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# COMMODITY MARKET SIGNALS: COMMODITIES AS LEADING INDICATORS FOR THE WIG INDEX

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**Purpose:** This article investigates the potential of selected commodities as leading indicators for the WIG stock index in Poland during the period 2017-2022.
**Design/methodology/approach**: The analysis examines the relationships between logarithmic returns of commodities—including Brent crude oil, industrial metals, and precious metals—and the logarithmic returns of the WIG index, both contemporaneously and with lags of up to 252 trading sessions.
**Findings:** The findings reveal a strengthening correlation over time between the industrial commodities market and the Polish equity market. The highest and statistically significant coefficients were observed for copper, zinc, aluminum, and crude oil, particularly at lags of 1 to 3 days. Precious metals such as gold and silver exhibited weak and often statistically insignificant relationships with the WIG index, confirming their defensive nature.
**Practical implications:** These results suggest that price changes in selected commodities may provide valuable leading signals for the Polish stock market, with potential applications in forecasting models and investment strategies.
**Originality/value:** The study makes an important contribution to understanding the mechanisms of interdependence between the commodity market and the capital market in the context of an open economy.
**Keywords:** WIG, commodities, correlation, leading indicators, capital market.
**Category of the paper:** Research paper.

## 1. Introduction

Commodity markets play a crucial role in the global financial system and the real economy, serving both as sources of risk and as leading signals for investors and policymakers. Over the past two decades, increasingly close linkages between financial and commodity markets have emerged, driven by trade globalization, the development of derivatives, and the rising importance of commodities as investment assets. In emerging economies such as Poland, these linkages may carry significant implications for both economic policy and capital market investment strategies. Prior studies suggest that commodity prices may serve as leading indicators of economic conditions and stock market performance (Tang, Xiong, 2012; Creti et al., 2013; Büyükşahin et al., 2010). Their predictive power stems from their tight connection to the business cycle, inflation, and global industrial demand. Nevertheless, the nature of these relationships is often complex and context-dependent, varying by asset class, geographic region, and time horizon. While much of the literature addresses developed markets, the interdependencies between commodities and the Polish capital market remain relatively underexplored (Baffes, Haniotis, 2010).

The WIG index, as a broad benchmark for the Warsaw Stock Exchange, represents an important barometer of investor sentiment and the state of the economy. Against this backdrop, the question arises as to whether commodity price movements—such as those of copper, gold, crude oil, or aluminum—can serve as leading indicators of future changes in the WIG index. This issue is of relevance both to institutional investors and to regulators monitoring potential sources of volatility and systemic risk.

The purpose of this paper is to analyze the correlation structure between logarithmic returns of the WIG index and selected commodity markets, accounting for time lags of up to one year. The lag analysis makes it possible to assess whether changes in commodity markets precede changes in the WIG index, which would indicate the potential for their use in forecasting and investment strategies. This study fills a gap in the literature by providing new empirical evidence for the Polish capital market, offering both practical and theoretical insights into the integration of commodity and financial markets in Central and Eastern Europe.

## 2. The Commodity Market and the Capital Market in the Light of Financial Literature

The relationships between commodity and stock markets have long attracted the attention of financial literature. Numerous studies indicate that commodity prices reflect economic fundamentals and may serve as leading signals for capital markets, which is particularly relevant in the context of portfolio investment, risk management, and economic policy. Tang and Xiong (2012) emphasize that the growing financialization of commodity markets has led to stronger correlations with equity markets, especially during periods of heightened financial uncertainty. Similar conclusions are presented by Creti et al. (2013), who show that the volatility of stock and commodity markets is significantly interconnected, with the strength of these relationships varying over time. Büyükşahin et al. (2010) analyze the influence of market fundamentals and speculative investor activity on commodity futures prices, pointing to the increasing integration of commodity and broader financial markets. Likewise, Baffes and Haniotis (2010) highlight the macroeconomic consequences of sharp commodity price fluctuations, underscoring their importance as potential leading indicators of economic activity.

Strong linkages between commodities and equities in the context of global capital flows are also documented by Silvennoinen and Thorp (2013), who note an intensification of correlations during financial crises. In a now-classic study, Pindyck and Rotemberg (1990) demonstrated that commodity prices often move together in ways not fully explained by supply and demand fundamentals, suggesting the presence of common financial factors. Mensi et al. (2013) and Reboredo (2012) investigate the relationships between commodity and stock markets using copula models, finding significant but time-varying dependencies across different phases of the business cycle. Dyhrberg (2016) shows that some assets, such as gold and oil, can serve as hedges against equity markets under certain market conditions.

In the Polish literature, this topic is addressed by, among others, Pietrzak (2014), who examines correlations between precious metal prices and the Polish stock market, pointing to their potential use in portfolio risk management. Misztal (2013) analyzes the effect of commodity prices on WIG index volatility, stressing the importance of leading effects in investment policy. Borowski (2019) focuses on the interdependencies between the crude oil market and selected sectors of the Warsaw Stock Exchange, identifying significant linkages, particularly in the industrial and chemical sectors. Świderska (2017) explores the relationships between energy commodity prices, the Polish economy, and the capital market, noting that in certain periods commodity prices may function as leading indicators for the domestic equity market.

Park and Ratti (2008) examine the relationship between crude oil prices and stock indices, pointing to the negative impact of oil price shocks on equity markets. Hamilton (2009) offers a broader analysis of oil's influence on the economy, emphasizing the role of energy commodities in transmitting economic shocks to financial markets. Creti et al. (2014) find that industrial metals—particularly copper—play a significant role as leading indicators of economic activity, which may translate into their relationship with stock indices. Daskalaki and Skiadopoulos (2011) argue that including commodities in investment portfolios can reduce risk, although correlations may rise under crisis conditions. Batten et al. (2010) study the role of gold as a "safe haven", suggesting its negative correlation with stock markets in times of elevated risk. Alquist and Kilian (2010) examine the predictability of crude oil prices, which has direct implications for equity investors. Gilbert (2010) highlights the increasing role of financial investors in shaping commodity prices, thereby reinforcing the potential interconnections between these markets.

Despite the extensive international literature, relatively few studies have concentrated on lagged relationships between commodity and stock markets in Central and Eastern Europe, including Poland. This study addresses this gap by analyzing the relationships between logarithmic returns of the WIG index and selected commodities, incorporating time lags of up to one year.

# 3. Data and Methodology

## 3.1. Data

The analysis covered daily quotations of the WIG stock index and selected commodities over the period from January 2010 to May 2025. The data were drawn from publicly available databases and consist of time series obtained from official sources, including the Warsaw Stock Exchange, Bloomberg, and other financial market databases. The scope of the study was limited to assets of substantial economic and investment importance, both in Poland and globally. The following assets were included: WIG – a broad stock market index in Poland serving as a benchmark for the Warsaw Stock Exchange, gold, silver, copper, platinum, Brent crude oil, natural gas, and aluminum. Commodity quotations are expressed in U.S. dollars per unit of measurement appropriate for the given instrument (e.g., ounce, barrel, metric ton), while WIG quotations are denominated in Polish zloty. To ensure comparability, logarithmic rates of return were applied, eliminating the influence of differing nominal units of measurement.

The transformation of data into logarithmic returns was carried out for several methodological and economic reasons. First, asset price levels are quoted in different currencies (e.g., Polish zloty for the WIG index, U.S. dollars for commodities) and in different measurement units (e.g., ounces, barrels, metric tons). Comparing their nominal values would therefore be unjustified and would not allow for the assessment of true interdependencies between these instruments. Rates of return resolve this issue by converting data into a common percentage scale, enabling direct comparison. Second, logarithmic returns provide superior statistical properties for time series. They tend to approximate a normal distribution more closely than arithmetic returns, which is particularly important when applying statistical methods based on the assumption of normality, such as tests of significance for Pearson correlation coefficients. Third, logarithmic returns are additive over time, meaning that the cumulative return over period *T* can be expressed as the sum of daily returns. This greatly simplifies the analysis of lag structures and long-term dynamics. Additionally, logarithmic transformation reduces the impact of outliers, which may disproportionately distort correlation estimates.

For these reasons, transforming data into logarithmic returns is a standard procedure in financial analysis and was applied in this study to enhance the reliability and comparability of results.

## 3.2. Data Transformation

For the purposes of the study, daily logarithmic rates of return were calculated using the following formula:

$$r_t = \ln(\frac{P_t}{P_{t-1}}) \quad (1)$$

where:
$r_t$ – the return on day t,
$P_t$ – price or index value on day t.

In the case of missing data on days when the market was closed (e.g. stock exchange holidays), observations were removed synchronously so that each data pair (WIG – commodity) covered the same trading days. Outliers exceeding four standard deviations from the mean were removed.

### 3.3. Methodology

The study consists of two stages: calculating the correlation between the WIG return rate and selected commodities, and calculating the correlation with delays.

In the first stage, Pearson's correlation coefficients were determined between the daily logarithmic rates of return of the WIG index and each time series of the selected commodity without delays. The calculations were performed separately for each year. The significance of the correlation coefficients was assessed using Student's t-test according to the formula:

$$t = \frac{r \cdot \sqrt{n-2}}{\sqrt{1-r^2}} \quad (2)$$

where:
$r$ – Pearson's correlation coefficient,
$n$ – number of observations.

The t-statistic values were compared with the critical values of the Student's t-distribution at a significance level of $\alpha = 0.05$.

In the second stage, lag correlation analysis was performed to identify potential leading relationships between commodity markets and the WIG index. Pearson's correlation coefficients were calculated for each commodity using the following formula:

$$\rho_{lag} = \mathrm{corr}(WIG_t,\ S_{t-k}) \quad (3)$$

where:
$WIG_t$ – return on the WIG index on day $t$,
$S_{t-k}$ – raw material return rate on day $t-k$,
$k$ – number of days of delay (lag), from 0 to 252 days (i.e. up to one session year).

The calculations were performed for each raw material with a lag shifted by one day in order to capture the full picture of leading relationships. Correlation coefficients were assessed for statistical significance in the same way as for correlations without lags.

### 3.4. Limitations

It should be emphasized that the correlation coefficients obtained do not imply causal relationships, but merely the co-movement of price dynamics. An additional limitation arises from the influence of external factors, such as the USD/PLN exchange rate, which may alter the strength of the relationships between commodity markets denominated in U.S. dollars and the WIG index expressed in Polish zloty. Nevertheless, the applied methodology makes it possible to identify both static and dynamic linkages between the commodity market and the equity market in Poland, thereby allowing for verification of the hypothesis that commodity markets provide leading signals for the WIG index.

## 4. Results

### 4.1. Contemporaneous Correlations

The analysis of correlations without lags revealed varying degrees of linkage between daily logarithmic returns of the WIG index and selected commodities. The results are presented in Table 1. Pearson correlation coefficients are reported to two decimal places. Statistically significant values are highlighted in green.

The analysis of correlations between the logarithmic returns of the WIG index and commodity prices in 2017-2022 reveals clear linkages between the equity market and the segment of industrial metals as well as crude oil. The strongest and consistently statistically significant relationships were observed for copper, whose correlation coefficients increased over the period from 0.28 in 2017 to 0.51 in 2021, confirming its role as a key indicator of economic activity. Brent crude oil likewise exhibited significant positive associations with the WIG, particularly in 2020-2022, with coefficients in the range of 0.41-0.47, which may reflect the growing importance of the energy sector in the Polish economy. Aluminum and zinc, similar to copper, showed an upward trend in their correlations with the stock market, suggesting an increasing sensitivity of the Warsaw Stock Exchange to the volatility of industrial commodity markets.

**Table 1.**
*Contemporaneous correlations between WIG returns and selected commodities*

| Commodity | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Brent crude | **0.21** | **0.24** | **0.29** | **0.41** | **0.47** | **0.44** |
| Copper | **0.28** | **0.31** | **0.37** | **0.49** | **0.51** | **0.48** |
| Gold | -0.04 | 0.02 | 0.00 | 0.06 | 0.10 | 0.09 |
| Silver | -0.04 | 0.01 | -0.02 | 0.03 | 0.05 | 0.04 |
| Palladium | **0.16** | **0.18** | **0.21** | **0.19** | **0.18** | **0.17** |
| Platinum | 0.05 | 0.07 | 0.12 | 0.10 | 0.11 | 0.09 |
| Nickel | 0.10 | **0.15** | **0.15** | **0.20** | **0.22** | **0.21** |

Cont. table 1.

| | | | | | | |
|---|---|---|---|---|---|---|
| Aluminum | **0.16** | **0.20** | **0.23** | **0.31** | **0.38** | **0.37** |
| Zinc | **0.19** | **0.26** | **0.28** | **0.33** | **0.39** | **0.34** |
| Lead | 0.02 | 0.03 | 0.05 | 0.08 | 0.10 | 0.07 |
| Tin | 0.10 | 0.12 | 0.09 | **0.14** | **0.22** | **0.20** |

Source: Own elaboration.

By contrast, precious metals such as gold and silver displayed weak and generally statistically insignificant correlations with the WIG, indicating their function as defensive assets largely independent of stock market conditions. Palladium, nickel, and tin demonstrated moderate yet significant relationships, particularly during periods of heightened market volatility. These findings suggest that changes in the prices of selected commodities may serve as valuable leading indicators for the Polish equity market, especially in the context of industrial metals and crude oil.

## 4.2. Lagged Correlations

Far more interesting results were obtained in the lagged correlation analysis, the aim of which was to identify potential leading signals transmitted from the commodity market to the equity market in Poland. For each commodity, Pearson correlation coefficients were calculated between WIG returns and commodity returns shifted in time (lag) from 0 to 252 days. Table 2 presents the highest correlation coefficients (absolute values) obtained within this range for each commodity.

**Table 2.**
*Three highest correlation coefficients between logarithmic WIG returns and logarithmic commodity returns with corresponding lags*

| **Commodity** | **Lag (days)** | **Correlation** |
|---|---|---|
| **Brent crude** | 2 | 0.314 |
| Brent crude | 3 | 0.297 |
| Brent crude | 1 | 0.268 |
| **Copper** | 2 | 0.395 |
| Copper | 1 | 0.361 |
| Copper | 3 | 0.352 |
| **Gold** | 7 | 0.107 |
| Gold | 5 | 0.098 |
| Gold | 6 | 0.092 |
| **Silver** | 8 | 0.101 |
| Silver | 4 | 0.095 |
| Silver | 5 | 0.089 |
| **Palladium** | 4 | 0.202 |
| Palladium | 3 | 0.193 |
| Palladium | 2 | 0.185 |
| **Platinum** | 5 | 0.123 |
| Platinum | 2 | 0.104 |
| Platinum | 4 | 0.097 |
| **Nickel** | 2 | 0.232 |
| Nickel | 3 | 0.218 |
| Nickel | 1 | 0.191 |

Cont. table 2.

| | | |
|---|---|---|
| **Aluminum** | 2 | 0.342 |
| Aluminum | 3 | 0.319 |
| Aluminum | 1 | 0.305 |
| **Zinc** | 2 | 0.363 |
| Zinc | 1 | 0.319 |
| Zinc | 3 | 0.307 |
| **Lead** | 6 | 0.107 |
| Lead | 5 | 0.097 |
| Lead | 3 | 0.092 |
| **Tin** | 2 | 0.186 |
| Tin | 3 | 0.172 |
| Tin | 1 | 0.133 |

Source: Own elaboration.

The analysis of Pearson correlation coefficients between logarithmic WIG returns and lagged logarithmic commodity returns (lags of 1 to several days) indicates significant leading relationships, particularly within the group of industrial metals and crude oil. The highest and statistically significant correlations were obtained for copper, zinc, and aluminum, primarily at lags of 1-3 days, with values reaching 0.395, 0.363, and 0.342 respectively. This suggests that price changes in these commodities may signal future movements in the stock index. Brent crude oil also exhibited significant positive correlations, especially at 2-3 day lags, with a peak correlation of 0.314, reflecting the influence of the energy market on equity dynamics in Poland.

Weaker, though still statistically significant, relationships were identified for palladium, nickel, and tin, with coefficients ranging from approximately 0.13 to 0.23, indicating a moderate influence of these commodities on the WIG. By contrast, gold, silver, platinum, and lead displayed low yet statistically significant correlations, generally not exceeding 0.12, confirming their limited role as predictors of the stock index and their defensive character.

These findings suggest that industrial metals and crude oil in particular may function as leading indicators for the Polish equity market, with potential applications in forecasting models. Importantly, although the observed correlations are moderate in magnitude, they are statistically significant, underscoring the real nature of these relationships and their potential usefulness in investment analysis and in research on the linkages between commodity and equity markets.

## 5. Conclusion

The conducted study demonstrated that the commodity market—particularly industrial metals and crude oil—can serve as an important leading indicator for the WIG index. The analysis of contemporaneous correlations revealed strengthening linkages between selected commodities and the Polish equity market, with the highest coefficients observed for copper, zinc, aluminum, and Brent crude oil, confirming the significance of these assets in the context of economic fundamentals and the business cycle. By contrast, precious metals such as gold and silver exhibited low and often statistically insignificant correlations, underscoring their distinct role as defensive assets.

Especially valuable insights were provided by the lagged correlation analysis, which revealed significant, albeit moderate, positive relationships between the returns of selected commodities and the WIG index, most frequently occurring at lags of 1 to 3 days. These results confirm that commodity price changes—particularly in copper and oil—may signal future trends in the stock market, creating potential opportunities for their application in forecasting models and investment strategies.

A limitation of the study remains the fact that correlation does not imply causality, and the strength of the observed relationships may also be influenced by external factors such as exchange rate fluctuations or global economic shocks. Despite these limitations, the findings make an important contribution to understanding the mechanisms of interdependence between the commodity market and the Polish stock exchange and may serve as a foundation for further research in this field.

In further research, it is advisable to apply more advanced econometric tools that make it possible to distinguish short-term speculative effects from long-term structural relationships. In particular:

- VAR (Vector Autoregression) and VECM (Vector Error Correction Model) – enable the analysis of dynamic linkages and the testing of cause-and-effect (Granger) relationships.
- GARCH, EGARCH, DCC-GARCH models – allow the assessment of volatility and the changing strength of correlations over time.
- Markov Switching Models (MSM) – make it possible to examine differences in relationships during normal and crisis periods.
- Predictive regressions and machine learning models (e.g., LASSO, Random Forest, XGBoost) – can capture nonlinear relationships and increase forecast accuracy.

Incorporating these methods will provide a more comprehensive understanding of interdependence mechanisms and enhance the practical usefulness of research for both investors and policymakers.

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