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GREENFLATION AND ESG PORTFOLIO PERFORMANCE IN INDIA: THE ROLE OF ESG RATINGS AND INVESTMENT HORIZON

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ABSTRACT

This study investigates the impact of the commodity inflation created due to the global energy transition, also known as 'greenflation' on the performance of high and low-green (ESG) rated equity portfolios in India. Two portfolios of identical weightage have been monitored and compared with a composite index of copper, nickel, aluminium and zinc prices (2018-25); the data has been provided by CRISIL ratings. The weightage is equal and the portfolios have been tracked against a composite index of copper, nickel, aluminium and zinc prices (2018-25); the data has been sourced from CRISIL ratings. The correlation between the return of the portfolios and metal prices is negative, with lower correlation for low-ESG stocks ($r = -0.596$), than for high-ESG stocks ($r = -0.667$). The high-ESG portfolios experienced a loss of 10.38% over the 2022-2025 greenflation peak, whereas low-ESG portfolios recorded a cumulative gain of 31.34% which were positive over the longer-term, indicating that they were vulnerable during the greenflation upswing rather than the downswing.

Keywords: Greenflation; ESG portfolios; Metal prices; Indian equity market; Investment horizon; CRISIL ratings; Commodity risk; Sustainable investing

Extended Summary

With the shift toward renewable energy, there are smaller, but significant, pressures on prices as ‘greenflation' — the rising cost of key minerals (copper, nickel, aluminium, and zinc) needed for solar and wind power, and electric vehicle infrastructure, are being overwhelmed by demand from mines. In terms of sustainable investing, this is a dilemma: Companies that are doing the most to transition are the ones most vulnerable to input cost shocks the transition itself creates. Although the macroeconomic literature about greenflation has increased over time, its direct impact on ESG portfolio returns in emerging markets, the fastest growing with the greatest reliance on transition metals as imports, is largely untested. This is a study that fills this gap of the literature and is conducted in India. Two equal-weighted portfolios, one comprising five Indian-listed companies with high ESG scores (61-66) and the other with low ESG scores (39-49), were built—one tilted towards clean tech and consumption companies while the other was towards traditional industrial and chemical companies. The correlations between annual compounded returns of both portfolios (2018-2025) and a composite metal

price index during the short (2022-2025) and long (2018-2025) term time periods were measured by Pearson's r.

The metal prices are moderately negatively correlated with both portfolios, where the correlation is higher in the high-ESG portfolio ($r = -0.667$) than in the low-ESG portfolio ($r = -0.596$). The two portfolios experienced a total loss of 10.38% and a total gain of 31.34%, respectively, for the period, for a difference of approximately 42 percentage points, which is consistent with both the input-cost channel (as metal prices increase, margins for clean-technology manufacturers decrease) and the valuation-risk channel (premium valuations for ESG projects lead to a drop in the project's earnings and thus the valuations are reduced). However, when considering the performance of these portfolios over the longer term (2018-2025), both portfolios have had strong absolute returns (+346.56% and +653.13% respectively), showing that Greenflation should not be viewed as an enduring threat to ESG investing, but rather as a time-varying risk premium. The results have implications for investors who may want to consider a strategy that simultaneously exposes investors to commodity- and ESG equity-exposure during periods of elevated transition metal prices, and for ESG rating agencies, which have not yet incorporated supply-chain concentration risk or commodity-exposure as material sustainability factors in their rating systems. The results support the call for policy changes in the context of supply-side changes (increasing recycling capacity, diversifying mineral supply, and streamlining permitting) that would shorten the transition period during which green companies would be vulnerable to the transition that they are funding, to the benefit of policy makers.

1. Introduction

This shift to a low-carbon global economy has created something new: a green transition inflationary trend, which is a structural increase in the prices of industrial commodities that is due to the greater demand for the transition than supply from extractive industries can keep up with. Greenflation is not a form of demand-pull or cost-push inflation, it is what energy transition does. The demand for critical transition metals – copper, nickel, aluminium and zinc – has increased significantly, far outstripping current mining supply, as governments and companies rush to invest in renewable energy infrastructure and energy efficient systems such as EVs. This imbalance is exacerbated by slow and delayed mine development, geopolitical concentration of reserves, and by the environmental permitting issues that have arisen in recent years for new mining activity that continues to exert an upward price pressure that cascades downstream through industrial supply chains globally. Greenflation creates a new channel of transmission from macroeconomic commodity shocks to asset valuations from a financial-markets standpoint. The traditional transmission of inflation to markets is mainly related to interest rate changes, to the spillover of consumer prices and to the wage–price dynamics (Bettarelli et al., 2023). But Greenflation is different: first, through input-cost intermediation for green-tech producers, and second, through valuation-risk intermediation for the green-tech stock-owning sustainability-oriented funds. In general, the structural content in the ESG (Environmental, Social, Governance) portfolios of clean-tech, renewable energy and EV-adjacent exposure makes them more susceptible to the impact of greenflationary pressures than

conventional portfolios. Which is a conundrum in sustainable investing – the companies that are the most transformative of sustainable energy are also the ones most exposed to rising prices for the materials they require for the transition.

Investors with a strong preference for high-ESG rated stocks that are oriented towards clean technology innovators are exposed to sharp increases in metal prices, reducing margins, increasing volatility, and leading to lower near-term returns. . Portfolios closer to traditional carbon-intensive industries on the other hand, can have a temporary edge as commodity prices are being driven up/down in the downstream prices, and the short time gain could be larger than the longer term gain of the sustainable industries. This study was stimulated by extensive research. The macroeconomic literature on greenflation continues to increase exponentially (Aguila & Wullweber, 2024; Bettarelli et al., 2023); however, there has been little research, which has focused on the short-term effects on an ESG portfolio's performance, particularly in emerging markets such as India. This is particularly important for India, one of the world's biggest markets for renewables and also seeing high growth in renewable energy investment including solar, wind and EV - and a high dependence on imported critical minerals. Therefore, ESG exposure in domestic portfolios is exacerbated on both sides of the equation, both in terms of input costs due to the global commodity cycles, and also in terms of valuational consequences arising from the ownership of transition-sensitive assets. There is little systematic empirical research that has focused on this double exposure as compared to the literature in the developed world on ESG, which usually considers commodity inflation as a less prominent risk factor. To fill this void, this study builds two equal-weighted portfolios of Indian stocks based on their CRISIL ESG ratings, one comprising high ESG rated stocks, and the other low ESG rated stocks, and analyzes their performance over two time horizons — a short-term window (2022–2025) during the height of the recent greenflationary episode, and a long-term window (2018–2025) over a complete market cycle. The study gives empirical evidence of the different effects of greenflation in ESG-stratified asset portfolios, and offers implications for financial market practitioners such as portfolio managers and ESG rating agencies/policy makers who are confronted with the financial risks hidden in the green transition. The rest of the paper is organized as follows: Section 2 is a review of relevant literature relating to greenflation, ESG portfolio performance and commodity-inflation transmission, and places the research in the recent context of literature published in this journal. The research aims are outlined in section 3. In Section 4, the dynamics of metal prices, which underlie the greenflation proxy, are explained. A methodology is described in Section 5. The results and discussion will be presented in section 6 and 7, respectively. This section concludes and Section 9 focuses on investment and policy options for mitigation.

2. Literature Review

The academic and policy literature pertinent to the present study is organised below in five thematic clusters – greenflation and commodity-inflation theory, ESG portfolio risk and return, inflation transmission mechanisms in the commodity markets, vulnerability of emerging markets, and finally, the specific contribution of the recent research that has been published in IIMB Management Review (IMR), and which makes the present study relevant in the context

of the journal's own research trajectory on ESG performance, composite sustainability indices and Indian equity market behaviour**.**

2.1 Greenflation and Commodity Inflation Theory

The inflationary impact of a structural change in demand (the transition to clean energy) on an inelastic short-run supply of critical minerals is what greenflation is. Bettarelli et al. (2023) offer empirical evidence that is seminal to the issue, finding that both market-based carbon-pricing policies and regulatory policies can have measurable and enduring impacts on consumer prices, and that the effects of regulatory carbon-pricing policies are larger than the effects of market-based policies. This is a regulatory pathway separate from the physical commodity pathway identified by Aguila and Wullweber (2024), who argue that tightened monetary policy also can contribute to heightening greenflation by increasing the cost of capital for green infrastructure investments, thus leading to a vicious cycle of supply-side lag and ongoing price pressure. Boer et al. (2023) estimate that the demand for energy-transition metals in ambitious net-zero scenarios could increase by many hundreds per cent within the next few decades, and that supply-side measures have limited options due to long mine lead times, geopolitical focus of reserves and environmental permitting. This is the expanding disconnect between rising demand and fixed supply that is unique to greenflation and makes it different from routine cyclical commodity price swings.

2.2 ESG Portfolio Risk and Return Literature

The risk and return properties of ESG portfolios have garnered significant academic attention, and the results have been quite mixed across markets and over time. Lopez Prol and Kim (2022) conclude that optimised ESG equity portfolios have less volatility than popular market indexes, but tend to underperform in times of commodity-inflationary periods, as they are structurally underweight on sectors that gain from commodity price increases. Berg et al. (2023) offer the view that well-designed ESG ratings deliver excess returns driven by investor demand, but caution that this performance premium is dependent on macroeconomic conditions, such as sectoral rebalancing out of growth-focused sustainability funds and the monetary tightening cycle. Clinebell and Meier (2022) pose a more provocative question: Will ESG investing create a disconnect between what is considered ‘good' in terms of sustainability goals and what is expected in terms of return on investment, leading to valuation bubbles where the valuations of clean-tech companies are not correlated with structural high commodity prices? This channel of valuation risk comes into play at a time when commodity cost pressures clash with ESG-driven share prices, resulting in larger declines than in regular stocks: during Greenflation.

2.3 Inflation Transmission Mechanisms and Commodity Markets

Shocks to commodity prices feed through to ESG portfolio performance via two main channels. The first is the input-cost channel, which is directly linked to higher prices for copper, nickel, aluminium and zinc, with the effect of reducing the operating margins of green-technology manufacturers, EV producers and renewable-energy developers and the growth in their earnings. The valuation-risk channel is the second: Capital inflows into ESG funds can be

extremely robust in bull markets, causing asset valuations to exceed fundamentals, while the pressure of greenflation on the underlying earnings base can increase the risk of a correction due to the valuation gap. Gil-Alana and Poza (2020) show that industrial metal prices, especially copper and aluminium, exhibit high levels of long memory and volatility persistence, implying that the greenflationary pressures are not only of a permanent nature but are also a part and parcel of the transition process. A similar observation is made by Söderholm and Ekvall (2020) who report that secondary supply through recycling will not be able to substitute for growth in primary supply in the short run, due to the technical and economic limits of recycling. Li et al. (2022) also highlight a geopolitical aspect because countries with high levels of reliance on imported critical minerals are more vulnerable to international supply shocks and speculative buying and selling of commodity futures, including India.

2.4 Emerging Market Vulnerability and Research Gap

Emerging markets are in a unique strategic situation in the greenflation equation: they're one of the most aggressive markets when it comes to renewable energy, and they're also one of the most dependent markets when it comes to critical minerals imports – which makes them vulnerable to both domestic inflation pressures and foreign commodity price fluctuations. Despite this, empirical ESG performance literature has been largely limited to the developed-market environment, and there is still a gap in empirical literature when it comes to greenflation in emerging-market equity portfolios. In India, the growing scale of solar and EV infrastructure, coupled with the National Action Plan on Climate Change, is a context that is pertinent for exploring this question. CRISIL ESG ratings offer a standardised classification approach to sustainable investing in India, facilitating meaningful portfolio stratification. This study is the first study to systematically empirically investigate metal price dynamics as a proxy for greenflationary pressure on the performance of high and low ESG rated equity portfolios across investment horizons in India.

2.5 Related Scholarship in IIMB Management Review

This study also places itself in the context of IMR's recent research on ESG performance, composite of sustainability indicators and the Indian equity market behaviour. Barman and Mahakud (2024) find that in India, the link between corporate social responsibility and financial performance is not necessarily strong and consistent, and that it varies according to the nature of binding mandatory CSR norms and group affiliation, in this journal. In IMR, Kukreti and Ganguly (2024) construct a composite index to monitor the reduction in carbon emissions in the telecom industry—a process that is not directly measurable at the company level—and their method is similar to the construction of the composite metal price index in this study (Section 5.3), and provides methodological precedent in the journal for this class of index construction. This study builds on George and Kayal (2026), who, in an upcoming IMR article, assess the impact of an ESG quality premium on Indian stock returns before and after the advent of COVID-19 and provide a template for horizon-sensitive factor analysis of Indian stocks that are being extended to the ESG-commodity relationship. Finally, Biswas and Thayyil (2026) explore the adoption of green technology and its link with exports in India and show that a

variety of domestic policy and trade events are driving the green transition, which is the same motor driving greenflationary pressure studied here. These contributions suggest that IMR has turned into a forum for index-based and sustainability-oriented empirical studies of Indian markets and are increasingly horizon-sensitive in their approach. The current study on greenflation and ESG portfolio performance fits naturally in this trajectory as it focuses on empirical studies of Indian markets, with a focus on sustainability and an index-based approach.

2.6 Practitioner Perspectives on Greenflation

In addition to the academic literature, industry and central-bank research have taken a different approach to greenflation. At a micro level, climbing raw-material prices and battery-component shortages were at the time questioning expectations of an unbroken downward EV battery price curve, as the metal-price shocks tracked in this study, at the portfolio level, became immediately apparent as input costs for manufacturers (Goldman Sachs Global Investment Research (Bhandari et al., 2022)). Interestingly, subsequent Goldman Sachs research on the same battery-metals segment revealed that prices were declining once again when new supply became available, suggesting the pressure is a transitional, not permanent event, which is similar to the long-term price trend analysis from gold, silver and copper provided in Section 7.3. As AllianceBernstein's Fraser-Jenkins and Harmsworth write, ESG investing and inflation appear to be at odds: When raw-materials producers and other assets that have proven to offset inflationary pressures are excluded from ESG-screened portfolios, they can leave portfolios relatively vulnerable once the inflationary pressure begins. In their Sveriges Riksbank working paper, Olovsson and Vestin simulate a green transition and conclude that its inflationary impact is heavily dependent on how it takes place: an expected, gradual transition does not necessarily involve higher prices, and can in fact be disinflationary, while an abrupt transition without time for firms and households to adapt results in a significant increase in both headline and energy inflation, as seen in the empirical data since 2021. The overall picture of this literature area reveals that the interpretation this study concludes is correct: greenflation is not a given or permanent aspect of a transition, but a risk, which is only as significant as the rate of implementation and the supply response.

3. Research Objectives

The overarching research question addressed by this study is how greenflationary pressure, proxied by a composite metal price index, affects the financial performance of ESG-stratified Indian equity portfolios. Specifically, the study aims to:

- Examine the distinct effect of greenflation on the risk-return profiles of high-ESG and low-ESG-rated portfolios in the Indian stock market.
- Quantify the relationship between composite metal price movements and portfolio returns across short-term (2022–2025) and long-term (2018–2025) investment horizons.

- Assess whether greenflation produces asymmetric performance effects between emission-intensive and low-emission industry compositions.
- Draw out implications for ESG rating frameworks, investor portfolio construction, and policy design in relation to green-transition commodity risk.

4. Greenflationary Metal Price Dynamics

The four metals examined—copper, nickel, aluminium and zinc—are at the heart of the green-technology supply chain and each have a unique and essential part to play in the demand scenario of greenflation theory—namely, the green transition infrastructure. The accelerating electrification of the global economy is driving unprecedented demand growth for copper, the necessary wiring component of electric vehicles, solar photovoltaic systems and wind turbine generators. Nickel is an important battery cathode material for lithium-ion batteries which are the principal battery chemistry for EVs and Grid-scale energy storage. The lightweight, high-strength properties of aluminium are essential to the lightweighting of EV structures and the manufacture of parts for solar and wind installations. The fourth transition metal in the group of prices that defines the greenflationary phase of the energy transition is zinc, as it is coated with it in sustainable building materials and components of solar panels. All four metals showed the price trends as shown in Figure 1 to Figure 4 from MCX India during the study period (2018-2025). The observed price acceleration since 2021 and subsequent price correction after the price peak in 2022 aligns with the demand-supply imbalance identified by the greenflation literature, which is structural rather than cyclical (Gil-Alana & Poza, 2020).

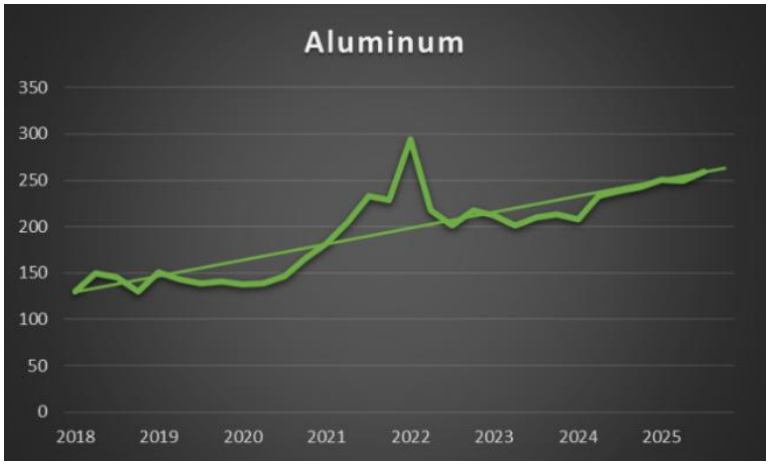

Figure 1. Copper price trajectory, 2018–2025. Source: www.mcxindia.com

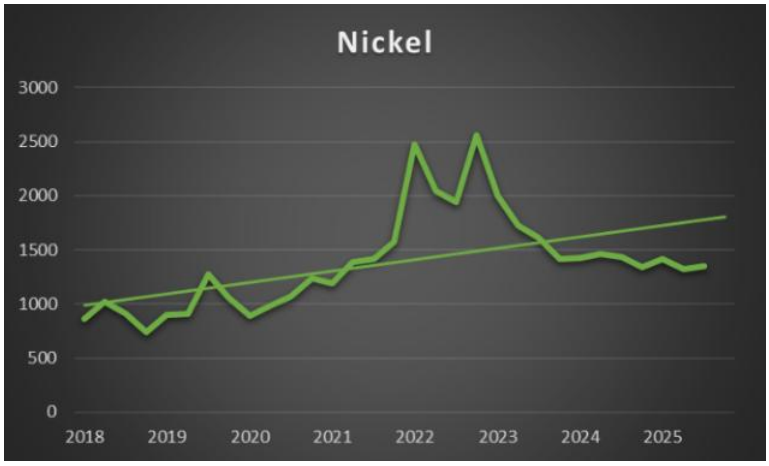

Figure 2. Nickel price trajectory, 2018–2025. Source: www.mcxindia.com

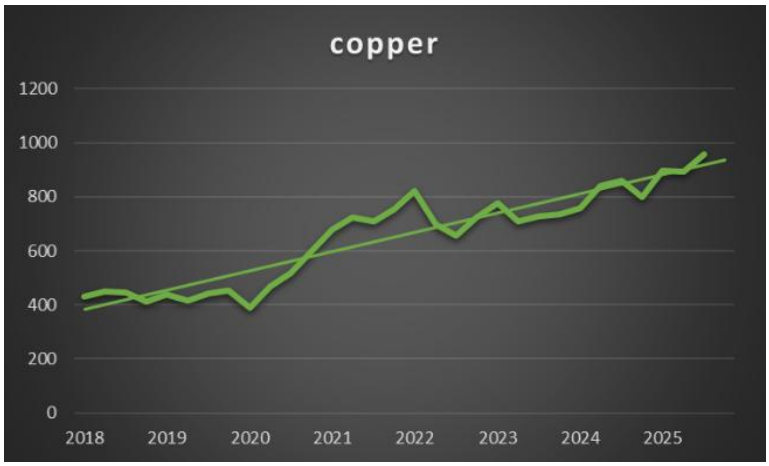

Figure 3. Aluminium price trajectory, 2018–2025. Source: www.mcxindia.com

Figure 4. Zinc price trajectory, 2018–2025. Source: www.mcxindia.com

3.1 Conceptual Framework

In this study, the research objectives are grouped into two transmission channels identified in the literature: the input-cost channel, whereby increasing transition-metal prices reduce the operating margin of green-technology companies; and the valuation-risk channel, whereby green-technology valuations increase due to better premium ESG valuations but then fall once the earnings base on which they are built declines. While these are not mutually exclusive explanations, the study interprets the empirical correlation findings in Section 7 in the context of both channels acting simultaneously; the former (input-cost channel) is anticipated to be dominant in the short term, where metal-price shocks will directly impact the quarterly earnings, while the latter (valuation-risk channel) is expected to be more relevant over a full market cycle, as it is through the repricing of growth expectations.

5. Methodology

This study is quantitative and comparative and compares the financial performance of Indian equity portfolios for three segments – Non-ESG, ESG, and GreenESG – based on greenflationary metal prices. A research design consisting of portfolio construction, composite index development, and correlation analysis is used, followed in the sequential phases outlined below.

5.1 Portfolio Construction

Two portfolios with equal weights were created based on CRISIL ESG ratings to standardise the sustainability classification in the Indian context. This was because CRISIL ratings have been specifically developed for Indian listed equities and take into consideration the materiality concerns as per regulatory disclosure norms in India, unlike the global rating conventions, noted by Barman and Mahakud (2024) in this journal. The high-ESG portfolio has five companies that have CRISIL ratings of 61–66 and are from the clean-tech, consumer staples, and logistics sectors. The low-ESG portfolio consists of five companies having CRISIL ESG ratings in the range of 39-49 with a traditional industrial/chemical profile. An equal-weighting scheme was used to ensure that no particular stock is able to dominate a portfolio's returns which would contaminate the result of the ESG-tier effect with concentration-based return differences between stocks. Table 1 shows the top 10 constituent firms along with their CRISIL ESG ratings.

Table 1 lists the ten constituent firms alongside their CRISIL ESG ratings.

Company	CRISIL ESG Rating	Tier
BF Utilities Ltd	39	Low ESG
Balaji Amines Ltd	47	Low ESG
Bharat Dynamics Ltd	49	Low ESG
Camlin Fine Sciences Ltd	42	Low ESG
Deepak Nitrite Ltd	45	Low ESG

Company	CRISIL ESG Rating	Tier
Castrol India Ltd	61	High ESG
Blue Dart Express Ltd	64	High ESG
Colgate-Palmolive India Ltd	63	High ESG
Aditya Birla Fashion & Retail Ltd	65	High ESG
Adani Green Energy Ltd	66	High ESG

Table 1. ESG rating of the chosen companies. Source: CRISIL Ratings

5.2 Return Computation

Annual portfolio returns were calculated as the percentage change in the share price of each constituent in the portfolio, from the start of the period to the end of the period:

$$\textbf{Annual Return} = [(\text{End of Period Price} - \text{Start of Period Price}) / \text{Start of Period Price}] \times 100\%$$

The individual company returns were subsequently averaged by the equal-weighted portfolio return formula: For a single period of time,

$$\text{Portfolio Return} = [\Sigma \text{ Individual Stock Return}_i] / n \times 100\%$$

The short-term and long-term period cumulative compounded returns were calculated by multiplying annual returns to show the compounding effect of the annual returns over the period rather than an arithmetic sum of the returns. This is important as arithmetic summation will underestimate the impact of sequential compounding in periods of high positive returns like that of Adani Green Energy during 2018-2020 and will, in turn, affect the long-term comparison of portfolios.

5.3 Metal Price Index Construction

Construct an index for the prices of metals. Stocks of copper, nickel and aluminium were used in the construction of a composite metal price index after normalisation by multiplying the annual prices as available in the respective stock exchanges against the annual prices of the three stock exchanges, namely MCX India and London Metal Exchange (LME).A composite metal price index was created by averaging the normalised annual price of copper, nickel and aluminium (from MCX India and London Metal Exchange (LME) with zinc added if available. All four metals were normalised on a common scale before the averages were calculated, meaning that none of them affected the composite index to a greater degree by virtue of their absolute price; otherwise, it would not have been possible to achieve this. It is similar to the way in which Kukreti and Ganguly (2024) constructed an environmental sustainability index for the telecom sector using a composite index, but does the same here, to interpret a large number of price series, which are correlated, but not necessarily identical, into one single proxy for the structural pressure of interest.

The formula used is:

$$\textbf{Metal Price Index } (X_i) = [\text{Normalised Copper Price}_i + \text{Normalised Nickel Price}_i + \text{Normalised Aluminium Price}_i] / 3$$

The composite index is used as the main proxy variable of greenflationary pressure in the correlation analysis in Section 6.

5.4 Statistical Analysis

To measure the linear association between the composite metal price index and each portfolio's annual returns, Pearson correlation coefficients were computed. Pearson's r was chosen because both the series of metal index returns and the series of portfolio returns are continuous measures and approximately normally distributed over the study period, and the relationship of interest — the linear input-cost and valuation-risk transmission mechanisms described in Section 2.3 — is best represented by a linear association measure. The analysis was repeated separately for the short-term and long-term periods, with the objective of determining whether or not the direction and strength of the correlation differ with investment periods, which is the main empirical question of the study.

The Pearson formula applied was:

$$r = \Sigma(x_i - \bar{x})(y_i - \bar{y}) / \sqrt{[\Sigma(x_i - \bar{x})^2 \times \Sigma(y_i - \bar{y})^2]}$$

5.5 Assumptions and Limitations

The assumptions of this analysis are as follows:

- Equal-weighted portfolios offer a better way of representing the differences in performance between different tiers of ESG portfolios, while avoiding the effects of differences in concentration within the portfolios.
- The composite metal price index is able to reflect the main avenues of the transmission of the greenflation costs for companies belonging to the green sector.
- The selected Indian companies' sustainability attitude is consistently captured in their CRISIL ESG ratings over the period under review.
- Long term projections assume the supply chain will become more innovative over time, with greater recycling capabilities and new mining projects, all of which will help to smooth out metal price fluctuations over time.

The conclusions of the results have been qualified by several limitations. The sample size of ten companies is small and limits generalisability beyond the companies analysed and the Indian market context; a larger sample size, stratified by industry, would enable a more precise separation of the input-cost and valuation-risk channels, and is deemed a priority for future research in Section 8. The magnitude, but not necessarily the direction, of the reported correlations may vary if the ratings were done with a different rating methodology because of the rating-system-specific biases introduced by reliance on CRISIL ratings. The analysis is limited to data until Q3 2025, and moves beyond this timeframe such as supply-side normalisation in the transition elements markets are not modelled. Lastly, the study is based on Pearson correlation, which does not imply causality, nor does it account for any other macroeconomic events or movements that occur simultaneously with the price of metals and which can affect the entire market environment and return of the portfolio. The use of a correlational design was intentionally chosen because the sample size for the firms was small, and fitting a regression model with too few degrees of freedom would be overfitting; a larger sample size of firms in the future would make a multivariate specification with the proper controls feasible and desirable.

6. Results

6.1 Low-ESG Portfolio: Annual Returns

Table 2 reports the annual returns of the five low-ESG-rated constituent firms across the 2018–2025 period.

Company	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25
BF Utilities Ltd	48.80%	-13.12%	37.71%	0.23%	53.10%	65.24%	-17.20%
Balaji Amines Ltd	-12.71%	132.01%	268.07%	-20.56%	-1.49%	-33.04%	-22.25%
Bharat Dynamics Ltd	26.51%	11.91%	142.35%	81.37%	0.00%	33.58%	36.48%
Camlin Fine Sciences Ltd	54.08%	45.69%	6.25%	23.06%	-15.18%	-3.54%	49.03%
Deepak Nitrite Ltd	68.75%	152.44%	164.39%	-20.28%	24.98%	0.53%	-26.43%

Table 2. Annual returns of the low-ESG-rated companies. Source: Yahoo Finance

Year	Portfolio Return
2018-19	37.09%
2019-20	65.79%
2020-21	123.75%
2021-22	12.76%
2022-23	12.28%
2023-24	12.55%
2024-25	3.93%

Table 3. Portfolio return of the low-ESG-rated companies. Source: Primary data

6.2 High-ESG Portfolio: Annual Returns

Table 4 reports the corresponding annual returns for the five high-ESG-rated constituent firms.

Company	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25
Adani Green Energy Ltd	297.73%	532.38%	26.38%	45.22%	-17.33%	-34.83%	-1.33%
Aditya Birla Fashion & Retail Ltd	14.42%	-27.49%	64.40%	5.60%	-22.19%	25.15%	-69.82%
Colgate-Palmolive India Ltd	8.86%	7.19%	-5.46%	3.79%	64.65%	6.04%	-17.09%
Blue Dart Express Ltd	-35.22%	87.60%	54.32%	21.87%	-4.46%	-5.37%	-18.15%
Castrol India Ltd	-14.51%	-4.83%	-0.20%	0.29%	45.96%	9.83%	1.12%

Table 4. Annual returns of the high-ESG-rated companies. Source: Primary data

Year	Portfolio Return
2018-19	54.26%
2019-20	118.97%
2020-21	27.89%
2021-22	15.35%
2022-23	13.33%
2023-24	0.16%
2024-25	-21.05%

Table 5. Portfolio return of the high-ESG-rated companies. Source: Primary data

6.3 Metal Price Index

The composite metal price index calculated as described in Section 5.3 is given in Table 6. The index climbs steadily from 473.9 in 2018 to 1,198.08 in 2022, before a slight correction to 854.83 by 2025, continuing the trend of a mismatch between demand and supply seen in Section 4.

Year	Metal Price Index
2018	473.9
2019	496.0
2020	472.64
2021	683.93
2022	1198.08
2023	997.08
2024	796.3
2025	854.83

Table 6. Composite metal price index. Source: Primary data

6.4 Correlation Analysis

Table 7 matches the composite metal price index with high and low ESG portfolio returns for each year of the study window, to serve as the input series for performing the Pearson correlation.

Period	Metal Price Index (x)	High ESG Return (y-high)	Low ESG Return (y-low)
2018–19	473.9	0.5426	0.4954
2019–20	472.64	1.1887	0.4923
2020–21	683.93	0.2789	0.8768
2021–22	1198.08	0.1535	0.2110
2022–23	997.08	0.1333	0.1573
2023–24	796.3	0.0016	0.2395
2024–25	854.83	-0.2105	0.1047

Table 7. Metal price index vs. high- and low-ESG portfolio returns. Source: Primary data

Applying the Pearson correlation formula to the full 2018–2025 dataset:

$$\textbf{High-ESG: } r = -253.79 / \sqrt{(380{,}678.57 \times 2.35)} = -253.79 / 843.96 = -0.667$$

$$\textbf{Low-ESG: } r = -227.72 / \sqrt{(380{,}678.57 \times 1.42)} = -227.72 / 734.92 = -0.596$$

Both coefficients are moderately negative on conventional interpretations, and the gap between them, 0.071, is a small number, even though positive on the short-term scale and negative on the long-term scale, as explained in section 7.1.

7. Findings and Discussion

The key findings from the analysis of the data are summarised in Table 8 and discussed in the subsections below.

Metric	High-ESG Portfolio	Low-ESG Portfolio
Short-term returns (2022–2025)	-10.38%	+31.34%
Long-term returns (2018–2025)	+346.56%	+653.13%
Pearson correlation (metal prices)	-0.667	-0.596

Table 8. Summary of key findings

7.1 Greenflation as a Differential Risk Factor: Theoretical Interpretation

Theoretical Interpretation of Greenflation as Differential Risk Factor (7.1) The correlation results are supportive of the theoretical hypothesis that greenflation also serves as a differential risk factor in screen these portfolios by ESG. The negative correlation in both portfolios is found to be in line with the input-cost transmission channel, documented in the literature on

greenflation (Aguila & Wullweber, 2024; Bettarelli et al., 2023): when the price of metal inputs is increasing, the cost structure of industries with deep dependence on metal inputs is declining, leading to a fall in returns on invested capital.

Yet, this correlation is stronger for the high-ESG portfolio than for the low-ESG portfolio (0.071 difference) due to the composition of the former, which is more structurally concentrated in clean-tech and green transition sectors. This is in line with the valuation-risk proposition of Clinebell and Meier (2022) that high-ESG assets priced at a premium (based on expected outperformance in the transition phase) will experience more severe corrections when commodity-cost shocks impact the earnings base supporting their premium valuation. The pattern also supports Lopez Prol and Kim (2022), who show that ESG-tilted portfolios outperform conventional benchmarks in the current inflationary period while they underperform during inflationary periods dominated by commodity prices in the developed-market setting. The result can be extended to an emerging-market environment where import dependence on transition metals further exacerbates the underlying pattern.

7.2 Short-Term Analysis (2022–2025): Vulnerability Under Peak Greenflation

The short-term window (2022–2025) is aligned with the maximum high point of the recent episode of "greenflation" in the global commodity space, where the composite metal price index peaked at 1,198.08 in 2022, followed by some rebalancing. The cumulative loss in high-ESG portfolios during this timeframe was −10.38%, compared to the cumulative gain of +31.34% in low-ESG portfolios, which represents a difference of some 42 percentage points. There are two reinforcing mechanisms responsible for this marked difference. The first is the input cost channel—where clean-tech companies in the high-ESG portfolio, like Adani Green Energy, were seeing higher input costs for copper and aluminium in their renewable-energy build-out programmes, and Aditya Birla Fashion & Retail was under input-cost pressure on lightweight and synthetic materials. Second, the valuation-correction channel: asset valuations that had increased over time during the pre-2022 bull market, eroded as real rates of interest rose, reflecting overall inflation activity, which reduced long-term growth prospects in those valuations.

In both channels, the high share of high-ESG portfolio firms in industries with longer investment horizons and whose products are more likely to be green inputs contributed to this. By comparison, commodities users like Bharat Dynamics and Deepak Nitrite from the traditional industrial segment showed the ability to pass cost increases downstream to customers and, in certain instances, to gain from an increase in commodity costs in other parts of their value chains, in line with the cost-transfer hypothesis usually observed during inflationary periods in carbon-intensive industries.

7.3 Long-Term Analysis (2018–2025): Structural Resilience

A Structural Resilience analysis was performed in 2018 for the period of 2018 to 2025.Structural Resilience analysis was conducted for the 2018-2025 period. Both of these portfolios have positive cumulative returns over the entire 2018-2025 period, meaning that greenflation is not a death sentence on ESG investment performance. The performance gap between high-ESG and low-ESG portfolios was widened to +346.56% (+653.13%) in 2019-20 and +346.56% (+653.13%) in 2020-21 with the performance of the low-ESG portfolio being led largely by the unusually high gains in the early period of Balaji Amines (+147.17%) and Bharat Dynamics (+127.23%). The high-ESG portfolio's strong long-term absolute returns stem from the market's quick re-rating of the renewable-energy assets during the initial phase of India's solar scale-up, particularly for Adani Green Energy, which has seen returns of 297.73% in 2018-19 and 532.38% in 2019-20. It was a time before the first major greenflationary impacts, and with commodity costs contained, there was significant momentum for a low-carbon transition that resulted in strong returns. After 2021, greenflation combined with the rising input prices gives a relatively strong explanation of the relative decline of the high-ESG portfolio, which aligns with the persistence of metal prices found by Gil-Alana and Poza (2020).

Most important, the positive long-run performance of both portfolios suggests that greenflation does not render the case for the transition-oriented ESG investment portfolio null and void, but instead adds a time-varying risk premium that is largest during the commodity demand stage of the transition. The structural benefits of firms engaged in green transition should become more pronounced as supply-side reactions to these pressures – namely expanded mining capacity, increased secondary (recycled) supply and recycling-technology innovations – gradually diminish the volatility of metal prices in the latter part of the transition.

7.4 Sectoral Asymmetries within the Portfolios

A more careful examination of Tables 2 and 4 also shows that each of the two portfolios is not uniform, but rather, there is meaningful heterogeneity within, and not only between, the two portfolios, so there is reason to be careful not to consider either as a homogeneous block. Amongst the high-ESG group, Colgate-Palmolive and Castrol India were the only companies to register positive returns during the highest greenflation year in 2022-23 (64.65% and 45.96% respectively) while other companies like Adani Green Energy and Aditya Birla Fashion & Retail were in the negative. This implies that the short-term risk of the high-ESG portfolio is not equally spread across all five companies, but is instead spread across the biggest metal players, and that the short-term risk correlation coefficient in Section 6.4 is informative at the portfolio level, but not at the firm level. Even within the low-ESG portfolio, a similar trend is true: Traditional company Bharat Dynamics earned a cost pass-through while Camlin Fine Sciences posted a loss of −15.18% during the same time period. This intra-firm variability suggests that in addition to sector or ESG tier classification, metrics that measure a firm's commodity exposure are more suitable as a unit of analysis for greenflation risk, which is explored further in Section 7.5.

7.5 Implications for ESG Rating Frameworks

One of the major takeaways from the findings is that existing ESG rating methodologies, including those of CRISIL, do not sufficiently include commodity exposure as a key risk factor. The current mechanisms for assessing ESG are mostly based on direct environmental impact metrics (such as emissions intensity, water use, waste disposal) and governance (such as the number of women on boards, the carbon footprint of the materials supply chain). There is less emphasis on structured stress-testing of firms' financial resilience to commodity cycles, which is what constitutes the 'Social' component of ESG. There is less focus on structured stress-testing of firms' financial resilience to commodity cycles (what constitutes the 'Social' component of ESG) than on direct environmental impact metrics (emissions intensity, water use, waste disposal) and governance (such as the number of women on boards, the carbon footprint of the materials supply chain). This results in a less complete picture of sustainability risk in transition periods. The inclusion of commodity-exposure factors (such as the percentage of production costs covered by critical transition metals, hedging coverage ratios, and concentration risk in the supply chain) would significantly improve the predictive value of ESG ratings for investors' decisions in inflationary times. For instance, stress-testing firms with ESG ratings and applying scenarios of sustained metal-price shocks similar to the approach taken in TCFD climate-scenario stress testing—would help identify firms that are transition resilient from those that have an ESG rating, but could be vulnerable to commodity-cost shocks. The proposal also would solve the within-portfolio heterogeneity that was discussed in Section 7.4 because both Colgate-Palmolive and Adani Green Energy will be rated in different tiers once a commodity-exposure adjusted rating is applied.

8. Conclusion

The study examines the differential effect of greenflation on ESG stratified equity portfolios for the first time in India and adds to the body of knowledge on sustainable investing in the context of commodity inflation. The analysis highlights a moderate negative correlation between metal price volatility and the returns of the portfolios, ranging from high-ESG ($r = -0.667$) to low-ESG ($r = -0.596$) with the former showing a more negative sensitivity, which is due to its higher structural sensitivity to green-transition input costs.

This study's major theoretical finding is the separation of the two channels of greenflation in green firms: the input-cost channel, which weakens profits by impacting the cost of their inputs; and the valuation-risk channel, which has the effect of correcting premium valuations won in green transition optimism periods when the valuations are tested against a declining commodity-cost environment. In the period 2022-2025, both channels were active and the total divergence in returns of high- and low-ESG portfolios was about 42 percentage points. But in the longer timeframe (2018-2025), both portfolios have provided solid absolute returns, suggesting a non-structural, but rather a transitional threat to ESG investment performance.

In a policy sense, interventions to tackle the critical mineral bottlenecks that are fueling greenflation are the most straightforward way to reduce transition costs for ESG-investors. These consist of investing in the domestic recycling system, sourcing from international

minerals in a diversified way and speeding up sustainable mining project permitting processes. Incorporating commodity-exposure stress-testing and transition-cost metrics into sustainability assessments would require ESG rating agencies to go the extra mile to more accurately forecast and communicate greenflation risk to investors.

Future research should expand the greenflation-ESG performance relationship to a larger sample of Indian-listed firms, assess the performance differences across various ESG frameworks, analyze the sector-level divergence within the ESG portfolio in a multivariate setting that controls for factors influencing the economy at the time of the analysis, and explore the ability of financial hedging tools (commodity derivatives and inflation-linked instruments) to effectively handle the volatility of the ESG portfolio caused by greenflation. It would be interesting to go beyond 2025 to see if the performance of high-ESG portfolios continues to decouple from fluctuations in metal prices over time, as is suggested by theoretical modelling of the green transition.

9. Mitigation Strategies

Based on the above insights, the following practical mitigation measures can be recommended to the two audiences most directly impacted by greenflation risk, namely: investors building and rebalancing ESG portfolios; and policy makers tasked with the supply-side risks that can trigger greenflation.

Investors should consider commodity exposure as a stand-alone element of portfolio risk, and not just as an indirect consequence of sector allocation, under the ESG paradigm. The within-portfolio heterogeneity observed in Section 7.4 indicates that a uniform adjustment to ESG allocation, for example by cutting back the allocation to all high-ESG stocks during a 'greenflationary episode', would be a 'cold' reaction that would hurt the stocks of companies like Colgate-Palmolive as well as those of companies with high exposure to metals, like Adani Green Energy. A more targeted approach, based on a greater sense of the firm's commodity-cost exposure, would ensure that the diversification and long-term return benefits found in Section 7.3 are maintained and that the target commodity vulnerability found in Section 7.2 is managed.

9.1 For Investors

- Enhance high-ESG equity holdings with green bonds and inflation-linked products to smoothen equity portfolio returns in inflationary surges.
- Integrate commodity exposure indicators and stress-testing metal prices into ESG portfolio construction and rebalancing.
- Use commodity derivative overlays (copper and nickel futures) as partial hedges against transmission from input costs to greenflation.

- Identify blended finance business models to share commodity risk during the transition phase with an increased number of investors in clean-tech projects, by integrating public concessional finance with private capital.

The findings also confirm for policy makers that greenflation is primarily a supply-side issue and thus should be addressed with supply-side instruments, not with demand management instruments like interest rate policy which, as Aguila and Wullweber (2024) explain, can have a counterproductive effect on greenflation: by driving up the costs of the green infrastructure that is necessary to alleviate the underlying mineral shortage. The following policy measures are of particular importance for how quickly the Indian ESG portfolios can be expected to become de-globalized from global metal price volatility, given India's global position as a rapidly growing renewable energy market and as a large consumer of transition metal.

9.2 For Policymakers

- Foster local recycling and critical mineral extraction at subsidised prices to secure stability of supplies and prevent greenflationary pressures.
- Expand carbon price mechanisms with direct assistance for green technology uptake to avoid carbon-tax induced inflationary pass-through to lessen the economic rationale for sustainable investments.
- Create green development finance institutions to help lower the cost of financing clean technology investments during high inflation periods.
- Increase cooperation and collaboration between nations through climate agreements to improve mineral supply chain diversity and decrease geopolitical concentration risk.

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Data Availability Statement

The underlying data employed in this study were obtained from the following sources: stock price data from Yahoo Finance; ESG ratings from CRISIL; and metal price data from the World Bank, London Metal Exchange and MCX India. The processed data (portfolio returns and correlation calculations) are available from the corresponding author upon reasonable request.

References

1. Aguila, N., & Wullweber, J. (2024). Greener and cheaper: Green monetary policy in the era of inflation and high interest rates. Eurasian Economic Review.
2. Barman, S., & Mahakud, J. (2024). Corporate social responsibility and financial performance: Do group affiliation and mandatory corporate social responsibility norms matter? IIMB Management Review. [Author to confirm volume/issue/page numbers before submission.]
3. Berg, F., Lo, A. W., Rigobon, R., Singh, M., & Zhang, R. (2023). Quantifying the returns of ESG investing: An empirical analysis with six ESG metrics.
4. Bettarelli, L., Furceri, D., Pisano, L., & Pizzuto, P. (2023). Greenflation: Empirical evidence using macro, regional and sectoral data. European Economic Review.
5. Biswas, S., & Thayyil, S. (2026). Going green — Exports and adoption of green technology in India. IIMB Management Review. [Author to confirm volume/issue/page numbers before submission.]
6. Boer, L., Pescatori, A., & Stuermer, M. (2023). Energy transition metals. IMF Working Paper.
7. Cesarone, F., Martino, M. L., & Carleo, A. Does ESG impact really enhance portfolio profitability? MDPI – Sustainability Journal.
8. Chen, P., & Semmler, W. Energy transition, price-quantity market interactions and inflation — A model-guided study and CIVAR empirics for the US explaining fossilflation and greenflation.
9. Clinebell, J., & Meier, J. (2022). Green or greed? Examining the realities of the ESG investment bubble. Advances in Economics, Management and Political Sciences.
10. De Spiegeleer, J., Hocht, S., Jakubowski, D., Reyners, S., & Schoutens, W. ESG: A new dimension in portfolio allocation.
11. Fraser-Jenkins, I., & Harmsworth, A. The intimate linkage of ESG and inflation: ESG and the Hegelian dialectic. AllianceBernstein.
12. García, F., Gankova-Ivanova, T., González-Bueno, J., Oliver, J., & Tamošiūnienė, R. What is the cost of maximising ESG performance in the portfolio selection strategy? The case of the Dow Jones Index average stocks. Entrepreneurship and Sustainability Issues.
13. George, A. K., & Kayal, P. (2026). Beyond junk: Evaluating quality premium's influence on stock prices and returns in India before and after COVID. IIMB Management Review. [Author to confirm volume/issue/page numbers before submission.]
14. Gil-Alana, L. A., & Poza, C. (2020). Volatility persistence in metal prices. Resources Policy (Elsevier).
15. Gong, C., Guo, M., & Zeng, Y. The effect of ESG performance on cost of debt: Evidence from corporate bonds. Journal of Corporate Finance (Elsevier).
16. Iazzolino, G., Bruni, M. E., Veltri, S., Morea, D., & Baldissarro, G. The impact of ESG factors on financial efficiency: An empirical analysis for the selection of sustainable firm portfolios. Corporate Social Responsibility and Environmental Management (Wiley).

17. Kukreti, K., & Ganguly, K. K. (2024). Development of a composite index to measure environmental sustainability in the telecom sector: A comprehensive approach towards carbon emission reduction. IIMB Management Review. [Author to confirm volume/issue/page numbers before submission.]
18. Kumar, N. C. A., Smith, C., Badis, L., Wang, N., Ambrosy, P., & Tavares, R. ESG factors and risk-adjusted performance: A new quantitative model. Journal of Sustainable Finance & Investment.
19. Li, X. et al. (2022). Effect of regulation on the increasing price of metals and minerals to meet the challenges in clean energy transitions: A case study of China. Sustainability.
20. López Prol, J., & Kim, K. (2022). Risk-return performance of optimised ESG equity portfolios in the NYSE. Finance Research Letters.
21. Nikhil Bhandari et al. (2022). Global batteries: The greenflation challenge. Goldman Sachs Global Investment Research.
22. Olovsson, C., & Vestin, D. Will a green transition lead to greenflation? Sveriges Riksbank Working Paper Series No. 420.
23. Söderholm, P., & Ekvall, T. (2020). Metal markets and recycling policies: Impacts and challenges. Mineral Economics.
24. Zou, H. (2022). Green or greed? Examining the realities of the ESG investment bubble. Advances in Economics, Management and Political Sciences.