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"Stylized facts" in Price Dynamics: Do They Matter for ESG Financial Markets?

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We investigate the presence of "stylized facts" within the ESG segment of the developed financial markets. The effects resulting from their presence are relevant given their impact on asset pricing, portfolio management, and even the efficiency of policy decisions. Moreover, during turbulent periods, the effects and presence of such elements can enable integration to act as a net transmitter of volatility. To explore this concept, we employed a broad and diversified toolset to detect their presence and influence. We tested five developed ESG indices, covering a time window from January 2014 to March 2023, by employing high-frequency data. The selection of indices captures and accounts for different geographical settings. The results suggest that "stylized facts" are present in the ESG segment of developed markets and volatility can spill over from market to market and fuel the contagion effect on a global scale, via the integration process and its effects.

Keywords: *Globalization; Market Integration; Developed Markets; ESG Indices; "Stylized Facts"; Volatility Spillover.*

Introduction

During the last decades, globalization and financial integration have become widely recognized forces shaping the modern world. It can be argued that globalization brought about a new age regarding portfolio diversification and investment opportunities (Okina *et al.,* 1999). Thus, opening unlimited possibilities for investors worldwide. According to Mussa and Goldstein (1993), the large decrease in the cost of telecommunications and access to information, coupled with a policy inclined towards financial liberalization from most governments, are the initial driving factors regarding financial globalization.

Furthermore, the authors underline that such an evolution led to the emergence of new concepts such as "institutionalization" and "securitization" of financial assets. It can be argued that such an evolution regarding the internationalization of financial assets and the ability of investors to choose from a large plethora of assets at a worldwide level, brought about the emergence of a new topic. The topic in question is the so-called integration of capital markets. The most relevant and famous notion regarding this topic was brought on by Obstfeld (1986), who employed a series of tests to check the level of integration of the capital markets at that time.

A notable result in this field can be attributed to the emergence of the so-called "law of one price" developed by Obstfeld (1986), stating that the price of a financial asset should be the same for both an investor residing in the country where the asset was issued and for a foreign investor. Nevertheless, such a concept can never be successfully implemented due to several obstacles such as the fiscal approach of the guest country, the level of market liberalization, and even the currency risk. Despite all this, the positive effects arising from the process of financial globalization mainly revolve around portfolio diversification opportunities and ultimately risk sharing or hedging. According to Okina et al, (1999), the advent of financial derivatives stimulated international capital flows and provided even more arbitrage options for investors. It can also be noted that the market integration process led to a "spillover" of risk and uncertainty, thus impacting the pricing of other financial assets in different capital markets in different geographical locations (Shen, 2018).

Thus, considering the spillover potential that may occur in integrated markets, we consider the effects arising from "stylized facts" to be relevant. The presence of "stylized facts" has the potential to enable the process of integration to serve as a net transmitter of volatility during turbulent times (Huang & Cheng, 2020; Lux, 2009). Furthermore, it can be considered that the presence of "stylized facts" is more noticeable in the case of developing and frontier markets, especially owing to certain characteristics related to such markets. The characteristics in question are often related to the general development level of the market, the reduced range of tradeable assets, insufficient liquidity, and also a reduced level of connectivity with other regional or international markets as explored in the work of Botoc and Anton, 2020. At the same time, certain economic, legal, and fiscal constraints may also be considered.

Hence, it can be argued that the topic of integration should be investigated and discussed while accounting for the presence and impact of "stylized facts". Moreover, we consider that the original contribution of this paper to the existing literature is represented by the approach that considers the effects and the potential of "stylized facts" within developed ESG markets. This point becomes relevant when considering the influence of "stylized facts" over the process of market integration.

The main consideration is the fact that during turbulent times, integration can act as a net transmitter of volatility on a global scale. Thus, leading to the contagion effect among globally integrated financial markets. We further consider that the presence of "stylized facts" leads to a degradation of accuracy and efficiency for linear asset pricing models. This development is noticeable during volatile periods,

characterized by excess volatility, as markets are no longer in equilibrium. In his work, Cont (2001, p. 224), identifies eleven "stylized facts" observable for financial time series:

The absence of linear autocorrelations: linear autocorrelations of returns are generally insignificant, except for very small intraday microstructures, that may confirm the "U" shape pattern trading in volumes that may occur during a trading session;

The presence of Heavy or "Fat" tails: the distribution of returns seems to display a power-law and encounter significant deviations from the mean is much greater than in the case of the normal distribution;

Gain or loss asymmetry: which considers that larger downward movements are more observable when compared to similar upward movements;

Aggregational Gaussianity: as the time frame over which returns are calculated is increased, their distribution tends to normalize. In particular, the shape of the distribution is not the same when employing different time frames;

Intermittency: returns display at any time scale, with a high degree of variability. This is quantified by the presence of irregular bursts in time series of a wide variety of volatility estimators;

Volatility clustering: different measures of volatility display a positive autocorrelation over several trading periods, which quantifies the fact that high-volatility events tend to cluster in time;

Conditional heavy tails: even after correcting returns for volatility clustering, the residual time series still exhibit heavy tails;

Slow decay of autocorrelation in absolute returns: the autocorrelation function of absolute returns decays slowly as a function of the time lag;

Leverage effect: most measures of the volatility of an asset are negatively correlated with the returns of that particular asset;

Volume/volatility correlation: trading volume is correlated with all measures of volatility.

Asymmetry in time scales: coarse-grained measures of volatility predict fine-scale volatility better than the other way around;

Expanding on the pioneering work of Cont (2001), several authors argue that "stylized facts" of financial assets are exclusive to high-frequency financial data. Furthermore, it can be argued that their presence in this type of data may indicate a short-term informational inefficiency of the market. Thus, "stylized facts" of financial time series are considered more relevant for high-frequency financial data (Lux, 2009; Cont, 2001; Sewell, 2011). Hence, it can be argued that their impact is crucial for market integration. During turbulent times, the presence and effects of "stylized facts" can lead to volatility spillover and contagion globally among integrated financial markets. As Shakeel and Srivastava (2021) note, the presence and effects of "stylized facts" can be considered a salient feature of high-frequency financial data. Hence, it can be argued that intraday trading patterns, such as the "U" shaped trading pattern with higher volumes at the opening and closing of a trading session increase the level of volatility.

Thus, high-frequency data exhibits volatility clusters over a single or more trading sessions. Arguably, the volatility clustering and the leverage effect "stylized facts" can be considered the most relevant when considering their potential impact regarding the volatility spillover and contagion effect. Nevertheless, the remaining "stylized facts" are also relevant and significant in this aspect. Hence, given the large plethora of "stylized facts," testing for their presence is necessary.

Considering this approach employed within the paper serves as a complement and extension to the existing literature regarding the topic of integration, covering the developed ESG market segment. This can be argued by the fact that the existing literature fails to account for the presence, influence, and potential of "stylized facts" to hamper the ability of linear pricing models and to allow the process of integration to serve as a net transmitter of volatility. This consideration remains especially relevant in the case of market segments, such as ESG stocks or indices. Starting from the points discussed above, we focus on the following research objective: Investigate the presence and impact of "stylized facts" within a selection of ESG indices and explore the influence and potential regarding the contagion effect, within the context of global integration.

The decision to focus exclusively on the ESG market segment is related to the characteristics of this particular segment. Therefore, characteristics such as a sustainable approach related to the issuers and their adherence to ESG guidelines together with financial and non-financial reporting standards can be considered as main pillars regarding the ESG investment approach. Moreover, another relevant consideration for this particular selection lies in the fact that the ESG market segment chosen is integrated to a certain extent with non-ESG developed markets. Therefore, it can act as an anchoring instrument within portfolios that have a medium to long-term holding period.

Thus, we consider the investigation regarding the presence and potential of "stylized facts" within market integration to be crucial. Especially given the propensity of integration to serve as a net transmitter of volatility on a global scale during periods of exogenous and endogenous shocks. Therefore, we have implemented a large set of statistical tools and tests to confirm the presence and impact of "stylized facts" within the selected stock market indices to accomplish this objective. To this end, we have implemented Portmanteau test statistics, the Hurst exponent, an EGARCH (1,1) model with student t distribution, a Hidden Markov Model and, lastly, we have also employed autocorrelation tests.

Hence, employing this approach regarding the process of integration in combination with the effects that arise from the presence of "stylized facts" for the ESG segment could further expand and complete the existing literature. Furthermore, we have considered the experience of Chancharat (2010) who provides an in-depth literature review regarding the process of market integration and its impact. A key element presented by both Chancharat (2010) and Al-Yahyaee et al (2019), that is relevant to this paper is the presence of structural breaks. Which have been identified in the long-term relationship between stock markets thus, accounting for both endogenous and exogenous shocks. We consider that the impact and volatility resulting from such

shocks may be further propagated by the presence and effects of "stylized facts" on a global scale.

With this in mind, the remainder of the paper is structured as follows: Section 1 is reserved for the literature review, Section 2 presents the data employed and Section 3 presents the methodology considered. Section 4 is dedicated to the results obtained after testing for the presence and impact of "stylized facts". Section 5 is reserved for a discussion regarding the implications of the results obtained while also considering the results of other research on this topic. Also, possible policy implications for both investors and policymakers are discussed. The last part concludes the paper.

Literature Review

The concept of market or functional integration represents a crucial aspect of international finance and asset pricing theory. According to Al Nasser and Hajilee, (2016), the process itself has been observed to occur on a global scale among both developed and developing stock markets. It can also be argued that the main drivers of market integration on a global scale are financial and market liberalization, the reduction of costs for obtaining information, and a general openness concerning fiscal and trade barriers (Mussa & Goldstein, 1993; Drennan, 1996; Al Nasser & Hajilee, 2016; Lane & Milesi-Ferretti, 2008). Moreover, it can be argued that given the international evolution of the process, the emergence of large financial hubs can occur as a natural evolution (Drennan, 1996; Drozdz *et al.,* 2001). As such, given the formation of certain large financial centers or hubs, it can be argued that certain changes in the aforementioned financial hubs or financial markets, may spill over to other smaller financial markets (Drozdz *et al.,* 2001; Bentes, 2015). Hence, we argue that certain large financial markets or financial hubs play a "leader" role while on the other hand, smaller markets tend to play a "follower" role, being directly, but not necessarily symmetrically, influenced by their larger peers.

Given the international and global nature of this process, the single most crucial advantage that arises from the process itself, and is of great concern to portfolio managers and investors alike is the international portfolio diversification opportunity (Shen, 2018). While in the same time, another advantage may be identified in the form of financial innovation, which occurs to provide and create financial instruments that satisfy the risk appetite of investors on an international scale (Okina et al, 1999).

While such a risk-sharing mechanism and financial innovation may prove beneficial during periods of relative calm and low levels of volatility, the same cannot be said at the onset of various endogenous and exogenous shocks. During such periods, it can be argued that the process of market integration can serve as a net transmitter of volatility due to the presence of "stylized facts". Thus, fuelling and aiding the spreading of the contagion effect.

It can be further argued that the literature concerning "stylized facts" can be traced back to the work of Cont (2001), who argues for the existence and presence of key "stylized facts" that pertain to the class of financial assets. Further exploration of the impact and presence of "stylized facts" in the works of Lux (2009) and Sewell (2011) argue that the effects of "stylized facts" are more relevant in the case of high-frequency financial data and can be considered to be a unique or salient characteristic that pertains to this particular type of data. Given this, we argue that the "stylized facts" of financial assets can be considered and viewed as a linking element between the non-ESG or classical stocks and indices and the ESG niche or segment.

Therefore, we consider the presence of "stylized facts" within stocks and indices, regardless of segment or niche, to be a linking element. Such a linking element could be further employed to explain the various connections and, ultimately, the process of functional integration among markets itself. Thus, as previously mentioned, the process of functional integration combined with the presence and effects of "stylized facts" amongst stocks and indices, can lead to a propagation of endogenous and exogenous shocks on a global scale.

A relevant example of this is the Global Financial Crisis of 2008-2010 and the COVID-19 pandemic shock, which both resulted in large levels of volatility spillover on a global scale and in both developed and developing markets (Lane, 2013; Helleiner, 2011; Vuong *et al.,* 2022).

Ultimately, causing exponential losses to portfolios that contained domestic and foreign assets. Another relevant aspect regarding the process of integration deals with the intensity and strength of the process. Namely, it can be considered that the process is more intense and stronger during periods of endogenous and exogenous shocks, as opposed to more serene and calm periods (Giofré and Sokolenko, 2022).

As such, we consider that the process of market integration can act as a net transmitter of volatility due to the presence of "stylized facts". Therefore, we will further proceed to test this belief by implementing the chosen methodology within the ESG segment of the stock market.

Data and Methodology

Given the objective of the paper, we have employed a dataset that focuses exclusively on developed ESG stock market indices. Hence, the main indices employed are obtained from the MSCI ESG Universal Index family (2023). As such, the selected ESG indices are France ESG Universal Standard, Spain ESG Universal Standard, UK ESG Universal Standard, Europe ESG Universal Standard, and lastly, the World ESG Universal Standard.

The MSCI ESG Universal family is composed exclusively of Large and Mid-cap constituents from Developed Stock Markets. The MSCI ESG Universal Index increases the weight of companies with robust ESG performance, including those that show improvement in the direction of their rating over the previous year.

In contrast, reducing the weight of those companies that lag behind their industry peers in terms of ESG performance and improvement. The MSCI ESG Universal Index minimizes exclusions to a core group of objectionable stocks. The exclusions reflect a common core among institutional investors and include those companies who are involved in controversial businesses such as weapons trading and violations of environmental and international norms. The main advantage regarding the selected data lies in the fact that the MSCI ESG screening process ensures that only companies with a high level of compliance to the ESG

guidelines are included. Furthermore, the aforementioned indices also continuously incorporate new constituents which comply to the ESG standards and guidelines while another relevant advantage is represented by the availability of data, which covers a large time frame.

As such, the data covering the ESG indices was provided by MSCI (2023), free of charge. Furthermore, given the previously mentioned constraints, the data collected covers the period starting from the 1st of January 2014 until the 16th of March 2023.

Considering that "stylized facts" may enable integration to serve as a net transmitter of volatility, we have decided to conduct a series of tests to investigate the presence of "stylized facts". As such, we have employed several statistical and graphical tests to investigate their presence. The tests employed are the following: summary statistics and normality tests regarding the distribution of data, Portmanteau test statistics, the Hurst Exponent, an EGARCH (1,1) with Student t distribution, and lastly, a two-state Hidden Markov Model with discrete non-parametric observation distribution. The model was implemented within the R programming language by using the hmm.discnp package (version 3.0-9 available at https://CRAN.R-project.org/package=hmm.discnp) provided by the work of Turner (2022). We have employed histograms, autocorrelation functions, and the Mcleod-Li test for the graphical tests.

Considering that to properly showcase the presence and effects of "stylized facts", one singular method or instrument does not provide satisfactory results, we have decided to employ a multitude of tools and methods. Therefore, we considered the experience and findings of Malmsten and Terasvirta (2010) who argue that the EGARCH family of models provides an efficient tool that can detect the leverage effect. Furthermore, Bulla and Bulla (2006) consider that the regime-switching mechanism and the slow decay of autocorrelations can be identified by employing a Hidden Markov Model. Lastly, Tzouras, Anagnostopoulos, and McCoy (2015), and Makatjane and Moroke (2022) provide evidence in favour of employing both a graphical approach such as the McLeod-Li test followed by ACF and PACF tests while at the same time employing Portmanteau test statistics able to properly detect autocorrelations.

Thus, considering the experience of other authors and researchers regarding the selection of methods, we have decided to implement this selection of tests given their ability to explore the presence of "stylized facts". For instance, the normality tests coupled with the summary statistics can provide valuable insights into the distribution of data and the presence of fat tails. The autocorrelation functions coupled with the Portmanteau test statistics are employed to investigate the presence of linear autocorrelations between returns. Furthermore, we have decided to employ an EGARCH (1,1) model with Student t distribution to investigate the leverage effect. We have also implemented a two-state Hidden Markov Model with discrete observation distribution to showcase the regime-switching mechanism and test the slow decay in autocorrelations. We have employed the Hurst Exponent to test the long-term memory of time series and observe whether the indices are mean reverting, trending, or following a random walk behaviour.

Regarding the graphical testing approach, we incorporate histograms to check for the presence of fat tails and to observe the data distribution further. Furthermore, we have employed both normal and partial autocorrelation functions to investigate the presence of linear autocorrelations within the indices. Lastly, a McLeod-Li test for conditional heteroscedasticity (ARCH) and autocorrelation is employed. With these considerations in mind, we will further proceed by presenting the results obtained after applying the tests. It is also important to note that all the tests presented above have been conducted within the R statistical software. Additionally, a visual mapping presentation of the employed methodology is provided in Figure 1.

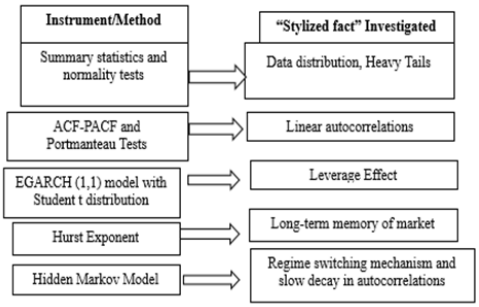

Figure 1. Visual Map of the Employed Methodology

Results

Regarding the results obtained, we begin by presenting the summary statistics and the normality tests employed to investigate the data distribution for the selection of ESG indices, which are reported in Table 1.

Table 1

Normality Tests for the ESG Selection of Indices

Test	Spain ESG	France ESG	UK ESG	EU ESG	World ESG
Shapiro	< 2.2e-16***	< 2.2e-16***	< 2.2e-16***	< 2.2e-16***	< 2.2e-16***
Anderson-Darling	< 2.2e-16***	< 2.2e-16***	< 2.2e-16***	< 2.2e-16***	< 2.2e-16***
Kolmogorov-Smirnov	3.335e-10***	1.458e-12***	6.439e-15***	< 2.2e-16***	< 2.2e-16***
Jarque-Berra	< 2.2e-16***	< 2.2e-16***	< 2.2e-16***	< 2.2e-16***	< 2.2e-16***
Anscombe	< 2.2e-16***	< 2.2e-16***	< 2.2e-16***	< 2.2e-16***	< 2.2e-16***
Geary	0.696	0.680	0.664	0.662	0.424
Bonnet-Seiter	< 2.2e-16***	< 2.2e-16***	< 2.2e-16***	< 2.2e-16***	< 2.2e-16***
Kurtosis	16.761	14.686	17.489	16.868	530.975
Skewness	-0.984	-0.576	-0.829	-0.638	9.003
, **, * indicates significance at the 90 %, 95 %, and 99 % levels, respectively.*					

The most relevant aspect to consider is the fact that for all the indices selected is a non-normal data distribution. This is further confirmed by the normality test of Jarque-Berra (1987) and by the Kolmogorov-Smirnov test (1953). Further tests such as the Shapiro, Anderson-Darling, or Bonnet-Seiter show the same result. Similarly, another relevant aspect of the area of "stylized facts" is the leptokurtic fat tail distribution observed via the excess kurtosis and negative skewness for most indices. The only exception is the World ESG Universal Index, which exhibits a large positive skewness and a very large kurtosis This result indicates that the index presents a leptokurtic distribution or heavy tail but is skewed towards the right or, positive. Therefore, certain "stylized facts" still apply to this index, regardless of skewness. Furthermore, we have also implemented a Hurst Exponent test to investigate the long-term memory of the market. This can be viewed in Table 2.

Table 2

Hurst Exponent for the ESG Selection of Indices

Hurst Exponent	Spain ESG	France ESG	UK ESG	EU ESG	World ESG
Simple R/S Hurst Estimation	0.490	0.509	0.510	0.491	0.495

As can be viewed in the table, the France ESG Universal Index and the UK ESG Universal Index show a trending behavior, as their H score is larger than 5. However, the three remaining indices exhibit a mean reverting behavior, as their H score is lower than 5. Furthermore, as was the case with the previous selection of indices, we have employed two classical Portmanteau tests, namely the Ljung-Box and Box-Pierce tests. The results obtained after applying this methodology are reported in Table 3.

Table 3

Portmanteau Test Statistics for the ESG Indices

Test	Spain ESG		France ESG		UK ESG	
	Value	p-value	Value	p-value	Value	p-value
Ljung-Box	39.477	0.008***	44.357	0.002***	51.539	0.000***
Box-Pierce	39.309	0.009***	44.154	0.002***	51.293	0.000***
Test	EU ESG		World ESG			
	Value	p-value	Value	p-value		
Ljung-Box	35.111	0.027**	212.09	< 2.2e-16***		
Box-Pierce	34.958	0.028**	211.79	< 2.2e-16***		
, **, * indicates significance at the 90 %, 95 %, and 99 % levels, respectively.*						

As it can be noted, we argue that for the entire selection of ESG indices, we can confirm the presence of autocorrelations. This, in turn, requires further investigation, to observe the degree and relevance of such autocorrelations. Thus, we will further continue to discuss the results for each index individually. With this in mind, we will proceed to investigate the first index contained within our selection, the Spain ESG Universal Index. Given the results obtained in Table 1, we consider that the index in question follows a non-normal leptokurtic distribution, which can also be confirmed by the histogram of Figure 2.

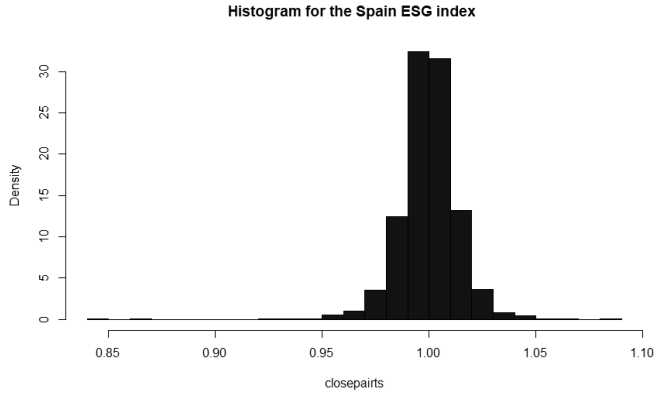

Figure 2. Histogram for the Spain ESG Universal Index

Thus, we can confirm the leptokurtic fat-tailed distribution of this index and the non-normal data distribution. Given the results of the Portmanteau test statistics, we have decided to further investigate by implementing the ACF and PACF functions. The results obtained are reported in Figure 3.

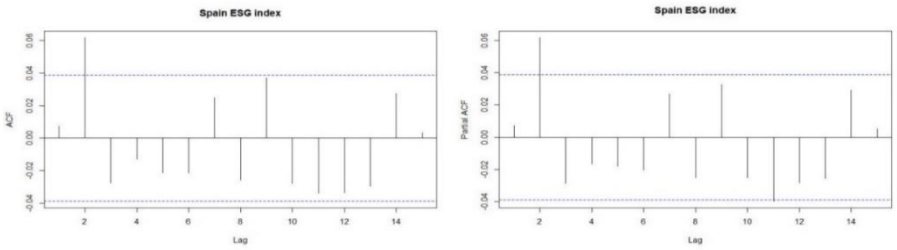

Figure 3. ACF and PACF for the Spain ESG Universal Index

The results obtained by the ACF and PACF functions confirm the presence of autocorrelations within this index. Moreover, it can also be noted that the autocorrelations identified, are slowly decaying over time, with a single spike being recorded at lag 2. To confirm those results, we have decided to supplement the classical Portmanteau tests by also employing the McLeod-Li test. The results are reported in Figure 4.

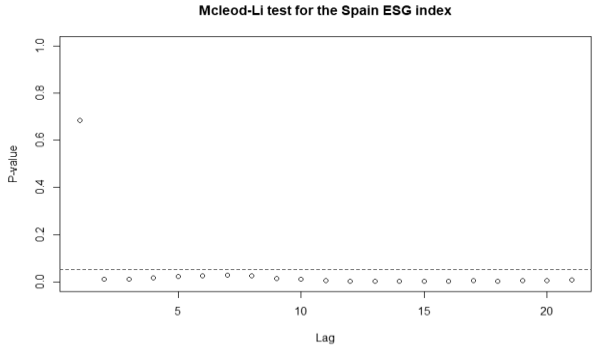

Figure 4. McLeod-Li test for the Spain ESG Universal Index

Thus, we can argue that the autocorrelations present within the index, do indeed align themselves to the category of "stylized facts". Furthermore, we have also implemented an HMM model, which managed to capture most "stylized facts" and also capture the regime-switching mechanism that is present within this index. As such, the results obtained are reported in Table 4.

Table 4

Two-state Hidden Markov Model for the Spain ESG Index

	Transition probabilities for a Two-state HMM		Goodness of fit test		
State	**1**	**2**	**AIC**	**BIC**	**log L**
1	0.498	0.501	49881.62	79363.74	-19894.81
2	0.498	0.501			

Lastly, to investigate the presence of the leverage effect, we have employed an EGARCH (1,1) model with student t distribution. The results obtained are reported in Table 9. Considering that the GARCH term (β1=0.967) is positive and statistically significant at the 1 % level. This result suggests that the current level of volatility is influenced by past levels, therefore confirming the presence of the leverage effect. Given the results obtained, we consider that the model successfully captures the leverage effect of "stylized fact" for this index. We will proceed to investigate the presence of "stylized facts" for the following index namely, the France ESG Universal Index. We can note that this index follows a similar leptokurtic non-normal data distribution as was the case with the previous index. This result can be confirmed by both summary statistics and normality tests presented in the histogram in Figure 5.

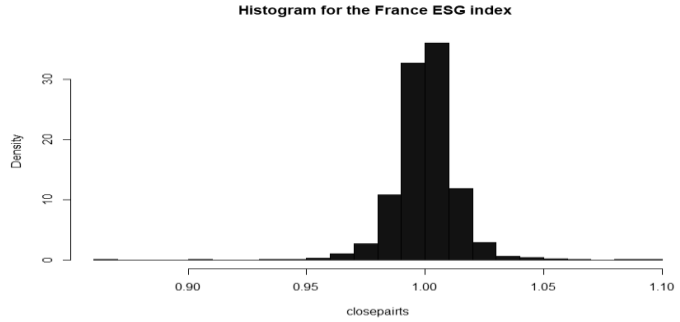

Figure 5. Histogram for the France ESG Universal Index

Furthermore, given the results obtained for the classical Portmanteau test statistics, we have decided to further investigate the presence of autocorrelations by employing an ACF and PACF function, the results obtained can be visualized in Figure 6. The results obtained after implementing the ACF and PACF tests, confirm the presence of autocorrelations within the index. Nevertheless, we can note that the autocorrelations identified are slowly decaying over time, with some exceptions. Spikes can be noted at lag 2, lag 6, and lag 14. Thus, to further investigate and conclude the issue of autocorrelations, we have also implemented a McLeod-Li test.

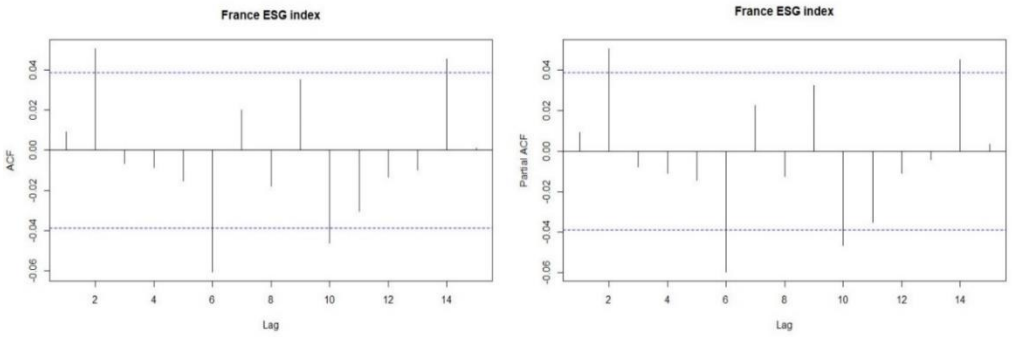

Figure 6. ACF and PACF for the France ESG Universal Index

The results obtained for the McLeod-Li test can be viewed in Figure 7. The results obtained for the McLeod-Li, confirm both the presence of autocorrelations and the significant spikes. One key note is the fact that the largest spike identified occurs at lag 1, while the remaining ones tend to appear afterward and at a lower intensity.

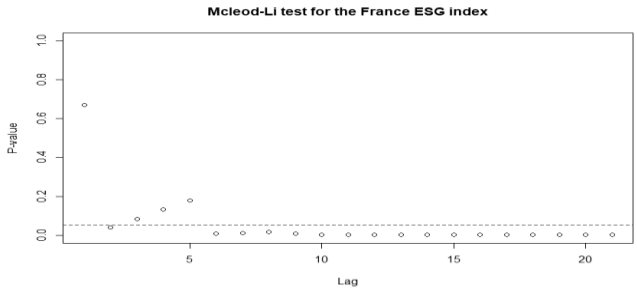

Figure 7. McLeod-Li test for the France ESG Universal Index

Given this, we argue in favour of the presence of slowly decaying autocorrelations. With this in mind, we have further employed an HMM model that manages to capture most "stylized facts" including the regime-switching mechanism that occurs within the index. The results obtained are reported in Table 5

Table 5

Two-state Hidden Markov Model for the France ESG Index

	Transition probabilities for a Two-state HMM		**Goodness of fit test**		
State	1	2	AIC	BIC	log L
1	0.498	0.501	49881.62	79363.74	-19894.81
2	0.498	0.501			

Lastly, we have also implemented an EGARCH (1,1) model with student t distribution, to investigate the presence of the leverage effect "stylized fact". The results obtained are reported in Table 9. Given that the resulting GARCH term ($\beta 1$=0.979) is positive and statistically significant at the 1 % level. This result suggests that the current level of volatility is influenced by past levels, therefore confirming the presence of the leverage effect. Given the results, it can be noted that the model successfully captures the leverage effect "stylized fact" for the France ESG Universal Index. Given this, we will proceed to investigate the presence of "stylized facts" for the UK ESG Universal Index. We can note that this index follows a similar leptokurtic non-normal data distribution as was the case with the previous index. This result can be confirmed by both summary statistics and normality tests and, in addition, by the histogram of Figure 8.

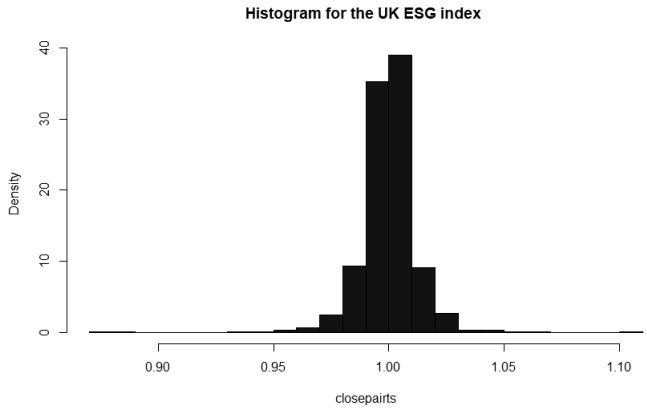

Figure 8. Histogram for the UK ESG Universal Index

Furthermore, given the strong results obtained while investigating the presence of autocorrelations via the Portmanteau test statistics, we have decided to further examine the issue. In doing so, we have implemented both ACF and PACF test functions. The results obtained can be visualized in Figure 9.

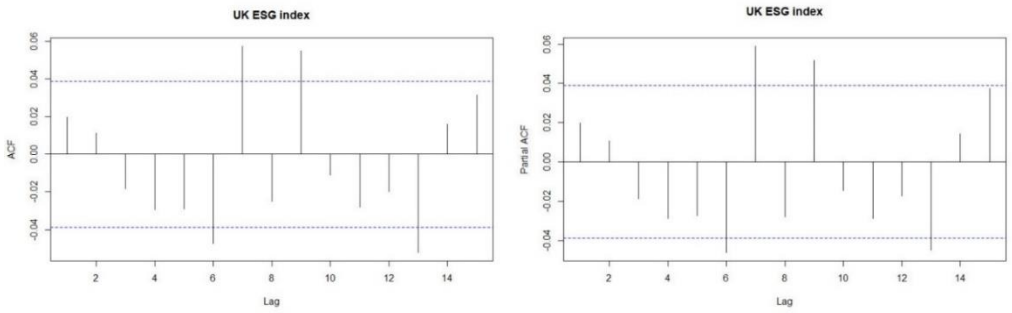

Figure 9. ACF and PACF for the UK ESG Universal Index

The results of the ACF and PACF test functions confirm the presence of autocorrelations and also indicate the presence of several spikes. As can be observed, several large spikes are recorded at lag 6, lag 7, lag 9, and lag 13. Given this, we have decided to supplement both the Portmanteau tests and the ACF and PACF approach by implementing the McLeod-Li test. The results obtained are reported in Figure 10.

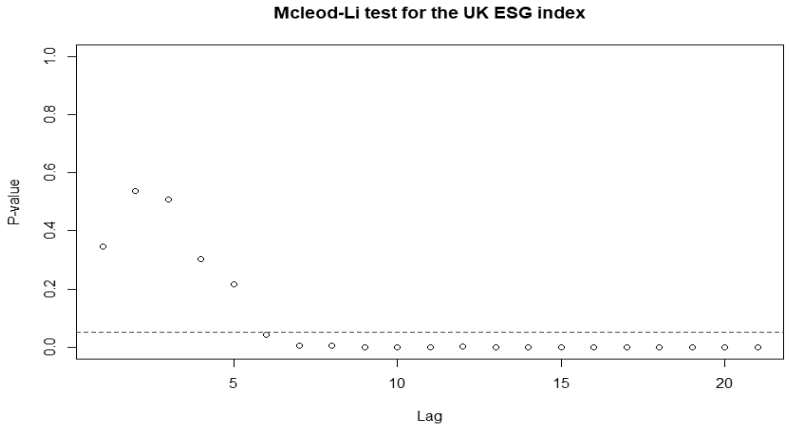

Figure 10. McLeod-Li test for the UK ESG Universal Index

The resulting McLeod-Li test confirms both the presence of autocorrelations and the presence of spikes within the data. As such, we note that the largest spikes appear at lag 2 and 3 afterward the autocorrelations are slowly decaying. Given this, the slowly decaying autocorrelations can be considered for this index. Furthermore, we have also implemented an HMM model that manages to capture most "stylized facts" while at the same time, it manages to capture the regime-switching.

Table 6

Two-State Hidden Markov Model for the UK ESG Index

	Transition probabilities for a Two-state HMM		Goodness of fit test		
State	1	2	AIC	BIC	log L
1	0.498	0.501	49893.19	79367.59	-19902.6
2	0.498	0.501			

Lastly, to investigate and confirm the presence of the leverage effect, we have decided to implement an EGARCH (1,1) model with the student t distribution. The results obtained are reported in Table 9. Of which, the resulting GARCH term (β1=0.965) is positive and statistically significant at the 1 % level. This result suggests that the current level of volatility is influenced by past levels, therefore confirming the presence of the leverage effect. Given the results, we note that the model successfully captures the leverage effect of "stylized fact" for the index. Given this, we will proceed to investigate the presence of "stylized facts" for the following index namely, the EU ESG Universal Index. We can note that this index follows a similar leptokurtic non-normal data distribution as was the case with the previous index. This result can be confirmed by both summary statistics and normality tests and, in addition, by the histogram of Figure 11.

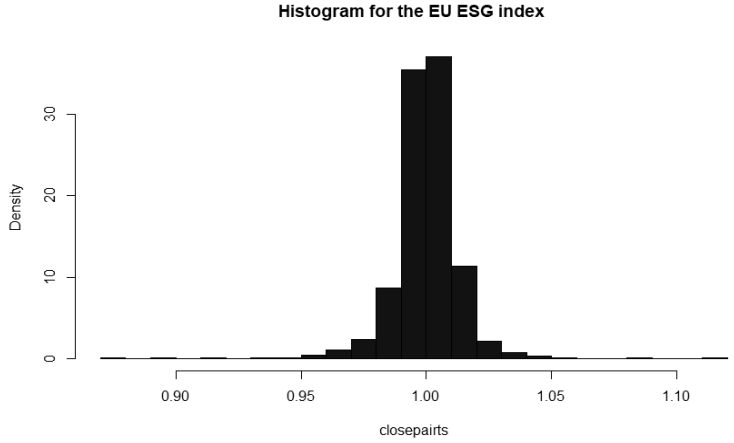

Figure 11. Histogram for the EU ESG Universal Index

Given the results obtained after applying the Portmanteau test statistics, which confirm the presence of autocorrelations, we decided to explore this further by implementing ACF and PACF test functions. The results obtained can be visualized in Figure 12.

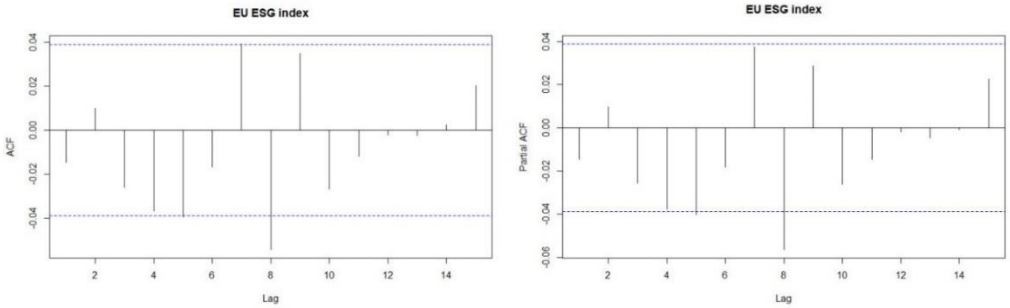

Figure 12. ACF and PACF for the EU ESG Universal Index

The results obtained after applying the ACF and PACF test functions confirm the presence of autocorrelations within the index. Thus, we can note several spikes, the largest of which occurs at lag 8. Given this result, we have further implemented a McLeod-Li test, while the results obtained can be viewed in Figure 13.

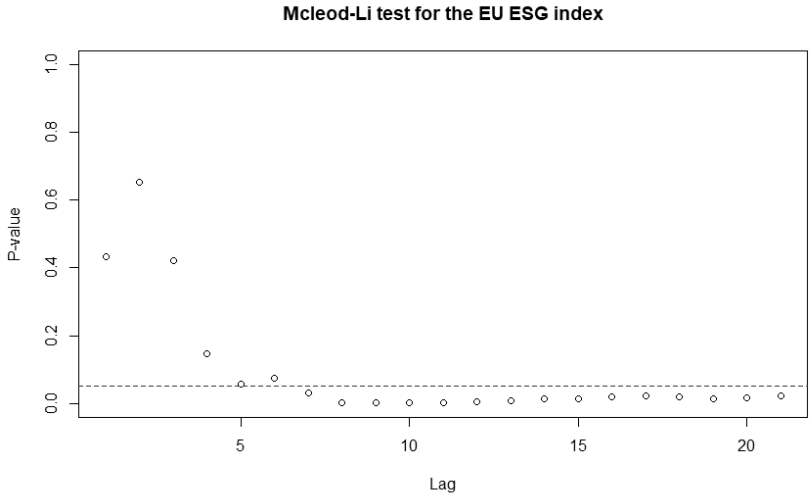

Figure 13. McLeod-Li test for the EU ESG Universal Index

The McLeod-Li test confirms the presence of autocorrelations and also identifies several relevant aspects. Namely, the number of occurring spikes. The largest of which is identified at lag 2, while the ACF and PACF test functions identified the largest spike at lag 6, while McLeod-Li captures the largest spike at lag 2. We maintain that given the data employed, the McLeod-Li test is a better fit and captures the autocorrelations more faithfully. As such, the autocorrelations identified have a slowly decaying effect over time, except for the spike at lag 2. Hence, we have also implemented an HMM model that manages to capture most "stylized facts" and also manages to capture the regime-switching mechanism of the market. The results obtained can be examined in Table 7.

Table 7

Two-state Hidden Markov Model for the EU ESG Index

	Transition probabilities for a Two-state HMM		**Goodness of fit test**		
State	1	2	AIC	BIC	log L
1	0.498	0.501	49912.52	79410.29	-19908.26
2	0.498	0.501			

Further, we have implemented an EGARCH (1,1) model with student t distribution, which confirms the presence of the leverage effect "stylized fact" within the index. The results obtained can be examined in Table 9, at the end of this section. Of which, the resulting GARCH term ($\beta 1$=0.965) is positive and statistically significant at the 1 % level. This result suggests that the current level of volatility is influenced by past levels, therefore confirming the presence of the leverage effect. Given the results, we argue that the model successfully captures the leverage effect "stylized fact" for the EU ESG Universal Index. Given this, we will proceed to investigate the presence of "stylized facts" for the following index namely, the World ESG Universal Index. We can note that this index follows a similar leptokurtic non-normal data distribution but, contrary to the majority of results reported so far, the skewness indicates that this particular index is skewed towards the right. This result can be confirmed by both summary statistics and normality tests and, in addition, by the histogram of Figure 14.

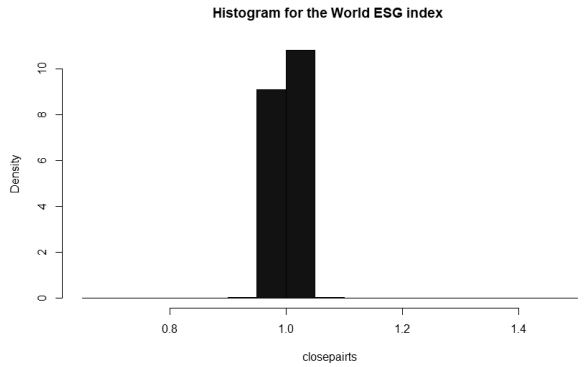

Figure 14. Histogram for the World ESG Universal Index

Thus, we can confirm that this particular index, although skewed to the right, presents the fat-tails and leptokurtic distribution which is in line with the "stylized facts". Furthermore, given the results obtained for the Portmanteau test statistics which confirm the presence of autocorrelations, we have decided to further explore this result by employing ACF and PACF test functions. The results obtained can be visualized in Figure 15. Given the results obtained, we argue that the presence of autocorrelations is confirmed. Hence, it can be argued that given its right-skewed character, the autocorrelations tend to differ from the remainder of the indices tested. Thus, it can be noted that the largest spike identified occurs at the 1 lag mark, in the form of negative autocorrelations. The following autocorrelations tend to slowly decay over time.

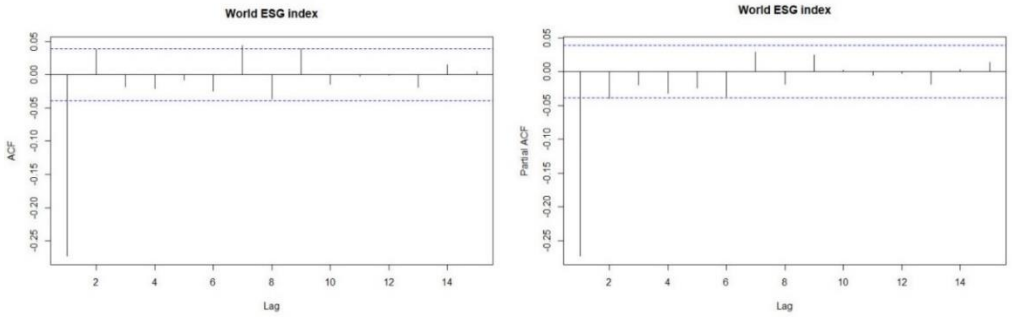

Figure 15. ACF and PACF for the World ESG Universal Index

With this in mind, we have decided to also employ a McLeod-Li test to clarify and better visualize this result. The results obtained after applying the McLeod-Li test can be viewed in Figure 16. The results obtained indicate that no significant spikes have occurred. Nevertheless, the test confirms the presence of autocorrelations. Thus, it can be noted that the autocorrelations present within the index align themselves with the slowly decaying nature of the category of "stylized facts".

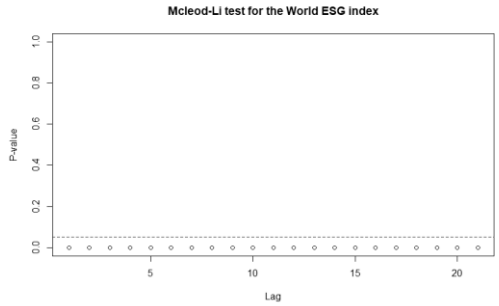

Figure 16. McLeod-Li test for the World ESG Universal Index

Furthermore, we have also implemented an HMM model that managed to capture most "stylized facts" and at the same time, it managed to also capture the regime-switching mechanism contained within the index. The results obtained are reported in Table 8.

Table 8

Two-state Hidden Markov Model for the World ESG Index

	Transition probabilities for a Two-state HMM		**Goodness of fit test**		
State	1	2	AIC	BIC	log L
1	0.498	0.501	50181.94	79971.88	-19992.97
2	0.498	0.501			

Lastly, we have also employed an EGARCH (1,1) model with student t distribution to test for the presence of the leverage effect. The results obtained can be examined in Table 9. Of which, the resulting GARCH term (β1=0.948) is positive and statistically significant at the 1 % level. This result suggests that the current level of volatility is influenced by past levels, therefore confirming the presence of the leverage effect. Given the results obtained, we maintain that the model successfully captures the leverage effect "stylized fact" for the World ESG Universal Index. Taking into account the results obtained, we can confirm that our entire selection of indices exhibits the presence and effects of "stylized facts".

Table 9

EGARCH Results for the Entire Selection of ESG Indices

Spain ESG Index	EGARCH (1,1)		France ESG Index	EGARCH (1,1)	
	Estimate	Probability		Estimate	Probability
C	1.00002 (0.000045)	0.000***	C	1.00027 (0.000006)	0.000***
ω	-0.29091 (0.014293)	0.000***	ω	-0.19232 (0.008049)	0.000***
α1	-0.10418 (0.010811)	0.000***	α1	-0.13215 (0.011005)	0.000***
β1	0.96724 (0.001612)	0.000***	β1	0.97922 (0.000872)	0.000***
γ1	0.15427 (0.016365)	0.000***	γ1	0.13941 (0.012790)	0.000***
shape	6.28633 (0.762640)	0.000***	shape	5.84229 (0.671147)	0.000***
AIC	-6.0701		AIC	-6.3185	
BIC	-6.0563		BIC	-6.3047	
Log L	7736.254		Log L	8052.563	
UK ESG Index	**EGARCH (1,1)**		**EU ESG Index**	**EGARCH (1,1)**	
	Estimate	Probability		Estimate	Probability
C	1.00011 (0.000024)	0.000***	C	1.00011 (0.000024)	0.000***
ω	-0.32263 (0.018259)	0.000***	ω	-0.32263 (0.018259)	0.000***
α1	-0.13219 (0.011095)	0.000***	α1	-0.13219 (0.011095)	0.000***
β1	0.96544 (0.001949)	0.000***	β1	0.96544 (0.001949)	0.000***
γ1	0.17892 (0.015914)	0.000***	γ1	0.17892 (0.015914)	0.000***
shape	5.08128 (0.518574)	0.000***	shape	5.08128 (0.518574)	0.000***
AIC	-6.4959		AIC	-6.4959	
BIC	-6.4821		BIC	-6.4821	
Log L	8284.989		Log L	8284.989	
World ESG Index	**EGARCH (1,1)**				
	Estimate	Probability			
C	1.00052 (0.000090)	0.000***			
ω	-0.50670 (0.036592)	0.000***			
α1	-0.17803 (0.010873)	0.000***			
β1	0.94899 (0.003659)	0.000***			
γ1	0.23885 (0.014877)	0.000***			
shape	4.67755 (0.419836)	0.000***			
AIC	-7.0676				
BIC	-7.0539				
Log L	9013.68				

Standard errors are reported in parentheses. *, **, *** indicates significance at the 90 %, 95 %, and 99 % level, respectively.

Comparative Analysis Between ESG and non-ESG Indices

Considering the results obtained and given the specific characteristics of the ESG market segment, we have decided to additionally include 2 non-ESG developed stock market indices to serve as a benchmark for a comparative analysis. The indices in question are the German DAX Index, which can be considered as a regional index and, the S&P 500 Index, which can arguably be considered as an international index. As such, we have employed the same methodology for the detection of "stylized facts", as in the case of the ESG selection. Thus, we will begin to present the results obtained by starting with the normality tests, as presented in Table 10.

Table 10

Normality Tests and Summary Statistics for the Benchmark Selection of Indices

Test	S&P 500	DAX
Shapiro	< 2.2e-16***	< 2.2e-16***
Anderson-Darling	< 2.2e-16***	< 2.2e-16***
Kolmogorov-Smirnov	< 2.2e-16***	< 2.2e-16***
Jarque-Berra	< 2.2e-16***	< 2.2e-16***
Anscombe	< 2.2e-16***	< 2.2e-16***
Geary	0.650	0.692
Bonnet-Seiter	< 2.2e-16***	< 2.2e-16***
Kurtosis	17.472	10.607
Skewness	-0.774	-0.493
, **, * indicates significance at the 90 %, 95 %, and 99 % level, respectively.*		

The most relevant aspect to consider is that the benchmark selection exhibits a non-normal data distribution. This is further confirmed by the normality test of Jarque-Berra (1987) and by the Kolmogorov-Smirnov test (1953). Further tests such as the Shapiro, Anderson-Darling, or Bonnet-Seiter show the same result. Another relevant aspect of the area of "stylized facts" is the leptokurtic fat tail distribution observed via the level of kurtosis and negative skewness, as in the case of the ESG selection. Therefore, it can be argued that similarly as in the case of the ESG selection, the benchmark selection exhibits the presence of the heavy tail "stylized fact". Furthermore, a Hurst Exponent test was also employed to investigate the long-term memory of the benchmark indices. The results for which are reported in Table 11.

Table 11

Hurst Exponent for the Benchmark Selection of Indices

Hurst Exponent	S&P 500	DAX
Simple R/S Hurst Estimation	0.480	0.503

As can be viewed in the table, the DAX Index shows a trending behavior, as the H score is slightly larger than 5. However, in the case of the S&P 500 Index we observe mean reverting behavior, as the H score is lower than 5. Furthermore, as was the case with the previous selection of indices, we have also employed two classical Portmanteau tests, namely the Ljung-Box and Box-Pierce tests. The results for which are presented in Table 12.

Table 12

Portmanteau Test Statistics for the Benchmark Selection of Indices

Test	S&P 500		DAX	
	Value	p-value	Value	p-value
Ljung-Box	176.25	< 2.2e-16***	37.87	0.013**
Box-Pierce	175.68	< 2.2e-16***	37.70	0.013**
Standard errors are reported in parentheses. *, **, *** indicates significance at the 90 %, 95 %, and 99 % level, respectively.				

As observed, we argue that for the benchmark selection, we can confirm the presence of autocorrelations. This, in turn, requires further investigation, to observe the actual degree and relevance of such autocorrelations. Thus, we will further continue to discuss the results for both indices individually. With this in mind, we will proceed to investigate the first index, namely the S&P 500 Index. Given the results obtained in Table 10, we consider that the index in question follows a non-normal leptokurtic distribution, which can also be confirmed by the histogram of Figure 17.

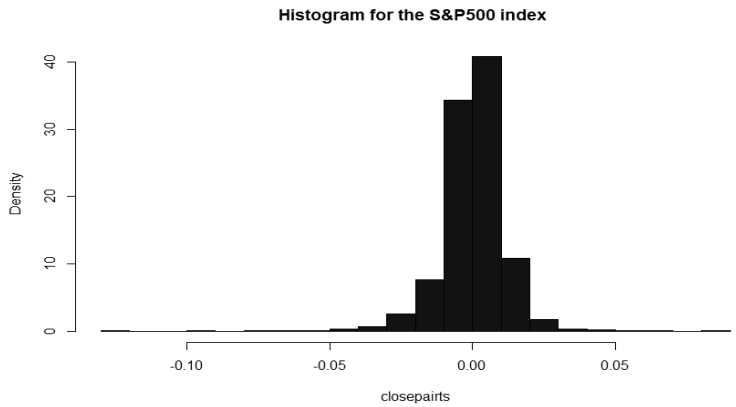

Figure 17. Histogram for the S&P 500 Index

Thus, we can confirm the leptokurtic fat-tailed distribution of this index and the non-normal data distribution. Given the results of the Portmanteau test statistics, we have decided to further investigate by implementing the ACF and PACF functions. The results obtained are reported in Figure 18.

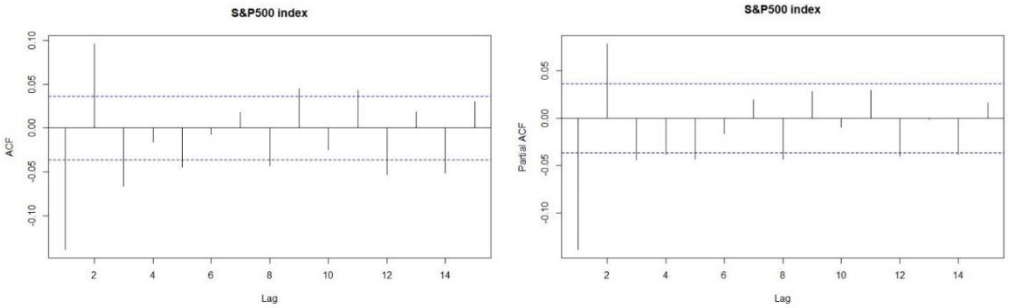

Figure 18. ACF and PACF for the S&P 500 index

The results obtained after applying the ACF and PACF test functions confirm the presence of autocorrelations within the index. We can note several spikes, the largest of which occurs at lag 1, followed by another spike which occurs at lag 2. Given this result, we have further implemented a McLeod-Li test, while the results obtained can be viewed in Figure 19.

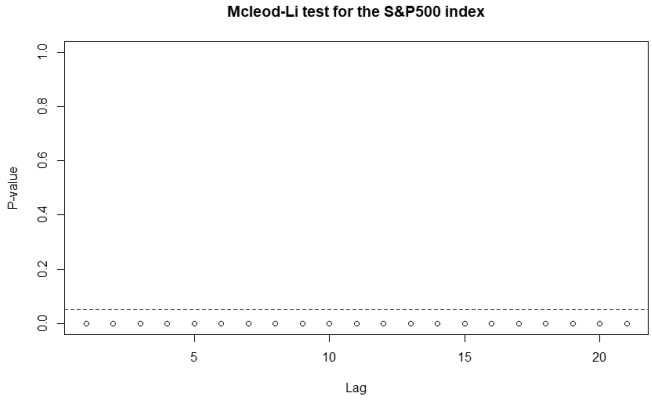

Figure 19. McLeod-Li test for the S&P 500 index

Given this, we argue in favour of the presence of slowly decaying autocorrelations. With this in mind, we have further employed an HMM model that manages to capture most "stylized facts" including the regime-switching mechanism that occurs within the index. The results obtained are reported in Table 13.

Table 13

Two-state Hidden Markov Model results for the S&P 500 index

	Transition probabilities for a Two-state HMM		Goodness of fit test		
State	1	2	AIC	BIC	log L
1	0.498	0.501	57467.34	91870.68	-22967.67
2	0.498	0.501			

Lastly, we have also implemented an EGARCH (1,1) model with student t distribution, to investigate the presence of the leverage effect "stylized fact". The results obtained are reported in Table 15. Given that the resulting GARCH term ($\beta 1=0.973$) is positive and statistically significant at the 1% level. The result suggests that the current level of volatility is influenced by past levels, therefore confirming the presence of the leverage effect. Given the results, it can be noted that the model successfully captures the leverage effect "stylized fact" for the S&P 500 Index. Given this, we will proceed to investigate the presence of "stylized facts" for the second benchmark index, namely the DAX Index. We can note that this index follows a similar leptokurtic non-normal data distribution as was the case with the previous index. This result can be confirmed by both summary statistics and normality tests and, in addition, by the histogram of Figure 20.

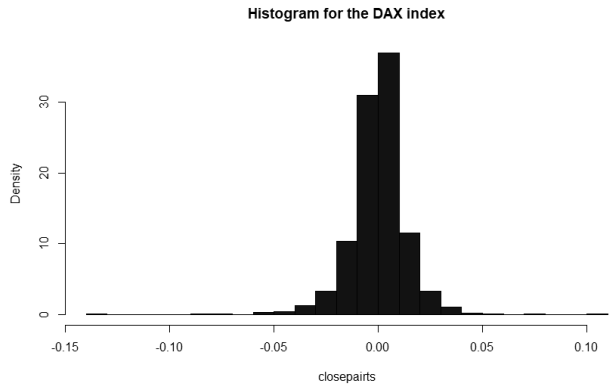

Figure 20. Histogram for the DAX Index

Given the strong results obtained while investigating the presence of autocorrelations via the Portmanteau test statistics, we have decided to further examine the issue for this index. In doing so, we have implemented both ACF and PACF test functions. The results obtained can be visualized in Figure 21.

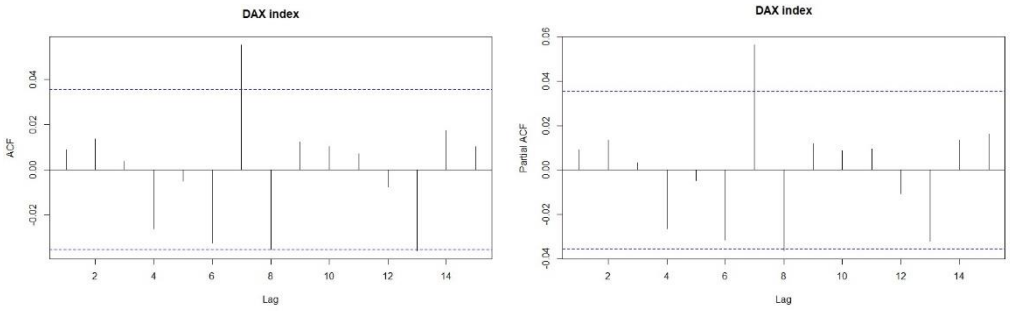

Figure 21. The ACF and PACF for the DAX Index

With this in mind, we have decided to also employ a McLeod-Li test to clarify and better visualize this result. The results obtained after applying the McLeod-Li test can be viewed in Figure 22. The results obtained indicate that no significant spikes have occurred. Nevertheless, the test confirms the presence of autocorrelations. Thus, it can be noted that the autocorrelations present within the index align themselves with the slowly decaying nature of the category of "stylized facts".

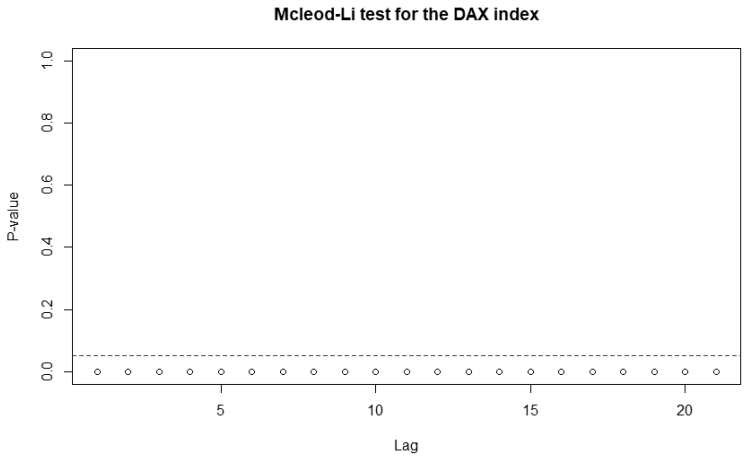

Figure 22. McLeod-Li test for the DAX index

Furthermore, we have also implemented an HMM model that managed to capture most "stylized facts" and at the same time, it managed to also capture the regime-switching mechanism contained within the index. The results obtained are reported in Table 14.

Table 14

Two-state Hidden Markov Model results for the DAX index

	Transition probabilities for a Two-state HMM		Goodness of fit test		
State	1	2	AIC	BIC	log L
1	0.498	0.501	61183.76	97951.53	-24487.88
2	0.498	0.501			

Lastly, we have also implemented an EGARCH (1,1) model with student t distribution, to investigate the presence of the leverage effect "stylized fact". The results obtained are reported in Table 15. Given that the resulting GARCH term (β1=0.969) is positive and statistically significant at the 1 % level. The result suggests that the current level of volatility is influenced by past levels, therefore confirming the presence of the leverage effect. Given the results, it can be noted that the model successfully captures the leverage effect "stylized fact" for the DAX Index.

Table 15

EGARCH Results for the Benchmark Selection of Indices

DAX Index	EGARCH (1,1)		S&P 500	EGARCH (1,1)	
	Estimate	Probability		Estimate	Probability
C	0.00044 (0.000127)	0.000***	C	0.000571 (0.000136)	0.000***
ω	-0.24316 (0.000127)	0.000***	ω	-0.299951 (0.021624	0.000***
α1	-0.16431 (0.010956)	0.000***	α1	-0.191495 (0.015141)	0.000***
β1	0.97344 (0.000216)	0.000***	β1	0.969159 (0.002254)	0.000***
γ1	0.14879 (0.011787)	0.000***	γ1	0.199551 (0.023634)	0.000***
shape	5.28154 (0.524068)	0.000***	shape	5.650271 (0.595600)	0.000***
AIC	-6.2277		AIC	-6.7262	
BIC	6.2158		BIC	-6.7138	
Log L	9509.404		Log L	9701.849	

Considering the results obtained, a short comparative analysis between the ESG and non-ESG indices is in order. At first glance, it can be noted that both the ESG and non-ESG indices follow a non-normal distribution. Additionally, the presence of slowly decaying autocorrelations is observed via the Portmanteau test statistics and the ACF and PACF tests.

As in the case of the ESG selection, this finding is further reinforced by the McLeod-Li test, which exhibits similar results as in the previous case. Lastly, the Hidden Markov Model and the EGARCH (1,1) with student t distribution indicate the presence of the leverage effects and also, of the regime-switching mechanism within the benchmark selection.

As such, we argue that the presence of "stylized facts" can be attested for both the ESG and non-ESG indices. It can be further argued that the impact of "stylized facts" generates different outcomes and effects given both general and particular sources of risk.

Thus, given the results obtained for the benchmark selection of indices, we argue that the presence of "stylized facts" in both the ESG and non-ESG market segments represents a relevant topic for investors, policymakers, and stakeholders alike. Furthermore, it can be argued that given the results, a given level of integration amongst the ESG and developed non-ESG indices may exist.

Given this, we argue that, in light of the results obtained, which confirm the presence and effects of "stylized facts" among the aforementioned indices, investors may consider the inclusion of ESG assets in portfolios.

The main advantage of this inclusion may lie in the potential of anchoring the portfolio, given the fact that the issuers of such assets are employing a sustainable approach, under the ESG guidelines and reporting standards, combined with the preference for medium and long-term assets. Therefore, providing additional protection to climate and ESG-related risks.

Another relevant aspect in this regard may arise from the regulatory side, as the ESG issuers are abiding by the international reporting standards and disclosure policies which may provide an additional benefit and insight to both investors and the general public alike thus allowing for optimal portfolio management decisions and capital allocation.

Comments on the Results and Policy Implications

The results confirmed the presence of both market integration and "stylized facts" within developed stock markets thus highlighting similarities with existing literature on the topic. It can be argued that the presence of both elements can also be identified within the non-ESG segments of the market and in smaller segments of the market such as the ESG stocks or indices. The results obtained for the ESG market segment prove this, confirming the relevance of "stylized facts". We further argue that the impact of "stylized facts" can be more pronounced within this segment, given the limited number of constituents within ESG indices. Additionally, the inclusion of new constituents proceeds at a slower pace, further contributing to this outcome.

As such, diversification and hedging could be beneficial during calm periods, while additional risk exposure may increase during turbulent times. Especially when considering

the potential of a more pronounced impact arising from the effects of "stylized facts" within this particular segment. Thus, a key implication regarding the process of market integration, is that the presence of "stylized facts" has a significant effect in regards to the conduct of the process itself in all segments of the market. In this sense, we note that during calm periods with no volatility, the process of market integration is present, albeit at a given level. Hence, during such times the process of integration does not serve as a net transmitter of volatility.

However, the same cannot be said during periods of contagion or volatility spillover, in which the process of market integration tends to peak. As Qui et al (2022) note, the process of integration tends to increase during periods of exogenous and endogenous shocks and stronger market comovements have been identified. During such moments, it can be argued that the market integration process, influenced by the effects of "stylized facts", becomes a net transmitter of volatility and contagion on a global scale. A similar point is debated by Huang and Yang (2023) and Al-Yahyaee et al (2019) who study the evolution and effects of the contagion effect, which is influenced by market integration, in an international setting. Arguing that the contagion effect flows from market to market and region to region during periods of crisis. Similarly, Chibane et al (2023) investigate the contagion and volatility effects within the European stock markets. Moreover, the author also suggests the relevant role that the process of market integration plays in aiding the transmission of the contagion effect. Nevertheless, they conclude that policy intervention can act as a stabilizing force thus influencing the course of market integration. Hence, it can be argued that integration can be directly influenced by the presence and effects of "stylized facts". Given the fact that integration has the potential to serve as a net transmitter of volatility during turbulent times, several implications for both investors and policymakers should be considered.

Thus, as key implications for investors and portfolio management in general, asset pricing decisions can be heavily impacted in a globally integrated environment. Another relevant point is presented by Kasa (1992) who tests the co-movement of five developed stock markets using both monthly and quarterly data. The results argue in favour of the presence of "leader" and "follower" markets. It can be argued that in certain cases, informational flows from larger financial hubs can influence the pricing mechanics in smaller or developing markets.

Hence, investors should consider the fact that the risk transmission mechanism operates on a global scale and the diversification of their portfolios should consider the advantages and disadvantages accompanying different stages of market integration and market phases and also the informational flows that may occur from larger financial hubs. The results obtained suggest that the stock markets in question contain four common vectors and also share a common stochastic trend. Hence, considering that such a combination of market integration and effects of "stylized facts" could favour the spreading of exogenous shocks and ultimately lead to the contagion effect and thus, deserves close consideration from investors and policymakers alike.

As implications for policymakers, we argue that their reaction regarding possible effects from an endogenous or exogenous shock can be limited given the globalized context and the given level of market integration at both regional and international levels. Hence, a possible solution to this issue could be a concerted global response to limit the impact of such shocks and provide relief to the global financial system. Considering the influence of "stylized facts" and how, in combination with the process of market integration, the spreading of shocks and risk contagion effects are favoured, policymakers are faced with the difficult task of assuring stability within the stock market.

Thus, we strongly consider that the process of market integration should be closely monitored. While also considering the influence and effects of "stylized facts" and how during periods of exogenous or endogenous shocks, the integration process serves as a net transmitter of volatility on a global scale. Thus, several key implications may arise for the interested stakeholders, as the market integration process can serve as a net transmitter of volatility during turbulent times.

As such, we note that the stakeholders can be subjected to additional risk exposures, especially if one is to consider the private pension scheme which is heavily reliant on pension and mutual funds. As such, stakeholders should also consider that market integration could also have a negative impact on both their investments and the shares or units owned in pension or mutual funds during turbulent or volatile periods. Another relevant aspect that is worth mentioning, is the fact that, given the continuous process of functional integration among global markets, episodes of shocks may negatively impact the stakeholders.

This impact can be best described by the propagation of recessions and financial crises, as was the case with the Global Financial Crisis of 2008–2010, which originated in the United States market initially, before becoming a global contagion.

At the same time, given the impact and consequences that flow from the presence and effects of "stylized facts", it can be noted that the "stylized facts" themselves are a deviation from informational and allocation efficiency (Risso, 2008). Especially when considering the resulting chaos and equilibrium deviations that are directly caused by endogenous and exogenous shocks. Thus, during such turbulent times, under the impact that stems from the effects of "stylized facts" and the spillover effect, the returns of financial assets may follow a biased Brownian motion. Therefore, indicating a clear deviation from the informational efficiency.

Lastly, several key implications arise for the entire ESG segment. Given the presence and impact of "stylized facts" within this segment of the market, it can be argued that the degree of interconnectedness with the non-ESG class of assets is crucial, as volatility may flow between them. Another relevant aspect that is noted by Azizi et al. (2024) is the need for a more enhanced and complete financial reporting and disclosure practice and stakeholder awareness. Given the fact that the ESG segment of the market is also subject to the impact of "stylized facts "and also other informational issues, such as the topic of "greenwashing". Nevertheless, it can be argued that ESG investments can act as a hedge against climate and ESG-related risks, and can provide informed investors with higher returns that are associated with the risk premium within this segment (Kraussl *et al.,* 2024).

Conclusions

In conclusion, we note that the impact of "stylized facts" presents a relevant topic to be considered. As the methodology confirms, "stylized facts" are present within the ESG segment of the developed markets. Thus, having the capacity and potential to enable the process of market integration to act as a net transmitter of volatility during turbulent times. Moreover, implications for asset pricing arise. Namely, the portfolio diversification combined with the risk transmission mechanism can provide investors with additional returns during times of economic prosperity. Nevertheless, during turbulent times such developments may produce additional risk exposure, ultimately leading to large losses.

Additionally, "stylized facts" can be considered as deviations from informational and asset allocation efficiency, leading to excess levels of volatility and ultimately to the spillover effect. Therefore, such deviations should be overseen and addressed by policymakers, in order to ensure financial stability.

In the end, the resulting process of market integration has provided investors with certain benefits that, nevertheless, come at the cost of stability during turbulent times. Another relevant aspect covered lies in expanding the existing literature on the topic by testing the presence and influence of "stylized facts" within the ESG segment of the market. To this end, we have employed a large selection of ESG indices obtained from the MSCI ESG Universal Index family.

The results obtained suggest that "stylized facts" are present and are not limited exclusively to this particular segment of the market. Furthermore, given the limited number of constituents and certain criteria regarding the inclusion of further constituents, the impact of "stylized facts" may be amplified, potentially leading to more volatility spillover and an additional risk exposure for investors that operate within this particular market segment. We consider that a limitation to the scope of the study is that the effects and the impact of "stylized facts" have been researched only for the case of developed financial markets.

As such, the scope of the study is limited as it only investigates the impact of "stylized facts" on developed financial markets, neglecting emerging and frontier markets. It also lacks research based on mixed ESG and non-ESG indices, which could provide additional information and insights concerning the impact and effects of "stylized facts". A potential future research direction is the testing of both the integration process and the impact of "stylized facts" between ESG and non-ESG indices, which could provide better results and understanding regarding the risk premium that is present within the ESG market segment. While also provide relevant insights concerning the portfolio diversification potential that may be provided by ESG indices and stocks. This research could benefit investors, the public, policymakers, and the interested stakeholders alike by providing information on pricing mechanisms, and diversification potential, and ultimately aid in the expansion of the existing literature on the ESG market. Finally, it can provide additional explanations regarding the risk transmission mechanism and the impact and effects of "stylized facts".

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