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Unearthing the Potential: Energy Metals as Hedging Assets in Portfolio Rebalancing Strategies

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Abstract: *This article analyzes energy metals, specifically Aluminum (MAL3), nickel futures (NICKELc1), and copper futures (HGU3), concerning 3 clean energy indexes: the S&P Global Clean Energy Index (SPGTCLEN), the Nasdaq Clean Edge Green Energy (CEXX), and the WilderHill Clean Energy Index (ECO). It focuses on a significant period during which investments in clean energy increased significantly, with capital allocations tripling from the previous decade. The study's findings are of great significance, given the recent surge in clean energy investments. As the world increasingly embraces cleaner energy sources, understanding how these assets relate to clean energy indexes becomes crucial for investors navigating this dynamic landscape. Moreover, the study's relevance is underscored by recurring market uncertainty, making it a valuable resource for investors seeking to make informed decisions and manage portfolio risks in an era marked by economic uncertainty, policy shifts, and environmental concerns. This work contributes to academic discourse and has practical implications for financial markets.*

1. INTRODUCTION

The acknowledgment of climate change as a worldwide concern has resulted in substantial transformations in energy and investment practices. This encompasses the implementation of regulations that prioritize clean energy, increased allocation of resources towards clean technology, the expansion of the clean energy industry, and heightened attention from the financial market. Investors are actively seeking sustainable alternatives and divesting from fossil fuels due to apprehensions about their long-term viability. The economic competitiveness of clean energy has increased, leading to the emergence of specialized investment vehicles and the potential for favorable financial returns. This trend lines up with the worldwide shift towards more sustainable energy sources in response to the challenge of climate change (Dias et al., 2023, 2023a, 2023b).

The expansion of the clean energy sector has resulted in an increasing need for crucial raw materials utilized in the production of clean energy solutions. The demand for certain commodities, particularly metals, is very high as a result of the extensive implementation of sustainable energy technology. As a result, it is anticipated that there will be notable alterations in the prices and market dynamics of these energy metals, hence impacting their association with the clean energy markets. Investors with substantial financial resources are keen on comprehending the relationship between clean energy companies and energy metals. Understanding this information is essential for effectively diversifying risks within the clean energy asset class, which is known for its volatility. This comprehension not only confers advantages to investors but also holds considerable importance for policymakers. The development of suitable covering strategies to manage risks stemming from unpredictable commodities

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markets is crucial to guaranteeing the stability of clean energy initiatives within a broader context (Ahmad et al., 2018; Asl et al., 2021).

In this manuscript, we will look at how the covering characteristics of energy metals assets like Aluminum (MAL3), nickel futures (NICKELc1), and copper futures (HGU3) relate to three clean energy indexes: the S&P Global Clean Energy Index (SPGTCLEN), the Nasdaq Clean Edge Green Energy Index (CEXX), and the WilderHill Clear Energy Index (ECO). The findings indicate that energy metals exhibited enhanced coverage attributes across the 2020 and 2022 occurrences. Consequently, it can be deduced that metals have the potential to provide a more favorable hedge opportunity for clean energy indexes such as SPGTCLEN, ECO, and CEXX.

In our perspective and based on the reviewed literature, there has been a lack of comprehensive investigation of coverage strategies for investors that possess assets in clean energy markets. The current body of research has overlooked the efficacy of energy metal coverage and the associated risks of portfolios that adopt clean energy assets. While there exists an increasing body of literature pertaining to material flows, supply limitations, and the significance of metals in the context of energy transition, limited research has delved extensively into the connection between clean energy assets and metals. Furthermore, it is worth noting that these studies often overlook the significance of energy metals and clean energy markets, despite the considerable reliance on metals as crucial components in clean energy technology.

The subsequent components of the study are divided into 4 distinct parts. Section 2 of this study delves into an analysis of the current body of literature on clean energy stocks. Additionally, it explores the properties of metals as both a means of hedging and a safe haven. Furthermore, it investigates the link between clean energy stocks and metals. In Section 3, the data and methodology are described. Section 4 provides a comprehensive presentation and analysis of the obtained results. Lastly, Section 5 concludes.

2. LITERATURE REVIEW

Green investors express apprehension regarding the adverse environmental consequences associated with the utilization of dirty energy sources and seek to harmonize their investment decisions with objectives about long-term ecological viability. In this study, the focus is on analyzing the performance of stock indexes related to clean and dirty energy. Clean energy indexes typically include renewable and sustainable technology companies, while dirty energy indexes encompass fossil-fuel corporations that are known to contribute to environmental damage. This study facilitates educated financial decision-making for investors, enables anticipation of regulatory changes, and helps the exploitation of emerging opportunities within the energy markets. Investors can evaluate the environmental impact of their investments through the assessment of financial performance, regulatory scenarios, and the challenges of the energy transition (Dias et al., 2023, 2023a, 2023b; Santana et al., 2023).

Numerous academic studies have examined the connections between clean energy indexes and dirty energy stock indexes, as well as how these relationships interact with oil prices and other pertinent factors, including those by Bondia et al. (2016), Vrînceanu et al. (2020), Asl et al. (2021), and Kanamura (2022). In their study, Bondia et al. (2016) investigated the enduring association between stock prices of alternative energy and oil prices. They employed threshold co-integration tests to analyze the data and observed a lack of sustained disturbances between the prices of alternative energy reserves. According to the findings of Vrînceanu et al. (2020), there is a limited association between oil markets and renewable energy markets. This suggests that fluctuations in oil prices have a relatively minor impact on the growth and progress of the renewable energy sector. The study conducted by Asl et al. (2021) examined the transmission of volatility across different energy and commodity indexes. The findings indicated that SPGCE and SPGO shares exhibited the highest average ideal weight and hedge effectiveness. This suggests that the positive performance of SPGSE counterbalances the negative performance of SPGO. In their study, Kanamura (2022) conducted an analysis to examine the correlations existing between several energy-related stock indexes and energy prices. The findings of the study indicated significant positive correlations between clean energy indexes, specifically the GCE and ECO, and the prices of WTI crude oil and natural gas. These interactions were deemed reasonable, as the rising trend of energy prices has a positive impact on the market value of renewable energy firms engaged in the sale of power through spot markets.

The authors, Farid et al. (2023), Dias, Teixeira, et al. (2023), and Dias, Alexandre, et al. (2023) recently investigated the relationships between clean energy stock indexes and assets classified as dirty energy. During the COVID-19 pandemic, Farid et al. (2023) investigated the co-movements of clean and dirty energy indexes. They discovered short-term weak linkages between clean and dirty energy stocks, as well as a few instances of high long-term co-movements. Dias, Teixeira, et al. (2023) evaluated movements between clean and dirty energy markets and discovered significant shocks between the energy indexes studied, calling the portfolio diversification concept into question. Dias, Alexandre, et al. (2023) investigated if the greater correlation caused by events in 2020 and 2022 resulted in volatility repercussions between clean energy indexes and dirty cryptocurrencies. Their findings suggested that clean energy stock indexes could serve as a potential safe haven for dirty energy cryptocurrencies, although associations differed depending on the cryptocurrency.

In summary, these studies contribute to the comprehension of the complex relationships between clean and dirty energy stock indexes, oil prices, and various other aspects. They offer valuable insights into diversification strategies and shed light on the influence of energy prices on renewable energy markets.

3. DATA AND METHODOLOGY

3.1. Data

The rationale behind including energy metals, namely Aluminum, copper, and nickel, lies in their status as widely traded commodities with transparent price processes. Moreover, the anticipated impact in the pursuit of sustainable energy solutions has substantial importance in rationalizing the incorporation of these metallic elements into the research. Aluminum, copper, and nickel play crucial roles as essential constituents in a diverse range of sustainable energy technologies, including electric vehicles (EVs), wind turbines, solar panels, and energy storage equipment.

The study used data spanning from July 13, 2018, through July 11, 2023, which was obtained from the Thomson Reuters Eikon database. To maintain consistency in comparing various assets and indexes, the study employs US dollars as the currency for all cited values, thereby mitigating the impact of currency fluctuations. The sample was partitioned into two distinct subperiods. The initial subperiod, referred to as “Tranquil,” encompasses the time span from July 2018 to December 2019. The subsequent subperiod, denoted as “Stress,” covers the years from

January 2020 to July 2023, during which significant events such as COVID-19 and the Russian invasion of Ukraine in 2022 occurred.

Table 1. Energy metals and Clean Energy Stock Indexes used in the manuscript

Indexes		**Characteristics**
WilderHill Clean Energy	ECO	This is a stock market index that tracks the performance of clean energy companies in the US. ECO was designed to provide investors with a benchmark to measure the performance of clean energy-related stocks in.
S&P Global Clean Energy	SPGTCLEN	This financial market index tracks the performance of global clean energy companies. This index from S&P Dow Jones Indexes reflects the world economy's rising reliance on clean and renewable energy.
Nasdaq Clean Edge Green Energy	CEXX	is a stock market index for clean energy and green technology companies. This index provides investors with insight into the financial performance of companies leading the clean energy transition.
Aluminum	MAL3	Aluminum is a metal used for a range of industrial and consumer applications, but its primary market commercialization occurs through futures and options in the primary material markets.
Nickel Futures	NICKELc1	Nickel is a metal used in a variety of industrial applications, including the manufacture of stainless steel and batteries, and its price is influenced by a range of factors, including industrial demand, supply, and global demand.
Copper Futures	HGU3	Copper futures are traded on commodity markets and have distinctive symbols like "HGU3." The symbol "HG" represents copper, while "U3" represents the month and year in which the futures contract expires. In this case, "U3" could represent a copper futures contract with a maturity date of September 2023, but it is critical to double-check the maturity date because these contracts have various maturities during the year.

Source: Own elaboration

3.2. Methodology

The present study is conducted in multiple phases. We will use core descriptive statistics and the Jarque and Bera (1980) adherence test to describe the sample in the first step. This test is based on the idea that the data is normally distributed. To assess the validity of the assumption of stationarity in the time series, we will employ a summary table with Breitung (2000), Levin et al. (2002), and Im et al. (2003). Additionally, to validate the results, we will use the tests of Dickey and Fuller (1981) and Perron and Phillips (1988) with the Fisher Chi-square transformation and Choi (2001). The test statistic in question conforms to a chi-square distribution, and its significance level is employed to ascertain the existence of a unit root. In contrast, the Choi Z-stat version of the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests presents an alternate methodology wherein the test statistics are obtained using the maximum likelihood estimation of the autoregressive model. To answer the research question, specifically the assessment of energy metals as hedge assets for clean energy stock indexes during the periods of 2020 and 2022, we will employ the ρDCCA estimation method proposed by Zebende (2011). This approach will enable us to quantitatively measure the degree of cross-correlation between energy metal and clean energy share indexes. The coefficient of Detrended Cross-Correlation analysis (DCCA) has a range of $-1 \leq \rho DCCA \leq 1$. In this context, a value of 1 indicates a state of perfect cross-correlation between the two signs, while a value of -1 signifies perfect anti-cross-correlation. A value of 0 denotes the absence of correlation between the time series. To enhance comprehension of the econophysical model in question, we recommend consulting the scholarly works authored by Zebende et al. (2022), Guedes et al. (2022), and Santana et al. (2023).

4. RESULTS

Figure 1 shows the evolution, in returns, of energy metals such as Aluminum (MAL3), nickel futures (NICKELc1), copper futures (HGU3), and clean energy stock indexes such as the S&P Global Clean Energy Index (SPGTCLEN), NASDAQ Clean Edge Green Energy (CEXX), and WilderHill Clean Energy Index (ECO) from February 16, 2018, to February 15, 2023. The examination of the indexes under discussion provides a clear and convincing indication of these markets' major fundamental disturbances. These disruptions, which became apparent in the first months of 2020, coincided with the onset of the first wave of the COVID-19 pandemic and the ensuing oil price war between Russia and Saudi Arabia. Furthermore, 2022 saw significant fluctuations in the time series, indicating new structural breakdowns. The Russian invasion of Ukraine and subsequent concerns about the resultant inflation fueled this particular volatility. For international financial markets, the authors Dias, Horta and Chambino (2023), Dias et al. (2023), Chambino et al. (2023), and Dias et al. (2023a) corroborate these findings.

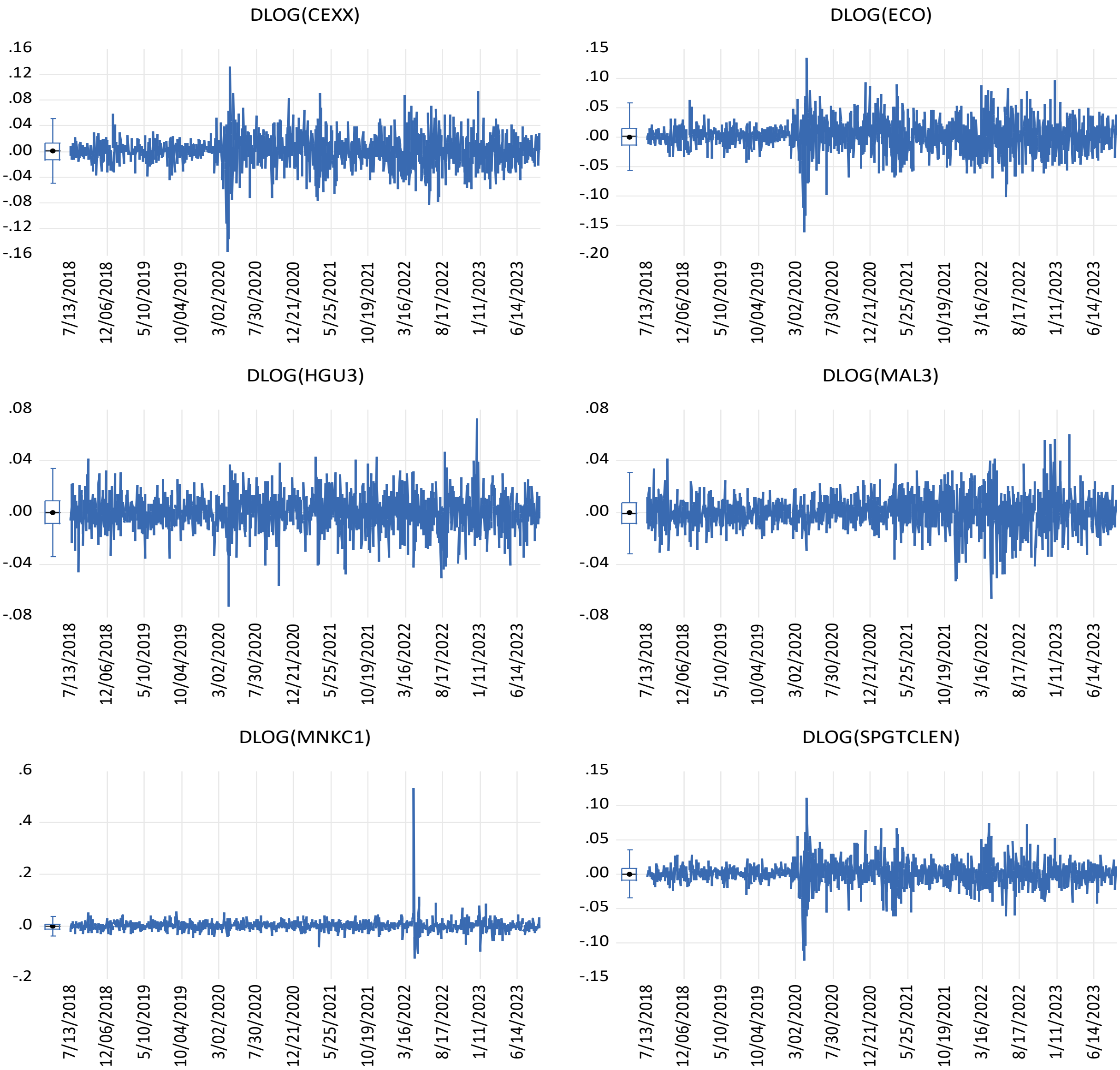

Figure 1. Evolution, in returns, of the financial markets under review, in the period from July 13, 2018, to July 11

Source: Own research

Table 2 shows a summary of the main descriptive statistics for the returns of different time series, namely Aluminum (MAL3), Nickel Futures (NICKELc1), Copper Futures (HGU3), S&P Global Clean Energy Index (SPGTCLEN), NASDAQ Clean Edge Green Energy (CEXX), and WilderHill Clean Energy Index (ECO). The period covered in this analysis spans from February 16, 2018, to February 15, 2023. When examining the mean return, it becomes evident that the financial markets exhibit positive values. However, when considering the standard deviation, it becomes apparent that the ECO stock index demonstrates the greatest value (0.027667), indicating a greater level of dispersion in contrast to the average. To determine if we were dealing with a normal distribution, we assessed the skewness and kurtosis. We observed that the skewness values deviated from zero, indicating asymmetry, while the kurtosis values deviated from 3, indicating non-normality. To establish validity, we conducted the Jarque and Bera (1980) and observed that the null hypothesis $H_0$was rejected at a significance level of 1%.

Table 2. Table overview of descriptive statistics in returns for the markets under consideration from July 13, 2018, to July 11, 2023

	CEXX	ECO	HGU3	MAL3	MNKC1	SPGTCLEN
Mean	0.000818	0.000412	0.000242	5.46E-05	0.000491	0.000639
Std. Dev.	0.025233	0.027667	0.014330	0.013571	0.024283	0.018158
Skewness	-0.344916	-0.303020	-0.182271	-0.042690	8.135917	-0.439446
Kurtosis	6.583154	5.930867	4.602964	5.078401	185.9311	9.671195
Jarque-Bera	699.0304	470.2566	141.8751	227.1697	1770749.	2377.058
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	1260	1260	1260	1260	1260	1260

Source: Own elaboration

To assess the validity of the assumptions of stationarity in the time series, we conducted panel unit root tests. Specifically, we applied the Breitung (2000), Levin et al. (2002), and Im et al. (2003) tests. Additionally, we validated the results using the Dickey and Fuller (1981) and Phillips and Perron (1988) tests with a Fisher Chi-square transformation. The time series used for these tests included the price index of Aluminum (MAL3), nickel futures (NICKELc1), copper futures (HGU3), the S&P Global Clean Energy Index (SPGTCLEN), NASDAQ Clean Edge Green Energy (CEXX), and the WilderHill Clean Energy Index (ECO). To ensure stationarity, the original data is transformed into first-order logarithmic differences. Stationarity is then confirmed by rejecting the null hypothesis (H_0) at a significance level of 1%, as indicated in Table 3.

Table 3. Summary table of unit root tests, in returns, for the markets under review, in the period from July 13, 2018, to July 11, 2023.

Group unit root test: Summary				
Method	**Statistic**	**Prob****	**Cross-sections**	**Obs**
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-144.615	0.0000	6	7545
Breitung t-stat	-69.4811	0.0000	6	7539
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-93.5172	0.0000	6	7545
ADF - Fisher Chi-square	1580.34	0.0000	6	7545
PP - Fisher Chi-square	1580.34	0.0000	6	7548

Notes: **Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Source: Own elaboration

Table 4 presents the Detrend Cross-Correlation Coefficient (ρDCCA) values for different price indexes, namely Aluminium (MAL3), Nickel Futures (NICKELc1), Copper Futures (HGU3), S&P Global Clean Energy Index (SPGTCLEN), NASDAQ Clean Edge Green Energy (CEXX), and WilderHill Clean Energy Index (ECO). The data covers the period from July 13, 2018, to July 11, 2023. Concerning the Tranquil period, it is observed that Aluminum (MAL3) has hedging properties in relation to the SPGTCLEN index. However, when considering the clean energy indexes ECO and CEXX, the hedging characteristics of Aluminum are found to be relatively weak. Regarding Copper Futures (HGU3), it was seen that it lacks the attributes necessary to align with the clean energy stock indexes. Conversely, Nickel Futures (NICKELc1) were discovered to serve as a suitable asset for all the 3 stock indexes under consideration (ECO, SPGTCLEN, and CEXX). During the stress period, there is a notable alteration in the coverage properties of energy metals about energy indexes. Specifically, Aluminum (MAL3), nickel futures (NICKELc1), and copper futures (HGU3) exhibit coverage asset characteristics for the clean energy equity indexes ECO, SPGTCLEN, and CEXX. The findings of this study hold significant implications for portfolio diversification and risk management strategies employed by investors in clean energy markets. They underscore the importance of meticulous evaluation of asset selection and market conditions.

Table 4. Summary of the ρDCCA coefficients, relating to the markets under analysis, in the Tranquil and Stress subperiods

Indexes	Tranquil			Stress		
	ρDCCA	Period (days)	Trend	*ρDCCA*	Period (days)	Trend
MAL3 | HGU3	0.41	n > 16	medium	0.60	n > 13	weak
MAL3 | MNKc1	0.27	n > 7	weak	0.44	n > 136	weak
MAL3 | ECO	0.37	n > 76	medium	0.19	n > 11	weak
MAL3 | SPGTCLEN	0.21	n > 11	weak	0.20	n > 16	weak
MAL3 | CEXX	0.35	n > 76	medium	0.17	n > 9	weak
HGU3 | MNKc1	0.36	n > 13	medium	0.15	n > 6	weak
HGU3 | ECO	0.50	n > 63	medium	0.27	n > 9	weak
HGU3 | SPGTCLEN	0.44	n > 35	medium	0.29	n > 9	weak
HGU3 | CEXX	0.57	n > 76	weak	0.30	n > 9	weak
MNKc1 | ECO	0.10	n > 10	weak	0.06	n > 6	weak
MNKc1 | SPGTCLEN	0.20	n > 9	weak	0.21	n > 52	weak
MNKc1 | CEXX	0.10	n > 11	weak	0.09	n > 43	weak
ECO | SPGTCLEN	0.79	n > 9	strong	0.88	n > 13	strong
ECO | CEXX	0.92	n > 6	strong	0.96	n > 6	strong
SPGTCLEN | CEXX	0.73	n > 9	strong	0.87	n > 6	strong

Note: Data collected by the author (Zebende Algorithm).

Source: Own elaboration

5. CONCLUSION

This study examined the potential of energy metals, specifically Aluminum (MAL3), nickel futures (NICKELc1), and copper futures (HGU3), to act as hedge assets during both tranquil and stressful periods. The analysis focused on their relationship with 3 clean energy indexes: the S&P Global Clean Energy Index (SPGTCLEN), Nasdaq Clean Edge Green Energy (CEXX), and WilderHill Clean Energy Index (ECO). The investigation spanned from 13 July 2018 to 11 July 2023. The findings indicate that energy metals exhibited enhanced coverage attributes in the periods of 2020 and 2022. Consequently, it can be deduced that metals may present a more favorable chance for hedging in clean energy indexes such as SPGTCLEN, ECO, and CEXX. Nevertheless, it is crucial to acknowledge that these findings are limited in their applicability to the conducted research and the analyzed period. Additional examination and the inclusion of other variables may be required in order to substantiate and extrapolate these results.

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