7004.91	3932.33	3778.51	4516.16	-44%	-46%	-36%
WIG – food	3716.49	2801.88	2504.68	2730.31	-25%	-33%	-27%
WIG – telecom	727.10	739.53	736.88	759.58	2%	1%	4%
WIG	59573.88	45084.39	39834.54	42466.95	-24%	-33%	-29%
WIG20	2280.49	1606.43	1425.99	1533.82	-30%	-37%	-33%

Source: Authors' own study.

In most cases, the mean levels of sector indices are lower in the pandemic period compared to the pre-pandemic period. Thus, we may conclude that the pandemic negatively influenced the capital market, however, it must be highlighted that the first negative changes appeared in the period of uncertainty and were caused rather by "fear of the unknown" than real economy changes that have happened later. However, there are two sectors that exhibit higher mean price levels in the period of crisis than before, i.e. WIG – IT, WIG – telecom.

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Figure 2 presents the mean changes in sector indices in the analyzed sub-periods. The sector indices are presented in ascending order according to the value of industry beta[3] coefficient in 2019 (the values of the beta coefficient are placed on the horizontal axis).

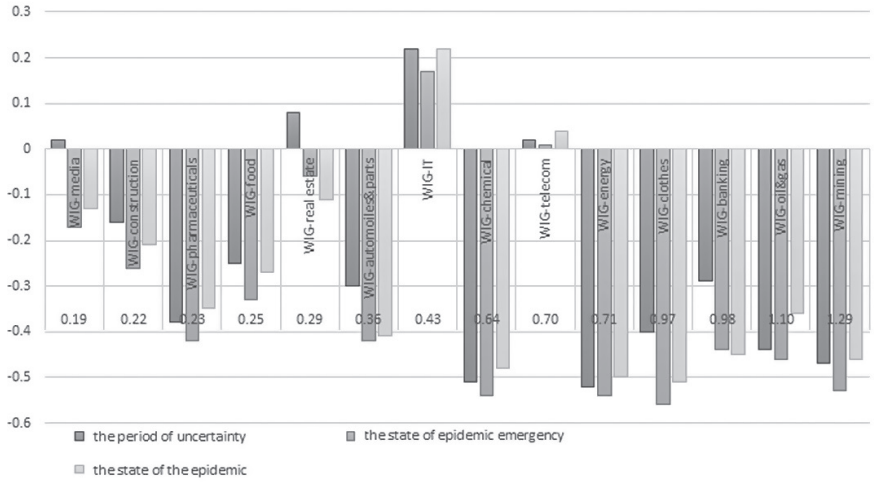

Figure 2. The beta changes in sector indices in the analyzed sub-periods

Source: Authors' own study based on https://stooq.pl and www.gpw.pl.

As it can be observed, the sector indices, which can be described as cyclical (oil & gas and mining), recorded large declines in their values in the analyzed sub-periods. However, there were also sector indices (i.e. chemical, energy, clothes), which fell even more, although they were characterized by an average beta coefficient lower than 1.

The two indices with the lowest value of the beta coefficient (i.e. media and construction) noted relatively low declines in their values. The media sector initially even gained in the period of uncertainty. However, there are also three sectors that are distinguished by better results and higher value of beta coefficient (i.e. real estate, IT, and telecom).

To detect any bias caused by seasonal economic cycles and trends that could coincide with the examined period, the corresponding periods in the preceding years (2017, 2018, 2019) are also analyzed (Table 4). We present the coefficient of variation for the analyzed indices in the period of COVID-19 crisis (4 February 2020 – 19 April 2020).

[3] Compared with the WIG20 index.

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Table 4. Coefficients of variation in the sub-period from March 4 to April 19 in 2017, 2018, 2019, and 2020

Data	Coefficient of variation in 2017	Coefficient of variation in 2018	Coefficient of variation for 2019	Coefficient of variation for 2020
WIG – banking	0.0234	0.0196	0.0134	0.1436
WIG – construction	0.0386	0.0188	0.0254	0.0694
WIG – chemical	0.0129	0.0229	0.0359	0.1198
WIG – energy	0.0275	0.0283	0.0453	0.0857
WIG – mining	0.0358	0.0638	0.0334	0.1140
WIG – IT	0.0128	0.0157	0.0209	0.0517
WIG – pharmaceuticals	0.0553	0.0295	0.0228	0.1374
WIG – media	0.0201	0.0092	0.0223	0.1180
WIG – automobiles & parts	0.0220	0.0175	0.0128	0.1222
WIG – real estate	0.0147	0.0060	0.0137	0.0998
WIG – clothes	0.0588	0.0262	0.0496	0.1600
WIG – oil & gas	0.0635	0.0292	0.0196	0.1218
WIG – food	0.0302	0.0147	0.0151	0.0736
WIG – telecom	0.0181	0.0128	0.0158	0.0584
WIG	0.0177	0.0175	0.0113	0.0824
VIW20	0.0922	0.0440	0.1006	0.3469
WIG20	0.0208	0.0207	0.0124	0.0845

Source: Authors' own study.

All sector indices show greater dispersion around the mean in the analyzed period of 2020, which clearly proves the substantial impact of fear caused by the COVID-19 crisis on the levels of individual indices. There are no seasonal effects for the period analyzed.

Discussion and conclusions

First of all, the results of the study show that the main Polish indexes – WIG and WIG20 – are strongly and significantly correlated with the fear proxied by WIV20 and VIX indexes. The same relation is observed for almost all sector indices (Table 1). It can be also noticed that in most cases the mean levels of sector indices are lower in the pandemic period compared to the pre-pandemic period (Table 3). These results support the hypothesis H0, which states that the fear is significantly related to the behaviour of investors as shown in the value of stock indices and the depth of sell-off.

Moreover, the results of the conducted analyzes indicate that in the short term, the impact of fear is the strongest, hitting all sectors of the economy, regardless of rational premises. The main source of fear seems to be not the growing number of infections (which is in line with Onali, 2020), but the uncertainty about the government's decisions. The increasing panic may have stemmed from concerns related to the periodic lack of authorities' decisions in the face of the pandemic. In the first half

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of March 2020, a negative and very strong correlation between the fear index and all analyzed stock indices (Table 2) was observed. This phenomenon can be explained by the Kahneman's quick and slow thinking that, in the face of a strong stimulus, indicates the existence of two different decision-making strategies (intuition and rational reasoning). Moreover, our results indicate that the correlation between the fear index (proxied by WIV20) and stock prices is more profound when the value of fear index surges than when it decreases. In other words, during the period of uncertainty, when the implied volatility increases rapidly, investors' reactions are most strongly related to fear. It is in accordance with Sarwar (2012) who indicates that stock prices react stronger to an increase in fear than a decrease. These findings support hypothesis H1, which states that in the short term there is a negative correlation between the fear proxied by WIV20 and VIX indexes and the value of sectoral indices. Additional analysis of the coefficient of variation confirmed a significant correlation of fear caused by the COVID-19 crisis with the level of individual indicators (Table 4).

During the COVID-19 crisis, most of the sector indices fell compared to the period preceding the crisis (the period of uncertainty – 10 out of 14 indices; the state of epidemic emergency and the state of epidemic – 12 out of 14 indices). We assume that these results may support the thesis that under uncertainty investors tend to focus on adverse scenarios (Cao et al., 2011).

According to hypothesis H2, it can be proved that negative impact of fear on the value of stock exchange indices in the long term is conditioned by a given industry. Indeed, the two sector indices, IT and telecom, did not decrease in any of the sub-periods of the COVID-19 crisis, compared to the pre-crisis period. Unlike Smales (2107), the telecom sector appeared to be insensitive to changes in investors' sentiment. The IT sector gained the most in all analyzed sub-periods. The construction, media, and real estate sectors seem to be not visibly affected by the crisis. Despite the common view that defensive stocks may do not fall even during the economic breakdown, some of the sectors described as defensive noted large drops during the COVID-19 crisis (i.e. chemical, energy, clothes).

The impact of the pandemic crisis on companies that are in the middle of long-term project realization, e.g. construction, may be delayed due to the fact that currently implemented activities are the result of investment planning and are often associated with securing the resources needed for the implementation of this investment. It means that in the moment of sudden economic events, the slowdown of already conducted investments is milder. Despite the fact that the background of the current pandemic crisis is of a health nature, it has not had a positive effect on WIG – pharmaceuticals. Investors' sentiment in this case is negative, although the increased demand for drugs and supplements was observed and research on the vaccine were undertaken. Thus, this sector recorded declines. This might be explained by the fact that a number of other medical activities have been temporarily blocked due to the limitations implemented in hospitals, reductions in prophylactic treatment, and cancellation of medical proce-

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dures. We also noticed that WIV20 better describes changes in Polish capital market in a short-time perspective (in our case it is two-week sub-periods) but later, a higher correlation with VIX is observed. This phenomenon suggests that factors based on local investment sentiment might have better use for predicting changes in an unstable and rapidly changing environment. This is recommended for further analysis.

Although our study is not free from limitations, these can be also seen as opportunities for future research. Our study shows the correlation between the fear and sector indices, but it does not fully prove the causality of the phenomenon. The influence of fear on sectoral indices is supported by literature review and analysis of the coefficient of variation. For future research, the use of more sophisticated methods, such as regression analysis, the Johansen cointegration test, or time series modelling, could provide deeper insights into the relationships between fear indexes and sector indices. Despite these limitations, the study contributes to the ongoing theoretical debate concerning fear spreading across the stock market.

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