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ORIGINAL ARTICLE

The ESG dilemma in emerging markets: Performance, uncertainty, and market turbulence

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ABSTRACT

This study examines the risk-return dynamics of equity funds in emerging markets with five- and one-globe ratings from Morningstar, with a focus on Brazil, Chile, India, Mexico, and South Korea. This research contributes to the growing body of literature on funds of funds (FoFs) in emerging markets by analyzing synthetic environmental, social, and governance (ESG) and non-ESG portfolios. The findings contribute to the debate on the effectiveness of ESG, showing that its performance depends on the local market structure, policy risk, and economic context. The study offers a novel perspective on how ESG fund performance shifts under macroeconomic stress in emerging markets within the context of global capital allocation, integrating multifactor models with nonlinear regime-switching techniques. Using the FF4 and FF5 models, we compare five- and one-globe fund portfolios (Morningstar Sustainability Rating). We extend these models using GEPU, VIX, and WTI indices to assess economic uncertainty. Finally, we apply Markov-switching regressions to capture regime shifts and nonlinear effects across volatility periods in each market. Using the FF4 and FF5 models, we examine five emerging markets (Brazil, Chile, India, Mexico, and South Korea) from September 2018 to September 2024 (73 observations) and find that market risk dominates across markets while size and value matter in India and Mexico. Brown funds in Brazil and Mexico benefit from oil price shocks, indicating their reliance on fossil fuels. Green funds in Chile and Mexico perform better under stable conditions. ESG funds are more sensitive to volatility, while brown funds are more resilient during crises. In Brazil and India, brown funds outperform, particularly during periods of high volatility (MS model). In Chile and Mexico, green funds perform better in calm markets. In South Korea, no significant differences were found, though green funds outperformed in the FF4 and FF5 models.

Keywords: ESG funds, emerging markets, Fama-French models, Markov switching, uncertainty.

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O dilema ESG nos mercados emergentes: desempenho, incerteza e turbulência do mercado

RESUMO

Este estudo examina a dinâmica de risco-retorno dos fundos de ações em mercados emergentes com classificações de cinco e um globo da Morningstar, com foco no Brasil, Chile, Índia, México e Coreia do Sul. Esta pesquisa contribui para o crescente corpo de literatura sobre fundos de fundos (FoFs) em mercados emergentes, analisando carteiras sintéticas ambientais, sociais e de governança (ESG) e não ESG. As conclusões contribuem para o debate sobre a eficácia do ESG, mostrando que seu desempenho depende da estrutura do mercado local, do risco político e do contexto econômico. O estudo oferece uma perspectiva inovadora sobre como o desempenho dos fundos ESG muda sob estresse macroeconômico em mercados emergentes no contexto da alocação global de capital, integrando modelos multifatoriais com técnicas não lineares de mudança de regime. Usando os modelos FF4 e FF5, comparamos carteiras de fundos com cinco e um globo (Classificação de Sustentabilidade da Morningstar). Ampliamos esses modelos usando os índices GEPU, VIX e WTI para avaliar a incerteza econômica. Por fim, aplicamos regressões de mudança de Markov para capturar mudanças de regime e efeitos não lineares em períodos de volatilidade em cada mercado. Usando os modelos FF4 e FF5, examinamos cinco mercados emergentes (Brasil, Chile, Índia, México e Coreia do Sul) de setembro de 2018 a setembro de 2024 (73 observações) e descobrimos que o risco de mercado é dominante em todos os países analisados, enquanto o tamanho e o valor são importantes na Índia e no México. Os fundos cinza no Brasil e no México se beneficiam dos choques nos preços do petróleo, indicando sua dependência de combustíveis fósseis. Os fundos verdes no Chile e no México têm melhor desempenho em condições estáveis. Os fundos ESG são mais sensíveis à volatilidade, enquanto os fundos cinza são mais resilientes durante crises. No Brasil e na Índia, os fundos cinza apresentam desempenho superior, especialmente durante períodos de alta volatilidade (modelo MS). No Chile e no México, os fundos verdes apresentam melhor desempenho em mercados calmos. Na Coreia do Sul, não foram encontradas diferenças significativas, embora os fundos verdes tenham apresentado desempenho superior nos modelos FF4 e FF5.

Palavras-chave: *fundos ESG, mercados emergentes, modelos Fama-French, comutação de Markov, incerteza.*

1. INTRODUCTION

Over the last two decades, socially responsible investing (SRI) has become increasingly popular, attracting large capital flows. Investors in this market seek financial returns while considering the environmental, social, and governance (ESG) impacts of their investments (Bialkowski et al., 2021). In recent years, there has been exponential growth in the number of SRI funds. According to data from the US SIF Foundation (2020), SRI assets in the United States (US) increased 25-fold from $639 billion in 1995 to $16.6 trillion by the end of 2019. This figure represents 33% of the $51.4 trillion in US assets under professional management. Worldwide, the number of signatories to the United Nations Principles for Responsible Investment (PRI), launched in 2006, increased from 734 in 2010 to 1,384 in 2015 and 3,826 in 2021. The total number of assets under management rose from $21 trillion in 2010 to $59 trillion in 2015 and $121.3 trillion in 2021 (UNPRI, 2025).

Investments in socially responsible funds in emerging markets are vital for addressing global climate and socioeconomic issues. These markets offer attractive investment opportunities for investors who prioritize ESG criteria. This approach fosters long-term economic development and promotes environmental conservation (Sullivan & Biliouri, 2012). Sustainable debt has dramatically increased, nearly reaching $200 billion in 2021. This highlights the rapid expansion of sustainable finance in these regions and its essential contribution to worldwide sustainability initiatives (Goel et al., 2022).

Including ESG considerations in investment decisions in emerging markets can significantly affect investment risk and uncertainty. Investors and financial institutions in these markets must fully appreciate how ESG elements shape the investment environment. Studies exploring this relationship provide valuable insights into the potential risks and uncertainties associated with socially responsible investments in these markets (Boubakri et al., 2021; Gao et al., 2023).

This study examines the risk dynamics between funds ranked by the Morningstar Sustainability Rating as five- and one-globe funds in emerging markets, with a focus on Brazil, Chile, India, Mexico, and South Korea. Our analysis incorporates uncertainty factors and considers how these factors interact differently in funds with high and low ESG rankings.

Morningstar's ESG fund rating, the Morningstar Sustainability Rating, uses a scale of one to five globes to indicate how well the companies in a fund's portfolio manage material ESG risks. The rating is based on company-level ESG Risk Ratings provided by Sustainalytics, which evaluate a company's exposure to industry-specific ESG risks and its management of those risks. To be eligible for the rating, at least 67% of a fund's assets must be covered by Sustainalytics ratings. The fund's overall ESG risk is then calculated as a portfolio-weighted average of its holdings' scores. Funds are ranked within their Morningstar Global Category, and percentiles are assigned: the top 10% receive five globes, the next 22.5% receive four, the next 35% receive three, and so on. The rating is purely risk-based and backward-looking; it does not incorporate ethical screening or sustainability objectives (Morningstar, 2019; Sustainalytics, 2025).

This study focuses on the aforementioned countries due to their growing ESG investment landscapes, diverse economic structures, and varying exposure to global uncertainty. These countries are key emerging markets where sustainable finance is expanding, driven by regulatory policies and investor demand. Brazil and Mexico, with their commodity-driven economies, provide insight into ESG fund performance in resource-dependent markets. Meanwhile, Chile's strong financial sector and robust ESG regulations set a benchmark for sustainable investing in Latin America. India and South Korea, with their dynamic equity markets and evolving ESG frameworks, help us understand the role of corporate governance and policy support in sustainable finance (Boubakri et al., 2021; Goel et al., 2022; Lestari & Frömmel, 2024).

Our study highlights significant regional differences, showing that brown funds in Brazil and India outperform green funds in high-volatility environments, whereas green funds perform better under stable conditions in Chile and Mexico. These findings underscore the dependence of ESG fund performance on macroeconomic conditions, market risks, and oil price dynamics.

While not the primary focus of our research, our study contributes to the growing body of literature on funds of funds (FoFs) in emerging markets by analyzing synthetic ESG and non-ESG portfolios. A FoF pools capital from multiple investors and allocates it across a portfolio of other investment funds, rather than investing directly in individual securities, such as stocks, bonds, or private equity assets (Harris et al., 2018; Denvir & Hutson, 2006).

Our results suggest that, during periods of heightened market volatility, brown funds in Brazil and India outperform their green counterparts. Conversely, green funds in Chile and Mexico exhibit superior performance under more stable conditions. Moreover, brown portfolios tend to benefit from oil price shocks, whereas green portfolios are more adversely affected by increased market volatility. These findings are consistent with previous studies that suggest the risk-return dynamics of ESG investments vary by region and market conditions (Koçak et al., 2022; Ji et al., 2021; Lestari & Frömmel, 2024). This study contributes to the literature by applying a Markov-switching framework to ESG fund analysis in emerging markets. This approach offers new insights into how economic uncertainty, oil price dynamics, and volatility jointly influence the performance of green and brown portfolios.

The remainder of the article is organized as follows. Section 2 reviews the relevant literature, and Section 3 describes our sample and methodology. Section 4 presents our results, and Section 5 concludes.

2. EVOLUTION OF RESEARCH ON GREEN INVESTING

2.1. Theoretical Modeling

Pástor et al. (2021) developed a general equilibrium model in which investor preferences for ESG characteristics shape asset prices. In their framework, firms are assigned an ESG score g_n, and investors derive utility not only from financial wealth but also from holding greener assets. This preference lowers the required return on such assets, resulting in the following expression for expected excess returns:

$$\mu_n = \mu_m \beta_{m,n} - \frac{\bar{d}}{a} g_n \quad \boxed{1}$$

where μ_m is the market equity premium, $\beta_{m,n}$ is the market beta of asset n, $\bar{d}$ is the average ESG preference among investors, and α denotes relative risk aversion. Consuently, green assets are expected to exhibit negative CAPM (Sharpe, 1964; Lintner, 1965) alphas:

$$\alpha_n = \mu_n - \mu_m \beta_{m,n} = -\frac{\bar{d}}{a} g_n \quad \boxed{2}$$

According to this model, green assets act as hedges against climate risks, while brown assets offer higher returns due to greater exposure to regulatory and market risks.

Although this model provides a coherent explanation for negative expected ESG premia, subsequent empirical evidence from Pástor et al. (2022) reveals substantial realized outperformance of green assets over brown assets. This return spread, captured by a green minus brown (GMB) portfolio, cannot be explained by higher expected returns. Instead, the authors attribute this outperformance to unanticipated increases in climate concerns that led to sudden shifts in demand for green assets.

To more accurately estimate expected returns, the authors propose purging realized returns of climate-related and earnings shocks using the following regression:

$$r_t = \mu + \beta x_t + \varepsilon_t \quad (3)$$

with the adjusted expected return estimator given by:

$$\hat{\mu} = \bar{r} - \hat{\beta}\bar{x} \quad (4)$$

where $\bar{r}$ is the sample average return, x_t represents the shock variable (e.g., climate news), and $\bar{x}$ is its mean. This method isolates the component of returns attributable to unexpected shocks and reveals that the adjusted GMB return remains negative.

However, the difference between expected and realized returns may also reflect compensation for climate risk. Green firms are less exposed to transition and physical climate risks, and they can serve as a hedge during periods of increased climate concern. Accordingly, the expected return equation can be extended to incorporate a priced climate risk factor:

$$\mu_n = \mu_m \beta_{m,n} + \mu_c \beta_{c,n} - \frac{\bar{d}}{a} g_n, \quad (5)$$

where μ_c is the climate risk premium and $\beta_{c,n}$ is the asset's sensitivity to climate shocks. If such shocks are partially anticipated due to evolving policy, scientific consensus, or market expectations, realized ESG premia may include a risk-based component. In this interpretation, green asset outperformance does not contradict the equilibrium model but rather represents an additional channel through which climate risk is gradually priced into asset returns. This model can be expanded to incorporate other risks inherent to emerging markets.

Several distinct features affect how the Pástor et al. (2021) framework applies in emerging markets.

Brazil, India, and South Africa are examples of economies that are generally more exposed to both physical climate risks, such as extreme weather and droughts, as well as transition risks, such as abrupt regulatory changes or trade restrictions on carbon-intensive exports.

Investor preferences in these markets are also more diverse. While global investors allocating capital to emerging market (EM) ESG funds may have prioritize sustainability (i.e., high $\bar{d}$), local investors often prioritize liquidity or short-term performance. This contributes to variation in demand. Additionally, ESG data in emerging markets may be less transparent, which makes estimating a firm's greenness score g_n more uncertain and introduces noise into asset pricing.

These issues are compounded by lower market efficiency, which implies that changes in climate risk premia (μ_c) or average ESG preferences ($\bar{d}$) may take longer to be incorporated into prices. This results in persistent mispricings and temporary arbitrage opportunities. All of these issues may influence the existence of an ESG premium.

2.2. Literature Review

Studies of investor motivation show that SRI investors differ from conventional investors demographically (Lewis & Mackenzie, 1999a; McLachlan & Gardner, 2004; Nilsson, 2009) and in beliefs and risk tolerance (Cullis et al., 1992; Williams, 2007). SRI investments are driven by financial and non-pecuniary motives (Beal et al., 2005; Lewis & Mackenzie, 1999b), and investors often accept lower returns and higher fees to align with their social values (Riedl & Smeets, 2017). Bauer et al. (2021) show that two-thirds of pension fund members support SDG-based engagement, even at a financial cost.

Studies on SRI *versus* conventional fund performance yield mixed results depending on market conditions and methodology. Some studies find no significant difference in returns between SRI and conventional funds (Bauer et al., 2005; Cortez et al., 2009; Bauer et al., 2007; Derwall & Koedijk, 2009). Similar findings emerge for sustainable stock indices (Statman, 2006; Schröder, 2007; Belghitar et al., 2014). However, Nofsinger and Varma (2014) show that ESG funds underperform in stable markets but outperform during crises. Cunha et al. (2020) found that ESG indices underperformed in the US and Asia-Pacific region but outperformed in Europe and Latin America. Badía et al. (2020) conclude that SRI performance depends on region, time, and screening criteria. Bansal et al. (2021) reveal that high-SRI stocks outperform during strong economic periods but underperform during recessions. They link this to shifts in investor demand based on wealth levels.

Studies of investor behavior indicate that SRI investors react differently to past performance. Unlike conventional investors, Bollen (2007) found that SRI investors kept their holdings even after negative returns. Benson and Humphrey (2008) and Renneboog et al. (2008) confirm that conventional fund flows are driven by current and past performance, while SRI flows depend less on financial returns. El Ghoul and Karoui (2017) show that SRI funds exhibit greater persistence and lower volatility but have weaker risk-adjusted returns, suggesting that SRI investors prioritize non-financial attributes. Hartzmark and Sussman (2019) found that US investors favored sustainable funds, with high-rated funds attracting inflows. However, there was no significant difference in performance between high- and low-rated funds.

The impact of COVID-19 on SRI funds has also been analyzed. Döttling and Kim (2024) found that high-rated SRI funds experienced more substantial outflows than lower-rated ones during the pandemic, as retail investors viewed non-pecuniary benefits as an unaffordable luxury during times of stress. This effect was observed across 43 countries, confirming that demand for ESG investments declines during financial crises.

Recent studies have explored the tradeoff between sustainability and performance. Gantchev et al. (2024) found that mutual funds increased their ESG holdings to attract capital after the introduciton of Morningstar's sustainability ratings. However, these funds underperformed, reducing investor interest in ESG ratings over time. Papathanasiou and Koutsokostas (2024) analyzed European ESG mutual funds and found that low-rated funds outperformed high-rated ones. However, both underperformed passive benchmarks during COVID-19, reflecting a "flight-to-quality" effect.

Minardi (2023) explores how ESG investing has evolved into a key tool for addressing climate and social challenges. The article outlines the growth of responsible investing and discusses its logic and mechanisms, such as screening, integration, engagement, and impact investing. Additionally, it addresses the limitations in ESG measurement, reporting, and alignment. The article emphasizes that, although ESG funds can mitigate risks, they are not necessarily designed for superior returns. Ultimately, the article argues that achieving a true green transition requires collaboration among financial institutions, corporations, governments, and civil society, as well as more meaningful and targeted sustainable investment strategies. Moreira et al.'s (2023) study of Brazilian publicly-traded companies shows that those in the birth and turbulence stages exhibit lower levels of ESG practices, especially in environmental and social dimensions, compared to those in the maturity stage. The results suggest a link between ESG adoption in the Brazilian capital market and indicators such as profitability, liquidity, indebtedness, market value, and analyst coverage.

Few studies examine SRI performance in emerging markets. Nevertheless, Ji et al. (2021) found that green fun ds outperformed brown ones in BRICS countries, and Lestari and Frömmel (2024) showed that SRI portfolios outperformed benchmarks in emerging markets. However, this outperformance is weaker in the US and Japan. Carvalho et. al (2021) evaluated the performance of asset pricing models in Latin American emerging markets by testing the Fama and French five-factor model alongside three- and four-factor alternatives. Using data from Brazil, Chile, Colombia, Mexico, and Peru, the authors found that the five-factor model offered superior explanatory power, though no model fully explained portfolio returns. The results underscore the importance of profitability and investment factors, but also point to persistent pricing anomalies, suggesting the potential inclusion of additional factors.

Using quantile regression, Silva et al. (2024) analyze how capital gains overhang (CGO), a proxy for the disposition effect, influences expected returns in the Brazilian stock market. Their results reveal a nonlinear and significant relationship, particularly at the extremes of the return distribution. Their findings suggest that Brazilian investors exhibit strong behavioral biases, such as selling winning stocks too quickly and holding losing stocks for too long. This helps to explain the momentum observed in stock returns at higher quantiles.

Uncertainty indices also influence financial assets. Chen et al. (2021) found that RVIX benefited energy assets, WTI oil futures, and natural gas prices. Dutta and Dutta (2022) observe that geopolitical risk (GPR) boosts renewable energy assets; however, Li et al. (2022) find a negative effect in China. Kanamura (2020) links GPR to Bloomberg Barclays MSCI and S&P green bonds, while Dutta, Bouri et al. (2020) and Dutta, Jana et al. (2020)

show that green assets are more sensitive to oil price volatility than to actual price changes. Hanif et al. (2023) reveal that the dependency between the oil and green stock markets increases over the medium and long term.

The role of ESG performance in financial stability is particularly pronounced during crises. Albuquerque et al. (2020), Koçak et al. (2022), and Broadstock et al. (2021) found that ESG performance reduces financial risk during economic downturns, though its impact is weaker under normal conditions. Zerbib (2019) further supports noting, demostrating that firms with strong environmental credentials benefit more from risk reduction than from investors' non-financial motivations. Oliveira et al. (2020) analyze the effects of uncertainty on sustainability indices in Brazil, China, Europe, and the US from 2010 to 2019. They demonstrate that, under certain conditions, sustainability indices can effectively hedge against for investors and asset managers.

Economic policy uncertainty (EPU) affects ESG and green financial markets differently across regions. Xi et al. (2023) show that China's green stock market suffers from rising EPU but benefits from declining EPU. Cepni et al. (2023) suggest that ESG portfolios can serve as a diversification strategy against risks related to physical climate variability. Conversely, Bin-Feng et al. (2024) found that rising environmental uncertainty negatively affects corporate ESG performance, as firms struggle with financial constraints and competitive pressures.

Bitencourt and Iquiapaza (2024) examined the asymmetric and nonlinear relationships between economic policy uncertainty, investor sentiment, and Brazilian stock market performance from 2011 to 2022 using a NARDL model. Their results show that increases in uncertainty lead to investor pessimism, whereas higher market performance reduces it. The effects differ between positive and negative shocks, highlighting the importance of accounting for asymmetries in short- and long-term dynamics. These findings are particularly relevant for investors and policymakers operating in Brazil's volatile market environment.

Zhang et al. (2024) demonstrate that strong ESG performance enhances corporate resilience during economic uncertainty. Jia and Li (2020), on the other hand, show that firms with superior sustainability practices experience increased firm value during uncertain periods. Additionally, Yang et al. (2024) examine the role of gold, oil, and market sentiment indicators, including the VIX, OVX (oil volatility index), and GPR (geopolitical risk index), in predicting ESG returns. Their findings suggest that gold and oil do not serve as safe havens for ESG stocks, but rather, act as diversifiers. Conversely, ESG stocks hedge against geopolitical risks and market uncertainties, particularly in bearish, cryptocurrency-driven markets.

3. METHODOLOGY

We examine the effect of the Morningstar globes classification for equity funds from the emerging countries Brazil, Chile, India, Mexico, and South Korea, comparing the returns of green, brown, and green minus brown portfolios of funds by applying a long–short portfolio strategy. We then study their respective performance in relation to risk factors and uncertainty indices. We examine their behavior from September 2018 to September 2024, analyzing a total of 73 observations.

Our data collection process comprises the following steps: extraction of equity funds' Morningstar globe ranking and monthly closing price data; extraction of local political uncertainty data for countries in the sample; acquisition of data for each country's global economic policy uncertainty (GEPU), oil price (WTI [West Texas Intermediate]), and the Chicago Board Options Exchange VIX; and collection of risk factors relevant to emerging markets: *HML* (high minus low), *SMB* (small minus big), *WML* (winners minus losers), *RMW* (robust minus weak), and *CMA* (conservative minus aggressive), alongside the market risk factor (*RmRf*), according to Fama and French (1993, 2015).

In the initial phase, the funds' monthly globe rankings (1 to 5) are extracted from the Morningstar Direct database. Each month, we select funds with one and five globes (representing the lowest and highest ESG ratings, respectively) and construct three different fund portfolios: green (G), brown (B), and green minus brown (GMB). We constructed equal-weighted portfolios using the returns of each fund. The green portfolio includes funds rated with five globes, and the brown portfolio includes funds rated with one globe. The GMB portfolio represents the return differential between the green and brown portfolios.

We extract monthly data on the global economic policy uncertainty index and the West Texas Intermediate (WTI) index from the Federal Reserve Bank of Saint Louis website. We also extract the market volatility(VIX) index from the Chicago Board Options Exchange.

We source monthly risk factors (*RmRf*, *HML*, *SMB*, *WML*, *CMA*, and *RMW*) for pricing models beginning with the first month of the period (September 2018). Initially, these data were expressed in US dollars and sourced from the Kenneth R French Data Library website as risk factors for emerging markets.

To assess the potential impact of the COVID-19 pandemic on fund performance, we introduce a dummy variable equal to 1 for March 2020, when the World Health Organization (WHO) officially declared COVID-19 a global pandemic (WHO, 2020), and equal to 0 for all other months in the sample period.

The net asset value (NAV) of each fund is calculated as follows:

$$r_{i,t} = \ln\left(\frac{NAV_{i,t}}{NAV_{i,t-1}}\right) \quad \boxed{6}$$

where $NAV_{i,t}$ is the NAV of fund i in month t. The funds are arranged in two equal-weighted portfolios, one for green funds and the other for brown funds, for each country. Lastly, we create a third portfolio as the difference between the two groups of funds. These portfolios are rebalanced monthly.

We compare the performance of five- and one-globe funds in each country (Brazil, Chile, China, India, Mexico, and South Korea) using two models: the momentum-extended Fama and French three-factor model (FF4) (Carhart, 1997) in Eq. 7 and the Fama-French five-factor model (FF5) (Fama & French, 2015) in Eq. 8.

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_{i,m} f_{RmRf,t} + \beta_{i,s} f_{SMB,t} + \beta_{i,h} f_{HML,t} + \beta_{i,w} f_{WML,t} + \varepsilon_{i,t} \quad \boxed{7}$$

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_{i,m} f_{RmRf,t} + \beta_{i,s} f_{SMB,t} + \beta_{i,h} f_{HML,t} + \beta_{i,c} f_{CMA,t} + \beta_{i,r} f_{RMW,t} + \varepsilon_{i,t} \quad \boxed{8}$$

where $R_{i,t}$ is the return of portfolio i in month t, $Rf_{,t}$ is the risk-free rate, $f_{RmRf,t}$ is the market risk factor, $f_{SMB,t}$ is the size factor, $f_{HML,t}$ is the book-to-market factor, $f_{WML,t}$ is the momentum factor, $f_{CMA,t}$ is the investment factor, $f_{RMW,t}$ is the profitability factor, and $\varepsilon_{i,t}$ is the error term.

We incorporate three economic policy uncertainty indices (GEPU, WTI, and VIX) into a multifactor model to evaluate the performance of five-globe and one-globe portfolios under economic uncertainty. This methodology is crucial, as it allows us to analyze how market volatility, investment opportunities, and future return expectations influence the risk-return tradeoff (Ang et al., 2006). Using GEPU, WTI, and VIX returns as explanatory factors, we measure a portfolio's exposure to global economic uncertainty, oil price volatility, and market fear sentiment, respectively. This provides a more comprehensive risk assessment than standard financial models.

Specifically, we employ the following multifactor model based on linear assumptions:

$$R_{i,t} = \alpha_i + \beta_{i,t} f_{RGEPU,t} + \beta_{i,t} f_{RWTI,t} + \beta_{i,t} f_{RVIX,t} + \varepsilon_{i,t} \quad \boxed{9}$$

where $R_{i,t}$ denotes the return of portfolio i in month t, $f_{RGEPU,t}$ denotes the return of the GEPU factor, $f_{RWTI,t}$ denotes the returns of the RWTI factor, $f_{RVIX,t}$ denotes the returns of the VIX factor, and $\varepsilon_{i,t}$ is the error term.

Finally, to capture non-linear and time-varying effects, we extend the analysis by employing a Markov switching (MS) regression model. This model is particularly well-suited for detecting structural changes in financial markets caused by heightened economic uncertainty (Li et al., 2021). Unlike static models, MS regression adjusts dynamically based on regime shifts, allowing for different volatility states. This is crucial for distinguishing periods of market stress from normal conditions and offers a more robust framework for assessing the behavior of low-score (Q1) and high-score (Q5) portfolios under varying economic conditions. The model effectively captures how portfolio performance evolves across different market regimes by using RWTI as the transition variable and incorporating RWTI and RVIX as common factors. This regime-dependent approach provides deeper insights into how investors respond to economic uncertainty, making it a more realistic and adaptable methodology for assessing risk and return dynamics.

The MS regression model operates on an unobservable first-order Markov chain characterized by different regime states and time-varying transition probabilities. In this framework, the likelihood of a particular state (*t*) depends on the state observed at the preceding time step, $P\,(S_t|S_{t-1})$, and the transition between regime states is influenced by a transition variable (*mt*), expressed as $P\,(S_t|S_{t-1}, m_t)$. The likelihood of transitioning from regime *i* to regime *j* is contingent upon the dynamics of the transition variable *k* periods prior, $p_{ij}\,(m_{t-k})$, where the transition probability $p_{ij}\,(z_{tk})$ indicates the anticipated duration, $[D_{ij}=1/(1-p_{ij})]$, of each regime. Specifically, we employ the following MS model:

$$R_{i,t} = \alpha_i S_t + \beta_i S_t * f_{RWTI,t} + \beta_i * f_{index,t} + \varepsilon_{i,t} \quad \boxed{10}$$

where $R_{i,t}$ denotes the return of portfolio i in month t, S_t ($S_t = \{0 \text{ or } 1\}$) denotes the time series' regime state based on transition probabilities, $f_{\text{index},t}$ denotes the *RGEPU* and *RVIX* factors, and $\varepsilon_{i,t}$ is the error term.

We estimated all time-series regressions, including those based on the Fama-French four- and five-factor models, as well as multiple regressions and the MS regression, using ordinary least squares (OLS). To correct for potential heteroskedasticity and autocorrelation in the residuals, we applied the Newey and West (1987) estimator to compute HAC-robust t-statistics.

However, our analysis is limited by our reliance on Morningstar's Sustainalytics ratings exclusively, which could cause us to overlook the extensive methodological differences that exist among various ESG rating providers. Other studies that rely on a single data source, such as those of Apergis et al. (2022), Agnese et al. (2023), and Treepongkaruna et al. (2024), reveal significant discrepancies in ESG scoring when using Refinitiv data exclusively. Berg et al. (2022) detail these scoring discrepancies further, attributing most variation to "rater effects," which occur when an agency's general perception of a company influences its ratings across multiple categories. These effects account for 38% of the variation in scope, 56% in measurement, and 6% in weighting. Additionally, Tabur and Bildik (2025) demonstrate that choosing between Bloomberg and Refinitiv ratings for 464 firms over a ten-year period can lead to substantially different conclusions about financial performance. This highlights the profound impact of selecting an ESG data provider on investment insights.

Moreover, other researchers have revealed that ESG rating providers for funds diverge markedly in terms of their data coverage, methodologies, and sensitivity to greenwashing. For instance, Abouarab et al. (2025) found that funds labeled as "environmental" by Morningstar demonstrates statistically significant reductions in carbon emissions when assessed using Refinitiv holdings data. However, these funds still exhibited inconsistencies that were indicative of portfolio adjustments designed to boost ratings. This phenomenon was less pronounced under Morningstar's standalone metrics. Nofsinger and Varma (2022) show that sustainable funds reduced their carbon risk following the public release of Morningstar's Carbon Risk Scores in May 2018 to levels exceeding those captured by other providers. This suggests that Morningstar is more responsive to emissions factors that other providers. Finally, Gangi et al. (2022) found low convergence between ESG ratings from Morningstar, Refinitiv, and Bloomberg for the same set of funds (with correlations below 0.50). This indicates that choices regarding corporate disclosure data, sector weightings, and aggregation rules can substantially alter the composition of "ESG funds" and influence conclusions about their sustainable performance.

4. RESULTS

4.1. Descriptive Statistics

We analyze a sample of funds from the emerging markets of Brazil, Chile, India, Mexico, and South Korea from September 2018 to September 2024. This period corresponds to 73 months. We rank all the funds according to their Morningstar Direct globe ranking, an ESG measure ranging from 1 to 5 (with 1 being the lowest score), and then distribute them into five groups. We then compare the performance of the highest-ranked (green) funds with that of the lowest-ranked (brown) funds, as well as the difference between the green minus brown portfolio (GMB) of the first two groups.

Table 1 presents the descriptive statistics of all the variables used in this study. JB statistics reject the normality assumption for all countries except South Korea. Brazil's funds have the highest mean and median returns, with the highest maxima and lowest minima. Indian and Mexican funds have the highest kurtosis and the most negative skewness.

There are differences in behavior among the selected emerging-economy funds. On average, green funds perform slightly better than their counterparts in Brazil, Chile, Mexico, and South Korea. In Table 1, we see no difference between brown and their funds in India.

4.2. Risk Analysis

Results from the FF4 model (Table 2) indicate that green and brown portfolios have significant exposure to the market factor (RmRf) at the 1% level across all five countries. This confirms that overall market movements strongly influence both portfolios. The HML factor is significant and positive for both portfolios in Brazil and India, suggesting a value tilt; however, it is mostly insignificant in other countries. The SMB factor is significant and positive in India and Mexico, indicating a preference for small-cap stocks. The WML factor shows mixed effects. It is significant in India and Mexico, suggesting that momentum plays a role in these markets. Elsewhere, it is largely insignificant. The alpha (α) is generally negative and insignificant except for the brown portfolio in Brazil, where it is marginally significant. This indicates that most portfolios do not generate abnormal returns beyond what is explained by the FF4 model. The GMB portfolio shows a significant negative HML coefficient in Brazil and India, implying that green stocks are more growth-oriented than brown stocks in these countries. R^2 values are relatively high, particularly in South Korea and Chile, indicating a strong model fit.

The results of the FF5 model (Table 3) indicate that market risk (RmRf) is dominant across all countries, with highly significant coefficients for green and brown portfolios. The HML factor suggests a value tilt in India and a growth-oriented tendency in South Korea. Conversely, the SMB factor (size) is significant in India and Mexico, indicating a preference for small-cap stocks. The CMA factor (investment) significantly affects returns in Brazil, Mexico, and South Korea. Conversely, RMW (profitability factor) is particularly relevant in India, where it helps explain the differences between green and brown stocks. The GMB portfolio in Brazil and India exhibits notable differences. India's green stocks are more growth-oriented and follow conservative investment strategies. On the other hand, Brazil's green stocks are less sensitive to market factor (RmRf) fluctuations. However, green and brown portfolios behave similarly in Mexico and South Korea, with no significant differences.

Regarding alpha (α), most values are insignificant, suggesting that green and brown portfolios do not generate abnormal returns beyond what is explained by the FF5 factors. The only exception is Chile's brown portfolio, which has a significantly negative alpha ($p < 0.05$), indicating underperformance. Overall, the FF5 model strongly explains portfolio returns, particularly in South Korea, where R^2 values exceed 0.85.

Figure 1 below show the monthly number of equity funds with available Globes from the five countries from September 2018 to September 2024.

Table 1
Descriptive Statistics of portfolio returns, economic variables returns and risk factors

	Mean	Median	Maximum	Minimum	Standard deviation	Skew.	Kurt.	JB	Prob.	Sum	Sum of squared deviations	N
Portfolio Returns												
Brazil G (%)	1.11	1.82	19.47	−31.44	8.06	−0.61	5.57	24.7	0.00	80.71	4,675.97	73
Brazil B	1.07	0.3	25.53	−37.70	8.97	−0.89	6.66	50.29	0.00	78.13	5,794.19	73
Brazil GMB	0.04	0.1	7.49	−9.21	3.48	−0.23	2.55	1.29	0.53	2.58	873.82	73
Chile G	0.41	0.48	14.77	−16.88	5.49	−0.17	3.66	1.71	0.43	30	2,172.92	73
Chile B	−0.18	0.11	8.49	−16.63	4.51	−0.51	4.28	8.16	0.02	−12.93	1,462.06	73
Chile GMB	0.59	0.4	15.41	−4.99	3.08	1.69	9.34	57.17	0.00	42.92	681.79	73
China G	0.28	0.25	21.17	−12.46	6.13	0.63	4.58	12.4	0.00	20.2	2,702.18	73
China B	0.72	1.06	15.94	−10.28	5.87	0.21	2.85	0.6	0.74	52.76	2,483.35	73
China GMB	−0.45	−2.25	27.82	−17.15	8.66	0.85	3.92	11.46	0.00	−32.56	5,404.88	73
India G	1.1	1.71	11.59	−21.74	4.99	−1.19	7.61	81.92	0.00	80.1	1,789.81	73
India B	1.1	1.1	11.35	−20.92	4.67	−1.33	8.54	14.85	0.00	80.35	1569	73
India GMB	−0.00	0.04	4.99	−6.38	2.08	−0.47	3.84	4.85	0.09	−0.25	310.81	73
Mexico G	0.44	0.92	12.92	−22.38	5.15	−1.54	8.46	19.65	0.00	32.26	1912.6	73
Mexico B	0.43	0.48	15.35	−23.93	5.17	−1.57	0.07	82.13	0.00	31.31	1921.4	73
Mexico GMB	0.01	−0.13	3.67	−4.06	1.53	−0.06	2.87	0.1	0.95	0.96	168.08	73
South Korea G	0.48	0.65	12.45	−12.56	5.42	−0.26	3.09	0.82	0.66	35.16	2,112.31	73
South Korea B	0.3	0.84	11.61	−13.39	5.13	−0.38	3.38	2.21	0.33	22.14	1,894.72	73
South Korea GMB	0.18	0.19	3.1	−2.76	1.11	−0.06	3.22	0.19	0.91	13.03	89.13	73
Economic variables returns												
RGEPU	0.00	−0.01	0.54	−0.29	0.16	0.55	4.05	7.08	0.03	0.24	1.81	73
RWTI	0.00	0.03	0.55	−0.57	0.14	−0.82	10.42	175.68	0.00	0.03	1.44	73
RVIX	0.00	−0.01	1.08	−0.33	0.21	1.94	11.05	242.94	0.00	0.34	3.12	73
Risk Factors												
RmRf	0.39	0.59	12.55	−17.09	5.03	−0.36	4.14	5.6	0.06	28.26	1,822.21	73
SMB	0.02	0.2	3.5	−3.35	1.53	−0.09	2.5	0.86	0.65	1.1	168.23	73
HML	0.8	0.83	6.06	−6.89	2.6	−0.16	2.96	0.31	0.86	58.11	484.87	73
WML	0.93	0.91	7.03	−9.15	2.83	−0.88	5.39	26.82	0.00	67.85	577.23	73
RMW	0.16	0.18	2.76	−3.02	1.33	−0.02	2.44	0.96	0.62	11.42	126.57	73
CMA	0.25	0.16	6.48	−3.96	2.05	0.26	3.33	1.18	0.55	18.52	303.56	73

Note: *This table presents the descriptive statistics for the analyzed variables, including measures of central tendency measures (mean and median), dispersion (standard deviation, minimum, and maximum), skewness, and kurtosis, and the Jarque-Bera test and its probability for monthly portfolio, economic variable, and risk factor percentile returns.*
Source: *Prepared by the authors.*

Table 2
FF4 pricing model

		α		RmRf		HML		SMB		WML		N	R²
Brazil	Green	−0.88	(−1.16)	1.13***	(4.93)	1.18***	(3.20)	−0.28	(−0.50)	0.46	(1.37)	73	0.51
	Brown	−1.09*	(−1.78)	1.28***	(7.34)	1.58***	(4.50)	−0.09	(−0.15)	0.25	(0.90)	73	0.61
	GMB	0.02	(0.05)	−0.15	(−1.61)	−0.40***	(−2.74)	−0.17	(−0.63)	0.22	(1.48)	73	0.22
Chile	Green	−0.44	(−1.06)	0.95***	(9.40)	0.19	(1.18)	−0.00	(−0.02)	0.16	(1.04)	73	0.69
	Brown	−0.82**	(−2.52)	0.80***	(15.51)	0.12	(1.12)	0.21	(1.14)	0.06	(0.48)	73	0.75
	GMB	0.19	(0.47)	0.15	(1.58)	0.06	(0.41)	−0.20	(−0.61)	0.12	(0.94)	73	0.06
India	Green	−0.13	(−0.49)	0.92***	(17.28)	0.46***	(3.45)	0.74***	(2.99)	0.33***	(3.58)	73	0.78
	Brown	−0.12	(−0.56)	0.76***	(14.67)	0.62***	(5.69)	0.82***	(2.87)	0.26***	(3.27)	73	0.71
	GMB	−0.20	(−1.07)	0.16***	(5.34)	−0.17**	(−2.00)	−0.06	(−0.35)	0.08	(1.05)	73	0.21

Table 2
Cont.

		α		RmRf		HML		SMB		WML		N	R^2
Mexico	Green	−0.44	(−1.33)	0.89***	(9.62)	0.24	(1.63)	0.65***	(2.92)	0.17	(1.05)	73	0.69
	Brown	−0.34	(−0.84)	0.83***	(8.10)	0.36**	(2.29)	0.54**	(2.16)	−0.03	(−0.20)	73	0.67
	GMB	−0.29	(−1.64)	0.06	(1.48)	−0.12	(−1.57)	0.12	(0.85)	0.21***	(3.55)	73	0.19
South Korea	Green	−0.20	(−0.73)	1.03***	(13.30)	−0.13	(−1.14)	0.11	(0.70)	0.22	(1.50)	73	0.85
	Brown	−0.27	(−1.45)	0.99***	(16.63)	−0.11	(−1.24)	0.19	(1.41)	0.09	(0.93)	73	0.91
	GMB	−0.13	(−0.90)	0.04*	(1.79)	−0.02	(−0.51)	−0.06	(−0.89)	0.14**	(2.41)	73	0.11

Note: *This table presents the results of time-series regressions based on the Fama-French four-factor model, which includes market risk premium (RmRf), size (SMB), value (HML), and momentum (WML) factors. The dependent variable is the excess return of the Green, Brown, and Green minus Brown (GMB) portfolios. For each portfolio, the estimated factor loadings (betas), intercept (alpha), R-squared, and OLS HAC-robust t-statistics are reported in parentheses. The reporting period is from September 2018 to September 2024, and statistical significance is denoted as follows: *p<0.1; **p<0.05; ***p<0.01. The reporting period is from September 2018 to September 2024. We also tested this model with a COVID-19 dummy (not reported here). We tested the Fama-French 4-Factor (FF4) model with an additional COVID-19 dummy variable for the impact of the pandemic on green and brown portfolios in Brazil, Chile, India, Mexico, and South Korea. The main findings indicate that market risk (RmRf) remains the dominant factor, with highly significant coefficients (p < 0.01) across all portfolios, confirming that both green and brown stocks are strongly driven by market movements even during the pandemic. HML (value factor) remains significant for Brazil and India, indicating a preference for value stocks. In contrast, SMB (size factor) is particularly relevant in India and Mexico, where small-cap stocks show stronger effects. Momentum (WML) plays a role mainly in India and Mexico, but is insignificant elsewhere.*
Source: *Prepared by the authors.*

Table 3
FF5 pricing model

		α		RmRf		HML		SMB		CMA		RMW		N	R^2
Brazil	Green	0.03	(0.04)	1.06***	(5.15)	0.57	(1.53)	−0.29	(−0.48)	0.69**	(2.05)	−0.89*	(−1.63)	73	0.52
	Brown	−0.43	(−0.68)	1.32***	(8.30)	0.69*	(1.94)	−0.00	(−0.00)	1.33***	(4.28)	−0.51	(−0.89)	73	0.65
	GMB	0.28	(0.78)	−0.26***	(−2.94)	−0.14	(−0.59)	−0.27	(−0.95)	−0.61**	(−2.31)	−0.40	(−1.72)	73	0.25
Chile	Green	−0.17	(−0.46)	0.94***	(9.90)	−0.10	(−0.61)	0.08	(0.26)	0.43	(1.57)	0.02	(0.05)	73	0.70
	Brown	−0.69**	(−2.33)	0.81***	(17.20)	−0.10	(−0.53)	0.26	(1.18)	0.35	(1.64)	−0.01	(−0.04)	73	0.76
	GMB	0.34	(0.89)	0.13	(1.38)	−0.02	(−0.10)	−0.16	(−0.42)	0.10	(0.38)	0.02	(0.08)	73	0.06
India	Green	0.17	(0.56)	0.83***	(15.00)	0.52***	(2.69)	0.87***	(3.45)	−0.17	(−0.75)	0.28	(1.24)	73	0.76
	Brown	0.06	(0.20)	0.64***	(10.45)	0.98***	(6.43)	0.80***	(2.91)	−0.71***	(−2.69)	−0.00	(−0.00)	73	0.73
	GMB	−0.07	(−0.35)	0.20***	(5.60)	−0.48***	(−3.48)	0.08	(0.58)	0.56***	(2.87)	0.28***	(2.66)	73	0.33
Mexico	Green	−0.17	(−0.58)	0.90***	(10.39)	−0.13	(−0.52)	0.79***	(3.10)	0.60**	(2.25)	0.15	(0.57)	73	0.70
	Brown	−0.26	(−0.73)	0.91***	(9.91)	−0.10	(−0.39)	0.64**	(2.32)	0.80***	(3.45)	0.09	(0.31)	73	0.72
	GMB	−0.09	(−0.52)	−0.00	(−0.13)	−0.05	(−0.38)	0.17	(1.08)	−0.18	(−1.21)	0.06	(0.31)	73	0.11
South Korea	Green	0.07	(0.28)	1.03***	(16.85)	−0.43**	(−2.53)	0.28	(1.74)	0.49***	(2.74)	0.29	(1.34)	73	0.85
	Brown	−0.11	(−0.65)	1.01***	(21.58)	−0.37***	(−3.26)	0.29**	(2.16)	0.44***	(3.93)	0.13	(0.83)	73	0.92
	GMB	0.01	(0.05)	0.02	(0.87)	−0.08	(−1.11)	0.02	(0.24)	0.08	(0.81)	0.15	(1.43)	73	0.05

Note: *This table presents the results from the Fama-French five-factor model regressions, incorporating the market (RmRf), size (SMB), value (HML), profitability (RMW), and investment (CMA) factors. The estimated coefficients for each factor are displayed in the table. The intercept (alpha), R-squared, and t-statistics, corrected using the OLS HAC estimator, are reported in parentheses. The dependent variable is the excess return of the evaluated portfolio. The reporting period is from September 2018 to September 2024, and statistical significance is denoted as follows: *p<0.1; **p<0.05; ***p<0.01. We also tested this model with a COVID-19 dummy (not reported here). The COVID-19 dummy remains significantly negative in Brazil, India, and Mexico across FF5 models, confirming that both green and brown portfolios suffered substantial losses during the pandemic. Brown stocks in Brazil and Mexico experienced sharper declines in FF5, suggesting that investment (CMA) and profitability (RMW) factors played a role in portfolio vulnerabilities. In contrast, South Korea consistently exhibits a significantly positive COVID-19 dummy in both models, indicating that both green and brown Korean stocks benefited during the pandemic. However, the effect is slightly weaker in FF5, implying that profitability and investment factors help explain some of this resilience. The GMB (Green Minus Brown) portfolio shows no significant effects of COVID-19 in most cases. In Chile, the COVID-19 dummy remains insignificant in both models, indicating that the pandemic had a limited direct impact on portfolio returns after accounting for market and factor exposures. FF5 provides a better fit (higher R^2 values) and reveals that profitability and investment strategies influenced portfolio responses to COVID-19, particularly in Brazil, Mexico, and South Korea.*
Source: *Prepared by the authors.*

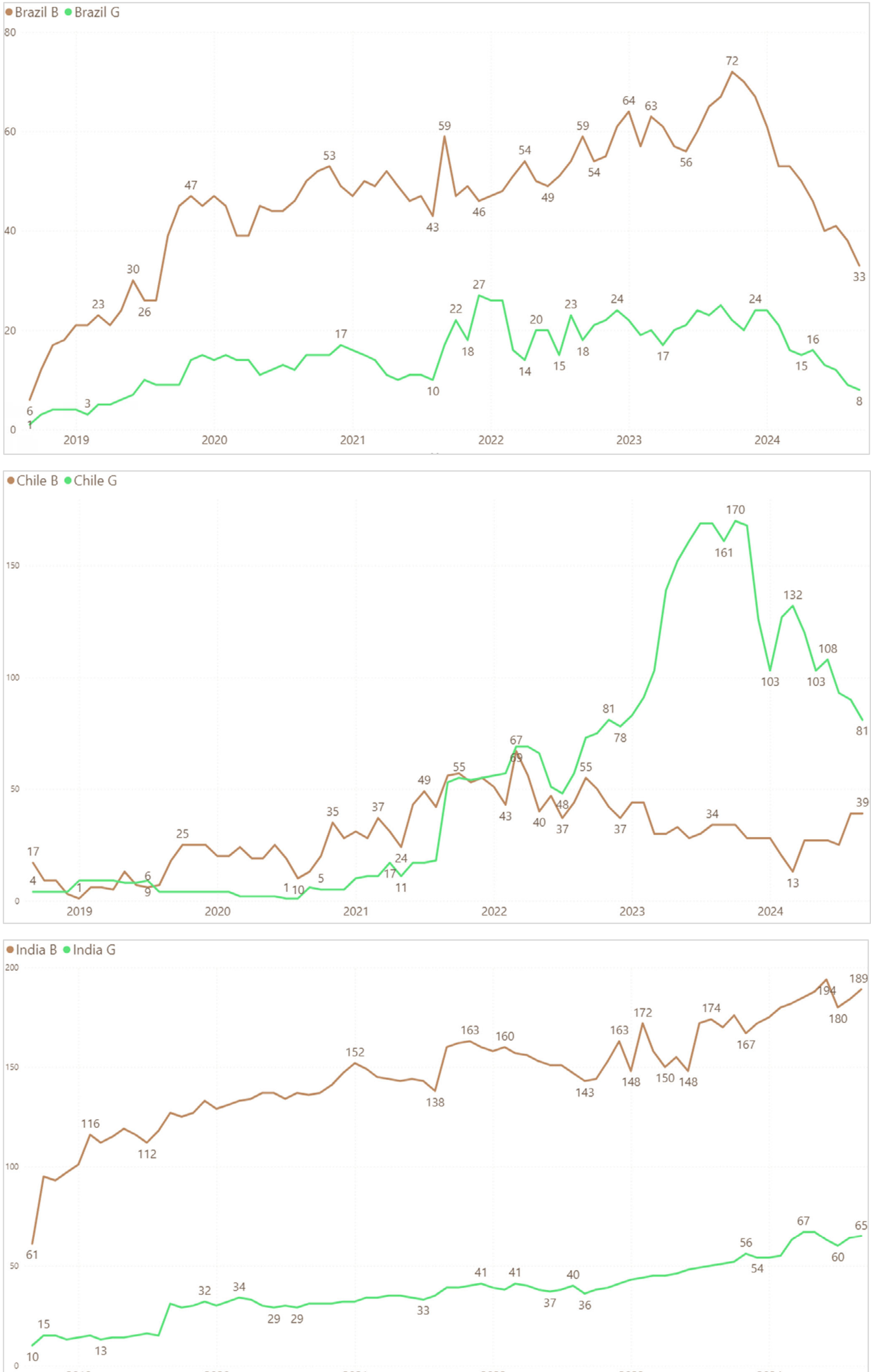

Figure 1 *Monthly number of green (g) and brown (b) equity funds from sept. 2018 to sept. 2024, for the Brazilian, Chilean, Indian, Mexican and South Korean markets*

Figure 1 *Cont.*
Source: *Prepared by the authors.*

4.3. Multiple and Markov-Switching Regressions

First, we assess multicollinearity among the independent variables. The pairwise Pearson correlation coefficients reveal that RGEPU and RVIX have a moderate positive correlation of 0.36. This indicates that higher economic uncertainty is associated with increased market volatility. Meanwhile, RWTI and RVIX exhibit a moderate negative correlation of –0.32, and RGEPU and RWTI show a weak negative correlation of –0.20. All of these correlations are statistically significant at the 1% level. Since none of the correlation coefficients exceed 0.50, we proceed with the regression analysis.

Table 4 shows that variations in economic uncertainty (RGEPU), oil price volatility (RWTI), and market volatility (RVIX) have a differential impact on green (G), brown (B), and green minus brown (GMB) portfolios in Brazil, Chile, India, Mexico, and South Korea. The findings suggest that, while RGEPU positively affects green and brown funds in most countries, supporting the argument that ESG portfolios can act as diversification tools against macroeconomic risks (Cepni et al., 2023), market volatility (RVIX) significantly undermines returns, particularly in Chile, India, and Mexico. Oil price fluctuations (RWTI) also benefit brown portfolios in Brazil and Mexico, but negatively impact GMB portfolios. This aligns with previous studies on ESG assets' sensitivity to oil shocks (Dutta, Bouri et al., 2020; Dutta, Jana et al., 2020).

These results contribute to the ESG literature by showing that, while ESG funds in emerging markets may provide some protection against economic policy uncertainty, they remain vulnerable to broader market shocks. This aligns with previous studies that suggest ESG investments may not always serve as safe havens during crises (Koçak et al., 2022) and may even experience outflows during high-volatility periods (Döttling & Kim, 2024). Country-specific variations further emphasize that ESG performance is not uniform across emerging markets. This finding reinforces the conclusions of Ji et al. (2021) and Lestari and Frömmel (2024), who found that the success of ESG investing depends on regional economic conditions and external risk factors.

4.4. Markov-Switching Analysis

Table 5 shows the returns of green, brown, and GMB portfolios during high- and low-volatility periods. RWTI is used as the transition variable. The regressions control for exposure to RGEPU and RVIX to capture global economic uncertainty and market volatility, respectively. Table 6 displays the transition probabilities between low- and high-volatility regimes, as well as the expected duration of each state, for green, brown, and GMB portfolios across countries. The results highlight the differential impact of oil price fluctuations (RWTI) as a transition variable, economic uncertainty (RGEPU), and market volatility (RVIX) on ESG portfolios in emerging markets, emphasizing the role of regime shifts in market stability.

Across all countries, alpha values tend to be higher in the low-volatility state than in the high-volatility state. This suggests that portfolio returns are more stable and higher when market conditions are calm. This contrast is especially significant for the GMB portfolio in Brazil, where the low-volatility alpha is -3.36, shifting to 1.93 during high-volatility periods.

Markov-switching regressions reveal that green funds in Chile and Mexico are positively affected by RWTI in low-volatility regimes. However, brown funds in Brazil and Mexico benefit even more. This reinforces the notion that fossil fuel-linked assets remain resilient under stable market conditions (Dutta, Bouri et al., 2020; Dutta, Jana et al., 2020). However, green portfolios tend to underperform during high-volatility regimes, though this is not significant. This aligns with prior research suggesting that ESG investments may not consistently offer safe-haven properties, particularly in emerging markets (Koçak et al., 2022; Ji et al., 2021).

The GMB portfolio reacts negatively to oil price fluctuations, particularly in countries with low volatility, such as Brazil, Chile, Mexico, and South Korea. This again supports the notion that brown stocks benefit more from rising oil prices while green portfolios tend to be negatively affected.

RGEPU positively impacts portfolio returns, suggesting that ESG investments may serve as partial hedges against economic uncertainty.

Additionally, RVIX negatively impacts nearly all portfolios, confirming that ESG funds are susceptible to systemic market risks, as reported by Albuquerque et al. (2020) and Broadstock et al. (2021).

The time-varying transition probabilities in Table 6 suggest that brown funds tend to remain in high-volatility states for longer periods, particularly in Brazil and Mexico. This finding aligns with the evidence presented by Badía et al. (2020), who argue that despite regulatory and reputational risks, brown assets may exhibit greater resilience in turbulent markets. Conversely, green funds in India and South Korea exhibit shorter durations in low-volatility regimes, suggesting heightened sensitivity to oil price shocks. These results reinforce the idea that ESG funds may not outperform in emerging markets and could be more volatile than their brown funds in some cases (Naqvi et al., 2021; Bansal et al., 2021). Overall, these results contribute to the ongoing discussion about ESG performance. They demonstrate that while these funds are becoming more relevant, their risk-return dynamics are heavily influenced by macroeconomic conditions and market fluctuations. Thins finding aligns with the previous observations by Lestari and Frömmel (2024) and Cepni et al. (2023).

Table 4
Multiple regressions

Country & Portfolio	α		RGEPU		RWTI		RVIX		N	R²
Brazil G	1.16	-1.51	10.04***	-2.79	8.04	-1.63	−19.09***	(−2.87)	73	0.26
Brazil B	1.13	-1.48	12.39**	-2.65	13.28**	-2.08	−22.11***	(−3.15)	73	0.32
Brazil GMB	0.03	-0.07	−2.35	(−1.06)	−5.24*	(−1.74)	3.02	-1.3	73	0.09
Chile G	0.46	-0.98	7.39***	-2.75	−0.11	(−0.04)	−16.63***	(−6.16)	73	0.34
Chile B	−0.13	(−0.29)	3.95**	-2.17	2.39	-1.17	−13.42***	(−5.51)	73	0.37
Chile GMB	0.59	-1.57	3.44*	-1.77	−2.50	(−1.41)	−3.21*	(−1.74)	73	0.06
India G	1.17**	-2.32	2.89	-0.91	−2.04	(−0.65)	−16.71***	(−5.33)	73	0.43
India B	1.16***	-2.84	1.82	-0.49	−2.15	(−0.63)	−14.00***	(−3.93)	73	0.35
India GMB	0.01	-0.03	1.08	-0.58	0.1	-0.09	−2.71***	(−2.73)	73	0.07
Mexico G	0.52	-1.5	4.75**	-2.19	1.46	-0.78	−19.53***	(−8.40)	73	0.58
Mexico B	0.5	-1.38	4.20*	-1.85	4.58**	-2.16	−18.13***	(−6.57)	73	0.55
Mexico GMB	0.02	-0.11	0.56	-0.54	−3.13***	(−3.40)	−1.40	(−1.35)	73	0.09
South Korea G	0.54	-1.03	6.44**	-2.43	−2.89	(−1.12)	−17.65***	(−7.62)	73	0.38
South Korea B	0.37	-0.76	4.03*	-1.68	−2.72	(−1.10)	−16.77***	(−7.49)	73	0.39
South Korea GMB	0.17	-1.59	2.41**	-2.27	−0.17	(−0.23)	−0.88	(−1.54)	73	0.11

Note: *This table presents the results of multiple linear regressions estimating the impact of economic uncertainty indicators on portfolio excess returns. The independent variables include the Refinitiv Global Economic Policy Uncertainty index (RGEPU), the return of WTI crude oil (RWTI), and the CBOE Volatility Index (RVIX). All models include a constant (intercept). The table reports the estimated coefficients, R-squared, and OLS HAC-robust t-statistics for each regression. The reporting period is from September 2018 to September 2024.*
*Statistical significance is denoted as follows: *p < 0.1; **p < 0.05; ***p < 0.01.*
Source: *Prepared by the authors.*

Table 5
Markov-switching regressions

Country	Portfolio	α_LV	α_HV	RWTI_LV	RWTI_HV	RGEPU	RVIX	L.L.
Brazil	Green	1.42	0.63	1.45	26.81	11.34**	−17.23***	−242.38
Brazil	Brown	1.85***	1.13	19.76***	8.52	−0.63***	3.08***	−241.40
Brazil	GMB	−3.36***	1.93***	−9.74**	−1.87	21.13	−36.56*	−185.70
Chile	Green	2.99***	0.14	20.71***	−3.00	7.31***	−17.31***	−201.14
Chile	Brown	0.46***	−0.17	5.57***	0.15	5.18***	−18.75***	−186.90
Chile	GMB	−0.26	3.51**	−5.20***	9.48	4.48***	−3.74***	−168.61
India	Green	2.70***	1.01**	−0.27**	−2.34	0.67***	−15.21***	−189.08
India	Brown	2.51***	0.36	25.28***	−12.65***	7.26***	−11.12***	−191.53
India	GMB	0.38***	−0.03	2.06***	−0.33	1.73***	−3.23***	−149.03
Mexico	Green	2.68***	0.24	9.16***	−0.67	4.04***	−20.21***	−181.70
Mexico	Brown	0.51*	0.62	14.29***	1.47	1.47	−16.02***	−189.62
Mexico	GMB	−0.00	0.03	−3.74***	−2.50	1.90***	−1.60***	−113.70
South Korea	Green	3.09***	−1.22	3.70	−5.97	8.07**	−19.43***	−205.00
South Korea	Brown	0.83***	0.33	0.14	−2.46	4.28***	−16.27***	−193.18
South Korea	GMB	−0.09	0.26	−1.42***	1.11	3.72***	−1.21***	−102.26

Note: *This table presents the results of the Markov switching regression model estimating the relationship between portfolio excess returns and economic uncertainty indicators under two distinct volatility regimes: low (LV) and high (HV). The dependent variable is the portfolio return for each country. The table reports the estimated intercepts (α_LV and α_HV), the coefficients for WTI returns under both regimes (RWTI_LV and RWTI_HV), and the regime-invariant coefficients for the Refinitiv Global Economic Policy Uncertainty Index (RGEPU) and the CBOE Volatility Index (RVIX). The last column shows the log-likelihood (L.L.) of the estimated model. Log Sigma was significant at 1 % for all regressions, except for India – Brown – High Volatility and South Korea – GMB – High Volatility. The reporting period is from September 2018 to September 2024.*
*Statistical significance is denoted as follows: *p < 0.1; **p < 0.05; ***p < 0.01.*
Source: *Prepared by the authors.*

Table 6
Time-varying and expected duration

Country	Portfolio	Time-varying				Expected Duration	
		Low/Low	Low/High	High/Low	High/High	Low	High
Brazil	Green	0.63	0.37	1.00	0.00	2.73	1.00
Brazil	Brown	0.00	1.00	0.14	0.86	1.00	7.24
Brazil	GMB	0.54	0.46	0.25	0.75	2.19	3.94
Chile	Green	0.00	1.00	0.12	0.88	1.00	8.24
Chile	Brown	0.24	0.76	0.09	0.91	1.31	11.02
Chile	GMB	0.90	0.10	0.35	0.65	10.32	2.86
India	Green	0.00	1.00	0.10	0.90	1.00	10.25
India	Brown	0.31	0.69	0.50	0.50	1.46	2.01
India	GMB	0.10	0.90	0.12	0.88	1.11	8.56
Mexico	Green	0.00	1.00	0.16	0.84	1.00	6.30
Mexico	Brown	0.01	0.99	0.20	0.80	1.01	5.12
Mexico	GMB	0.00	1.00	0.18	0.82	1.00	5.58
South Korea	Green	0.00	1.00	0.73	0.27	1.00	1.37
South Korea	Brown	0.00	1.00	0.08	0.92	1.00	12.18
South Korea	GMB	0.07	0.93	1.00	0.00	1.08	1.00

Note: *This table presents the estimated probabilities of transitioning between low- and high-volatility regimes, as well as the expected duration of each regime, for green, brown, and GMB portfolios in different countries. The "Time-Varying" section shows the average probabilities of remaining in or switching between regimes. Low/Low and High/High represent the probability of staying in the same regime, while Low/High and High/Low represent the probability of switching from high volatility to low volatility and from low volatility to high volatility, respectively. The "Expected Duration" columns report the expected number of periods that the portfolio remains in each regime. These estimates are derived from the Markov switching model applied to the period from September 2018 to September 2024.*
Source: *Prepared by the authors.*

5. CONCLUSION

This study examined the performance and risk dynamics of ESG funds in emerging markets, with a focus on Brazil, Chile, India, Mexico, and South Korea. Our findings reveal significant disparities between green, brown, and GMB portfolios, challenging the notion that ESG investments consistently outperform other investments or act as safe-haven assets. As shown in MS-Regression, brown funds tend to outperform green funds in Brazil and India, particularly during periods of heightened market stress. This finding reinforces previous research suggesting that ESG funds may not consistently deliver higher returns due to liquidity constraints or greenwashing concerns (Badía et al., 2020; Fish et al., 2019; Naqvi et al., 2021). Conversely, green portfolios exhibited stronger performance in Chile, Mexico, and South Korea, which aligns with studies indicating that ESG investments can provide resilience in certain economic environments (Jia & Li, 2020; Derwall & Koedijk, 2009).

Our Fama-French factor analysis supports these conclusions, demonstrating that market risk (RmRf) dominantly factor influences ESG fund performance across all countries. The HML factor (value vs. growth) is significant in Brazil and India, suggesting that green funds tend to hold growth-oriented assets, whereas brown funds tend to hold value stocks. The SMB factor (size effect) is particularly relevant in India and Mexico, indicating a strong presence of small-cap stocks in both green and brown portfolios. The momentum factor (WML) is significant in India and Mexico, showing that past winners continue to perform well in these markets. Interestingly, including the COVID-19 dummy variable revealed that green and brown portfolios in Brazil, India, and Mexico suffered significant negative shocks during the pandemic, while South Korean ESG funds demonstrated resilience. These results reinforce the idea that ESG performance varies widely across regions and economic conditions (Albuquerque et al., 2020; Broadstock et al., 2021).

Our risk analysis underscores the importance of oil price volatility (RWTI), economic uncertainty (RGEPU), and market volatility (RVIX) in shaping ESG portfolio performance. Green funds in Brazil, Chile, and Mexico are more sensitive to macroeconomic uncertainty, while brown funds benefit from oil price fluctuations, which is consistent with the literature on ESG assets and commodity exposure (Dutta, Bouri et al. (2020); Dutta, Jana et al., 2020; Hanif et al., 2023). Markov-switching regression analysis confirms that, during crises, ESG funds do not always provide stability, as they tend to remain in high-volatility regimes, except in specific cases, such as Brazilian and Chilean GMB portfolios. These findings contribute to the ongoing debate about the financial viability of ESG investing in emerging markets, reinforcing the idea that its effectiveness depends on regional economic conditions, policy risks, and market structure (Lestari & Frömmel, 2024; Cepni et al., 2023).

While our study offers valuable insights, it is subject to data limitations due to changes in Morningstar's ESG rating methodology, the relatively short observation period, and the bias of relying solely on this provider's ratings. Future research should incorporate additional macroeconomic and climate-related variables, analyze ESG bonds alongside equity funds, and expand the sample period to capture longer-term trends. Moreover, it could include risk factors and indices from Global Factor Data by Jensen et al. (2023). In future research, we recommend using longer time periods, value-weighted portfolio construction, and comparing ESG ratings from different data providers to test the consistency of results, and applying quantile regression as a robustness test.

These findings are limited in several ways. They serve as a foundation for investors and policymakers seeking to understand how ESG strategies perform under varying economic conditions, particularly in emerging markets where regulatory and financial uncertainties are crucial in shaping sustainable investment outcomes.

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Datasets related to this article will be available upon request to the corresponding author.

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