Connectedness and Portfolios in Emerging Markets: ESG Leaders vs. Conventional Indexes

Abstract

This study investigates the dynamic connectedness of ESG Leaders and conventional equity indexes with commodities in emerging markets. Using data for emerging markets stocks from three regions (Asia, Europe and Latin America) from July 2013 to October 2022, we compare the spillover effects from commodities to ESG and conventional indexes. The TVP-VAR results indicate that most of the transmission of shocks occurs between equity indexes, whereas spillover from commodities is limited. While there are similarities in the behavior of ESG Leaders and conventional index time series, slightly higher transmission is documented from commodities to conventional indexes compared to the ESG Leaders. Regional differences in connectedness are observed. Within a portfolio framework, the highest Sharpe ratios are noticed in portfolios based on minimizing dynamic connectedness, but no notable differences can be seen between using the ESG Leaders or conventional emerging market indexes.

JEL Classification: F3, G11, G15, M14, Q010

Keywords: International Financial Markets, Asset Allocation, Investment Decision, Portfolio Choice, Hedging, Sustainable Investing, ESG Investing

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1. Introduction

The environmental, social, and governance (ESG) pillars are used in corporations to capture non-financial risks and opportunities, as well as to evaluate the long-term sustainability of investments. There are many companies that incorporate ESG in their business practices to strengthen the relationship between society and their employees and to address climate risk. This increase in stakeholder capitalism has brought about the need for corporations to focus on financial and ESG performance. Just like corporations, investors are also incorporating ESG elements into their decisions. Corporations with the highest ESG ranking have been sought out by investors who wish to implement a green investment scheme or desire for their portfolios to have more exposure to companies with a strong sustainability profile. By 2020, global sustainability investment has exceeded \$35.3 trillion, with an expectation to further increase to \$50 trillion by 2025[1], making the investment in high ESG ranking corporations a fertile ground for study. While most of the sustainable investment is concentrated in developed markets, emerging markets ESG equity funds and bond issuance experienced fast growth in 2021[2].

Due to the past progress in economic globalization, there is a developing segment of the finance literature analyzing the relationship between ESG ranking and stocks performance that captures equity investment opportunities in the global stock markets. However, the relationship

[1] Henze, V. and Boyd, S. ESG May Surpass \$41 Trillion Assets in 2022, But Not Without Challenges, Finds Bloomberg Intelligence. Bloomberg, January 14, 2022. https://www.bloomberg.com/company/press/esg-may-surpass-41-trillion-assets-in-2022-but-not-without-challenges-finds-bloomberg-intelligence/

[2] Gautam, D., Goel, R., & Natalucci, F. (2022). Sustainable Finance in Emerging Markets Is Enjoying Rapid Growth, But May Bring Risks. https://www.imf.org/en/Blogs/Articles/2022/03/01/sustainable-finance-in-emerging-markets-is-enjoying-rapid-growth-but-may-bring-risks

between the investment in highly ranked ESG corporations or funds, also referred to as ESG Leaders, and commodities in a global setting has not been widely studied, with the volume of academic work on the dynamic connectedness from commodities to ESG Leaders indexes being even thinner. Yet, the association among these asset classes is sensible because investment in commodities serves as a tool that investors could use to diversify and hedge against inflation while considering their ESG objectives.

Much of the literature on the interaction between ESG investments and commodities focuses on developed economies. Those covering emerging markets are rather recent (e.g., Umar et al., 2020; Iglesias-Casal et al., 2021; Pisera and Chiappini, 2022, among the few we could find). Although there exists some evidence related to the dynamic connectedness of ESG investment and commodity prices in developed markets, there are still unexplored aspects in emerging markets. For instance, is there a lower level of volatility spillover from commodities to the ESG Leaders indexes of emerging markets than to more traditional equity indexes from the same region? How does the transmission of shocks from commodity prices to ESG Leader indexes of emerging markets differ from conventional indexes such as the MSCI World Index? Would the transmission of shocks be greater from crude oil given its importance in the world economy than from other commodities, such as gold? Studying these questions within the frame of emerging markets compared to developed economies is of interest because energy demand from developed economies in Europe and North America has declined, with the demand for energy resources shifting to emerging markets such as those in Asia. According to Xia et al. (2022), after the U.S., the largest share of world oil consumption can be found in China and India. The rapid industrialization in these emerging markets increases oil consumption but could also increase climate risk. There are also differences in the relationship between commodities and equities of developed and emerging markets. de Boyrie and Pavlova (2018) show that Asian stocks have a lower level of co-movement with commodities than developed markets, whereas Latin American equity markets have a higher level of integration with commodities.

Analyzing the last question is of particular interest given that two of the most widely used commodities in the finance literature have been crude oil and gold. Besides being the most widely used energy material, crude oil presents those countries that have this resource with both political and economic power (Bashir et al., 2020, 2021a,b), but could also lead to environmental degradation and diminish ESG efforts. Gold, on the other hand, has been considered by Baur and McDermott (2010, 2016) and Akhtaruzzaman et al. (2021) as a flight-to-safety or safe haven asset during times of crisis, and/or a hedge by Baur and Lucey (2010) and Gürgün and Ünalmiş (2014), among others. As such, it is unsurprising that crude oil and gold have been the commodities of choice to include in many studies given the role it plays in present day economies.

Motivated by these questions, different hypotheses are tested. As MSCI ESG Leaders indexes provide exposure to companies with high ESG performance and Sadorsky (2014) finds lack of evidence of a spillover effect from commodities to socially responsible investing, there exists a smaller level of dynamic connectedness from crude oil and gold to the MSCI ESG Leader indexes of emerging markets than to conventional indexes from the same regions (Hypothesis 1), and there exists a lower level of dynamic connectedness between commodity prices and the ESG Leader Index of emerging markets than when employing the World Index (Hypothesis 2). Furthermore, based on the findings of de Boyrie and Pavlova (2018) research work on commodities in emerging markets, regional differences between the three regions studied are expected (Hypothesis 3). Finally, in a portfolio setting using the dynamic portfolio framework of Broadstock et al. (2022), it is expected for the ESG EM Leaders indexes to enhance the performance of portfolios compared to the conventional emerging markets indexes, based on the findings of Diaz et al. (2022) who highlights the role of SRI investments in portfolios with other assets (Hypothesis 4).

The main contribution of this paper is to offer fresh evidence on the connectedness and spillover effects across ESG investments proxied by the MSCI ESG Leaders indexes of three emerging markets (i.e., Asia, Europe, and Latin America), conventional equity indexes, developed markets index (MSCI World) and commodities represented by the prices of crude oil and gold. These two commodities are selected because they serve as a strategic resource and safe haven asset, as previously mentioned. The MSCI ESG Leaders indexes consist of corporations with the highest ESG ranking relative to their sector peers. To achieve the goal of this study, we employ the time-varying parameter Vector Autoregressive (TVP-VAR) model to measure Antonakakis et al. (2020) spillovers. The advantage of this method is that it obtains more accurate parameter estimations given the model does not require the size of the rolling window to be set, does not lose the observations, and is not sensitive to outliers. We further establish the hedging effectiveness of all the indexes to determine if any profitable trading opportunities exist. Lastly, we set up dynamic portfolios to examine optimal weights and risk adjusted performance based on the connectedness results.

The rest of the paper is organized as follows: Sections 2 and 3 present the literature review and describe the data and methodology employed to measure the dynamic connectedness between commodities and indexes in the sample. Section 4 describes the empirical findings, while section 5 presents concluding remarks.

2. Literature Review

There is a growing body of literature on the dynamic relationship of ESG assets with other assets classes and conventional equities. Along the line of research studying transmission between ESG and conventional equities, recent studies have been performed by Balcilar et al. (2017), Sharma et al. (2022), Amansour et al. (2022), and Rehman et al. (2021), among others. Balcilar et al. (2017) document substantial unidirectional volatility transmissions from conventional to sustainable equities (global, North America, Europe, and Asia-Pacific indexes), but also show that that adding sustainable stocks to conventional stock portfolios improves the risk/return profile of the portfolios. Sharma et al. (2022) examine the causality and spillover between NASDAQ clean energy indexes and their conventional counterparts and show that the connectivity between the two sets of indexes increased after the Covid-19 pandemic. Furthermore, Amansour et al. (2022) find a substantial degree of connectedness between S&P and DJ indexes and their respective sustainability indexes over the whole sample studies, as well as in subsamples before and during the Covid-19 pandemic. Focusing on emerging markets, Rehman et al. (2021) show that ESG equity indexes are integrated with the conventional indexes in all BRICS countries under their period of study. A separate strand of the literature investigates the dynamics of sustainable/ESG assets and commodities. Sadorsky (2014) models volatilities and correlations between the Dow Jones Sustainability Index, oil, gold, and the S&P 500 and finds that the sustainability Index has similar dynamic conditional correlations and hedge ratios in portfolios with oil and gold as the S&P 500. Andersson et al. (2022) use data for FTSE4GOOD Global, MSCI World ESG Leaders, Dow Jones Sustainability World Index and confirm the bidirectional causality between ESG and conventional indexes found in other studies. They also show weaker causality, particularly between ESG assets and commodity returns. Pedini and Severini (2022) investigate the safe haven, diversification, and hedging aspects of ESG assets compared to their conventional counterparts in portfolios with oil, gold, and cryptocurrencies. They find that the ESG indexes under study (the Dow Jones Sustainability World Index, the S&P Global Clean Energy Index and the Standard & Poor Green Bond Index) appear to be very good diversification and hedge assets. The ability of SRI assets to amplify the performance of different portfolios containing conventional equities, Treasury bonds, gold, crude oil, or Bitcoin is confirmed by Diaz et al. (2022), who also show the significance of ETFs linked to renewable energy equities as diversifiers. Analyzing volatility spillover, Cagli et al. (2022) show that the ESG indexes they study are net volatility transmitters, whereas the commodities, except for crude oil and copper, are net volatility receivers. Lastly, using advanced machine learning algorithms, Jabeur et al. (2021) look from a different angle at commodities, clean energy and ESG indexes. They show that during the Covid-19 pandemic, high values of clean energy and ESG indexes are associated with lower crude oil prices.

Few studies examine the linkages between ESG assets and commodities in emerging markets. Iglesias-Casal et al. (2020) explore the role of socially responsible investments in Brazil as diversifiers and hedges. Their results reveal substantial benefits to diversification with respect to gold, the oil volatility index, and the ISE. More recently, Pisera and Chiappini (2022) used data for the MSCI China ESG leaders, the MSCI AC Asia Pacific ESG leaders, the Shanghai Stock Exchange Environmental protection and the Shanghai Stock Exchange sustainable development industry indexes to study their hedging and safe haven properties during the Covid-19 pandemic. The authors find the risk hedging properties of ESG indexes exceed those of cryptocurrencies, but they do not document any safe haven properties of ESG, Bitcoin, gold, and oil for their sample. Umar et al. (2020) focus on causality and volatility transmission among oil, bonds, VIX, economic policy uncertainty and country level MSCI ESG Leaders indexes for selected developed and emerging markets (namely, USA, Australia, Canada, China, Europe, India, Japan, Russia, South

Africa, and the United Kingdom). Their results indicate a higher risk of contagion and smaller portfolio diversification potential of these ESG indexes during turbulent periods. Developed market ESG indexes have higher net total directional connectedness to others.

As previously stated, this study builds on the existing literature and expands it by comparing the regional effects in the transmission of shocks between ESG indexes, conventional equity indexes, and commodities simultaneously. An earlier study Umar et al. (2020) includes all country level ESG index data in one system, which makes is harder to disentangle the transmission channels and does not compare the transmission between conventional and ESG indexes. To the best of our knowledge, studies have yet to investigate the connectedness of the MSCI EM Asia, Europe, and Latin America ESG Leaders indexes with their conventional counterparts and commodities. As prior studies document that Asian emerging market conventional equities show a much lower level of connectedness with commodities than developed markets, while Latin American stocks exhibit a higher level of integration with commodities (de Boyrie and Pavlova, 2018), it is important to study how these relationships apply to ESG Leaders indexes in emerging markets.

3. Data and Methodology

3.1 Summary Statistics

Daily data for emerging market (EM) MSCI ESG Leaders Indexes (i.e., MSCI EM Asia, Europe, and Latin America ESG Leaders Total Return Indexes) and their respective conventional regional stock market indexes (i.e., MSCI EM Asia, Europe and Latin America Total Return Indexes), the MSCI World Index, as well as for crude oil (Crude Oil-WTI Spot Cushing U$/BBL) and gold (Gold Bullion LBM $/t oz DELAY) are obtained from DataStream. The ESG Leaders' equity indexes consist of companies with the highest environmental, social and governance performance based on risk management in the different sectors of the parent index, thus serving as a good proxy for socially responsible investing. Emerging markets, rather than developed economies, are selected given the current interest in the portfolio diversification benefits that may exists in emerging markets. The data under study spans from July 12, 2013 to October 3, 2022 based on the availability of data. Spillovers are examined using the first log-difference of the series, that is, $y_{it} = \ln(x_{it}) - \ln(x_{it-1})$. The Asia indexes consist of constituents from Chia, India, Indonesia, Korea, the Philippines, Taiwan, and Thailand. Those of Europe consist of The Check Republic, Greece, Hungary, Poland, and Turkey. Constituents from Brazil, Chile, Colombia, Mexico, and Peru are used to form the MSCI EM indexes.

As can be expected, the MSCI EM Indexes encompass more constituents than the MSCI EM ESG Leaders Index. For example, the MSCI EM Index for Asia consists of 1,151 constituents, while the one for Europe has 40 constituents, and the one for Latin America has 90. The MSCI EM Leaders has less constituents with Asia having 349 and Latin America only 49.

Table 1 shows that four of the series have negative average returns and five positive average returns. Both of Asia's indexes show positive average returns as do the MSCI Emerging Market Index for Latin America, the MSCI World Index, and Gold. The riskiest series based on variance is crude oil, with a significant variance of 9.48%. The variance of all other series falls between 0.81% and 4.67%. All series are significantly negatively skewed except for Latin America ESG Leaders. The indexes for Europe are the only ones that are leptokurtic distributed. If we are to combine the results of the D'Agostino (1970), Ascombe and Glynn (1983), and Jarque and Bera (1980) tests, the findings show that all series are significantly non-normally distributed and stationary at the 1% significance level, this last based on the ERS (Elliott et al., 1996) test. Pronounced autocorrelation in both the series and square of the series based on the Fisher and

Gallagher (2012) weighted Portmanteau test is found. This finding supports the use of the TVP-VAR model, which allows for a time-varying variance-covariance structure.

The correlations presented in Table 2 are mostly significant at the 1% level. The lowest correlations between series are found for Gold and all other series, followed by crude oil. High correlations between the MSCI World Index and the indexes of Latin America are seen. A high and not surprising relationship between the MSCI ESG Leaders Indexes and that of their respective Emerging Market indexes is noted.

Figure 1 presents the graphs of indexes at level in logarithmic scale. The exponential growth of the return of conventional regional and ESG Leaders Indexes follow each other rather closely. In terms of scale, the ESG Leaders Indexes of Asia and Europe have grown at the same rate as their conventional regional indexes. However, the ESG Leaders Index of Latin America has shown a greater level of growth than its regional counterpart, possibly due to the region's expansion in sustainable investments. Although all indexes show a dip during the start of COVID pandemic, only those for Europe reveal a significant dip at the beginning of the conflict between Russia and Ukraine; even though a slight decline in the growth of the Asian index returns is seen after the conflict. These findings are supported by those of Yousaf et al. (2022) who found that the stock markets of Hungary, Russia, Poland, and Slovakia reacted in anticipation of the conflict as well as in the post-invasion days. The authors also note a significant and adverse effect on the event day in the indexes of the European and Asian regions. The indexes of North America, Latin America, and the Middle East and Africa are less affected by the conflict. As such, the rise in the Latin America index can be explained by a flight to safety opportunity.

The Asia ESG Leaders Index has the highest growth among the three indexes under study. Latin America and Europe follow it. The European index has the lowest change over time. These findings differ from the conventional market indexes in that the EM Latin American Index's return is closest to the MSCI World Index, even surpassing it in the 2013-2014 period. The high increase in the Latin American index could also be explained by the region's high exposure to commodities. The EM Asia and Europe MSCI Indexes' growth is much lower than that of Latin America. The return of the Asian index is only slightly higher than those of Europe, yet again. The gold index growth is much higher than that of crude oil throughout the period under study, but only the crude oil index shows a dip during the beginning of the COVID pandemic; most possibly because Russia is one of the world's largest energy exporters.

3.2 TVP-VAR based Dynamic Connectedness Approach

To establish the dynamic connectedness among the indexes under examination, a time-varying parameters vector autoregression (TVP-VAR) model is employed. The model, which expands the popular work of Diebold and Yilmaz's (2009, 2012, 2014) dynamic connectedness approach, is first proposed by Anatonakakis and Gabauer (2017) and Korobolis and Yilzmas (2018), with further improvements presented by Antonakakis et al. (2020).

Diebold and Yilmaz's (2009, 2012, 2014) original approach examines spillovers in a predetermined network to compare the impacts of a shock in one variable on another variable's forecast error variance by considering the feedback loops of the entire network. However, this approach uses an arbitrarily chosen rolling window size to estimate the dynamic connectedness. To correct this shortcoming, Antonakakis et al. (2020) ultimately propose and apply a time-varying parameter vector autoregressive (TVP-VAR) model with a time-varying structure that allows for the variance-covariance matrix to vary through a Kalman filter with forgetting factors first proposed by Koop and Korobilis (2014).

Antonakakis et al.'s (2020) TVP-VAR(p) model can be defined as:

$$x = \psi_t x_{t-1} + \varepsilon_t \qquad\qquad \varepsilon_t|\Omega_{t-1} \sim \mathrm{N}(0, S_t) \tag{1}$$

$$vec(\psi_t) = vec(\psi_{t-1}) + \xi_t \qquad\qquad \xi_t\,|\Omega_{t-1} \sim N(0, R_t) \tag{2}$$

where x_t and x are k x 1 dimensional vectors of endogenous variables, respectively, ε_t is an k x 1 dimensional vector of iid disturbances, ψ_t and S_t are k x k dimensional matrixes, Ω_{t-1} embodies all available information until t-1, $vec(\psi_t)$ and ξ_t are k^2 x 1 dimensional vectors, and R_t are k^2 x k^2 dimensional matrix. The variance-covariance matrixes, S_t and R_t are allowed to vary over time, as well as all parameter (ψ_t) and the relationships across series. Finally the TVP-VAR is transformed into a TVP-VMA model using the Wold representation theorem: $x_t = \sum_{i=1}^{p} \psi_{it} x_{t-1} + \varepsilon_t = \sum_{j=0}^{\infty} \Lambda_{jt} \varepsilon_{t-j} + \varepsilon_t$. The coefficients of the latest model are extracted to calculate the generalized forecast error variance decomposition (GFEVD) of Koop et al. (1996) and Pesaran and Shin (1998). The impact of a shock from series *j* to series *i* in terms of its forecast error variance share is modeled using the H-step ahead (scaled) GFEVD, which can be formulated as:

$$\phi_{ij,t}^{g}(H) = \frac{\sum_{h=0}^{H-1}\left(\ell_i' \Lambda_{ht} \Sigma_t \ell_j\right)^2}{\left(\ell_j' \Sigma_t \ell_j\right) \sum_{h=o}^{H-1}(\ell_i' \Lambda_{ht} \Sigma_t \Lambda_{ht}' \ell_i)} \tag{3}$$

$$\tilde{\phi}_{ij,t}^{g}(H) = \frac{\phi_{ij,t}^{g}(H)}{\sum_{k=1}^{K} \phi_{ij,t}^{g}(H)} \tag{4}$$

where ℓ_i is a k x 1 dimensional zero vector with unity of its ith position and zero otherwise, $\phi_{ij,t}^{g}(H)$ is the proportional reduction of the H-step forecast error variance of series *i* due to the conditioning on the future shocks of series *j*, and H is the forecast horizon. Diebold and Yilmaz (2009, 2012, 2014) propose to normalize the unscaled GFEVD (i.e., $\sum_{j=1}^{K} \phi_{ij,t}^{g}(H) \neq 1$) to unity by the row sums resulting from the generalized spillover table, $\tilde{\phi}_{ij,t}^{g}(H)$.

The connectedness measures can be calculated as follows:

$$C_{i\rightarrow j,t}^{g,TO}(H) = \sum_{j=1,i\neq j}^{k} \tilde{\phi}_{ji,t}^{g}(H), \tag{5}$$

$$C_{i\leftarrow j,t}^{g,FROM}(H) = \sum_{j=1,i\neq j}^{k} \tilde{\phi}_{ij,t}^{g}(H). \tag{6}$$

The NET total directional connectedness of series *i* is simply the difference between the TO and the FROM total directional connectedness. That is,

$$C_{i,t}^{g,NET}(H) = C_{i\rightarrow j,t}^{g,TO}(H) - C_{i\leftarrow j,t}^{g,FROM}(H). \tag{7}$$

Series *i* is a net transmitter (i.e., it is driving the network) if $C_{i,t}^{g,NET}(H) > 0$. In other words, series *i* is influencing all other series more than it is influenced by them. If $C_{i,t}^{g,NET}(H) < 0$, series *i* is a net receiver of the shock since it is influenced more by the other series.

The bilateral net transmission of shocks between both series (i.e., *i* and *j*) can be estimated using the net pairwise directional connectedness:

$$C_{i,t}^{g,NET}(H) = \tilde{\phi}_{ji,t}^{g}(H) - \tilde{\phi}_{ij,t}^{g}(H). \tag{8}$$

If $C_{i,t}^{g,NET}(H) > 0$, series *i* dominates series *j*. If < 0, then the opposite is true.

The total connectedness index (TCI) represents market risk. It is equal to the average level of spillover on the series' forecast error variance share that is explained by all other series. Chatziantoniou and Gabauer (2021) adjust the TCI to find the average amount of network in percent, such that,

$$C_{t}^{g}(H) = \frac{1}{k-1}\sum_{i=1}^{K} C_{i\leftarrow j,t}^{g,FROM}(H) = \frac{1}{k-1}\sum_{i=1}^{k} C_{i\rightarrow j,t}^{g,TO}(H), \quad 0 \leq C_{t}^{g}(H) \leq 1 \tag{9}$$

A high value indicates high market risk, while a low value indicates the opposite.

The pairwise connectedness index (PCI) is also calculated since it can be considered the TCI on a bilateral level. PCI shows the level of interconnectedness between the two series.

$$C_{ij,t}^{g}(H) = 2\left(\frac{\tilde{\phi}_{ij,t}^{g}(H) + \tilde{\phi}_{ji,t}^{g}(H)}{\tilde{\phi}_{ii,t}^{g}(H) + \tilde{\phi}_{ij,t}^{g}(H) + \tilde{\phi}_{ij,t}^{g}(H) + \tilde{\phi}_{jj,t}^{g}(H)}\right), \quad 0 \leq C_{ij,t}^{g}(H) \leq 1 \quad (10)$$

The interpretation of PCI is just like that of TCI but on a bilateral level.

3.3 Portfolio Back-Testing Models

Gregory (2021) examines the returns of 16 MSCI ESG Leader indexes and finds that although there is no difference in their market efficiency from those of MSCI Standard indexes, a few of the ESG indexes violate the conditions of weak-form efficiency, and all violate the conditions for semi-strong efficiency. Danila (2022) examines the random walk of socially responsible investments (SRI) and ESG indexes in emerging markets using three different tests (i.e., Augmented Dickey-Fuller (ADF) unit root test, variance ratio test, and the Hurst exponent test). Using daily data for 14 SRI/ESG indexes, the author concludes that none of the indexes follow random walk. These findings point to profitable trading opportunities. Therefore, to assess the investment performance of the indexes under study, we employ a portfolio back testing approach. Given the study's framework, an area of interest is the hedging potential of ESG leaders against that of crude oil and gold. Following the work of Broadstock et al. (2022), three different portfolios are formed. The first two (i.e., the minimum variance portfolio (MVP) and the minimum correlation portfolio (MCP)) are based on conventional approaches, and the other (i.e., the minimum connectedness portfolio (MCoP)) follows the connectedness approach. Influenced by Markowitz's modern portfolio theory (1959), the MVP approach generates a portfolio consisting of the lowest possible volatilities of the indexes under consideration. The portfolio weights are calculated as follows:

$$\omega_{S_t} = \frac{S_t^{-1}I}{IS_t^{-1}I} \quad (11)$$

where ω_{S_t} is a k x 1 dimensional portfolio weight vector, I is a k dimensional; vector of ones, and S_t is a k x k dimensional conditional variance-covariance matrix in period t.

Christoffersen et al. (2014) postulated that the portfolio weights of an MCP are obtained by minimizing the conditional correlations, instead of the conditional variances, as in the case of the MVP approach. In this instance, and by definition R_t to be a k x k dimensional matrix, the conditional correlations and weights can be estimated as:

$$F_t = diag(S_t)^{-0.5} S_t diag(S_t)^{-0.5} \tag{12}$$

and

$$\omega_{F_t} = \frac{F_t^{-1} I}{I F_t^{-1} I} \tag{13}$$

Instead of the conditional variance or correlations, the MCoP, introduced by Broadstock et al. (2022), uses the pairwise connectedness indexes. This method provides a more robust portfolio that is not heavily affected by shocks. This robustness is achieved by giving higher weights to variables that do not, or are not influenced by others, thus minimizing the interconnectedness and spillover across variables. Using the pairwise connectedness index matrix defined as PCI_t, and the identity matrix I, the portfolio weights can be expressed as:

$$\omega_{F_t} = \frac{PCI_t^{-1} I}{I PCI_t^{-1} I} \tag{14}$$

Finally, the Sharpe ratio and a hedge effectiveness score is used to represent the portfolio's performance. Following the work of Sharpe (1966), the Sharpe ratio is estimated as follows:

$$SR = \frac{r_p}{\sqrt{Var(r_p)}} \tag{15}$$

and the hedge effectiveness score as:

$$HE = 1 - \frac{Var(r_p)}{Var(r_{unhedged})}$$

where $r_p$is the return on a portfolio, Var(r_p) is the variance of the portfolio returns, and $Var(r_{unhedged})$ is the variance of the un-hedged assets.

In the case of the Sharpe ratio, a higher value indicates a higher level of return vis-à-vis the portfolio's level of risk. Since the hedge ratio measures the percent reduction in the variance of the unhedged position, the higher value would symbolize a higher risk reduction.

4. Empirical Results

4.1 Dynamic Connectedness

Table 2 reports correlations of the index returns under study. The three EM ESG Leaders indexes are less correlated with the MSCI World Index in comparison with the conventional EM indexes, except for Europe. The EM ESG Latin America Index is less correlated with crude oil than the conventional EM Latin America Index (25% compared to 30%). In contrast, while EM ESG Asia and Europe Indexes have about the same correlation with oil, as the conventional counterparts. Crude oil returns are more correlated with emerging market equities in Europe and Latin America than with Asia.

The differences between conventional and ESG index correlations with gold are relatively small. The EM ESG Latin America Index return is less correlated with gold than the conventional Latin America index (12.07% compared to 13.23%), while the Asian conventional and ESG index have about the same correlation with gold, which is also the lowest (about 2.9%). Overall, the correlations among equity markets appear much higher than equity indexes with oil or gold.

Figure 2 presents the dynamic total connected using the TVP-VAR approach. The figure has three panels, presenting results for the total connectedness separately for Asian, European, and Latin American ESG and conventional indexes. In all three panels, we see elevated connectedness during the second half of 2016, which coincide with the emerging markets rebound during that year and the commodities markets strong gains. There is a notable spike in transmission in 2020 during the COVID market sell-off, as well as a smaller peak at the beginning of 2022 during the beginning of the Russian invasion of Ukraine. When the conventional index is compared to the ESG Leaders Index for each region, the total connectedness exhibits a very similar pattern over time.

Figure 3 shows the net pairwise dynamic connectedness in panel A for Asia, panel B for Europe, and panel C for Latin America. The connectedness with the ESG Leaders and the conventional market index for each region are reported separately. This analysis reveals the evolution of the directional connectedness of paired markets. There is a variation in the transmission comparing the ESG Leaders indexes and the respective market index for each region. When the areas shaded in black in Figure 3 fall in the range of positive values (above the line), the corresponding index is considered a net transmitter of shocks, whereas the negative values indicate a net recipient of shocks. The Asia conventional market index and the Asia ESG leaders index appear to be net receivers from the MSCI World Index. The Europe and Latin America conventional and ESG indexes behave similarly with a smaller level of net transmission from MSCI World. There appears to be a higher level of spillover to the ESG Leaders indexes (compared to conventional indexes) from the MSCI World Index in all the regions. The transmission from crude oil to the conventional and ESG indexes varies over time but is relatively low, with an upsurge after COVID from the stocks to oil. Higher transmission between stocks and gold is noted in the case of Latin America, but there is not much difference when comparing conventional to ESG indexes. Not surprisingly, there is substantial transmission between the MSCI World Index and gold, with a spike during the COVID period. The spillover to ESG Leaders indices from commodities is less than the spillover from commodities to the MSCI World Index, in support of hypothesis 2.

Table 3 reports the average dynamic connectedness for each of the three regions and in a separate system with either a conventional or an ESG Leaders Index. Starting with Asia in Panel A of Table 3, the MSCI World Index has a substantial spillover effect on the ESG and conventional market indexes. The impact of oil and gold innovations on the forecast error variance on the conventional Asia Market Index is 3.45% and 1.83%, respectively. Similarly, innovations in crude oil and gold returns explain 3.06% and 1.81% of EM ESG Leaders Asia’s forecast error variance, respectively. Gold appears to be a net receiver of shocks.

Panels B and C of Table 3 report the average connectedness results over the sample period for the Europe and Latin America regions, respectively. Interestingly, crude oil can explain a more significant proportion of the forecast error variance of both the EM ESG Europe and the conventional market index (7.05% and 7.85%). Slightly different results are obtained for Latin America, with 4.73% of the forecast error variance of the EM ESG Index attributed to oil innovations and 6.39% of the forecast error variance of conventional market index explained by oil shocks. Overall, the ESG and conventional market indexes respond slightly differently to shocks in crude oil prices, where conventional indexes have a higher response to oil shocks, with some regional differences observed. Innovations in gold prices explain 2.78% and 2.20% of the forecast error variance of the EM Europe ESG Index and the Europe conventional market index, respectively. The results for Latin America point to lower, but similar level of spillover from gold to the conventional and ESG index. It is also notable that gold is a net receiver of shocks across all regions, while oil is a net transmitter in most cases.

In sum, regional differences in the transmission of shocks between crude oil, gold, and EM ESG and EM conventional equity indexes are observed (in support of hypothesis 3). Most of the spillover is noted among equity markets. The commodities under study (crude oil and gold) have some impact, but not surprisingly, a lot less than equity to equity spillover. Some differences between ESG and conventional indexes are noted in terms of spillover received from commodities, where oil explains a high proportion of the error variance of conventional indexes than ESG Leaders indexes (most notable in the Latin America case). These findings are in support of our hypotheses 1 and 2, and similar to the results from studies on developed markets such as the one by Andersson et al. (2022) who reveal weaker causality between ESG assets and commodity returns.

4.2 Dynamic Portfolios

Three different portfolio construction approaches are used to compare the financial performance of the ESG and conventional emerging market indexes in a portfolio context, including other assets. The methods employed are the MVP, MCP, and MCoP.

The results from the three portfolio construction approaches are presented in tables 4, 5, and 6. Each table reports the mean weight for each asset, the standard deviation top and bottom 5 percent, as well as the Hedging effectiveness (HE). Each portfolio contains either the EM ESG Leaders Index for each region or the conventional equity index for the region, in addition to MSCI World Market Index, crude oil, and gold.

Table 4 reports the results of forming portfolios using the MVP approach separately for each emerging market. Starting with Asia, the mean weights of the conventional equity index for the region, MSCI World Market Index, crude oil, and gold are 23%, 36%, 1%, and 40%, respectively. The mean weights of the ESG Leaders Asia Index, MSCI World Market Index, crude oil and gold are as follows: 23%, 36%, 1% and 40%, respectively, with minor differences in the upper and lower 5% of the distribution. The two assets with the highest mean weight are gold and the World index. Crude oil has the lowest average weight in the portfolio. In terms of hedging effectiveness, if we invest using the average weights listed above, the volatility of each unhedged position in the portfolio will be reduced by 69% for the ESG Leaders index and 62% for the conventional market index. The results for the average portfolio weights for Emerging European and Latin American portfolios are quite different. While the MSCI World Index and gold have the two highest weights, oil and either the conventional or ESG leaders index have an average close to zero. Investing in each asset in the proportions specified by the MVP weights, there will be a substantial volatility reduction compared with investing in individual assets, as shown by the hedging effectiveness results.

While the MVP approach aims to minimize portfolio variance, the MCP approach focuses on reducing correlations among assets. The mean and standard deviation of the MCP portfolio weights are presented in Table 5. There are some notable differences in the results, particularly regarding the weight of crude oil and the regional equity indexes. For the Asia emerging markets portfolio, the average weights for the conventional equity index, MSCI World Market Index, crude oil, and gold are 24%, 17%, 26%, and 34%, respectively. In the portfolio containing the ESG Index, the average weights for EM ESG Leaders Index, MSCI World Market Index, crude oil, and gold are similar - 24%, 17%, 25%, and 33%, respectively. Gold has the highest weight, together with MSCI World, but crude oil and the conventional or ESG Leaders Index also have a much higher weight in the portfolio when the focus is on correlations. Investing using this approach will reduce the volatility of investing in each asset individually, mostly in the case of crude oil. When looking at the results for the EM Europe MCP portfolio, the regional ESG Leaders Index has a lower average weight (12%) compared to the weights of the regional ESG Leaders EM Asia Index (24%) and the regional ESG Leaders Latin America (17%). The weight of the MSCI World Index is higher in all EM Europe and Latin American MCP portfolios, whereas crude oil has a steady weight of about 26%. Investing using the weights of the MCP approach results in reducing the volatility of investing in the individual asset in the case of the EM ESG Leaders Index, the conventional equity index, and crude oil, but is not be an effective hedge for investing in MSCI World Market Index and gold. The most significant difference in the weights of the MCP portfolio compared to MVP is that the conventional market indexes for Europe and Asia, the ESG Leaders indexes for Europe and Asia, as well as crude oil have much higher mean weight.

The MCoP portfolio construction method centers on minimizing the pairwise connectedness (return spillovers) across assets. Table 6 reports weights using this approach. The resulting weights are similar to the weights obtained using the MCP approach. Again, the EM Europe ESG Leaders Index has a lower average weight (18%) compared to the weights of the EM Asia ESG Leaders Index (23%) and the Latin America ESG Leaders Index (22%) in each of the regional portfolios. The weights of the conventional indexes in the other regional portfolios are very similar to the MSCI ESG Leaders Indexes' weights per region. Crude oil is about 28% to 29% of each portfolio under the MCoP method, with gold having a slightly higher mean weight between 31% and 33%. The hedging effectiveness results of the MCoP portfolios appear similar to those of the MCP portfolios. Including either the ESG Leaders index or the conventional market index reduces the portfolio's volatility, compared to investing in the unhedged index in all three regions. Overall, the ESG and conventional indexes have very similar portfolio weights.

Figures 4, 5, and 6 present the evolution of the portfolio weights over time for the MVP, MCP, and MCoP portfolio construction methods, respectively. As noted in the average weight results in the tables above, crude oil does not have much weight in any of the regions under the MVP approach but has higher weight under the other two approaches. The ESG Leaders Indexes for all three regions have varying weights under the three portfolio approaches, with notable spikes around the COVID-19 market sell-off in 2020. The weights of the conventional and ESG Leaders Indexes fluctuate over time in each region, but the movements of ESG and non-ESG appear very similar over time.

The results are in line with those of Managi et al. (2012) who argue that there are no differences between the socially responsible (SR) indexes and the conventional indexes in select developed markets (U.S., U.K., and Japan). Lastly, Table 7 reports the Sharpe ratios of the regional portfolios for the three portfolio construction approaches. The results are reported separately for the portfolios containing the conventional regional equity index and the portfolios containing the ESG Leaders equity regional index. Starting with the portfolio constructed using the conventional market index in Panel A of Table 7, for the EM Asia portfolio, the MCoP method has the highest Sharpe ratio of 0.0339. The MCoP approach results in the highest Sharpe ratio for the EM Europe and Latin America portfolios (0.0328 and 0.0323, respectively). Forming a portfolio using the MCoP approach can select asset weights so that the resilience to shocks is improved and spillover is minimized. The results using an ESG Leaders equity regional index in the portfolio are reported in Panel B of Table 7. While there are some differences in the mean and standard deviations for the portfolios, the Sharpe ratios are very similar to those reported in Panel A, again confirming that the MCoP approach results in the highest Sharpe ratio for each region. While the expectation is for the ESG EM Leaders indexes to enhance portfolio performance compared to the conventional emerging markets indexes (hypothesis 4), support for this hypothesis is not evident, as the Sharpe ratios do not show substantial differences.

5. Conclusion

This study adds to the literature on the importance of ESG investments from the perspective of an international investor interested in emerging markets equities, information that is not only relevant to investors but to portfolio managers and corporate entities as well. The dynamic connectedness of ESG Leaders and conventional equity indexes with commodities is investigated, as well as evidence about the benefit of using ESG Leaders vs conventional indexes in a portfolio context is added. Ten years of data for emerging markets stocks from three regions are employed (Asia, Europe and Latin America) to compare the spillover effects from oil and gold to ESG and conventional indexes.

The empirical results show that substantial amount of the transmission of shocks takes place between equity indexes, and the spillover from commodities is lower. The behavior of ESG Leaders and conventional index time series is comparable. The evidence suggests that there is relatively higher transmission from commodities to conventional indexes compared to transmission to the ESG Leaders indexes. Gold is a net receiver of shocks across all regions, whereas oil is a net transmitter in the majority of cases. Some differences in connectedness are observed among Asian, European and Latin American emerging markets, with oil explaining a higher proportion of the error variance of conventional indices than ESG Leaders indices for all three regions, with the effect more pronounced in Latin America. While the spillover evidence in the current study is for emerging markets, the findings are in line with the results of studies on ESG and commodities in developed markets.

Within a portfolio framework, however, there are no substantial variability in the portfolio weights of ESG or conventional indices when added to portfolios including oil, gold and a developed market index. The Sharpe ratios reveal no notable differences between including the ESG Leaders or conventional emerging market index for any of the three emerging market regions. As such, from a portfolio investor perspective, it makes little difference whether the ESG Leaders emerging market index or the conventional market index for the region will be included in the portfolio. More scrutiny is needed into ESG ratings and classifications, to ensure the ways they differentiate equity indexes is actually based on measures of sustainability and achievements along the stated corporate goals.

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Table 1. Summary Statistics of Price Index Returns

	MSCI Emerging Markets ESG Leaders			MSCI Emerging Market Index			Index		
	Asia	Europe	Latin America	Asia	Europe	Latin America	MSCI World	Crude Oil	Gold
Mean	0.019	-0.048	-0.006	0.014	-0.061	0.001	0.030	-0.010	0.012
Variance	1.123[a]	4.057[a]	3.067[a]	1.066[a]	4.674[a]	2.830[a]	0.897[a]	9.484[a]	0.811[a]
Skewness	-0.336[a]	-9.251[a]	0.775[a]	-0.340[a]	-11.566[a]	-0.945[a]	-1.239[a]	-0.900[a]	-0.064
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.205)
Excess Kurtosis	3.652[a]	217.825[a]	8.950[a]	3.626[a]	296.986[a]	11.004[a]	19.078[a]	30.706[a]	3.581[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Jarque-Bera	1333.089[a]	4619704.545[a]	7976.087[a]	1315.711[a]	8577782.842[a]	12049.789[a*]	35778.205[a]	91455.044[a]	1240.988[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ERS	-14.969[a]	-16.483[a]	-7.750[a]	-16.819[a]	-12.432[a]	-7.966[a]	-19.441[a]	-18.958[a]	-15.513[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Q(20)	20.469[a]	216.284[a]	41.926[a]	28.563[a]	218.611[a]	44.283[a]	152.428[a]	109.557[a]	10.182
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.486)
$Q^2(20)$	855.284[a]	222.444[a]	1706.554[a]	1068.972[a]	151.073[a]	1878.705[a]	2125.606[a]	1127.963[a]	117.910[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

[a, b, c] denote significance at 1%, 5% and 10% significance level.

Table 2. Correlation of Price Index Returns

		MSCI Emerging Markets ESG Leaders			MSCI Emerging Market Index			Index		
		Asia	Europe	Latin America	Asia	Europe	Latin America	MSCI World	Crude Oil	Gold
MSCI Emerging Markets ESG Leaders	Asia	1.0000								
	Europe	0.3578[a]	1.0000							
	Latin America	0.3909[a]	0.3824[a]	1.0000						
MSCI Emerging Market Index	Asia	0.9800[a]	0.3681[a]	0.4162[a]	1.0000					
	Europe	0.3426[a]	0.9720[a]	0.3741[a]	0.3534[a]	1.0000				
	Latin America	0.4135[a]	0.4157[a]	0.9789[a]	0.4403[a]	0.4062[a]	1.0000			
	MSCI World	0.4566[a]	0.4063[a]	0.6260[a]	0.4813[a]	0.3817[a]	0.6575[a]	1.0000		
	Crude Oil	0.1127[a]	0.2552[a]	0.2519[a]	0.1170[a]	0.2554[a]	0.3035[a]	0.2756[a]	1.0000	
	Gold	0.0292	0.1301[a]	0.1207[a]	0.0286	0.1068[a]	0.1323	0.0475[b]	0.0789[a]	1.0000

[a, b, c] denote significance at 1%, 5% and 10% significance level.

Table 3. Averaged Dynamic Connectedness Table

Table 3a. MSCI EM Asia

	Market Index	World Index	Crude Oil	Gold	FROM		ESG Leaders	World Index	Crude Oil	Gold	FROM
Index	67.28	27.44	3.45	1.83	32.72	Index	68.40	26.74	3.06	1.81	31.60
MSCI World Index	17.50	74.37	6.11	2.02	25.63	MSCI World Index	15.69	75.99	6.27	2.06	24.01
Crude Oil	2.58	7.93	87.95	1.55	12.05	Crude Oil	2.22	7.96	88.26	1.56	11.74
Gold	1.72	2.74	1.71	93.83	6.17	Gold	1.57	2.74	1.72	93.97	6.03
Contrib. TO Others	21.80	38.11	11.26	5.40	76.58	Contrib. TO Others	19.48	37.45	11.04	5.42	73.38
NET Directional Connectedness	-10.92	12.48	-0.79	-0.77	**cTCI/TCI 25.53/19.14**	NET Directional Connectedness	-12.13	13.44	-0.70	-0.61	**cTCI/TCI 24.46/18.34**
NPDC Transmitter	0.00	3.00	2.00	1.00		NPDC Transmitter	0.00	3.00	2.00	1.00	

Table 3b. MSCI EM Europe

	Market Index	World Index	Crude Oil	Gold	FROM		ESG Leaders	World Index	Crude Oil	Gold	FROM
Index	68.74	21.21	7.85	2.20	31.26	Index	68.53	21.65	7.05	2.78	31.47
MSCI World Index	20.25	71.88	5.81	2.06	28.12	MSCI World Index	20.21	71.96	5.78	2.05	28.04
Crude Oil	9.03	7.16	82.32	1.49	17.68	Crude Oil	8.12	7.19	83.21	1.48	16.79
Gold	3.29	2.76	1.70	92.25	7.75	Gold	3.98	2.69	1.67	91.66	8.34
Contrib. TO Others	32.57	31.12	15.36	5.75	84.80	Contrib. TO Others	32.31	31.53	14.50	6.30	84.65
NET Directional Connectedness	1.31	3.00	-2.32	-1.99	**cTCI/TCI 28.27/21.20**	NET Directional Connectedness	0.84	3.49	-2.29	-2.04	**cTCI/TCI 28.22/21.16**
NPDC Transmitter	2.00	3.00	1.00	0.00		NPDC Transmitter	2.00	3.00	1.00	0.00	

Table 3c. MSCI EM Latin

	Market Index	World Index	Crude Oil	Gold	FROM		ESG Leaders	World Index	Crude Oil	Gold	FROM
Index	67.54	24.00	6.39	2.07	32.46	Index	71.03	22.27	4.73	1.97	32.46
MSCI World Index	23.81	68.66	5.68	1.85	31.34	MSCI World Index	21.65	70.60	5.84	1.91	31.34
Crude Oil	8.05	7.31	83.20	1.45	16.80	Crude Oil	5.74	7.47	85.27	1.52	16.80
Gold	3.08	2.74	1.66	92.52	7.48	Gold	2.73	2.74	1.69	92.84	7.48
Contrib. TO Others	34.94	34.04	13.73	5.37	88.09	Contrib. TO Others	30.12	32.49	12.26	5.40	88.09
NET Directional Connectedness	2.48	2.70	-3.08	-2.10	**cTCI/TCI 29.36/22.02**	NET Directional Connectedness	1.15	3.09	-2.47	-1.76	**cTCI/TCI 26.75/20.07**
NPDC Transmitter	2.00	3.00	1.00	0.00		NPDC Transmitter	2.00	3.00	1.00	0.00	

Table 4. Dynamic Multivariate Portfolio Weights – Minimum Variance Portfolio.

Emerging Market - Asia

	Mean	Std. Dev.	5%	95%	HE	p-value		Mean	Std. Dev.	5%	95%	HE	p-value
Market Index	0.23	0.10	0.08	0.42	0.68	0.00	ESG Leaders	0.23	0.09	0.11	0.42	0.69	0.00
MSCI World Index	0.36	0.14	0.05	0.55	0.62	0.00	MSCI World Index	0.36	0.14	0.06	0.54	0.62	0.00
Crude Oil	0.01	0.01	0.00	0.04	0.96	0.00	Crude Oil	0.01	0.01	0.00	0.04	0.96	0.00
Gold	0.40	0.12	0.22	0.61	0.58	0.00	Gold	0.40	0.13	0.22	0.60	0.58	0.00

Emerging Market - Emerging Europe

	Mean	Std. Dev.	5%	95%	HE	p-value		Mean	Std. Dev.	5%	95%	HE	p-value
Market Index	0.01	0.02	0.00	0.08	0.92	0.00	ESG Leaders	0.01	0.03	0.00	0.11	0.91	0.00
MSCI World Index	0.54	0.15	0.29	0.72	0.58	0.00	MSCI World Index	0.54	0.15	0.28	0.72	0.58	0.00
Crude Oil	0.01	0.02	0.00	0.05	0.96	0.00	Crude Oil	0.01	0.02	0.00	0.05	0.96	0.00
Gold	0.45	0.15	0.26	0.71	0.54	0.00	Gold	0.44	0.14	0.26	0.69	0.53	0.00

Emerging Market - Latin America

	Mean	Std. Dev.	5%	95%	HE	p-value		Mean	Std. Dev.	5%	95%	HE	p-value
Market Index	0.00	0.01	0.00	0.00	0.86	0.00	ESG Leaders	0.00	0.01	0.00	0.01	0.87	0.00
MSCI World Index	0.56	0.13	0.30	0.72	0.57	0.00	MSCI World Index	0.55	0.14	0.30	0.72	0.57	0.00
Crude Oil	0.01	0.02	0.00	0.05	0.96	0.00	Crude Oil	0.01	0.02	0.00	0.05	0.96	0.00
Gold	0.43	0.14	0.26	0.69	0.52	0.00	Gold	0.44	0.14	0.26	0.69	0.53	0.00

Table 5. Dynamic Multivariate Portfolio Weights – Minimum Correlation Portfolio.

Emerging Market - Asia													
	Mean	Std. Dev.	5%	95%	HE	p-value		Mean	Std. Dev.	5%	95%	HE	p-value
Market Index	0.24	0.03	0.20	0.29	-0.01	0.82	ESG Leaders	0.24	0.03	0.20	0.29	0.07	0.10
MSCI World Index	0.17	0.05	0.09	0.25	-0.20	0.00	MSCI World Index	0.17	0.06	0.09	0.25	-0.17	0.00
Crude Oil	0.26	0.04	0.19	0.33	0.89	0.00	Crude Oil	0.25	0.04	0.19	0.33	0.89	0.00
Gold	0.34	0.03	0.28	0.39	-0.33	0.00	Gold	0.33	0.03	0.28	0.39	-0.29	0.00

Emerging Market - Emerging Europe													
	Mean	Std. Dev.	5%	95%	HE	p-value		Mean	Std. Dev.	5%	95%	HE	p-value
Market Index	0.13	0.07	0.02	0.23	0.70	0.00	ESG Leaders	0.12	0.07	0.00	0.22	0.66	0.00
MSCI World Index	0.25	0.05	0.18	0.33	-0.58	0.00	MSCI World Index	0.26	0.04	0.19	0.33	-0.55	0.00
Crude Oil	0.26	0.05	0.17	0.35	0.85	0.00	Crude Oil	0.26	0.05	0.18	0.36	0.85	0.00
Gold	0.36	0.04	0.29	0.43	-0.74	0.00	Gold	0.35	0.04	0.29	0.42	-0.71	0.00

Emerging Market - Latin America													
	Mean	Std. Dev.	5%	95%	HE	p-value		Mean	Std. Dev.	5%	95%	HE	p-value
Market Index	0.14	0.07	0.00	0.24	0.56	0.00	ESG Leaders	0.17	0.07	0.05	0.29	0.59	0.00
MSCI World Index	0.24	0.09	0.07	0.36	-0.38	0.00	MSCI World Index	0.22	0.09	0.03	0.33	-0.40	0.00
Crude Oil	0.26	0.04	0.20	0.34	0.87	0.00	Crude Oil	0.26	0.04	0.20	0.34	0.87	0.00
Gold	0.36	0.03	0.32	0.43	-0.53	0.00	Gold	0.35	0.03	0.31	0.43	-0.55	0.00

Table 6. Dynamic Multivariate Portfolio Weights – Minimum Connectedness Portfolio.

Emerging Market - Asia

	Mean	Std. Dev.	5%	95%	HE	p-value		Mean	Std. Dev.	5%	95%	HE	p-value
Market Index	0.23	0.02	0.20	0.27	-0.17	0.00	ESG Leaders	0.23	0.02	0.21	0.28	-0.09	0.05
MSCI World Index	0.17	0.05	0.07	0.22	-0.39	0.00	MSCI World Index	0.17	0.05	0.06	0.22	-0.36	0.00
Crude Oil	0.29	0.02	0.27	0.33	0.87	0.00	Crude Oil	0.29	0.02	0.27	0.33	0.87	0.00
Gold	0.31	0.02	0.28	0.36	-0.54	0.00	Gold	0.31	0.02	0.28	0.35	-0.50	0.00

Emerging Market - Emerging Europe

	Mean	Std. Dev.	5%	95%	HE	p-value		Mean	Std. Dev.	5%	95%	HE	p-value
Market Index	0.18	0.06	0.03	0.25	0.66	0.00	ESG Leaders	0.18	0.06	0.00	0.25	0.62	0.00
MSCI World Index	0.22	0.04	0.17	0.28	-0.79	0.00	MSCI World Index	0.22	0.04	0.16	0.30	-0.72	0.00
Crude Oil	0.28	0.03	0.23	0.34	0.83	0.00	Crude Oil	0.28	0.03	0.24	0.34	0.84	0.00
Gold	0.32	0.04	0.25	0.39	-0.98	0.00	Gold	0.32	0.04	0.25	0.39	-0.91	0.00

Emerging Market - Latin America

	Mean	Std. Dev.	5%	95%	HE	p-value		Mean	Std. Dev.	5%	95%	HE	p-value
Market Index	0.19	0.03	0.14	0.24	0.49	0.00	ESG Leaders	0.22	0.03	0.17	0.28	0.53	0.00
MSCI World Index	0.19	0.06	0.08	0.25	-0.61	0.00	MSCI World Index	0.18	0.06	0.05	0.23	-0.61	0.00
Crude Oil	0.29	0.02	0.25	0.33	0.85	0.00	Crude Oil	0.28	0.02	0.25	0.32	0.85	0.00
Gold	0.33	0.03	0.29	0.39	-0.77	0.00	Gold	0.32	0.03	0.28	0.38	-0.78	0.00

Table 7. Sharpe Ratios

A. Market Index

	Emerging Market								
	Asia			Europe			Latin America		
	MVP	MCP	MCoP	MVP	MCP	MCoP	MVP	MCP	MCoP
Mean	0.0002	0.0001	0.0002	0.0000	-0.0001	0.0002	0.0001	0.0001	0.0002
Std. Dev.	0.0104	0.0112	0.0059	0.0119	0.0127	0.0061	0.0111	0.0120	0.0062
Sharpe Ratio	0.0192	0.0089	0.0339	0.0000	-0.0079	0.0328	0.0090	0.0083	0.0323

B. ESG Leaders Index

	Emerging Market								
	Asia			Europe			Latin America		
	MVP	MCP	MCoP	MVP	MCP	MCoP	MVP	MCP	MCoP
Mean	0.0002	0.0001	0.0002	0.0000	0.0000	0.0002	0.0000	0.0001	0.0002
Std. Dev.	0.0102	0.0111	0.0059	0.0118	0.0124	0.0061	0.0112	0.0120	0.0062
Sharpe Ratio	0.0196	0.0090	0.0339	0.0000	0.0000	0.0328	0.0000	0.0083	0.0323

Figure 1. Graphs of Indexes (Level) – Logarithmic Scale

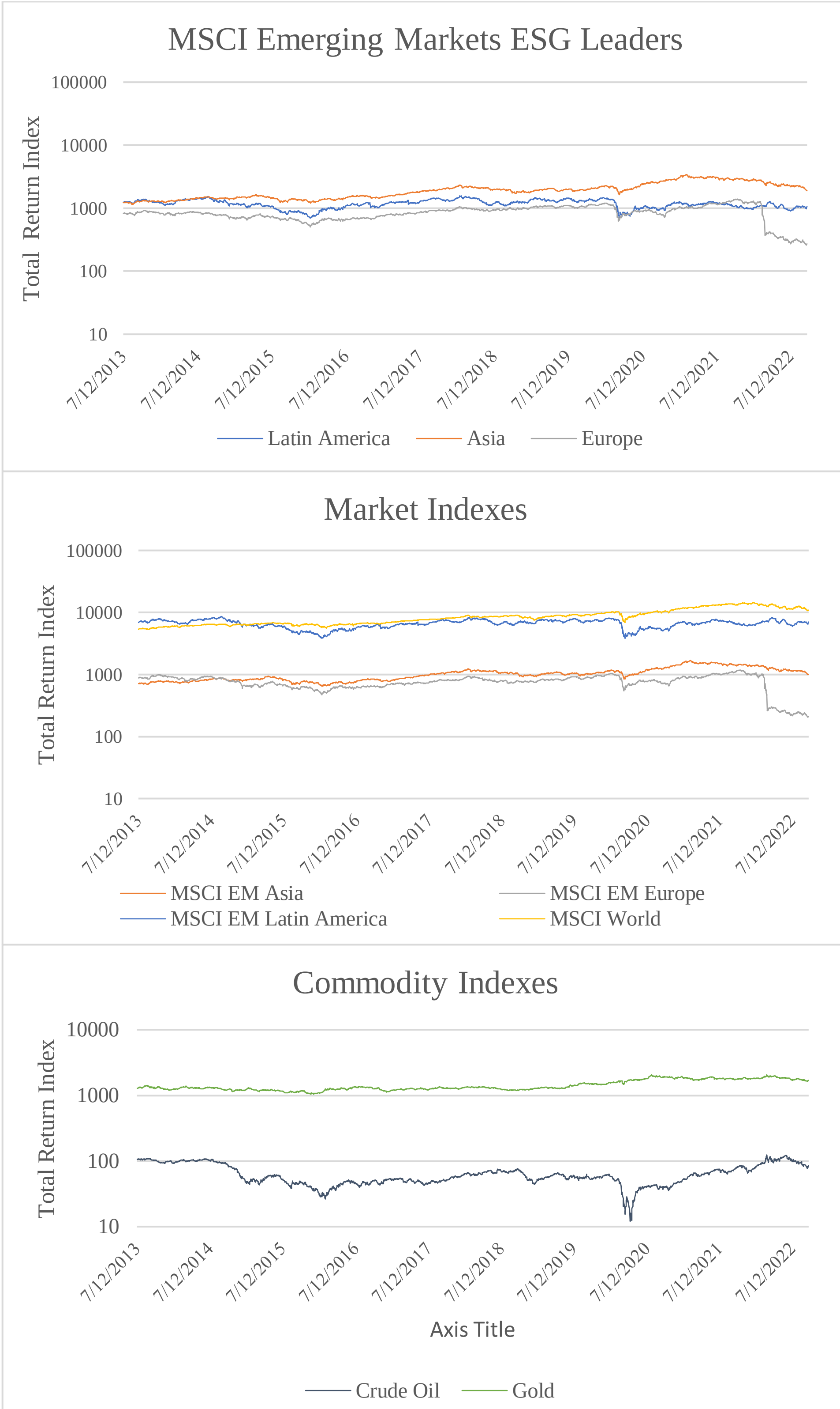


Figure 2. Dynamic Total Connectedness for Emerging Markets

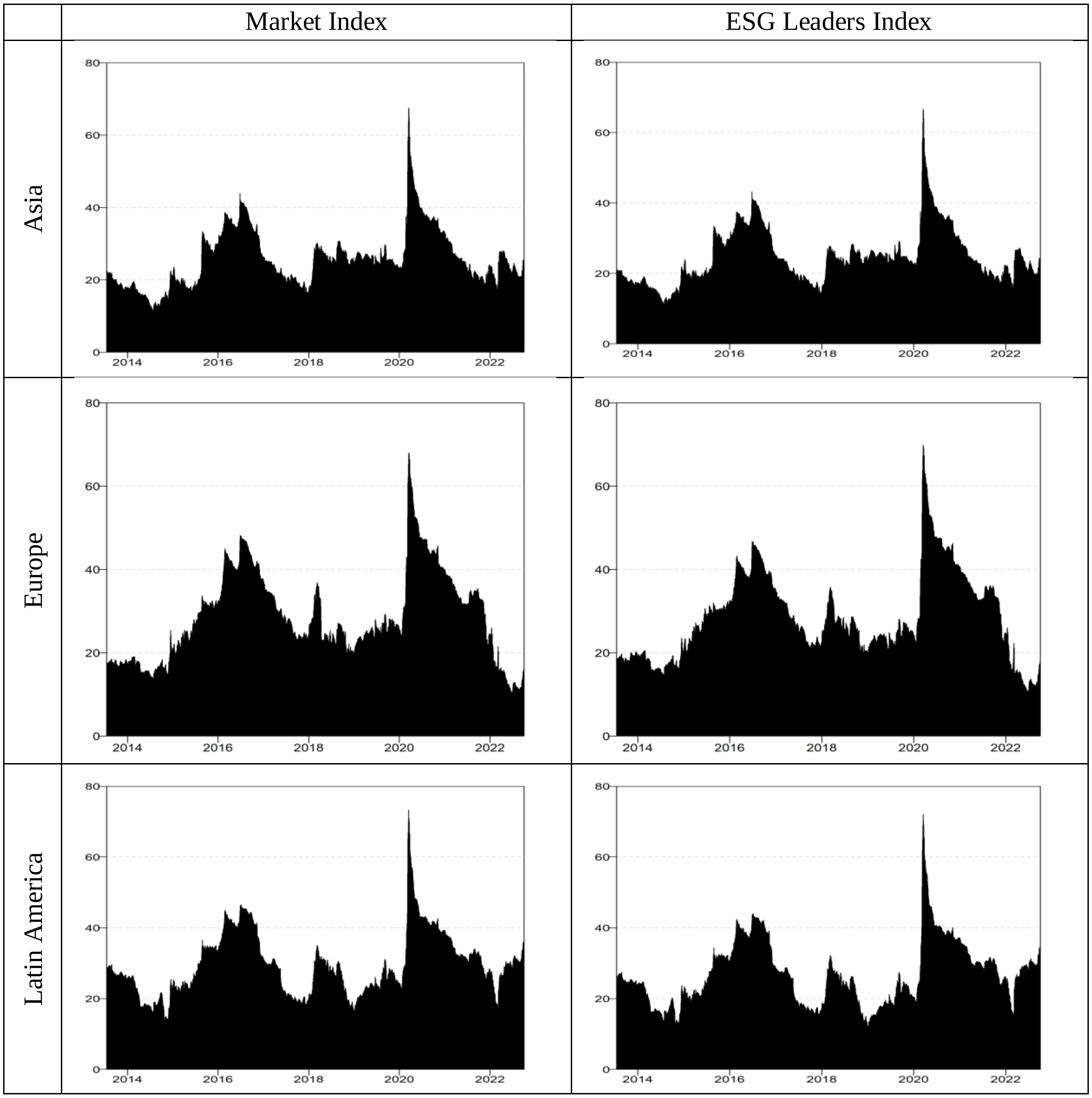


Figure 3. Net Pairwise Dynamic Connectedness for Emerging Markets

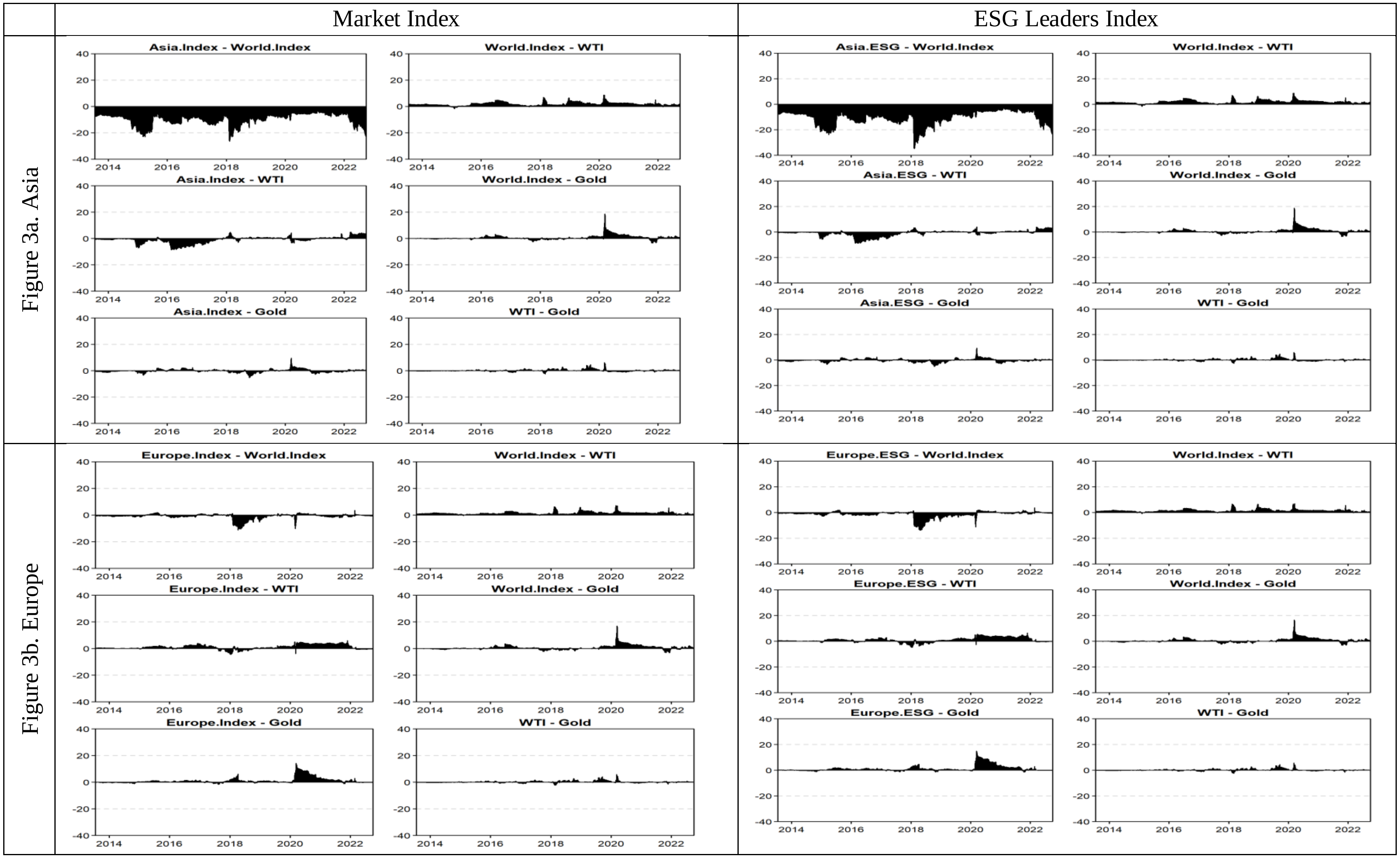


Figure 3c. Latin America

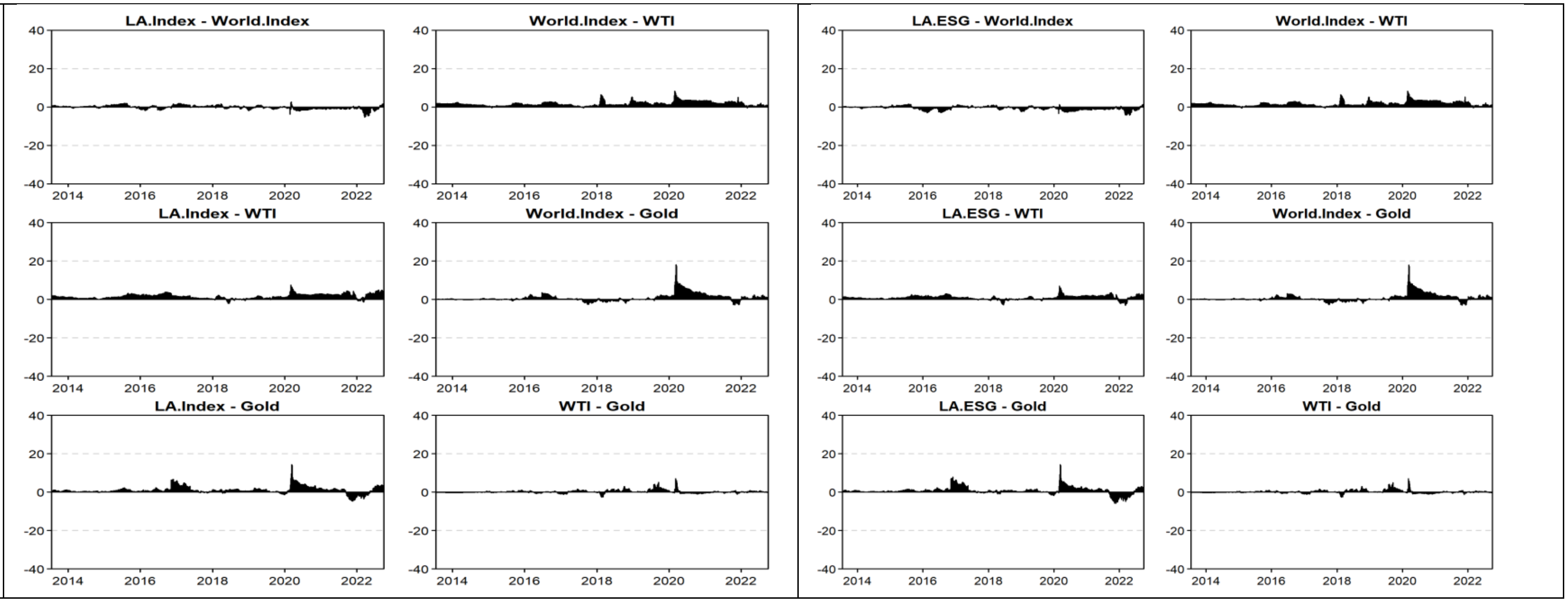
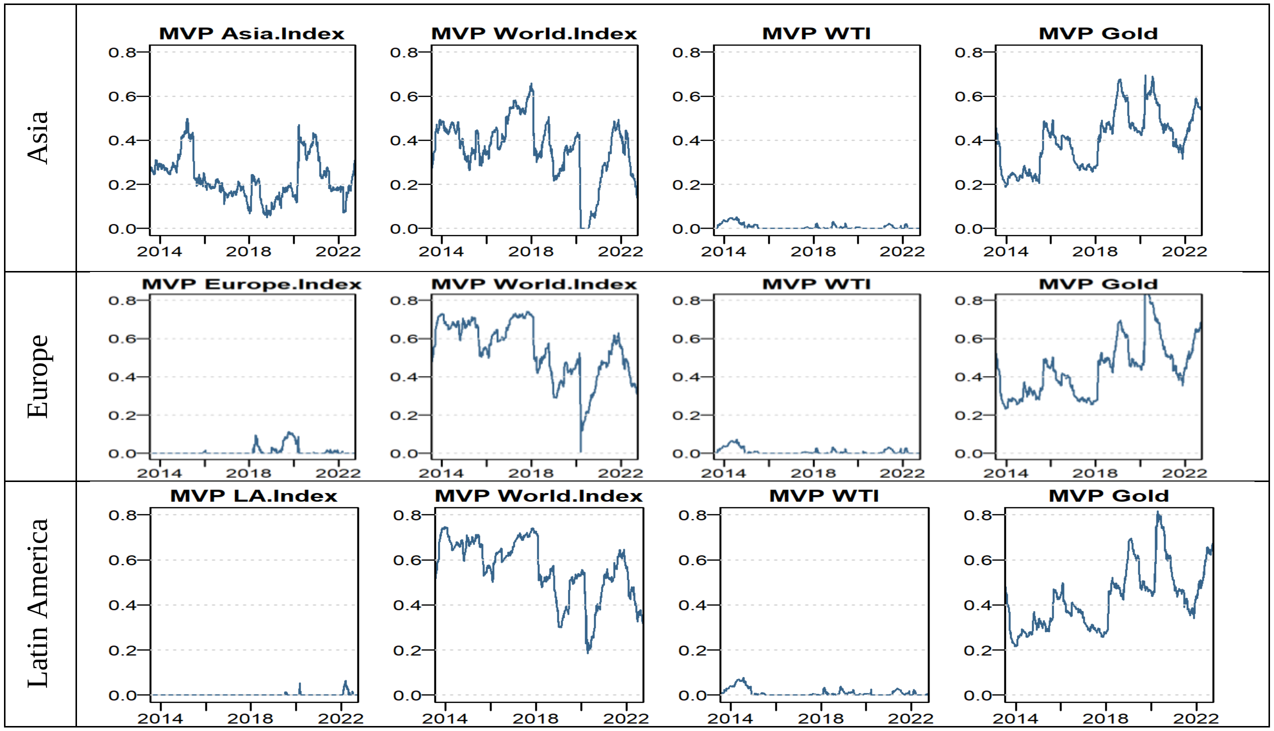


Figure 4. Dynamic Multivariate Portfolio Weights for Emerging Europe – Minimum Variance Portfolio. Obtained using the variance-covariance matrices from the TVP-VAR(0.99,0.99) with one lag.

4a. Market Index



4b. ESG Leaders Index

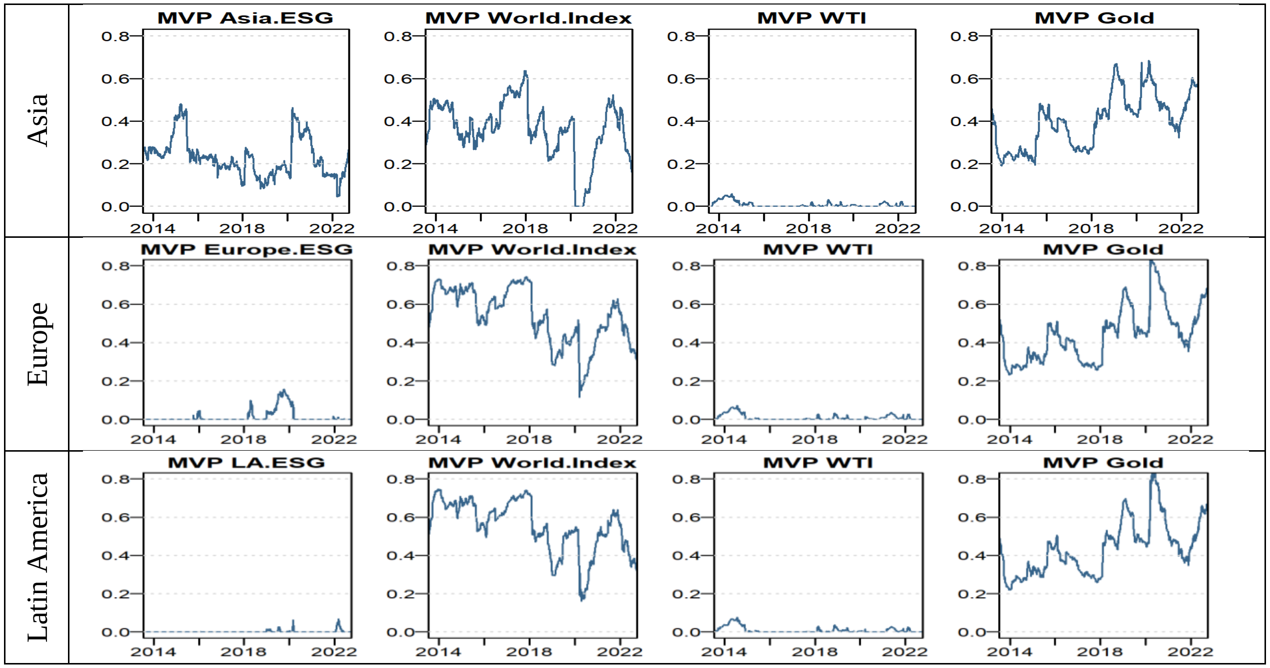
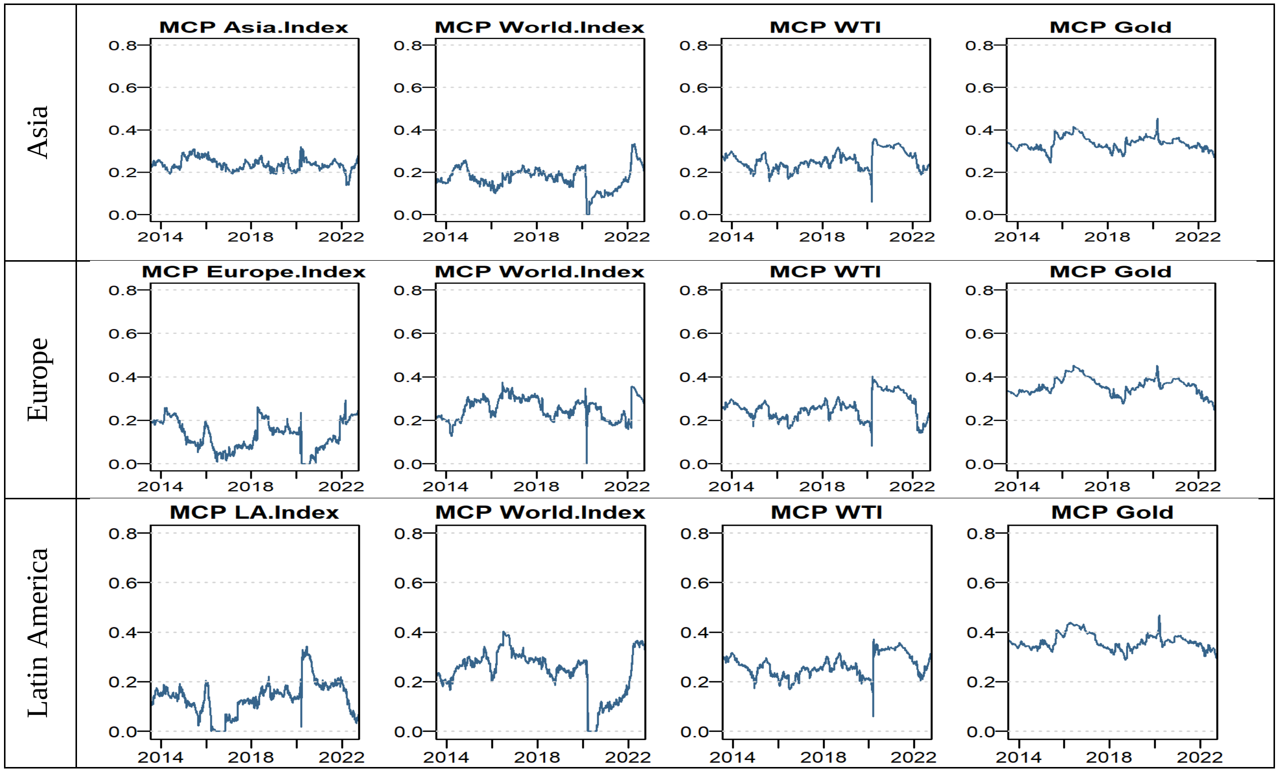


Figure 5. Dynamic Multivariate Portfolio Weights for Emerging Europe – Minimum Correlation Portfolio. Obtained using the variance-covariance matrices from the TVP-VAR(0.99,0.99) with one lag.

5a. Market Index



5b. ESG Leaders Index

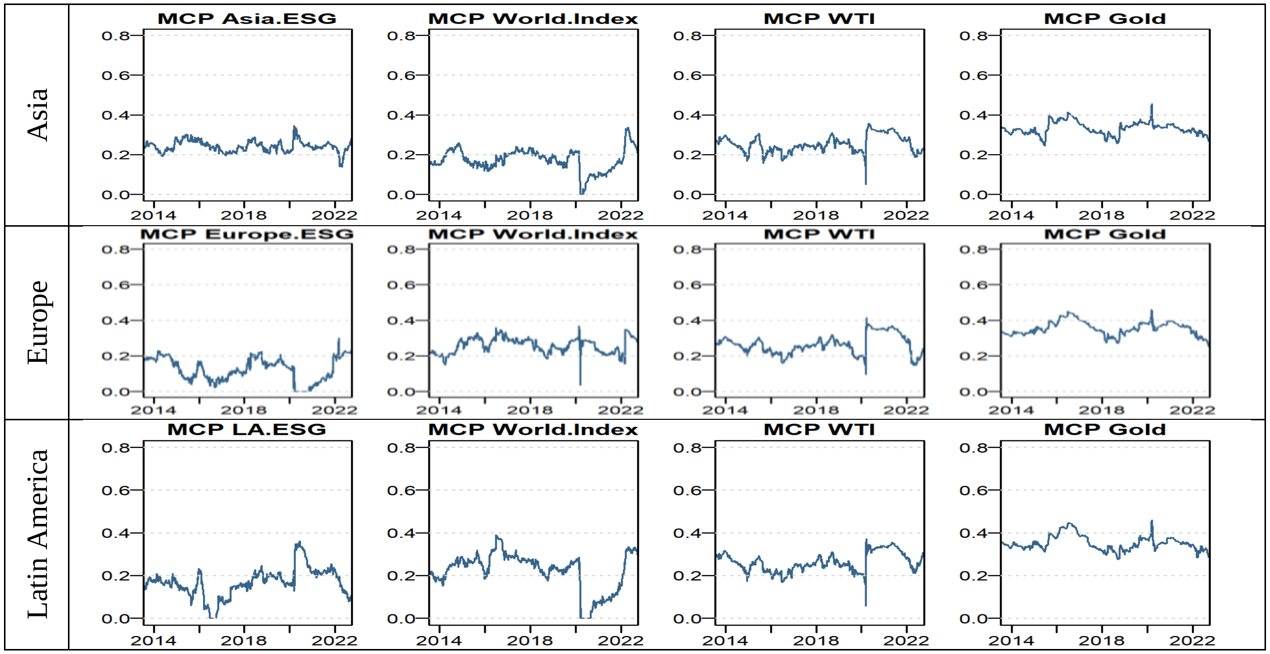
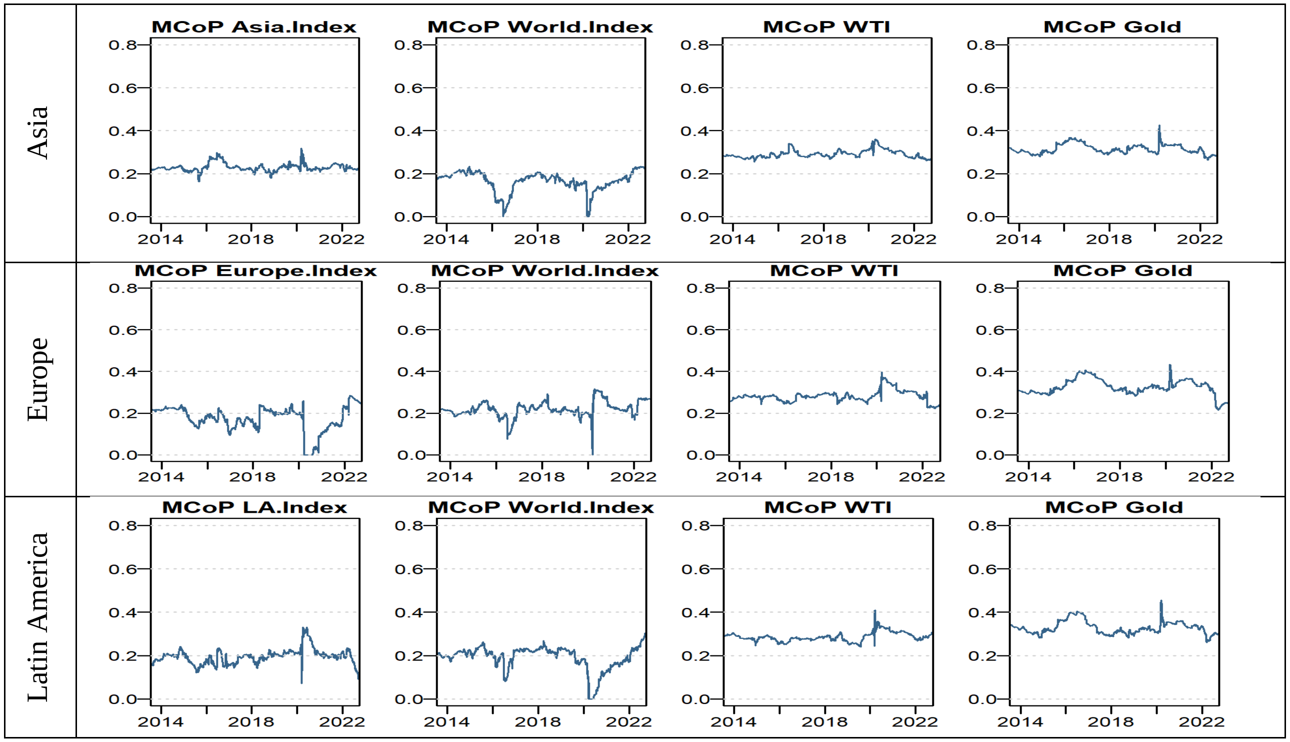


Figure 6. Dynamic Multivariate Portfolio Weights for Emerging Europe – Minimum Connectedness Portfolio. Obtained using the variance-covariance matrices from the TVP-VAR(0.99,0.99) with one lag.

6a. Market Index



6b. ESG Leaders Index