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Precious Metals or Currencies? Which Perform Better as Hedge and Safe-Haven Assets Against the Polish Capital Market in Times of Elevated Risk?

Metale szlachetne czy waluty? Co działa lepiej
jako aktywa zabezpieczające lub aktywa „bezpiecznej
przystani” w stosunku do polskiego rynku kapitałowego
w czasach podwyższonego ryzyka?

Abstract

This paper investigates the diversification properties of precious metals and international currencies as potential hedge and safe-haven assets for investors trading on the Polish capital market from 2007 to 2023. We apply two statistical models: the Multivariate Factor Stochastic Volatility (MFSV) model and a regression model with dummy variables, in which the residual term is modelled as a GARCH process. The results indicate that international currencies are generally more effective than precious metals in mitigating portfolio risk on the Polish capital market. Hedge properties are observed for all analysed currencies, whereas safe-haven properties are identified only for the British pound and the Swiss franc. Among precious metals, only platinum exhibits safe-haven characteristics, while gold appears to provide the strongest hedging properties against stock portfolios. In the case of bond portfolios, gold and silver offer both hedge and safe-haven benefits. Overall, precious metals are better diversifiers for Polish bond investors, while currencies are better for stock investors on average. The results of quarterly data analysis show that both precious metals and currencies can serve as safe-haven assets during periods of market turmoil. However, the safe-haven properties of the analysed assets were stronger during the Global Financial Crisis period and weaker during the Russia-Ukraine war.

Keywords:

Poland, hedge, precious metals, safe-haven, international currencies

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Streszczenie

Celem artykułu jest zbadanie znaczenia metali szlachetnych i walut międzynarodowych w procesie dywersyfikacji portfela inwestycji na polskim rynku kapitałowym jako aktywów zabezpieczających oraz aktywów typu „bezpieczna przystań” w odniesieniu do polskiego rynku akcji i obligacji w okresie 2007–2023. Stosujemy dwa modele statystyczne: wielowymiarowy model stochastycznej zmienności i model regresji ze zmiennymi sztucznymi oraz resztami modelowanymi jako

Słowa kluczowe:

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proces GARCH. Nasze badania wykazują, że waluty międzynarodowe w większym stopniu niż metale szlachetne łagodzą ryzyko portfelowe na polskim rynku kapitałowym. Wszystkie analizowane waluty pełnią funkcję aktywów typu hedge, funkcja safe-haven jest zaś obserwowana tylko w odniesieniu do funta brytyjskiego oraz franka szwajcarskiego. Co ciekawe, tylko platyna wykazuje funkcję safe-haven, złoto w największym stopniu stanowi zabezpieczenie dla portfela akcji, a złoto i srebro działają jako aktywa typu hedge i safe-haven wobec portfela obligacji. Metale szlachetne stanowią lepsze aktywa dywersyfikujące portfel dla inwestorów na polskim rynku obligacji, z kolei waluty dla inwestorów na rynku akcji. Wyniki analizy w podziale na kwartały pokazują, że zarówno metale szlachetne, jak i waluty mogą stanowić aktywa typu safe-haven w okresach niestabilności na rynkach finansowych. Jednakże w przypadku niektórych aktywów atrybut bezpiecznej przystani był silniejszy w okresie globalnego kryzysu finansowego niż podczas agresji Rosji na Ukrainę.

Introduction

Safe-haven and hedge assets¹ allow investors to protect their portfolios during periods of market turmoil. Precious metals are considered low-risk investments due to their ability to hedge and offset risks in global financial markets. Their high economic value and ability to preserve value during inflationary periods and episodes of market stress make them attractive investment opportunities. Precious metals, especially gold and silver, are considered safe-haven assets because of the belief that they possess inherent value [Starr, Tran, 2007]. Traditionally, gold and silver have been considered substitutes for money [Batten et al., 2010] and are treated as both a store of value and a medium of exchange [Jain, Ghosh, 2013]. Their safe-haven characteristics are well documented in the academic literature, with gold frequently playing a central role in investment and monetary debates [O'Connor et al., 2015].

International currencies can also serve as safe-haven and hedge assets when global financial risk increases. Usually, the US dollar is regarded as a safe-haven currency during periods of financial turmoil. However, alongside the US dollar, the Japanese yen, Swiss franc and several other currencies are also considered hedge or safe-haven assets. The ability of a currency to fulfil the role of a safe haven stems largely from the participation of non-residents in foreign exchange markets. Investors tend to purchase currencies with high liquidity and broad international circulation during periods of elevated uncertainty, including the US dollar, euro, British pound, Japanese yen, Swiss franc, and Chinese renminbi. Most studies identify reserve currencies as the primary candidates for safe-haven and hedge assets [Sato, Nakata, 2024].

The main aim of the article is to examine precious metals and international currencies as potential hedge and safe-haven assets against two Polish market indicators – the stock market WIG index and the Polish bonds index – during periods of elevated risk between 2007 and 2023. Our research proceeds in several stages, each designed to provide a deeper understanding of the role of precious metals and currencies as hedge and safe-haven assets. The first, preliminary step is to calculate Pearson linear correlations, which assume that the rates of return are independent of each other. This allows us to see the overall strength and direction of the relationship between assets. Then we use a more advanced model: the Multivariate Factor Stochastic Volatility model (MFSV). The aim is to capture the dependencies between all assets simultaneously and to take into account the time dependencies of returns along with the volatility clustering effect. Hidden factor analysis enables us to capture the full relationship between all assets, which is not possible when analysing individual pairs. However, the model does not allow us to investigate the existence of a hedge or safe-haven effect using a statistical test. Therefore, in the next stage, we use a classic econometric tool based on a linear model with dummy variables. This allows us to verify the existence of a hedge or safe-haven effect using a statistical test.

¹ The terms *hedge asset*, *hedge function*, and *hedge attribute* are used interchangeably to describe the ability to reduce risk. See Feder-Sempach [2024] for further discussion.

Nevertheless, we cannot determine at which points of the long sample spanning several global financial crises, the safe-haven effect was stronger or weaker. Consequently, in the final stage of the analysis, we examine the safe-haven effect in a moving window in quarterly periods.

Our study reveals several important findings. First, the relationships between the Polish capital market and precious metals and international currencies are effectively captured through factor-loading analysis. Second, the results reveal an interesting pattern: international currencies appear to serve as better safe-haven assets for Polish stock market investors, whereas precious metals perform better for Polish bond market investors. Third, the analysis identifies periods during which safe-haven effects were particularly pronounced, including the Global Financial Crisis (GFC), the Eurozone crisis, the political uncertainty surrounding Brexit and the election of Donald Trump, the COVID-19 crisis, and the Russia-Ukraine war. The quarterly analysis provides a new perspective for Polish investors seeking to reduce portfolio risk during periods of heightened uncertainty.

This article contributes to the ongoing search for effective hedge and safe-haven assets. It extends previous research by comparing the interrelationships between the Polish stock and bond markets and potential hedge and safe-haven assets across multiple crisis periods. In the last few years, traditional investment strategies have become less effective in the face of elevated risk and uncertainty. Our study expands the existing literature by providing an in-depth analysis of the hedge and safe-haven properties of various precious metals and international currencies available on the Polish capital market under different market conditions.

The article is structured as follows: Section 1 introduces the topic; Section 2 reviews the literature; Section 3 describes the data, research sample and the factor loading analysis; Section 4 presents the hedge and safe-haven methodology; Section 5 discusses the empirical results, and the final section concludes the paper.

Literature review

The definition of safe-haven and hedge assets remains controversial in the academic literature, as there is no single economic theory that conclusively explains the existence of assets capable of maintaining or increasing their value during periods of market turmoil. In general terms, a safe-haven asset is defined as an asset that is either uncorrelated or negatively correlated with other assets during periods of financial stress [Baur, Lucey 2010; Baur, McDermott 2010]. This means that the decoupling of safe-haven assets from equity markets during normal periods is a necessary condition distinguishing them from risk-free assets [Baur, McDermott 2016]. This special attribute makes safe-haven assets a key instrument of portfolio optimisation, as they may compensate investors for losses during periods of market instability. By contrast, a hedge is an asset that is uncorrelated or negatively correlated with other assets or portfolios on average, regardless of the phase of the economic cycle.²

Precious metals are natural resources and are therefore subject to unlimited demand and limited supply. Due to these characteristics, together with the development of derivative markets, they have become an attractive investment alternative to stocks. The hedge and safe-haven properties of precious metals have been widely examined in relation to stock indices, exchange rates, and cryptocurrency investments. While the relationship between stock markets and gold has received substantial attention in the literature, silver, platinum, and palladium have been studied to a much lesser extent. Moreover, the interplay between precious metals and stock markets has been analysed from various perspectives, including external factors, empirical modelling approaches, and portfolio construction strategies. These relationships have also been investigated across different stock markets, primarily in advanced economies and, to a lesser extent, in emerging markets.

The stock-gold nexus was originally examined by Baur and McDermott [2010] with the use of quantile regression techniques. They found that gold was a hedge in the United States and European markets and a safe-haven in emerging markets. In a subsequent study, Baur and McDermott [2016] show that gold served

² For more, see Bogołębska, Feder-Sempach, Stawasz-Grabowska [2024]. Safe Assets in the Global Economy Supply, Demand and Financial Stability, Routledge, Chapter 1.

as a particularly strong safe-haven asset in the aftermath of the September 11, 2001 attacks and the collapse of Lehman Brothers in September 2008. The authors attribute investors' demand for gold to behavioural biases associated with its historical role as both a currency and a store of value. **Drake [2022]** finds that the commonly assumed negative correlation between gold returns and stock markets was not confirmed during either the Global Financial Crisis (GFC) or the COVID-19 pandemic, although it was observed during the 1990–1991 recession and the 2001 recession.

Azimli [2022] emphasises the dynamic connectedness among four commodities – copper, iron, gold, and silver – and 10 major global stock indices. The results indicate that silver outperformed gold as a safe-haven asset in the post-COVID-19 period. **Lucey and Li [2015]** provide evidence that, during periods of extreme distress in US stock and bond markets, silver, platinum, and palladium acted as safe havens when gold did not. In contrast, **Sikiru and Salisu [2021]** indicate that only gold served as a safe-haven asset during the COVID-19 pandemic. **Mokni et al. [2021]** show that, while gold plays a dominant role in hedging market uncertainty, precious metals exhibit heterogeneous responses during the COVID-19 crisis.

The relationship between stock markets and precious metals during the first two decades of the 21st century was examined by **Van et al. [2022]**. Using a conditional correlation MGARCH (multivariate generalised autoregressive conditional heteroskedasticity) framework and a happiness index as a proxy variable, they demonstrate that this approach facilitates exploration of the nexus between stock markets and precious metals during the COVID-19 period, whereas a bivariate GARCH model does not provide sufficiently robust empirical evidence. Their findings suggest that psychological and behavioural factors play an important role in these financial relationships. **Gustafsson et al. [2022]** highlight the hedging properties of gold and silver for clean energy stocks. The role of precious metals in sustainable investing is further examined by **Lei et al. [2023]**, who demonstrate that gold and palladium can serve as safe havens for ESG indices, with gold playing a particularly important role in ESG portfolio risk management.

Gencyurek and Ekinçi [2023] investigate the role of precious metals in risk management, diversification, hedging, and safe-haven investment strategies in the stock markets of the BRICS countries and Turkey using DCC-IGARCH-t models and rolling Hong causality tests with daily data from 2015 to 2022. Their findings indicate that all four precious metals are effective tools for risk management, although they are less efficient as hedging instruments. Furthermore, to mitigate risk during the COVID-19 pandemic, investors should increase the share of precious metals in their portfolios, with the exception of gold. These studies confirm that precious metals are too heterogeneous to be treated as a single asset class. **Korsah et al. [2025]** show, based on evidence from silver, platinum, and African stock markets, that precious metals exhibit varying hedge and safe-haven properties across different markets.

Mujtaba et al. [2024] examine the hedge and safe-haven properties of four commodity classes – precious metals, energy, agriculture, and livestock – for the United States and China at both the aggregate equity index and sectoral levels using daily data from 2014 to 2020. Their findings suggest that precious metals function only as weak safe havens for equity sectors in both China and the United States. Moreover, in the case of China, precious metals provide only weak hedging benefits for most sectors and for the Shanghai Composite Index (SCI).

Besides precious metals, various currencies have also been investigated as potential safe havens. The list of safe-haven currencies largely overlaps with the major reserve currencies, indicating the quasi-monopolistic role of the US dollar, followed by the euro, in fulfilling this function. Therefore, the determinants of safe-haven currency status are closely related to the determinants of international currency status [**Bogotębska et al., 2019**]. However, the global structure of foreign exchange reserves, which reflects the degree of currency internationalisation [cf. **Feder-Sempach et al., 2025**], does not fully explain the strong role of the Japanese yen and Swiss franc as safe-haven assets, while simultaneously overstating the role of the euro. **Ranaldo and Söderlind [2010]** and **Grisse and Nitschka [2015]** find that the Swiss franc and Japanese yen can effectively function as safe-haven currencies during crisis periods and market crashes, whereas other currencies appear to be highly correlated with stock markets.

Coudert, Guillaumin, and Raymond [2014], using daily data for 26 currencies issued by both advanced and emerging economies between 1999 and 2013, conclude that only the Japanese yen and the US dollar exhibit safe-haven properties. Hossfeld and MacDonald [2015], using monthly data spanning more than 26 years, find that the US dollar – and even more strongly the Swiss franc – qualify as safe-haven currencies. The empirical analysis conducted by Rasmus and Yamamoto [2016] using daily data indicates that, during the global financial crisis, the Japanese yen displayed the strongest safe-haven behaviour. Their findings also suggest that safe-haven currency behaviour is time-dependent, thereby supporting the theoretical predictions of Baur and Lucey [2010]. Importantly, spillovers also exist between foreign exchange markets and precious metals markets. Although the linkages between commodity and currency markets have been widely studied, the hedge and safe-haven properties of precious metals against currency fluctuations remain underexplored. Mensi et al. [2022], using quantile cross-spectral analysis, time-frequency spillover methods, and quantile regression techniques, show that all precious metals can serve as effective safe-haven assets and strong hedges against major currencies.

Interesting evidence for the Polish capital market is provided by Miłobędzki [2017], who showed that all analysed currencies – the euro, US dollar, British pound, Swiss franc, and Japanese yen – serve as strong hedges for stocks and as diversifiers for 10-year Polish government bonds under normal market conditions. Under extreme market conditions, all of these currencies acted as safe-haven assets for stocks listed on the Warsaw Stock Exchange and as either diversifiers or weak hedges for Polish bonds from 2005 to 2015. The analysis was conducted using an asymmetric GJR-GARCH model based on the framework proposed by Baur and Lucey [2010].

Data and sample description

In our research, we use daily closing prices from January 1, 2007 to December 31, 2023 for four precious metals: gold (xaupln), silver (xagpln), platinum (xptpln), and palladium (xpdpln), as well as five international currencies: the euro (eurpln), US dollar (usdpln), British pound (gbppln), Swiss franc (chfpln), and Japanese yen (jpypln). All daily quotations are denominated in Polish zloty (PLN). The analysis also includes two Polish market indices: the Warsaw Stock Exchange's WIG index (wig) and the Polish 10-year government bond yield (bondpln³).

Table 1. Descriptive statistics of logarithmic returns (multiplied by 100) of time series used in the study

	Mean	St. Dev.	Skewness	Kurtosis	Min	Q1	Median	Q3	Max
wig	0.01	1.27	-0.75	10.87	-13.53	-1.91	-0.61	0.04	-0.61
bondpln	0.00	1.74	0.19	12.81	-16.01	-2.50	-0.76	-0.02	-0.76
xaupln	0.03	1.16	0.19	10.13	-9.01	-1.66	-0.54	0.01	-0.54
xagpln	0.02	1.82	-0.79	12.20	-18.88	-2.70	-0.80	0.05	-0.80
xptpln	0.00	1.48	-0.45	8.89	-12.40	-2.23	-0.77	0.01	-0.77
xpdpln	0.04	2.05	-0.59	11.00	-20.07	-3.02	-0.96	0.08	-0.96
eurpln	0.00	0.53	0.14	9.94	-3.60	-0.74	-0.24	-0.01	-0.24
usdpln	0.01	0.87	0.11	7.57	-6.92	-1.27	-0.45	-0.02	-0.45
gbppln	0.00	0.71	0.11	5.92	-4.05	-1.10	-0.40	-0.02	-0.40
chfpln	0.01	0.73	-0.18	12.16	-7.95	-1.01	-0.33	0.00	-0.33
jpypln	0.00	1.03	0.51	10.76	-7.73	-1.46	-0.51	-0.04	-0.51

Notes: gold (xaupln), silver (xagpln), platinum (xptpln), palladium (xpdpln), euro (eurpln), US dollar (usdpln), British pound (gbppln), Swiss franc (chfpln), Japanese yen (jpypln).

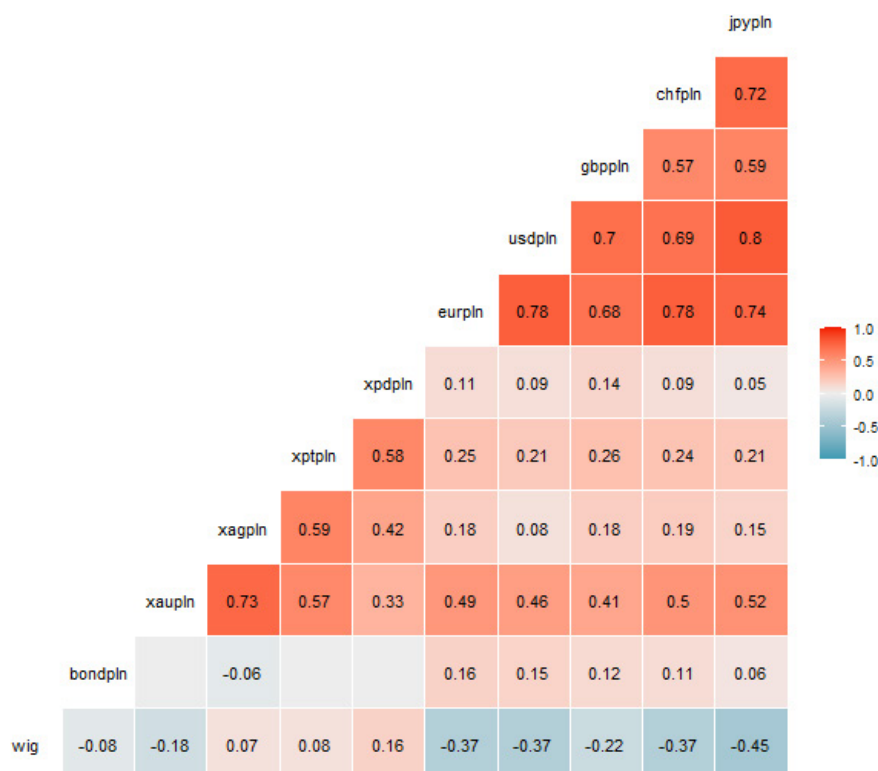
Source: Authors' own elaboration.

³ Polish 10-year government bond yield (10YPLY.B).

Table 1 presents descriptive statistics for the logarithmic return series used in the study. A comparison of the values of precious metals and currencies indicates that precious metals exhibit higher standard deviations and kurtosis, as well as larger maximum declines and increases within the sample period. This suggests that precious metals are subject to greater volatility and have more extreme outliers than currencies.

Figure 1 shows Pearson correlation coefficients calculated for the series used in the study based on the entire sample. The results indicate that international currencies are, on average, negatively correlated with the WIG index, with the strongest negative correlation observed for the Japanese yen and the weakest for the British pound. Precious metals, by contrast, are only weakly correlated with the WIG index, with gold being the only metal exhibiting a negative correlation. For bonds, the opposite relationship is observed: international currencies are positively correlated with the bond index, whereas precious metals are either uncorrelated or only weakly negatively correlated with the bond index. These preliminary results indicate that currencies can act as a hedge for WIG investments, while precious metals may provide hedging benefits for bond investments over the long term. In the further part of the study, these relationships are examined in greater detail, particularly during periods of market decline, which is crucial for identifying safe-haven assets.

Figure 1. Correlogram of time series used in the study. Pearson linear correlation coefficients not statically significant at the 0.1 level were omitted



Notes: gold (xaupln), silver (xagpln), platinum (xptpln), palladium (xpdpln), euro (eurpln), US dollar (usdpln), British pound (gbppln), Swiss franc (chfpln), Japanese yen (jpypln).

Source: Authors' own elaboration.

Research methodology

As noted above, the primary objective of this study is to examine whether international currencies and precious metals can be used as hedges against investments in the WIG index and Polish government bonds. This objective is pursued in two stages. In the first stage, the dynamic correlations among the assets included in the sample are analysed using the Multivariate Factor Stochastic Volatility (MFSV) model proposed by **Kast-**

ner et al. [2017]. This framework combines two important statistical tools: principal component analysis and stochastic volatility modelling. Consequently, we can reduce the state-space of the analysed assets to a lower-dimensional orthogonal latent factor space, and simultaneously we can study the time-varying correlation for each pair of assets. The MFSV model has been applied in several empirical studies, including analyses of correlations among cryptocurrencies [Shi et al., 2020], research on cryptocurrencies as an independent asset class [Sifat, 2021], and studies investigating gold, Bitcoin, and international currencies as strong safe-haven assets for major global stock markets [Feder-Sempach et al., 2024]. In contrast to this last study, however, we use the MFSV model primarily to examine the dependence of individual assets on the main latent factors and, consequently, to identify hedge assets rather than safe-haven assets. In the second stage, the findings from the MFSV analysis are compared with results obtained using a classical econometric tool: a regression model with dummy variables, as in Baur and Lucey [2010]. However, the identification of safe-haven assets requires not only estimates based on the full sample, but also the detection of periods during which correlations become significantly negative. Consequently, the second part will be extended with rolling regressions, as in Ciner et al. [2013] and Lucey and Li [2015].

The MFSV model can be presented in the form of a system of equations:

$$\begin{cases} y_t = \Lambda f_t + U_t (h_t^U)^{\frac{1}{2}} \epsilon_t \\ f_t = V_t (h_t^V)^{1/2} \xi_t \end{cases}, \quad (1)$$

where $y_t = (y_{1t}, \dots, y_{mt})^T$ is the zero-mean vector of m observed logarithmic returns, and $f_t = (f_{1t}, \dots, f_{rt})^T$ represents the vector of r unobserved latent factors. Furthermore, Λ is the $m \times r$ dimensional factor-loading matrix. $U_t (h_t^U) = \text{diag}(\exp(h_{1t}), \dots, \exp(h_{mt}))$ is the $m \times m$ diagonal matrix of series-specific (idiosyncratic) variances, while $V_t (h_t^V) = \text{diag}(\exp(h_{m+1t}), \dots, \exp(h_{m+rt}))$ is the $r \times r$ diagonal matrix of latent factor variances [Kastner et al., 2017]. Both idiosyncratic and latent factor innovations are assumed to be independent standard multivariate distributions: $\epsilon_t \sim N(0, I_m)$, $\xi_t \sim N(0, I_r)$. The logarithms of variances follow an autoregressive process of order one:

$$\begin{cases} h_{it} = (1 - \phi_i)\mu_i + \phi_i h_{i,t-1} + \sigma_i \eta_{it}, & i = 1, \dots, m, \\ h_{m+j,t} = \phi_{m+j} h_{m+j,t-1} + \sigma_{m+j} \eta_{m+j,t}, & j = 1, \dots, r. \end{cases} \quad (2)$$

The model was estimated using the Bayesian approach with the R CRAN package *factorstochvol* [Hosszejni, Kastner, 2021]. Under Bayesian inference, all model parameters are treated as random variables. Thus, instead of point estimates, we obtained whole posterior distributions based on Markov Chain Monte Carlo (MCMC) draws. The model was estimated by means of 10,000 draws with thinning 10 plus 1,000 discarded burn-in draws. We used priors from Kastner et al. [2017].

In the second stage, we use classical frequentist inference and estimate the parameters of the following regression model with dummy variables proposed by Baur and Lucey [2010]:

$$r_{k,t} = a + b_1 r_{stock,t} + b_2 r_{stock,t(q)} + c_1 r_{stock,t} + c_2 r_{stock,t(q)} + e_t, \quad (3)$$

where $r_{k,t}$, $r_{stock,t}$ represent the logarithmic returns of metals and stock respectively. The terms $r_{stock,t(q)}$ account for the asymmetries of positive and negative (extreme) shocks and are included in order to focus on periods of declining stock markets. In particular, we analyse the role of metals in times of stress or extreme stock market situations and include regressors that contain stock returns falling within the lower $q\%$ quantiles, such as the 5%, 2.5% and 1% quantiles. If a return is larger than the $q\%$ quantile, the value of $r_{stock,t(q)}$ is zero. If different thresholds are estimated simultaneously, the parameters b_2 can be viewed as a vector. Finally, in order to better capture the arrival of new information into the markets we assume error term e_t following the asymmetric GJR-GARCH (r,s) process of Glosten et al. [1993]

$$h_t = \omega + \sum_{i=1}^r \alpha_i e_{t-i}^2 + \sum_{i=1}^r \beta_i e_{t-i}^2 D(e_{t-i} > 0) + \sum_{j=1}^s \gamma_j h_{t-j} \quad (4)$$

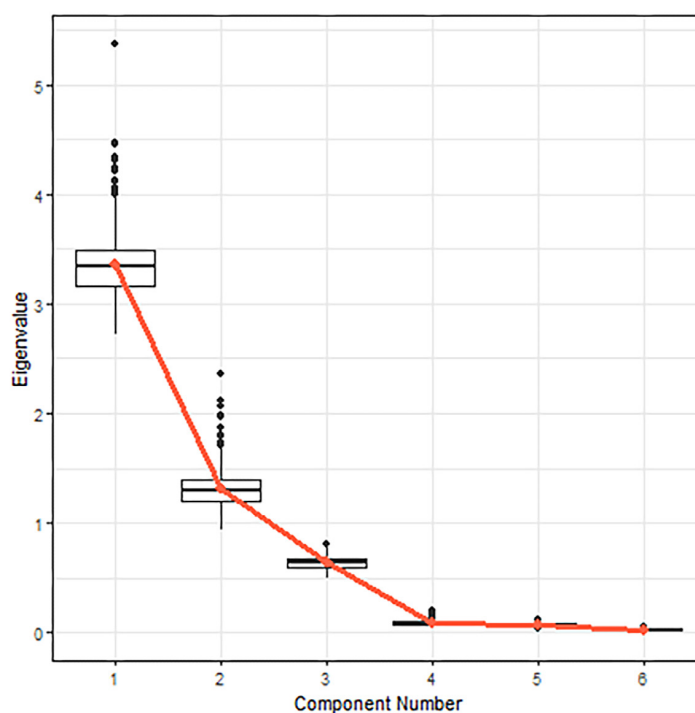
with the error term assumed to follow a Generalized Error Distribution (GED).

Results and discussion

Safe-haven and hedge status in full sample period

We begin by discussing the results obtained from the factor-loading analysis. This allows us to investigate safe-haven and hedge relationships that cannot be observed directly. Factor loadings quantify the extent to which a variable is related to a given factor. Factor analysis makes it possible to reduce a multidimensional observation space into a lower-dimensional and orthogonal (uncorrelated) latent factor space. The factors are ordered so as to maximise the volatility explained by the model.

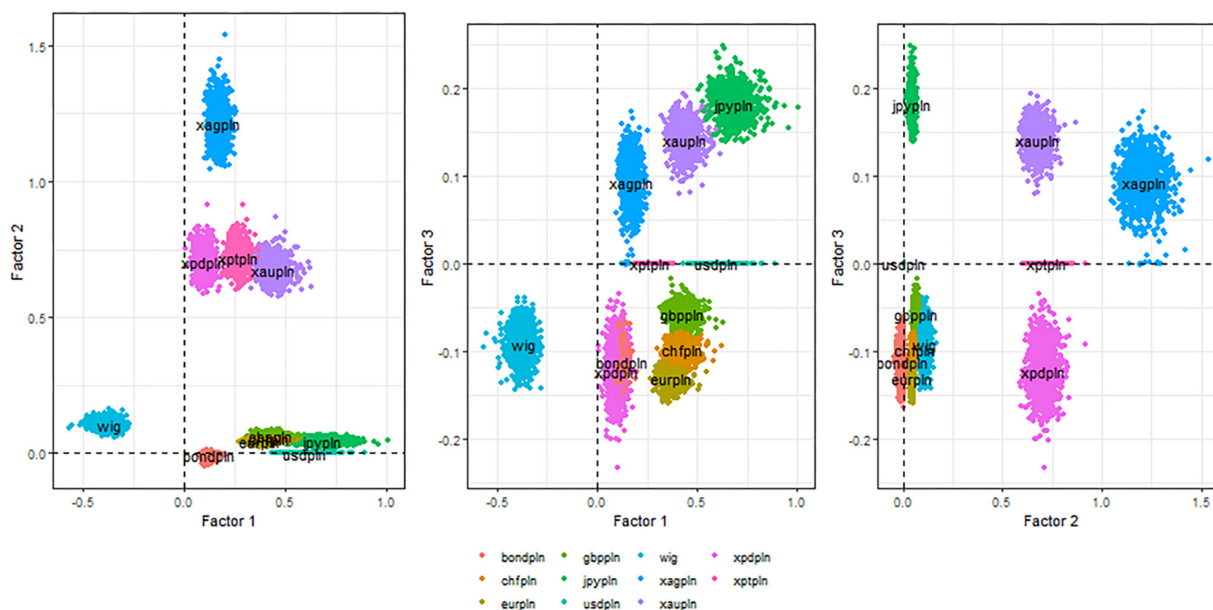
Figure 2. Posterior draws (boxplots) and posterior means (grey dots) of the eigenvalues of $\Lambda^T \Lambda$



Source: Authors' own elaboration.

The factor-loading analysis captures the relationships between each precious metal or selected currency, and stock indices and the underlying factor. We distinguished three principal factors (see the scree plot of the eigenvalues of $\Lambda^T \Lambda$ in Figure 2) to explain the complex concept of potential safe-haven and hedge assets and their relationship with the main Polish market indices. Although the factor-loading state space is three-dimensional, the results are presented in two-dimensional posterior distribution plots to facilitate interpretation (see Figure 3). The mean factor loadings are reported in Table 2.

Figure 3. The joint two-dimensional posterior distributions of factor loadings: monochrome clouds consist of MCMC draws; names of series placed in posterior means



Source: Authors' own elaboration.

Table 2. Posterior means and 95% credible posterior interval in parenthesis of factor loadings (x entries are set to zero by restriction)

	Factor1	Factor2	Factor3
wig	-0.372 (-0.450, -0.308)	0.107 (0.077, 0.137)	-0.092 (-0.128, -0.056)
bondpln	0.120 (0.092, 0.152)	-0.006 (-0.031, 0.004)	-0.111 (-0.143, -0.080)
xaupln	0.439 (0.365, 0.529)	0.677 (0.608, 0.750)	0.142 (0.110, 0.173)
xagpln	0.168 (0.118, 0.223)	1.215 (1.093, 1.347)	0.093 (0.038, 0.141)
xptpln	0.269 (0.220, 0.326)	0.723 (0.645, 0.807)	x
xpdpln	0.095 (0.049, 0.149)	0.705 (0.624, 0.792)	-0.123 (-0.173, -0.070)
eurpln	0.368 (0.312, 0.439)	0.043 (0.033, 0.053)	-0.131 (-0.149, -0.115)
usdpln	0.592 (0.499, 0.707)	x	x
gbppln	0.424 (0.357, 0.503)	0.064 (0.050, 0.079)	-0.057 (-0.074, -0.040)
chfpln	0.420 (0.355, 0.503)	0.053 (0.041, 0.065)	-0.099 (-0.117, -0.082)
jpypln	0.680 (0.571, 0.817)	0.044 (0.027, 0.062)	0.183 (0.150, 0.214)

Notes: The following colour convention was used: green – when 95% credible posterior interval does not contain 0 and is above zero, which indicates a positive association with the hidden factor (the higher the average value, the stronger the association); blue – when the 95% credible posterior interval contains 0, indicating a lack of dependence (correlation) with the hidden factor; red – when 95% credible posterior interval does not contain 0 and is below zero, which indicates a negative relationship with the factor (negative correlation).

Source: Authors' own elaboration.

Interpreting the latent factors is a crucial step in understanding the underlying structure of the data. The first latent factor can be interpreted as an *international currency factor*. All analysed currencies load strongly on this factor, suggesting that their behaviour is influenced by similar economic forces. The behaviour of international currencies, such as the euro, US dollar, British pound, Swiss franc, and Japanese yen, is primarily driven by supply and demand conditions in foreign exchange markets. Factors such as interest rates, inflation, economic growth, political stability, and market sentiment shape exchange rate movements from the perspective of investors [Trancoso, Gomes, 2023]. Precious metals also load positively on the first factor, although to a much smaller extent. Gold represents an important exception, as it is very strongly linked to the first factor, as strongly as currencies. This may be explained by the historical role of gold within the international monetary system and by the fact that gold remains an important component of central banks' foreign exchange reserves [Arslanalp et al., 2023]. The WIG index is the only analysed asset that loads negatively on the first factor.

The second latent factor may be interpreted as a *precious metals factor*, as it is strongly associated with all analysed precious metals. Precious metal returns exhibit strong positive loadings on this factor, suggesting that their prices are influenced by common economic forces. Precious metal prices depend on numerous factors, including macroeconomic indicators, political and geopolitical developments, and market supply and demand conditions. Although the determinants vary across individual metals and time periods, real GDP growth and interest rates are generally regarded as key drivers of precious metal markets. Moreover, monetary policy plays a particularly important role in determining gold prices. Central bank decisions regarding interest rates and inflation may significantly influence precious metal valuations; for example, a 10-basis-point increase in the US monetary policy rate may reduce commodity prices by between 0.5% and 2.5% after 18–24 business days [Miranda-Pinto et al., 2023].

The relatively weak correlations between precious metals and stock indices, exchange rates, bond yields, and crude oil prices suggest potential hedging properties of precious metals [Stephanie et al., 2023]. However, currencies are also related to the second latent factor, but to a lesser extent. In this context, the dominant role of the US dollar as the primary currency for precious metals trading should be noted. Commodity prices often display a negative relationship with the US dollar [Rees, 2023]. Notably, the bond index is the only analysed asset exhibiting insignificant loadings on the second factor.

The third factor is more difficult to interpret but is strongly connected with the Japanese yen, gold, and silver. The Japanese yen is positively related to all three factors, highlighting its strong independence from the remaining assets. The yen is the third most traded currency in international foreign exchange markets, primarily due to the strength of the Japanese economy as a leading exporter of goods such as automobiles, electronics, and machinery. The Japanese economy is deeply integrated into global trade, and a weaker yen can boost exports by making Japanese goods more affordable abroad. One of the key determinants of the yen exchange rate is Japan's monetary policy. The Bank of Japan maintained an ultra-loose monetary policy with very low or even negative interest rates for an extended period in order to stimulate economic growth, which may explain the distinctive behaviour of the yen relative to other reserve currencies [Chen, 2024]. Additionally, carry trade strategies aimed at borrowing in yen and investing in higher-yielding assets may contribute to yen exchange rate dynamics [Sato, Nakata, 2024]. Importantly, the third factor is negatively associated with both the WIG index and the bond index, which means it could potentially diversify Polish investment portfolios.

The WIG index is negatively related to both the first and third latent factors, indicating behaviour distinct from that of international currencies. This means that the first and third factors may serve as hedges for investments in the WIG index during the sample period. Consequently, international currencies and gold, which are strongly positively related to the first factor, may be regarded as potential hedge and safe-haven assets against investments in the WIG index. By contrast, Polish bond yields seem to be unrelated to the second factor and negatively associated with the third factor. This suggests that both the second and third factors may provide hedging benefits for bond investments. As a result, precious metals that are positively related to the second factor – particularly gold and silver, which are also positively associated with the third factor – may serve as potential hedge and safe-haven assets for Polish bond portfolios.

Table 3. Estimation results for the regression model with dummy variables and with residual term modelled as a GARCH process given by Equations (3) and (4) for precious metals

	xaupln			xagpln			xptpln			xpdpln		
	estimates	std. error	t-stat.	estimates	std. error	t-stat.	estimates	std. error	t-stat.	estimates	std. error	t-stat.
wig	-0.1103	0.0118	-9.3479***	0.0573	0.0114	5.0147***	0.0365	0.0197	1.8571*	0.1528	0.0213	7.1724***
wig_5	-0.0341	0.0348	-0.981	-0.0106	0.0087	-1.2204	0.0391	0.0697	0.5613	0.012	0.0255	0.4707
wig_2.5	0.0728	0.0332	2.1924**	0.1252	0.0245	5.1079***	0.0698	0.0921	0.7573	0.171	0.047	3.6401***
wig_1	-0.0159	0.0692	-0.2291	0.0412	0.0501	0.8235	-0.1312	0.0703	-1.8668*	-0.0932	0.0872	-1.0691
bondpln	-0.0374	0.0094	-3.9679***	-0.0504	0.0207	-2.4324**	-0.0081	0.0144	-0.5642	0.0148	0.0159	0.9286
bondpln_5	0.0002	0.0286	0.008	-0.0476	0.0157	-3.028**	0.0046	0.0503	0.0921	-0.1239	0.3169	-0.391
bondpln_2.5	0.0184	0.0419	0.4393	0.1643	0.0247	6.6627***	0.0257	0.062	0.415	0.1758	0.4018	0.4376
bondpln_1	-0.0159	0.0385	-0.413	-0.0092	0.0299	-0.3068	0.003	0.0554	0.055	-0.0221	0.0687	-0.3213
wig_lag1	-0.0219	0.009	-2.4339**	-0.0229	0.0071	-3.2314***	0.0081	0.0192	0.4225			
wig_5_lag1	0.0268	0.0142	1.8852*	-0.0567	0.0093	-6.1083***	-0.0074	0.0669	-0.1106			
wig_2.5_lag1	-0.0583	0.0945	-0.6166	0.0568	0.0093	6.0959***	0.0081	0.0851	0.0958			
wig_1_lag1	0.0757	0.0994	0.7612	0.0871	0.014	6.2231***	0.0801	0.0779	1.0282			
bondpln_lag1	-0.0154	0.0074	-2.0888**	-0.0154	0.0236	-0.6517	-0.0222	0.0131	-1.6961*			
bondpln_5_lag1	-0.0019	0.0076	-0.2442	0.0676	0.0457	1.4782	0.0519	0.0354	1.4672			
bondpln_2.5_lag1	0.0125	0.007	1.7909*	-0.1209	0.0067	-18.1163***	-0.0304	0.0205	-1.4784			
bondpln_1_lag1	-0.0236	0.0116	-2.0333**	-0.0071	0.0462	-0.1527	-0.0193	0.0431	-0.4471			
ω	0.0168	0.0042	3.9479***	0.036	0.0046	7.7611***	0.0233	0.0079	2.9588***	0.0713	0.0195	3.6509***
α_1	0.0892	0.0123	7.2454***	0.0808	0.0074	10.8519***	0.0696	0.0125	5.5838***	0.0903	0.0145	6.2295***
β_1	0.9085	0.0113	80.4601***	0.9294	0.0032	290.5697***	0.9303	0.0123	75.4936***	0.9083	0.0135	67.3612***
ω_i	-0.0215	0.0141	-1.529	-0.0417	0.0113	-3.7048***	-0.0222	0.0109	-2.0314*	-0.03	0.0135	-2.2235*
Shape (GED)	1.2873	0.0364	35.3568***	1.1583	0.0332	34.8889***	1.4449	0.0429	33.6987***	1.3279	0.0381	34.8568***

Notes: ***, **, * indicate statistical significance at the 0.01, 0.05 and 0.10 level respectively.

Source: Authors' own elaboration.

Table 4. Estimation results for the regression model with dummy variables and with residual term modelled as a GARCH process given by Equations (3) and (4) for international currencies

	eurpln			usdpln			gbppln			chfpln			jpypln		
	estimates	std. error	t-stat.	estimates	std. error	t-stat.	estimates	std. error	t-stat.	estimates	std. error	t-stat.	estimates	std. error	t-stat.
wig	-0.0963	0.0062	-15.5819***	-0.1675	0.011	-15.1882***	-0.1007	0.0094	-10.7122***	-0.1025	0.0081	-12.6418***	-0.2456	0.0135	-18.1514***
wig_5	-0.0181	0.0204	-0.8899	0.0086	0.0386	0.2223	0.0569	0.0241	2.361**	0.0391	0.0088	4.4612***	-0.0406	0.0367	-1.1053
wig_2.5	-0.012	0.0275	-0.4378	-0.0717	0.0634	-1.1315	-0.0656	0.0304	-2.1535*	-0.0787	0.0202	-3.8991***	-0.0613	0.0462	-1.3259
wig_1	-0.0023	0.025	-0.0922	0.0175	0.0561	0.3128	0.0154	0.0329	0.4687	0.0412	0.0344	1.1975	0.0524	0.0454	1.1547
bondpln	0.0275	0.0036	7.6478***	0.0396	0.0073	5.4226***	0.0369	0.0065	5.667***	0.0127	0.0059	2.1517**	-0.0243	0.0067	-3.6151***
bondpln_5	-0.0151	0.0063	-2.3904**	-0.0402	0.0223	-1.7985*	-0.0469	0.0195	-2.4005**	0.0104	0.0151	0.6869	0.0041	0.0108	0.377
bondpln_2.5	0.0094	0.0132	0.7104	0.0223	0.0273	0.8178	0.0394	0.025	1.572	-0.0037	0.0208	-0.1756	0.0034	0.013	0.2601
bondpln_1	-0.0243	0.0074	-3.273***	-0.0025	0.0251	-0.0991	-0.0161	0.0235	-0.6869	0.0042	0.0191	0.2222	-0.0029	0.0227	-0.1298
wig_lag1	-0.012	0.0055	-2.1821**				-0.0085	0.0097	-0.8798	-0.0022	0.0079	-0.2737	-0.0041	0.0092	-0.4442
wig_5_lag1	0.0171	0.0171	0.9989				0.0293	0.0263	1.1131	0.0065	0.0126	0.5136	0.0232	0.0209	1.1137
wig_2.5_lag1	-0.0239	0.0261	-0.9153				-0.0226	0.0337	-0.6712	-0.0675	0.0088	-7.654***	-0.0479	0.0262	-1.8332*
wig_1_lag1	0.0267	0.0251	1.0601				0.0303	0.0303	1.0001	0.0719	0.0163	4.4109***	0.0519	0.0444	1.17
bondpln_lag1	-0.01	0.0035	-2.8393***				0.0043	0.0066	0.6479	-0.003	0.0051	-0.5967	-0.0016	0.0064	-0.2538
bondpln_5_lag1	-0.0071	0.0111	-0.6407				-0.0337	0.0282	-1.1929	-0.0094	0.0164	-0.5735	-0.0224	0.0041	-5.5263***
bondpln_2.5_lag1	-0.0009	0.015	-0.0627				-0.008	0.0381	-0.2088	-0.0088	0.013	-0.6753	0.0071	0.0102	0.6987
bondpln_1_lag1	0.0202	0.0139	1.4471				0.0445	0.0256	1.7408*	0.0402	0.0191	2.1036*	0.028	0.0106	2.6342**
ω	0.0021	0.0006	3.4859***	0.004	0.0014	2.8604***	0.0096	0.0024	3.9086***	0.0061	0.0014	4.237***	0.009	0.0026	3.5276***
α_1	0.1019	0.0137	7.4349***	0.0616	0.0096	6.4131***	0.0939	0.0138	6.8035***	0.1205	0.0151	7.9847***	0.0872	0.0144	6.0655***
β_1	0.9027	0.0123	73.5384***	0.9426	0.0086	109.3479***	0.9014	0.0132	68.0561***	0.8888	0.0124	71.4412***	0.9098	0.0129	70.6144***
ω_i	-0.0281	0.0137	-2.0491**	-0.0212	0.0097	-2.1887**	-0.0327	0.0142	-2.3014*	-0.0465	0.0163	-2.856***	-0.0144	0.0141	-1.0165
Shape (GED)	1.4387	0.0442	32.5191***	1.5435	0.0482	32.0053***	1.5111	0.0456	33.1311***	1.4471	0.044	32.8878***	1.411	0.0407	34.6804***

Notes: ***, **, * indicate statistical significance at the 0.01, 0.05 and 0.10 level respectively.

Source: Authors' own elaboration.

In the second part of the analysis, we compare the factor-loading results obtained from the first part with the classical approach from [Baur and Lucey \[2010\]](#). Tables 3 and 4 show the estimation results from Equations (3) and (4) for precious metals and international currencies respectively. The lag length is selected using the Akaike Information Criterion. Following [Baur and Lucey \[2010\]](#), we identify a hedge effect when the estimate of b_1 is statistically significant and negative, and a safe-haven effect when the sum of significant estimates of b_1 and b_2 from Equation (1) is negative.

The results reported in Table 3 indicate that the hedge function of precious metals is observable for gold against the WIG index and gold and silver against bond yields. This is consistent with the results obtained in the principal component analysis: gold was the only precious metal strongly associated with the first factor, which is negatively linked to the WIG index. Furthermore, among precious metals, gold and silver exhibited the strongest association with the third factor, which is negatively connected with the bond index.

Table 4 demonstrates that the hedge function of international currencies is considerably more pronounced in the Polish stock market. All analysed currencies – the euro, US dollar, British pound, Swiss franc, and Japanese yen – exhibit hedging attributes against the WIG index. In the case of bond portfolios, only the Japanese yen functions as a hedge, confirming that the yen behaves differently from the remaining international currencies. These findings are again consistent with the factor-loading analysis, as all currencies were positively connected with the first factor, whereas only the yen was strongly associated with the third factor.

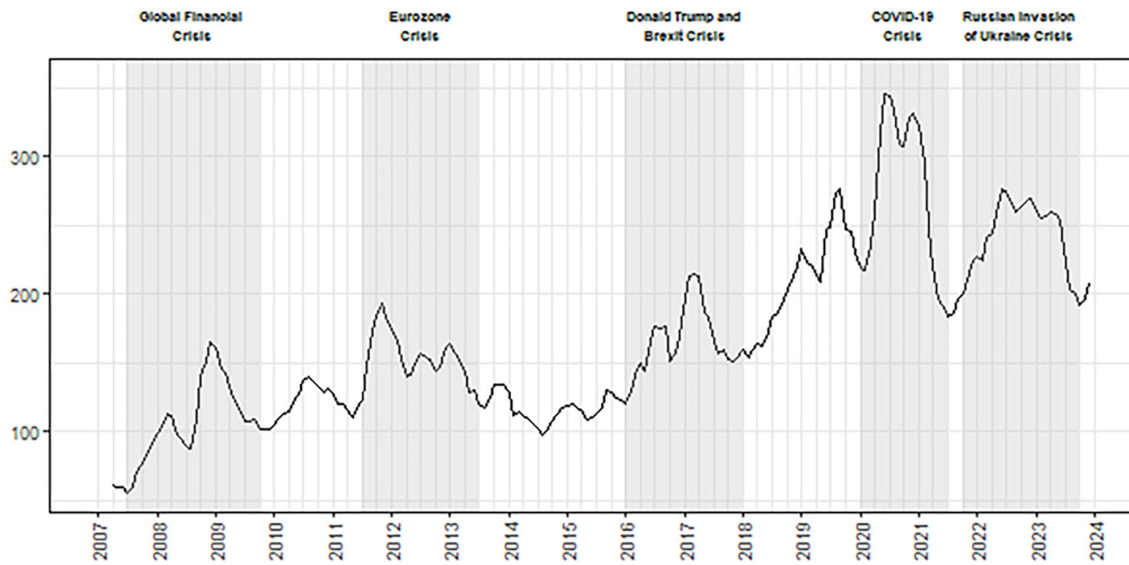
Regarding safe-haven properties, platinum exhibits safe-haven attributes against the WIG index. Interestingly, gold and silver display safe-haven properties on the Polish bond market after one day of trading. Similarly, the British pound and Swiss franc exhibit contemporaneous safe-haven properties against the WIG index, while the Japanese yen displays this property after one trading day. Furthermore, the euro, US dollar, and British pound demonstrate safe-haven properties against Polish bond yields. Overall, the factor-loading analysis finds that international currencies provide stronger diversification benefits for portfolios constructed on the Polish capital market than precious metals, particularly in the case of stock portfolios.

Safe-haven status in subsample period

Following [Lucey and Li \[2015\]](#), we estimate the time-varying safe-haven status of precious metals and international currencies from Q1 2007 to Q4 2023. For each quarter, we re-estimate Equation (3). The use of quarterly data facilitates a clearer identification of the periods during which individual precious metals and currencies function as safe-haven assets. Figures 4–6 and Tables 5–6 report the sums of statistically significant negative coefficients, which indicate periods during which precious metals and currencies enter safe-haven status against Polish stock and bond markets. Based on the Global Economic Policy Uncertainty Index,⁴ several major periods of elevated global risk affecting Polish capital market investors can be identified: the Global Financial Crisis (2007–2009), the Eurozone crisis (2011–2013), the political uncertainty surrounding Brexit and the first election of Donald Trump (2016–2017), the COVID-19 crisis (2020–2021), and Russia's invasion of Ukraine (2021–2023). These periods are highlighted in grey in Figures 4–6 and summarised in Tables 5–6.

⁴ For more, see [Mokni et al., \[2021\]](#).

Figure 4. The Global Economic Policy Uncertainty Index based on monthly data, smoothed using a 4-period moving average with five periods of heightened uncertainty, as defined in the study



Source: Authors' own elaboration.

Table 5. Quarter by quarter safe-haven status by asset for Polish stock market (WIG) in five crisis periods

Asset	Global Financial Crisis Q3 2007 / Q3 2009	Eurozone crisis Q3 2011 / Q2 2013	Donald Trump and Brexit crisis Q1 2016 / Q4 2017	COVID-19 crisis Q1 2020 / Q2 2021	Russian invasion of Ukraine crisis Q4 2021 / Q3 2023	Other periods
xaupln	2007 Q3, 2008 Q4, 2009 Q2	2013 Q1	2016 Q2	2020 Q1	2023 Q2	2011 Q2, 2014 Q4
xagpln	2007 Q3, 2009 Q2, 2009 Q3,	2013 Q1	2016 Q2, 2016 Q4	2020 Q1	2023 Q1, 2023 Q2,	2009 Q4, 2011 Q2, 2014 Q1, 2014 Q4, 2023 Q4
xptpln	2008 Q4	2012 Q3, 2013 Q1	2016 Q1, 2016 Q2	2020 Q1, 2021 Q2	2023 Q1	2007 Q2, 2010 Q2, 2013 Q3
xpdpln		2012 Q3, 2013 Q2	2016 Q1, 2016 Q4,		2022 Q3, 2023 Q1, 2023 Q3	2010 Q2, 2011 Q2, 2013 Q3, 2014 Q1, 2015 Q2,
eurpln			2016 Q1	2020 Q1	2023 Q3	2011 Q2, 2015 Q1, 2018 Q2
usdpln	2008 Q1	2012 Q4, 2013 Q1, 2013 Q2	2016 Q2		2023 Q1, 2023 Q3	2013 Q3, 2019 Q3
gbppln	2008 Q1, 2009 Q1	2012 Q2	2016 Q1		2022 Q3	2010 Q1, 2011 Q1, 2011 Q2, 2015 Q1, 2019 Q3
chfpln			2016 Q2	2020 Q1	2021 Q4, 2023 Q3	2007 Q1, 2014 Q1, 2015 Q1
jpypln	2008 Q4		2016 Q2		2023 Q2	2010 Q1, 2010 Q3, 2011 Q2, 2013 Q3, 2014 Q3, 2015 Q1, 2018 Q1, 2019 Q3

Notes: gold (xaupln), silver (xagpln), platinum (xptpln), palladium (xpdpln), euro (eurpln), US dollar (usdpln), British pound (gbppln), Swiss franc (chfpln), Japanese yen (jpypln).

Source: Authors' own elaboration.

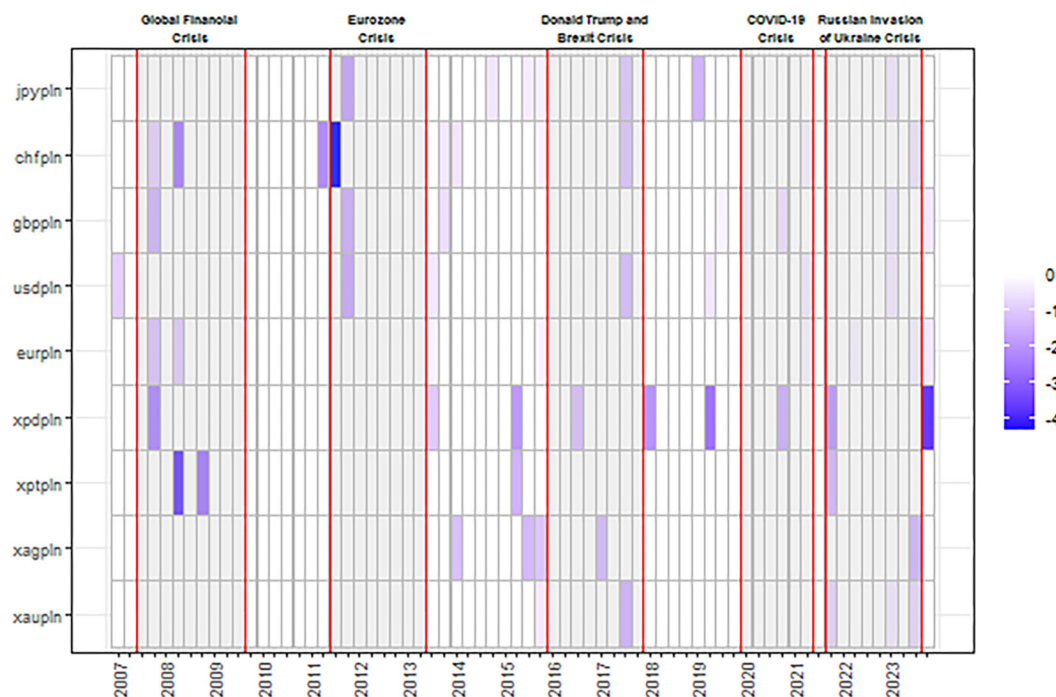
Table 6. Quarter by quarter safe-haven status by asset for Polish bond market in five crisis periods

Asset	Global Financial Crisis Q3 2007 / Q3 2009	Eurozone crisis Q3 2011 / Q2 2013	Donald Trump and Brexit crisis Q1 2016 / Q4 2017	COVID-19 crisis Q1 2020 / Q2 2021	Russian invasion of Ukraine crisis Q4 2021 / Q3 2023	Other periods
xaupln					2023 Q1, 2023 Q3	2015 Q4, 2017 Q3, 2021 Q4
xagpln			2017 Q1		2023 Q3	2014 Q1, 2015 Q3, 2015 Q4
xptpln	2008 Q2, 2008 Q4					2015 Q2, 2021 Q4
xpdpln	2007 Q4		2016 Q3	2020 Q4	2021 Q4	2013 Q3, 2015 Q2, 2018 Q1, 2019 Q2, 2023 Q4
eurpln	2007 Q4, 2008 Q2			2021 Q2	2022 Q2, 2023 Q3,	2013 Q3, 2015 Q4, 2023 Q4
usdpln		2011 Q4		2021 Q2	2023 Q1	2007 Q1, 2013 Q3, 2017 Q3, 2019 Q2
gbppln	2007 Q4	2011 Q4		2020 Q1, 2020 Q4	2023 Q1	2013 Q4, 2019 Q3, 2023 Q4
chfpln	2007 Q4, 2008 Q2	2011 Q3		2021 Q2	2023 Q3	2011 Q2, 2013 Q4, 2014 Q1, 2015 Q4, 2017 Q3
jpypln		2011 Q4			2023 Q1	2014 Q4, 2015 Q3, 2015 Q4, 2017 Q3, 2019 Q1

Notes: gold (xaupln), silver (xagpln), platinum (xptpln), palladium (xpdpln), euro (eurpln), US dollar (usdpln), British pound (gbppln), Swiss franc (chfpln), Japanese yen (jpypln).

Source: Authors' own elaboration.

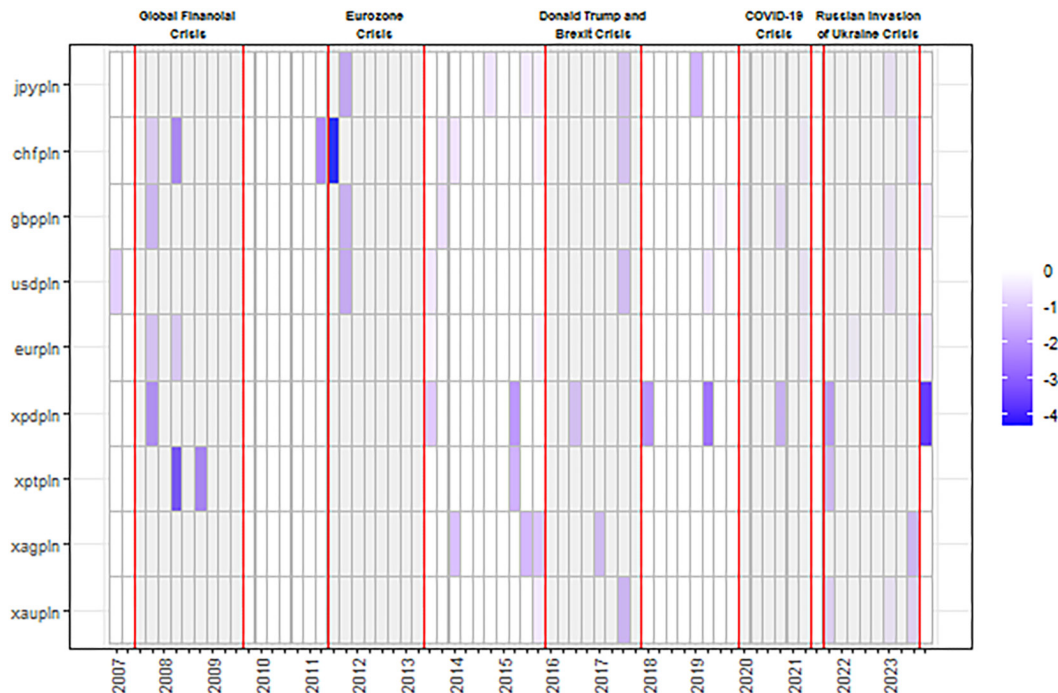
Figure 5. Precious metals and currencies as safe-haven assets against WIG – heatmap of significant negative coefficient of vector (b1) in Equation (3); crisis periods marked in grey



Notes: gold (xaupln), silver (xagpln), platinum (xptpln), palladium (xpdpln), euro (eurpln), US dollar (usdpln), British pound (gbppln), Swiss franc (chfpln), Japanese yen (jpypln).

Source: Authors' own elaboration.

Figure 6. Precious metals and currencies as safe-haven assets for Polish bond market – heatmap of significant negative coefficient of vector (c1) in Equation (3); crisis periods marked in grey



Notes: gold (xaupln), silver (xagpln), platinum (xptpln), palladium (xpdpln), euro (eurpln), US dollar (usdpln), British pound (gbppln), Swiss franc (chfpln), Japanese yen (jpypln).

Source: Authors' own elaboration.

Figures 5 and 6 show the sums of statistically significant negative coefficients in the form of heatmaps. Darker blue shading indicates a stronger safe-haven effect, whereas white cells indicate the absence of safe-haven properties. Additional quarter-by-quarter results for individual precious metals and currencies are provided in Appendix Figures 1 and 2, which present the values of the significant negative coefficient sums from Equation (3).

In sum, both precious metals and currencies can serve as safe-haven assets during periods of market turmoil. However, these properties appear strongest during the GFC period and weakest during the Russia-Ukraine war. The nature of the relationships also changes after the GFC. In particular, the Swiss franc exhibits especially strong safe-haven properties during the Eurozone crisis, while platinum displays pronounced safe-haven characteristics during the GFC. Palladium also demonstrates stronger safe-haven properties than other precious metals during selected periods. The prices of precious metals vary across market states, and the effects of financial stress can be asymmetric under different market conditions [Chen et al., 2022]. Overall, the results indicate that precious metals are better diversifiers for Polish bond portfolios, whereas currencies appear more effective for stock portfolios.

Conclusions

To minimise risk, investors should diversify their portfolios by searching for financial assets that are either negatively correlated or uncorrelated with their primary investments. This study examines the Polish capital market and evaluates the hedge and safe-haven properties of four precious metals and five international currencies. When it comes to the question posed in the title, our analysis shows that international currencies generally provide stronger diversification benefits for portfolios built on the Polish capital market than precious metals, particularly in the case of stock portfolios. The returns on the analysed hedge and safe-haven assets tend to move differently from Polish financial assets as market conditions change.

Hedge properties against the WIG index are observed for all analysed currencies: the euro, US dollar, British pound, Swiss franc, and Japanese yen. Safe-haven properties relative to the WIG index are identified simultaneously for the British pound and Swiss franc, and for the Japanese yen after one trading day. Among precious metals, only gold acts as a hedge and platinum as a safe haven against the WIG index. Gold and silver appear to provide the strongest hedging benefits for both stock and bond portfolios. For Polish bond portfolios, the Japanese yen is the only currency exhibiting hedge properties, confirming its distinctive behaviour relative to other international currencies. Safe-haven properties for Polish bonds are observed for the euro, US dollar, and British pound. Overall, the findings suggest that precious metals may provide stronger diversification benefits for Polish bond investors, whereas currencies appear more effective for stock investors. Nevertheless, the safe-haven effects are concentrated within specific subperiods of 2007–2023 when quarterly data are used.

The factor-loading analysis further indicates that the first latent factor is associated with international currencies, the second factor with precious metals, and the third factor is strongly correlated with the Japanese yen. These findings may help Polish investors differentiate between the diversification roles of the Japanese yen and other international currencies, as the yen exhibits substantial independence from other assets.

Our findings are important not only for academics studying portfolio diversification, but also for Polish investors and portfolio managers seeking to reduce portfolio risk during periods of elevated uncertainty. The results suggest that investors should adopt balanced diversification strategies involving both international currencies and precious metals. International currencies generally provide stronger diversification benefits for Polish stock portfolios, whereas precious metals may play a more important role in bond portfolio diversification. Since Poland is not part of the euro area, the Polish capital market may be perceived as riskier compared to developed eurozone markets. Consequently, the Polish zloty, domestic stocks, and bond markets may exhibit behaviour that differs from that observed in more mature European financial markets. Our findings may also be relevant for policymakers, as understanding the interconnectedness between stock and bond market indices and currencies can support monetary policy decisions in Poland and other Central European economies.

Despite the contributions of this study, several limitations should be acknowledged. Future research could extend the analysis to a larger sample of European economies and incorporate out-of-sample validation procedures. It would also be valuable to expand the range of analysed precious metals to include rarer metals such as rhodium or iridium, as well as additional international currencies such as the Chinese renminbi. Finally, although the Global Economic Policy Uncertainty Index serves as a useful proxy for uncertainty, future studies could also employ alternative measures of market risk, such as the VIX index.

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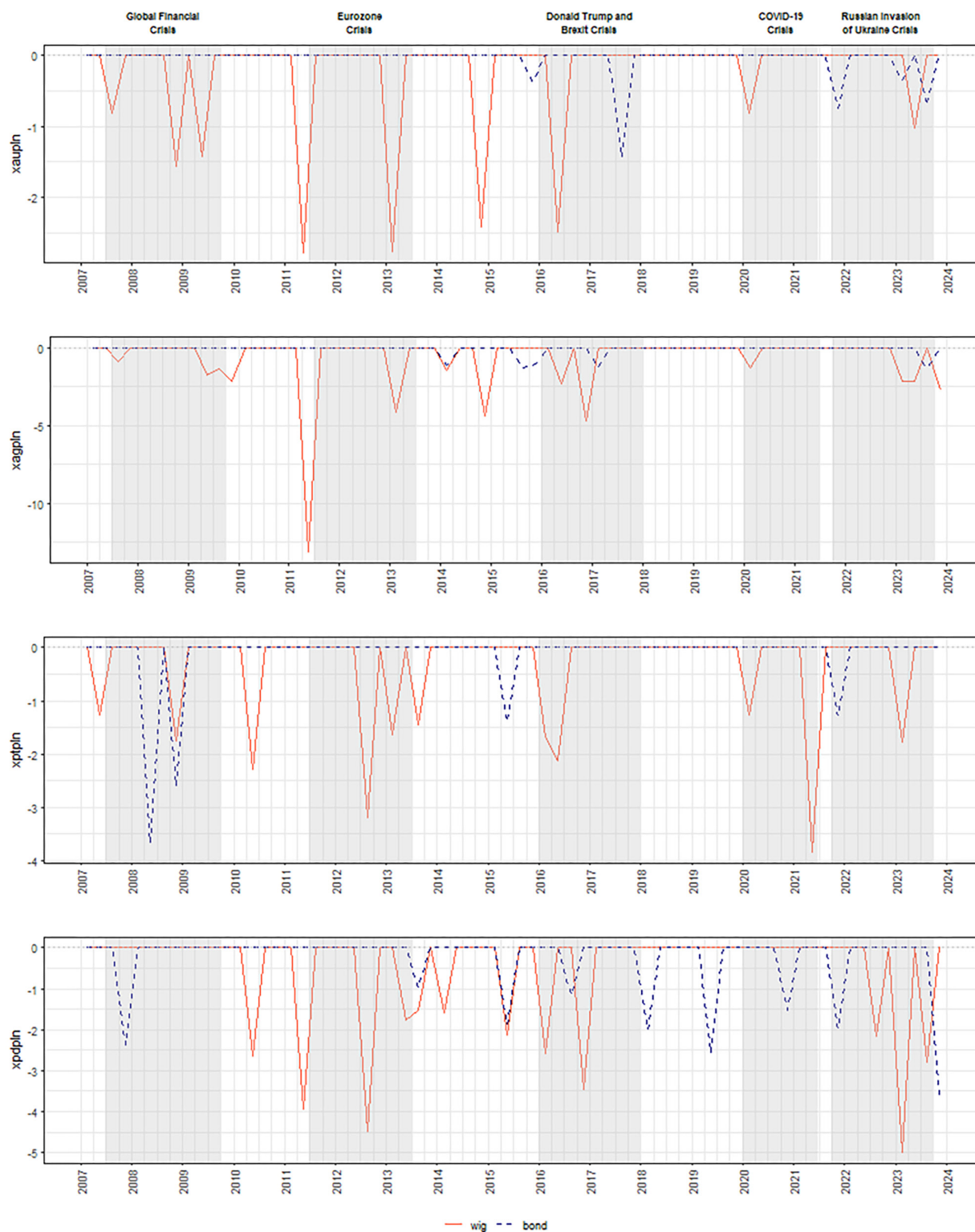
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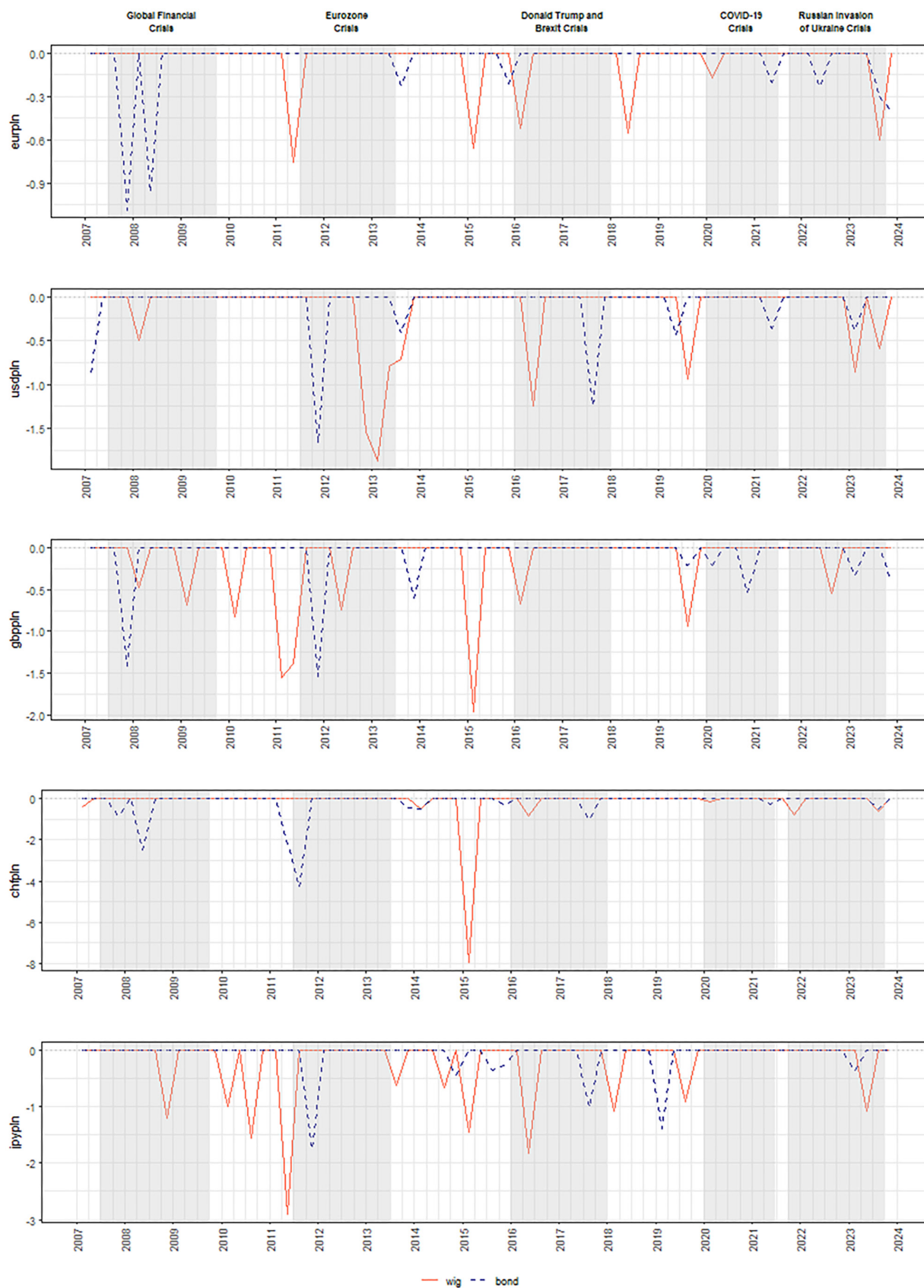
Appendix

Figure A1. Precious metals as safe-haven for WIG and bonds as sums of significant negative coefficient of Equation (3): vector (b₁) solid red colour and vector (b₂) dashed navy blue



Source: Authors' own elaboration.

Figure A2. Currencies as safe-haven for WIG and bonds as sums of significant negative coefficient of Equation (3): vector (b₁) solid red colour and vector (b₂) dashed navy blue



Source: Authors' own elaboration.