

Article

Circular Economy Impact Analysis on Stock Performances: An Empirical Comparison with the Euro Stoxx 50[®] ESG Index

Donato Morea ^{1,*}, Fabiomassimo Mango ², Mavie Cardi ³, Cosimo Paccione ² and Lucilla Bittucci ²

¹ Department of Mechanical, Chemical and Materials Engineering, University of Cagliari, Via Marengo, 2, 09123 Cagliari, Italy

² Department of Management, Sapienza University, Via del Castro Laurenziano, 9, 00161 Rome, Italy; fabiomassimo.mango@uniroma1.it (F.M.); paccione.1946592@studenti.uniroma1.it (C.P.); lucilla.bittucci@uniroma1.it (L.B.)

³ Department for Research, Link Campus University, Via del Casale di San Pio V, 44, 00165 Rome, Italy; m.cardi@unilink.it

* Correspondence: donato.morea@unica.it

Abstract: Environmental issues have a considerable impact in all economic sectors, also influencing financial markets. As a result, environmental, social, and governance (ESG) awareness is rising in the financial sector. In this perspective, the concept of circular economy (CE) assumes central relevance. The aim of our study is to investigate the relationship between CE strategies and market performance; to this end, we use ESG scores as a proxy for CE. Our initial assumption is that since CE is a component of the “E” factor—in that it can generate positive and measurable environmental impacts—then it can be associated with the ESG score. Therefore, we can methodologically overcome the lack of a specific score related to CE. We use a preselection model based on historical performance by verifying the percentages of the presence of stocks in the two selected indices, namely ESG Euro Stoxx 50[®] and Euro Stoxx 50-ESG. Overall, we find that ESG profiles have a positive impact on stock performance, although ESG scores do not express higher performance per se. Furthermore, our analysis shows that, to date, there is no evidence that CE initiatives can influence stock returns.

Keywords: circular economy; environmental; social and governance (ESG); portfolio analysis; financial markets



Citation: Morea, D.; Mango, F.; Cardi, M.; Paccione, C.; Bittucci, L. Circular Economy Impact Analysis on Stock Performances: An Empirical Comparison with the Euro Stoxx 50[®] ESG Index. *Sustainability* **2022**, *14*, 843. <https://doi.org/10.3390/su14020843>

Academic Editors: Marc A. Rosen and Ioannis Nikolaou

Received: 13 November 2021

Accepted: 11 January 2022

Published: 12 January 2022

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1. Introduction

Environmental issues have a considerable impact in all economic sectors, also influencing movements and trends of financial markets. As a consequence, there is a rising environmental, social, and governance (ESG) awareness observable at an international level; actually, climate change and other environmental challenges assume relevance in terms of general economic balances, also representing a potential source of financial risk. As a result, the financial sector is paying increasing attention to the assessment of environmental risks in order to develop appropriate strategies [1,2].

Following this direction, in the last decade, ESG investments have grown rapidly and, as a natural consequence, the asset allocation process started evolving [3,4]. At the same time, in recent years, regulators and institutions have been supporting this approach, providing standards and taxonomies on ESG issues [5,6].

In light of the above, the concept of circular economy (CE) assumes central relevance: from a general perspective, several scholars have explored its meaning and definition [7–9] and there is a broad consensus that this term represents the capacity of the productive activity to regenerate itself not by discarding waste but by reusing it [10–12]. This is an antithetical conceptual framework to the linear economy concept traditionally used in production-consumption models [13].

Institutions and regulators are assigning the greatest importance to the potential of the CE to increase competitiveness and achieve social and environmental objectives. In fact, CE is a key pillar of the European Green Deal, presented in December 2019 by the European Commission, that wants to turn the climate challenge into an opportunity for a new development model aimed at making the European Union (EU) carbon neutral by 2050 through an ecological transition path and an industrial strategy oriented towards sustainable productions [14].

Furthermore, in the context of the NextGenerationEU (that assumes the green transition as a strategic priority), the new CE Action Plan, presented in March 2020, and the new European Industrial Strategy are complementary institutional instruments prioritizing the drivers of the industrial transformation. In particular, the new CE Action Plan pays attention to sustainable product design and circularity in production processes, as well as to certain resource-intensive sectors with high environmental impact [15,16].

CE is one of the six environmental objectives of the EU Taxonomy Regulation, which gives rise to the first classification system for sustainable economic activities. In this way, it will be possible to assess the environmental sustainability of investments, thus orienting them towards more sustainable and circular technologies. In light of the evolving regulatory path in this area, more transparent and consistent data on circularity performance (both historical and forward-looking) will be needed to reorient capital allocation to go green [17].

Indeed, unlike ESG factors, for which various providers and agencies assign a rating, CE is still not certified and rating or score have not yet been defined. As a result, in the absence of a score indicating the level of CE-compliance of companies, it is not possible to identify the correct statistical relationship between this aspect and the stock returns of listed companies.

In light of the above, there is a need for further developments in the literature related to circular economy. Therefore, in order to investigate the relationship between CE strategies and market performance, we use, in the context of our analysis, the ESG score as a proxy for CE. We assume that since the CE is a component of the “E” factor—as it can generate positive and measurable environmental impacts—then it can be associated to the ESG score. Our approach allows us to methodologically overcome the absence of a specific score related to CE, and subsequently to analyze its relationship with stock performance, considering the CE attitude of the sample of selected firms. Moving from this assumed gap, and considering the increasing importance that CE practices will assume in light of the new global challenges, the main research question of the paper is: *Do companies that adopt CE practices show better returns in the financial markets?*

In our research, we use a preselection model based on historical performance by checking the percentages of the presence of stocks in the two selected indices, namely ESG Euro Stoxx 50[®] and Euro Stoxx 50-ESG.

The results of our analysis show that—in general—ESG profiles have a positive impact on the performance of stocks, although ESG scores do not per se express higher performance. In addition, our analysis shows that—to date—there is no evidence that circular economy initiatives can affect stock returns.

Our paper, investigating the impact of CE initiatives on stock performance, contributes to several streams of literature. First, we contribute to the advancement of studies on ESG scores in the financial sector; we add to this stream of literature by providing evidence that ESG scores can positively impact stock performance. Moreover, and from a more targeted point of view, the paper helps to identify a methodology for assessing the impact of CE practices on stock returns, given the absence of a score expressing firms’ level of CE. Implications relate to the opportunity to broaden the empirical research base for the future development of a methodological approach to be used for the purpose of explicitly evaluating CE policies and their effects on stock performance. Our paper is relevant for scholars and policymakers as it aims to investigate whether the adoption of CE policies and the integration of ESG factors into corporate strategies can be driven by the ability to achieve better performance rather than by the need to be compliant with international

practices and regulations. Research in this area is extremely crucial as it can contribute to a more rapid integration of ESG criteria into companies' strategies and financial markets' expectations, as well as contribute to the dissemination of the culture of circular economy as a tool to improve the level of sustainability and profitability.

The paper is structured as follows: Section 2 is focused on the literature review. Section 3 describes the research methodology used. Section 4 reports the findings. Section 5 discusses the results obtained and, finally, Section 6 provides the main conclusions.

2. Literature Review

CE paradigm can be conceptually considered as an economic system based on business models that replace the concept of "end-of-life" with reuse, recycling, and recovery of materials in production/distribution and consumption processes [10]. It intervenes with sustainable development objectives at various levels: micro (products, companies, consumers), meso (integrated economic agents), and macro (cities, regions, nations) [8]. In general terms, the concept of CE and the positive externalities that can result from it have been extensively explored in literature. For the purposes of our analysis objectives, it is interesting to note that research on CE shows that circularity indicators to measure the same at different levels are still unclear [18]. In particular, Sassanelli et al. [19] argued that measuring the performance of CE practices is not common to understand, especially in firms. Thus, there is an opportunity for further development of appropriate indicators to measure CE strategies [20,21]. Even in light of the multiple operational nuances of the CE, a standardized framework of indicators to measure the level of circularity (for products, companies, or regions) is currently lacking [22]. Some authors argue for the usefulness of indicators on CE that encompass multidimensional characteristics, with a focus on social and environmental practices [23].

In the light of the above, there is space for further development in the related studies. Moving from this possible research gap and given our assumption considering the ESG score as a proxy of CE and the increasing importance that the environmental "E" component, the scope of our analysis, takes into account some of the main strands of ESG literature.

The research on financial performance and ESG criteria can be traced back to 1970 [24], but in recent years, in the light of the renewed attention to sustainability issues and ESG factors, a growing number of studies have been conducted on the relationship between ESG factors and market performance.

Given this premise, it seems useful, in order to go further with our analysis, to recall the essential contributions of the literature on this relationship. Actually, literature has investigated the role of ESG factors from different perspectives. However, for the purpose of our study, the main strand of literature that offers reasons for reflection is related to the impact of ESG information on the market, with particular reference to two profiles: the relationship between ESG information and shareholder value and the relationship between ESG information and portfolio performance.

On a broad level, several studies focus on how the market reacts to various events involving ESG-related reflections. Kruger [25] uses firms' corporate social responsibility (CSR) as a proxy for ESG performance to analyze how stock markets react to positive and negative CSR-related events, showing that the reaction is strongly negative in the face of negative events and weakly negative for positive events. Naughton et al. [26] show that ESG asset announcements generate positive abnormal returns when investors place a valuation premium on ESG performance; similarly, according to Flammer [27], markets react positively to the announcement of positive environmental impact initiatives. Still moving in this direction is the study by Capelle-Blancard and Petit [28], which identified a negative market reaction to negative ESG news. According to the evidence from this strand of the literature, ESG information can be correlated with shareholder value as better ESG performance could translate into value due to several factors such as operational efficiencies and increased employee adherence to company policies. However, another

stream of literature observes negative market reactions to positive ESG news due to higher agency costs incurred by firms [29].

Numerous studies emphasize the positive impact of ESG efforts on firms' financial performance [30,31]. It should be noted that ESG best practices are found to have different effects depending on firms' business areas [32]. The study conducted by Eccles et al. [33] analyzes a sample of 180 US firms, finding significantly better market performance by firms that meet sustainability criteria. Similar results are identified with respect to the impact of environmental practices [34].

Cui and Docherty [35] examine stock returns around ESG news announcements by using the event study methodology and calculate the cumulative abnormal return (CAR) to 21 trading days around for each news release. They found evidence that the market overreacts to ESG news.

With specific reference to the impact of ESG ratings on stock prices, Latino et al. [36] provide causal evidence that investors' portfolio allocation decisions are influenced by changes in ESG ratings, unrelated to any sustainability news, leading to temporary price pressures on the affected stocks; in particular, the study observes a rebalancing of investors' portfolios towards stocks perceived as more ESG-oriented.

Some of the literature focuses on using ESG ratings to analyze market reactions. Part of this area of research is the study by Shanaev-Ghimire [37] that assesses the effects of ESG rating changes on stock returns by investigating the impact of 748 ESG rating updates on stock returns of US companies over the period 2016–2021. Findings of the study suggest that ESG rating upgrades lead to positive but insignificant abnormal returns, while downgrades are detrimental to stock performance. In contrast, according to Demers et al. [38], ESG scores are not necessarily good predictors of stock price resilience.

Environmental risk is central in the study conducted by Pizzutilo et al. [39], which is focused on the relationship between the so-called carbon risk and the cost of debt, considering a sample of companies listed in the Euro Stoxx 600 index, in order to investigate the relationship between the carbon emissions of these companies and the cost of debt in the years 2010 to 2017. The results highlight the attention of European financial markets to the exposure of companies to carbon risk, showing, in fact, a positive relationship between carbon risk and the cost of debt.

From a different perspective, a recent ESG report of the Stern University [40] demonstrated a weak positive relation between ESG reputation of the investments and a greater performance on the financial market by observing the behavior of the stock prices. Similar conclusions were found by La Torre et al. [41], which have demonstrated that the EuroStoxx50 companies' performance does not seem to be affected by their efforts in terms of ESG commitments. In addition, the research also demonstrated that there are several more decisive factors conditioning the stock performance. On the same line, Sahut et al. [42] investigated how ESG scores influence the monthly market return in the Swiss, US, and United Kingdom (UK) stock markets by using a four-factor based linear model following during the 2007–2011 period. They find that the variation of the Global ESG score is a significant but slightly negative factor of a stock's monthly performance in the UK, but not significant in the US and Switzerland.

In the light of the subsequent remarks in the following paragraphs, it is interesting to highlight that a large part of the literature analyzes different portfolio strategies to understand how portfolio performances are affected from an ESG perspective.

Several studies focus on the relationship between ESG ratings and asset performance, generally sharing a negative correlation between ESG scores and performance. This may be motivated by some discrepancy in the methodologies adopted by various ESG rating providers. For example, there is no clear evidence that ESG-oriented indexes and funds systematically outperform their non-ESG comparables [3].

Finally, some studies focus on assessing how ESG assets reacted to the COVID-19 pandemic crisis and whether or not ESG performance mitigates financial risk during a crisis period. Indeed, the relation between ESG ratings and stock performance with specific

temporal reference to the COVID-19 crisis has been analyzed by several authors, albeit with not always aligned results [43–45]. According to the study by Engelhardt et al. [46]—focused on the relation between ESG ratings and stock performance of European companies during the pandemic—high ESG ratings correspond to higher abnormal returns and lower stock volatility.

Overall, the above literature review suggests that ESG ratings and scores are often used as functional elements in performance analyses. In fact, several authors use ESG ratings and scores as a proxy to conduct various types of performance analyses.

However, no studies exploring the relationship between CE strategies and market performance seem to be available that use the ESG score as a proxy for CE. Considering this hypothetical research gap, our study aims to offer new insights and analysis perspectives on CE and its possible connections with ESG assessment profiles, methodologically overcoming the current absence of a specific CE score.

3. Materials and Methods

This section shows the database useful for the survey and the methodology adopted to demonstrate the possible relationship between the variability of stock returns and the start of circular economy initiatives.

3.1. Data Description: EuroStoxx50 and Its ESG Recalibration

Our area of investigation relates to the segment of companies listed on the Euro Stoxx 50 and EuroStoxx50-ESG. To analyze the relationship between the circular economy initiatives and stock return variability, we believe it is necessary to produce a mapping of both ESG-scored companies and companies that have launched CE initiatives. Double mapping is necessary because:

- There is still no scoring that allows appreciating the degree of compliance reached with the precepts of the CE, and that would have allowed to directly estimate the indicated statistical relationship.
- The attention paid by individual companies to the problem of reusability of products sold in their production cycle is relatively recent.
- It is useful for verifying whether there is a direct relationship between the two different, but still connected, activities aimed at improving the internal level of sustainability and whether these, together or separately, have an impact on the variability of the stock returns being analyzed.

In this view, reminding that:

- The EuroStoxx50 Index is Europe's leading blue-chip index for the Eurozone, providing a representation of the region's supersectoral leaders. The index covers 50 stocks from 8 Eurozone countries: Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, and Spain. Today it has 40 issuers with ESG scoring, including 32 with launched CE initiatives.
- In 2012, the Deutsche Börse Groups' operator, Stoxx Ltd. [47], which is also the creator of the homonymous Euro Stoxx 50, released the recalibration of the latter, based on ESG classification method, named Euro Stoxx 50-ESG. With this method, the index is not equally weighted, but the components of the original index are represented in the new index with weights expressing the ESG score (<https://www.stoxx.com/rulebooks>, accessed on 5 January 2022) of their issuers. The particularity of this procedure lies in the substitution of the 20% of the component stocks of the original index that is the last in the chart classified according to the ESG classification methods. Namely, the less ESG compliant firms (those with the lowest ESG scores) are excluded independently from their market capitalization and their historical performances. The substitution procedure was conducted by referring to the ranking of the EuroStoxx50 universe adjusted for the ESG score. Indeed, the index creator assigned a rank to each potential future component beyond the present components. So, by adjusting this ranking for the ESG score, it is possible to immediately identify the replacing

stocks. (https://www.stoxx.com/document/Indices/Common/Indexguide/stoxx_index_guide.pdf, accessed on 5 January 2022). In this index, all components have an ESG scoring and 40 have also launched Circular Economy initiatives.

Beyond the index construction, which is outside the aim's scope of this work, what could really help to gather evidence for our initial assumptions is the historical analysis of the EuroStoxx50 and the ESG declination mentioned above. For this intention, also for a preliminary overview, the daily return from the ESG index start date (19 March 2012) to date (19 October 2021) was considered. The sample location and scale parameters of the return distribution in the cited period are listed in Table 1.

Table 1. Return sample distribution features.

Index	Sample Mean	Sample Variance
EuroStoxx50	0.63593	37.38800
EuroStoxx50-ESG	0.02765	15.0072

As can be seen by the descriptive parameters above, it seems that the non-ESG declination of the stock has performed better than the ESG one, however with reference to cumulative log-return over the considered period, it is evident that the ESG declination had a better return. Indeed, in the ESG index, the cumulative log-return is approximately 1.14, compared to 0.47 of the original version.

Beyond the profitability, a deeper analysis of the distributional property of the data is presented. In Figure 1, the Q-Q plot of the distribution of the log return of the two indexes is shown and it is evident that both distributions do not have particularly heavy tails, especially the ESG one. Moreover, the asymmetry in both the distributions is particularly remarkable, with the left tail being particularly pronounced compared to the right one.

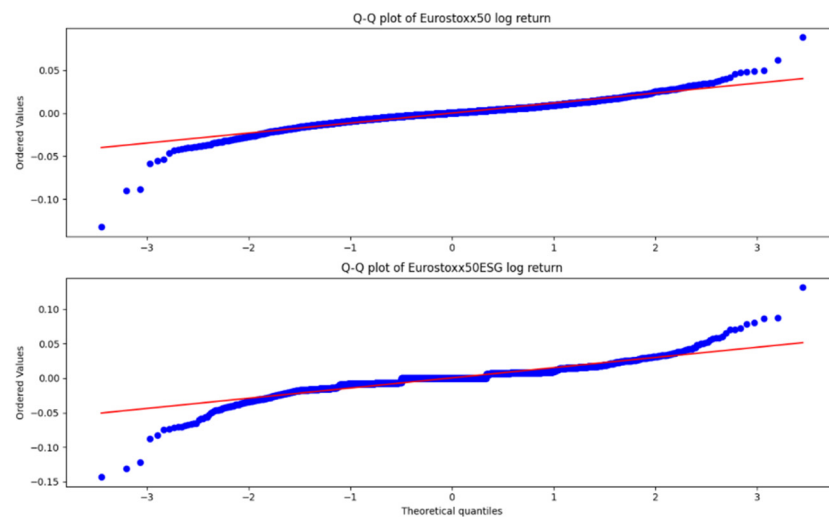


Figure 1. Log return Q-Q plot.

The inferred skewness of the distribution is just confirmed when calculating its sample version. In the Euro Stoxx 50 it is -0.8323 , while in the ESG, recalibration is approximately -0.6456 . Therefore, the latter managed to reduce the higher empirical frequency for the left tail observations, again over the period considered.

Moreover, the excess sample kurtosis in the distributions is also quite evident, but now quite the same for the two indexes, 10.76 for the Euro Stoxx 50 versus 10.92 of the Euro Stoxx 50 ESG.

In light of these results, it could be inferred that the recalibration proposed by the Euro Stoxx 50-ESG improves not all the performance of the original index, but also the

descriptive statistics, even if in a light way. Therefore, it can be argued that the ESG factors impact not only the profitability determinants of the respective portfolio or index examined but also the riskiness of the investment.

3.2. Model Description

To check whether the listed companies in the chosen indices that initiate CE initiatives are more profitable, we will use a robust portfolio preselection model. The basic idea is that the preselection model should prefer listed ESG companies, and even more so those that have also launched CE initiatives. The assumption is that the market, by acquiring this information, directs its choices towards these assets. The preselection model chosen aims to “capture” this phenomenon, that is, to verify whether the listed companies that have launched CE initiatives, and which are also ESG compliant albeit with different scoring, are the ones on which investors will focus their attention, buying them.

In this view, we propose a back test analysis using the rolling windows technique that will allow us to identify the preferred securities as a proxy for the highest returns. In short, we want to apply the preselection model to:

- The Eurostoxx50 index, reminding that, to date, it has 40 issuers with ESG scoring, of which 32 have launched CE initiatives;
- The Eurostoxx50-ESG index, in which all components have an ESG scoring and of which 40 have also launched CE initiatives.

To check if:

- In the first basket:
 - Companies with ESG scoring are preferable, and therefore more selected, than the others;
 - Companies with ESG scoring and that have, at the same time, launched CE initiatives are preferable to those that do not possess both characteristics.
- In the second basket:
 - Companies that, having ESG Scoring, have launched CE initiatives are preferable to those that have not launched such initiatives.

Before going into the empirical analysis, this section has described the portfolio selection and optimization procedure used to carry out the profitability comparison of the two scenarios just described. The algorithm adopted is defined in a few steps comprising the data acquisition. For this latter procedure, all the price-historical series for all the components of the Euro Stoxx 50 standard in addition to those of the substitutes chosen from the last ESG recalibration in the Euro Stoxx 50 ESG were extracted; and then the daily percentage return for each of them was evaluated.

Before deepening the empirical analysis, it is necessary to illustrate the preselection model used (adaptive strategy model; ASM) to carry out the comparisons described above. The preselection model used for the back test is a model that continuously identifies the optimal strategy among the different ones that can be used, offering the possibility of maximizing profits by dynamically identifying an optimal subset of securities in the initial basket that is different, time by time, in the composition. The output will be identified in the vector of cumulative returns and in the matrix of optimal portfolio selections. The back test is based on the following methodological steps.

SECTION 1—Input

1. Loading database of the returns (n), with (T) records.
2. Selection of the number of titles (m) on which to perform the analysis (with $n > m$).
3. Definition of the period in the sample, the so-called learning period (t, with $t \leq T$) and by the difference in the period Out of sample, or the back test period.
4. Selection of strategies (z) to be used.
5. Selection of the number of securities to invest in (sub portfolio $p \leq m \leq n$).

SECTION 2—Core

6. Calculation of the Sharpe ratio and effective return by applying the chosen strategies (five strategies that do not allow short selling, the so-called only-long, known in the literature and also used in operational practice) on the set of stocks selected on to perform the analysis (m).
7. Identification of the winning strategy, or the one with the highest Sharpe ratio.
8. Identification of the best stock (p), selected from the set (m), on which to invest identified by ordering the weights in descending mode of the winning strategy (Roll 0).
9. Reapplication of all chosen strategies to the best (p) stocks.
10. Calculation of the Sharpe ratio and effective return for all strategies.
11. Identification of the winning strategy, or the one with the highest Sharpe ratio.
12. Identification of the units to invest in.

SECTION 3—Rolling

13. Repetition (T-t) of the points ranging from 6 to 12, expelling the oldest data and including the new one.
14. Calculation of the Sharpe ratio and the actual yield by applying the chosen strategies on the new set of selected stocks on which to perform the analysis (m).
15. Identification of the winning strategy, or the one with the highest Sharpe ratio.
16. Identification of the best securities (p), selected from the set (m), on which to invest identified by ordering the weights in descending mode of the winning strategy (Roll 0).
17. Reapplication of all chosen strategies to the best (p) stocks.
18. Calculation of the Sharpe ratio and the effective return for all strategies.
19. Identification of the winning strategy, or the one with the highest Sharpe ratio.
20. Identification of the stock on which to invest.

SECTION 4—Output

21. Finally, the process described will generate:
 - The vector of the cumulative returns in the back test period;
 - The matrix of the stocks on which to invest from time to time along the back test period;
 - The vector of the extraction percentages of each single security as a proxy for market satisfaction.

In short, the ASM is the result of the optimal solutions derived from the application of the five selected models:

- (1) Global minimum variance constraints strategy (GMVC).
- (2) Most diversified portfolio strategy (MDP).
- (3) Risk parity strategy (RP).
- (4) Mean variance constraints strategy (MVC).
- (5) Equally weighted strategy (EW).

Concretely representing a sixth solution, the optimal one, that is built on the best result obtainable, time in time, from the application of the first ones. The instrumental reliability of the adaptive model for this analysis is confirmed by the constantly positive cumulative returns inferred in the various back tests performed and which makes it possible to search for greater profitability of certain assets within the basket of selected securities: Eurostoxx50 and Eurostoxx50-ESG.

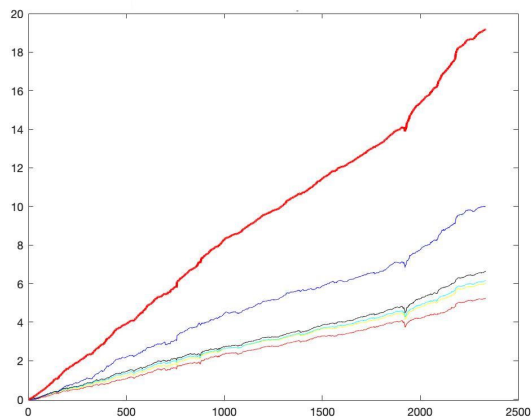
4. Results

The preselection model was applied to both indices, favoring three different extractions, namely 5, 10, and 15 stocks out of the total. After this, the percentage of the presence of all stocks in the various combinations was analyzed.

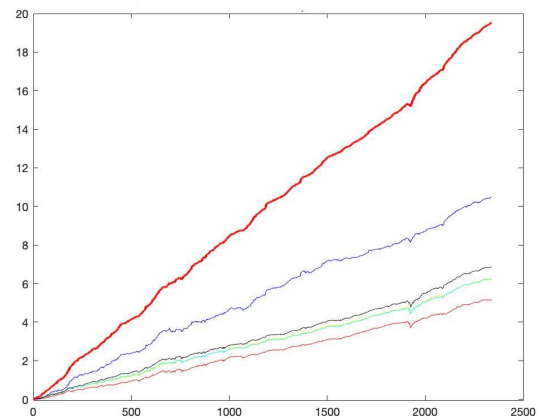
So, in Figures 2–4, it is shown the cumulative returns applying the different strategies chosen for all the days considered in the back test, together with the most performative

one, the ASM for the three extractions selected (5, 10, and 15 stocks on 50), for each Index. The legend is the following.

- GMVC effective cumulative return
- MDP effective cumulative return
- RP effective cumulative return
- MVC effective cumulative return
- EW effective cumulative return
- Winner strategies effective cumulative return (ASM)

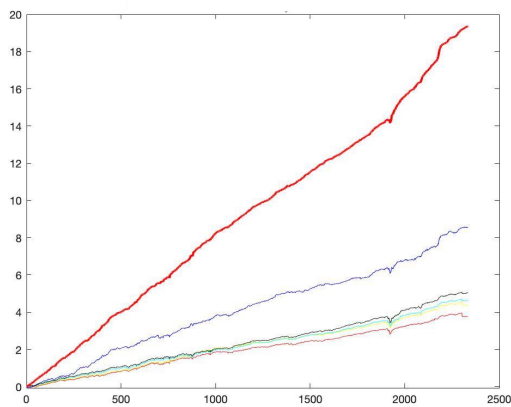


(a)

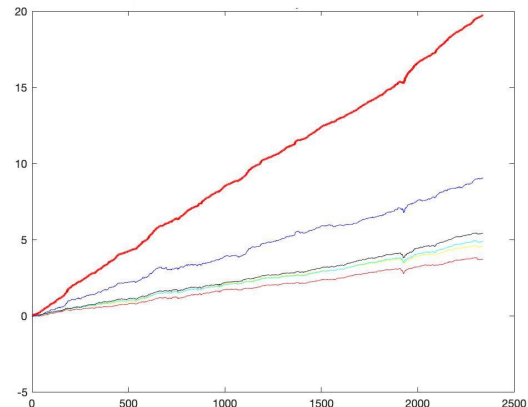


(b)

Figure 2. Cumulative performance with the top 5 stocks preselected on EuroStoxx50 (a) and cumulative performance with the top 5 stocks preselected on EuroStoxx50-ESG (b).



(a)



(b)

Figure 3. Cumulative performance with the top 10 stocks preselected on EuroStoxx50 (a) and cumulative performance with the top 10 stocks preselected on EuroStoxx50-ESG (b).

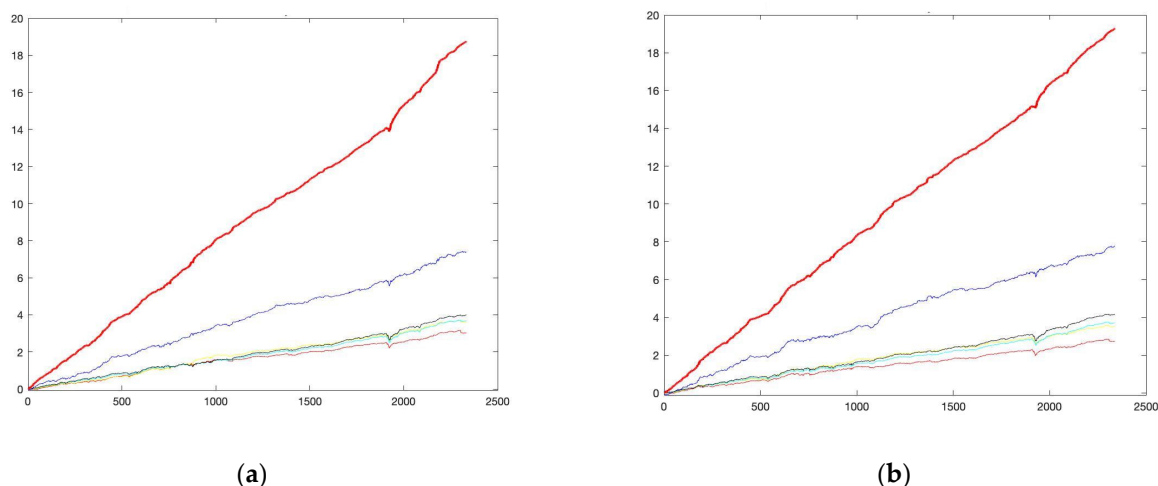


Figure 4. Cumulative performance with the top 15 stocks preselected on EuroStoxx50 (a) and cumulative performance with the top 15 stocks preselected on EuroStoxx50-ESG (b).

The analysis of the graphs reveals that:

- The preselection of securities, in all three different draws (5, 10, 15) shows positive results, i.e., the trend of cumulative returns is always positive for each strategy adopted, albeit lower than that of the ASM;
- Individual strategies improve performance when applied with stocks identified by the ASM preselection;
- In absence of preselection, this does not happen. Figure 5 shows the investing in the full basket of the Eurostoxx50;
- The best results are obtained for Eurostoxx50-ESG;
- The ASM is a robust model to identify the best Stocks to invest.

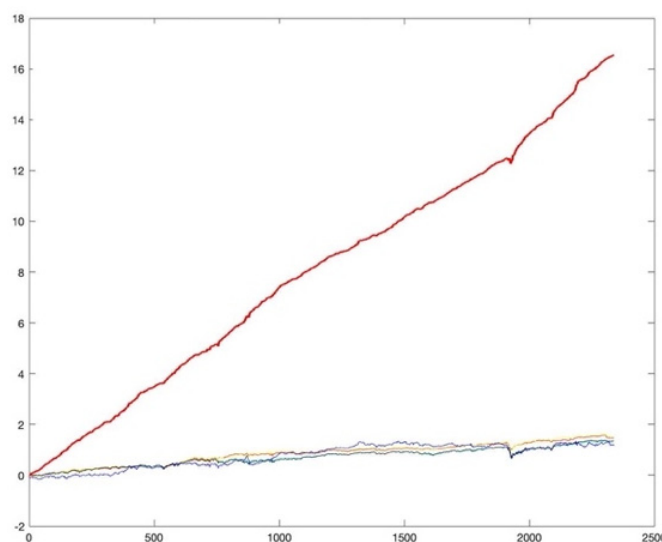


Figure 5. Investing in the full basket of the Eurostoxx50 in the absence of preselection.

Next, we counted the presence of each stock in the adopted strategy, on each day considered in the period of analysis, and then isolating the stocks with more daily presence, in a number decided according to the actual dispersion of presence for all stocks. This procedure returns an approximate proxy of how the market perception of the analyzed stocks was, so it is natural to invest more in this (the conceptual interpretation of the daily presence of stocks only considers the historical non-dynamic perspective; therefore,

the interpretation should not be confused with a useful indication in forecasting stock prices). It is undeniable that serving the market expectation from the simple stock presence distribution could seem reductive, however, it could provide effective indications about market humors and sentiments in order to obtain a day-by-day screen of the financial market perspectives relative to the examined stocks in the period considered. Indeed, by checking the historical behavior of each stock, it is evident that the hypothesis supported above has empirical fundamentals. We will wait for useful data not available today, to start a second phase of the research that will allow us to identify the relationship between CE initiatives and the profitability of stocks, as well as to measure the contribution of the different variables.

In order to provide further support for these points, it might be important to give an example of a sample of price series; therefore, we considered as an example the first common stock (Adidas-ADS.DE) between the Euro Stoxx 50 and Euro Stoxx 50 ESG, highlighting the days when the stock was chosen as one of the best-performing stocks by the algorithm, so as to highlight the relationship between the positive correspondence with the evolution of the stock price (Figure 6).

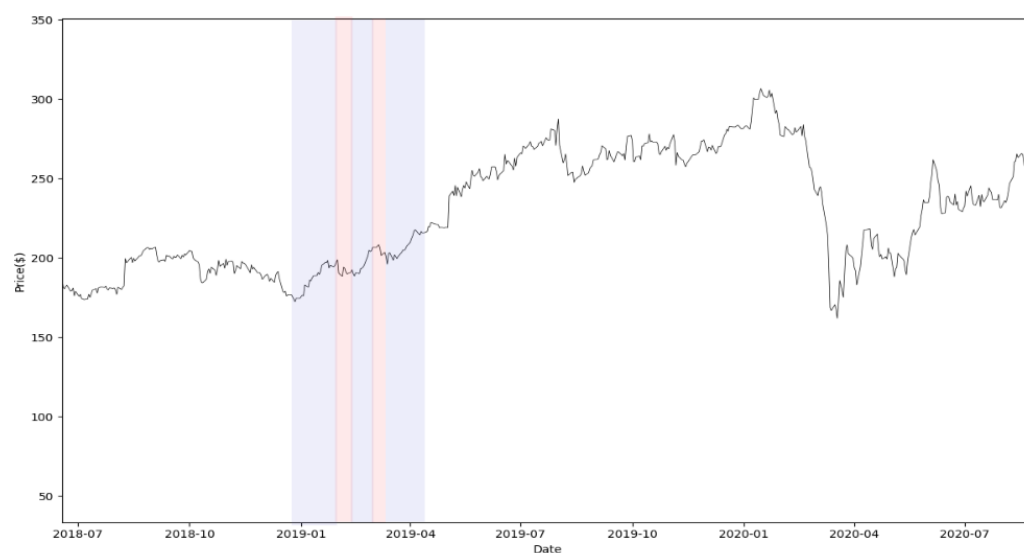


Figure 6. Section of historical series-ADS.DE.

It is also remarkable that the stock presence in the best performing daily strategy provides a hint about the market directions and sentiment for a future short-horizon perspective. Indeed, in the considered period, it is possible to detect a clustering behavior of the stock presence that retraces the stock performance. In particular, the blue-colored rows cluster in Figure 6 is associated with a positive trend in the same period of the stock price series as well as with the down-trend of the same with red coloured rows clusters. This is not conclusive evidence, but it enforces the idea of interpreting the stock presence as an indicator of the state of the relative market.

It is now necessary to analyze the percentage of the presence of each stock, for each Index, within the back test period, i.e., the out-of-sample period. For this objective, the presence percentages of each security are calculated as the ratio between the days of presence of the specific security and the total rounds of the back test (2335), noting that these are daily surveys.

The following tables show the stocks extracted with reference to the various preselections (5, 10, and 15 stocks) in both the two indices.

In Table 2, we reported the present percentage of the five stocks, respectively:

Table 2. Presence percentage—5 stocks.

(a)	
EuroStoxx50	P-Daily
AD.AS	52.70%
FLTR.IR	38.70%
AMS.MC	35.30%
ADS.DE	31.10%
KNEBV.BE	25.00%
(b)	
EuroStoxx50-ESG	P-Daily
AD.AS	48.70%
AMS.MC	31.50%
ADS.DE	29.50%
TEP.PA	25.40%
KNEBV.HE	24.50%

(a) of the preselected EuroStoxx50 and highlighted the stocks which do not have the ESG scoring;

(b) of the preselected EuroStoxx50-ESG and highlighted the substitutes of the original index components we focused on.

The same scheme has been followed for the other two preselected activity (10 and 15 stocks) (Tables 3 and 4).

Table 3. Presence percentage—10 stocks.

(a)	
EuroStoxx50	P-Daily
AD.AS	66.90%
AMS.MC	49.70%
FLTR.IR	47.30%
KNEBV.HE	46.20%
ASML.AS	42.30%
ADS.DE	40.80%
DB1.DE	38.00%
RI.PA	35.30%
IBE.MC	34.60%
VIV.PA	27.30%
(b)	
EuroStoxx50-ESG	P-Daily
AD.AS	64.50%
TEP.PA	46.20%
AMS.MC	45.90%
KNEBV.HE	43.40%
ASML.AS	40.80%
RYA.L	40.50%
ADS.DE	40.20%
MRK.DE	35.40%
RI.PA	33.60%
IBE.MC	30.00%

Table 4. Presence percentage—15 stocks.

(a)	
EuroStoxx50	P-Daily
AD.AS	77.00%
DB1.DE	68.40%
AMS.MC	60.20%
KNEBV.HE	57.40%
FLTR.IR	55.00%
ASML.AS	54.60%
BN.PA	54.30%
ADS.DE	50.50%
RI.PA	46.60%
IBE.MC	43.00%
VIV.PA	40.50%
AI.PA	36.30%
SAN.PA	35.60%
CS.PA	34.00%
SAF.PA	33.90%
(b)	
EuroStoxx50-ESG	P-Daily
AD.AS	73.60%
TEP.PA	59.30%
DB1.DE	58.80%
AMS.MC	56.00%
KNEBV.HE	55.60%
ASML.AS	50.60%
RYA.L	49.90%
BN.PA	49.80%
ADS.DE	49.00%
MRK.DE	46.70%
RI.PA	43.50%
PUB.PA	41.60%
IBE.MC	39.40%
TRN.MI	37.70%
VOW.PA	37.30%

The first empirical evidence of this research is that:

- Securities with ESG scoring, present in the highest number in Eurostoxx50 (40 out of 50), are not systematically more profitable than those without ESG scoring;
- Securities with ESG scoring, attributable to the Eurostoxx50-ESG blue chips, are not systematically more profitable than substitutes (10 out of 50) for securities without ESG scoring.

As a result, ESG scoring is not useful for systematically identifying, with absolute certainty, the best stocks to invest in. Now it is necessary to review these results by contemplating the initiatives of CE.

An additional contribution of this paper within the existing literature was to cluster, from the ESG label, the CE conditions of the stocks, thus searching for evidence of better stock performances by companies that respect the CE paradigm. For this purpose, a filtering list of the involved firms has been prepared, based on those companies that have shown in the past years an approach tending towards the CE model; in Figure 7, the substitutes stocks are indicated in yellow, while excluded companies (from the Euro Stoxx 50 ESG) in blue. Moreover, the presence (or absence) of indications related to the CE model—and the documental source from which the information was collected—were reported.

Stocks	Web site
Aidas	https://theecobahn.com/ideas/adidas-three-loop-strategy-recycled-circular-regenerative/
Adyen	-
Ahold delhaize	https://www.aholddelhaize.com/sustainability/eliminate-waste/
Air liquid	https://www.airliquide.com/magazine/energy-transition/circular-economy-disruptive-model
Airbus group	-
Allianz	https://www.agcs.allianz.com/news-and-insights/expert-risk-articles/trend-com-pass-environmental-trends.html
Amadeus	https://corporate.amadeus.com/documents/en/resources/corporate-information/corporate-documents/global-reports/2019/7-environmental-sustainability.pdf
Anheuser bush	-
ASML holding	https://www.asml.com/en/company/sustainability/circular-economy
Axa	-
BASF	https://www.basf.com/global/en/who-we-are/sustainability/we-drive-sustainable-solutions/circular-economy.html
Bayer	https://www.process-worldwide.com/bayer-announces-sustainability-package-and-wants-to-be-climate-neutral-by-2030-a-890933/
BMW	https://www.bmwgroup.com/en/news/2021/re-bmw-circular-lab.html
BNP paribas	-
CRH	https://www.crh.com/sustainability/our-sustainability-priorities/environment
Daimler	https://www.daimler.com/sustainability/resources/circular-economy.html
Danone	https://www.danone.com/impact/planet/packaging-positive-circular-economy.html
Deutsche borse	-
Deutsche post	https://freightweek.org/index.php/en/latest-news/96-integrators/1187-deutsche-post-dhl-joins-fedex-in-developing-circular-economy
Deutsche Tel.	-
ENEL	-
Engie	https://www.engie.com/en/group/social-responsibility/circular-economy
Eni SPA	-
Essilorluxottica	-
Flutter entertainment	-
Iberdrola	https://group.intesasanpaolo.com/it/sala-stampa/news/credito-e-risparmio/2021/finanziamento-circular-250-mln-a-iberdrola
Inditex	https://www.inditex.com/en/our-commitment-to-the-environment/closing-the-loop/sustainable-material
Infineon	https://www.infineon.com/dgdl/Infineon_CSR16_E_29.11.16_FINAL.pdf?fileId=5546d461584d1a550158b45cb6040920
ING group	-
Intesa San paolo	https://group.intesasanpaolo.com/it/sala-stampa/news/credito-e-risparmio/2021/finanziamento-circular-250-mln-a-iberdrola
Kering	-
Kone corporation	https://www.kone.com/en/sustainability/environment/circular-economy/
L'oreal	https://www.loreal.com/en/articles/sharing-beauty-with-all/plastic-packaging-policy/
Linde PLC	https://www.linde-engineering.com/en/images/2020-sustainable-development-report_tcm19-609189.pdf
Louis Vuitton	https://www.thefashionlaw.com/lvmh-aims-to-ensure-that-all-new-products-will-result-from-eco-design-by-2030/
Munchen reuk	https://www.munichre.com/en/risks/renewable-energy-and-energy-efficiency.html
Pernaud ricard	https://www.packagingdigest.com/sustainability/pernod-ricard-distills-sustainability-packaging
Prosus	https://www.prosus.com/sustainability/climate-action
Safran	https://verticalmag.com/press-releases/safran-runs-helicopter-engine-using-100-sustainable-fuel/
Sanofi	https://www.sanofi.com/-/media/Project/One-Sanofi-Web/Websites/Global/Sanofi-COM/Home/common/docs/our-responsibility/documents-center/factsheets-pdfs-2020/
Santander	https://www.en.enor.com/conocenos/sala-de-informacion-enor/notas-de-prensa/banco-santander-primer-entidad-financiera-en-espana-que-consigue-el-certificado-resic
SAP	-
Shneider electric	-
Siemens	-
Totalenergie SE	https://www.prnewswire.com/news-releases/totalenergies-joins-the-recycling-partnerships-polypropylene-recycling-coalition-to-increase-us-plastic-recovery-and-advance
Vinci	https://www.vinci.com/vinci.nsf/en/item/optimising-resources-thanks-to-the-circular-economy.htm
Vivendi	https://www.vivendi.com/en/our-group/environmental-societal-social-commitments/our-environmental-commitments/
volkswagen	-
Vonovia	https://reports.vonovia.de/2020/sustainability-report/environment/materials-and-products.html
Ryanair	https://corporate.ryanair.com/wp-content/uploads/2018/03/Environmental-Policy-Doc.pdf
Terna	https://www.economymagazine.it/news/2020/04/08/news/terna-presenta-nuovo-piano-di-sviluppo-oltre-14-miliardi-per-la-rete-13676/
Publicis GRP	https://publicisgroupe-csr-smart-data.com/assets/upload/en/Publicis%20Groupe%20Environmental%20Policy_2021.pdf
Worldline	-
Teleperformance	-
Michelin	https://www.h-a-d.hr/pubfile.php?id=850
Legrand	https://www.legrandgroup.com/en/our-responsibility/environment/innovating-circular-economy
Merck	https://www.merckgroup.com/en/sustainability-report/2020/environment/waste-and-recycling.html
CAP gemini	https://www.capgemini.com/our-company/our-corporate-social-responsibility-program/environmental-sustainability/waste-management/
stellantis	https://www.stellantis.com/content/dam/stellantis-corporate/sustainability/csr-disclosure/fca/fca_2020_sustainability_report.pdf

Figure 7. Firms with and without a CE approach.

Thanks to the previous investigations (Figure 7) and outputs shown in Tables 2–4, it is now possible to infer more about the impact of CE paradigm adoption on the market performances. Indeed, reporting the aforementioned Tables 2–4, modified to take into account also the indication regarding the CE approach, we notice that CE condition does not imply a higher performance; moreover, it seems that it is not the reason for the over-performance of the ESG compliant stocks (Tables 5–7).

Table 5. Presence percentage—5 stocks—CE approach.

(a)		
EuroStoxx50	P-Daily	CE Approach
AD.AS	52.70%	Yes
FLTR.IR	38.70%	No
AMS.MC	35.30%	Yes
ADS.DE	31.10%	Yes
KNEBV.BE	25.00%	Yes
(b)		
EuroStoxx50-ESG	P-Daily	CE Approach
AD.AS	48.70%	Yes
AMS.MC	31.50%	Yes
ADS.DE	29.50%	Yes
TEP.PA	25.40%	No
KNEBV.HE	24.50%	Yes

Table 6. Presence percentage—10 stocks—CE approach.

(a)		
EuroStoxx50	P-Daily	CE Approach
AD.AS	66.90%	Yes
AMS.MC	49.70%	Yes
FLTR.IR	47.30%	No
KNEBV.HE	46.20%	Yes
ASML.AS	42.30%	Yes
ADS.DE	40.80%	Yes
DB1.DE	38.00%	No
RI.PA	35.30%	Yes
IBE.MC	34.60%	Yes
VIV.PA	27.30%	Yes
(b)		
EuroStoxx50-ESG	P-Daily	CE Approach
AD.AS	64.50%	Yes
TEP.PA	46.20%	No
AMS.MC	45.90%	Yes
KNEBV.HE	43.40%	Yes
ASML.AS	40.80%	Yes
RYA.L	40.50%	Yes
ADS.DE	40.20%	No
MRK.DE	35.40%	Yes
RI.PA	33.60%	Yes
IBE.MC	30.00%	Yes

Table 7. Presence percentage—15 stocks—CE approach.

(a)		
EuroStoxx50	P-Daily	CE Approach
AD.AS	77.00%	Yes
DB1.DE	68.40%	No
AMS.MC	60.20%	Yes
KNEBV.HE	57.40%	Yes
FLTR.IR	55.00%	No
ASML.AS	54.60%	Yes
BN.PA	54.30%	No
ADS.DE	50.50%	Yes
RI.PA	46.60%	Yes
IBE.MC	43.00%	Yes
VIV.PA	40.50%	Yes
AI.PA	36.30%	Yes
SAN.PA	35.60%	Yes
CS.PA	34.00%	No
SAF.PA	33.90%	Yes
(b)		
EuroStoxx50-ESG	P-Daily	CE Approach
AD.AS	73.60%	Yes
TEP.PA	59.30%	No
DB1.DE	58.80%	No
AMS.MC	56.00%	Yes
KNEBV.HE	55.60%	Yes
ASML.AS	50.60%	Yes
RYA.L	49.90%	Yes
BN.PA	49.80%	No
ADS.DE	49.00%	Yes
MRK.DE	46.70%	Yes
RI.PA	43.50%	Yes
PUB.PA	41.60%	Yes
IBE.MC	39.40%	Yes
TRN.MI	37.70%	Yes
VOW.PA	37.30%	Yes

It is evident that the CE concept does not have a systematic impact on the financial market performance. Indeed, on the selection of 5, 10, and 15 stocks, it seems that the CE approach is not a key feature for the overperformance of stocks.

5. Discussion

The first evidence in this research is that the ESG attribute effectively impacts on the stock performance but not in a significant way. Indeed, the ratio between ESG substitutes stocks and the number of preselected stocks is always greater for all the simulations compared to the equivalent ratio of stocks excluded by the ESG index (Table 8).

Table 8. Ratios without CE approach.

Simulation	x	Excluded Stocks	ESG Substitutes
	x/5	0.20	0.20
	x/10	0.10	0.30
	x/15	0.13	0.33

The second evidence in this research, adding further information, and, in particular, the CE filtration, highlights the results obtained are not particularly significant, for that reason, it could be inferred that for investigating this particular attribute and the eventual impact on stock prices needs to derive a proper score independently from the ESG one despite it is widely believed that the “E” component is most developed. The following Tables 9 and 10 are built on the data in Tables 5–7. Table 9 shows, for all three preselections analyses (5, 10, and 15 stocks preselected by the model):

- On the left column of the matrix, the percentage of stocks that are excluded from the initial Eurostoxx50 to construct the Eurostoxx50-ESG on the total of stocks preselected (black color) and the percentage of the latter who have launched CE initiatives (blue color);
- On the right column of the matrix, the percentage of stocks that are included to form the Eurostoxx50-ESG on the total of stocks preselected (black color) and the percentage of the latter who have launched CE initiatives (blue color);

Table 9. Ratios with (blue color in the brackets) and without (black color) CE approach.

x/Preselected Num.	x	
	Excluded Stocks/CE	ESG Substitutes/CE
x/5	0.20 (0.0)	0.20 (0.0)
x/10	0.10 (0.0)	0.30 (0.20)
x/15	0.13 (0.06)	0.33 (0.26)

Table 10. Ratios for all the stocks, with (blue color in the brackets) and without (black color) CE approach.

x/Preselected Num.	x	
	ESG + CE Approach EuroStoxx50	ESG + CE Approach EuroStoxx50-ESG
x/5	0.80 (0.80)	1 (0.80)
x/10	0.90 (0.80)	1 (0.80)
x/15	0.86 (0.73)	1 (0.80)

Table 10 shows, for all the three preselections:

- On the left column of the matrix the percentage of stocks that are not excluded from the initial Eurostoxx50, on the total of stocks preselected (black color) and the percentage of Eurostoxx50 stocks which have launched CE initiatives (blue color);
- On the right column of the matrix, the percentage of stocks in the Eurostoxx50-ESG which are ESG compliant on the total of stocks preselected, clearly, for the Eurostoxx50 ESG is 1 (Black color), and the percentage of the Eurostoxx50-ESG index stocks which have launched CE initiatives (Blue color).

Considering the comparison shown in Table 9, the stocks that exhibit a great ESG score (the substitutes ones) are preselected more compared to the others (Excluded stocks), and moreover, the same demonstrate a greater reactivity to CE precepts. This result enforces the deduction that ESG stocks perform more than the non-ESG ones, but it could hardly be concluded that the overperformances are driven mostly by the CE responsiveness of the preselected firms.

This is confirmed by Table 10, in which the ratio of stocks in both the indexes that embrace the CE attributes are quite the same in percentage (blue brackets). This means that there is no difference in terms of the presence frequency between the Eurostoxx50 stock basket (left column), which also counts the excluded stocks, and the basket with all ESG stocks (right column); and each ratio is always lower than the correspondence ESG ratio (black brackets). So, it would expect that the CE feature is not the right metric to determine the overperformances of stocks.

So, in light of this, all the ESG stocks are in great part CE compliant and are preselected the more by the algorithm (so, are empirically more performative), but it could not assert the contrary, or that the CE compliant firms are more preselected by the ASM (and so more performative).

6. Conclusions

The lack of a score relating to the level of compliance with the criteria of CE achieved by companies does not allow, at the state of the art, to identify the correct statistical relationship, as well as the measure, of the degree of dependence with the stock returns of listed companies. However, through a two-step approach, we were able in this first stage of the research to identify elements for reflection regarding the contribution to the profitability of companies' CE initiatives.

In the first step, we verified the reliability of the preselection model and the percentages of the presence of stocks in the two selected indices, Eurostoxx50 and Eurostoxx50-ESG, also identifying the best stocks.

In the second step, we double-checked between the winning stocks considering the presence of an ESG scoring as a proxy for its sub-variable "Environmental" related to the attention to the surrounding environment and the presence of initiation of individual CE initiatives.

In light of the above, the conclusion is that the ESG attribute has a positive impact on stock performance, although the presence of an ESG score is not a condition of higher performance compared to the stocks of companies with no ESG score; moreover, our analysis shows that—to date—there is no evidence that CE initiatives can influence stock returns.

However, in light of the forward-looking relevance that CE will be increasingly assumed in corporate strategies, we believe that integrating CE elements into operational approaches could give rise to increasing opportunities in terms of stock performance in the future.

The present study provides the first step of investigation. According to our findings, there is a clear need for a more focused definition of common informational disclosure processes related to indicators of CE practices; this could be considered by policymakers and regulators within the broader regulatory framework of environmental initiatives.

As a result, there will be a need to develop assessment methodologies specifically dedicated to CE strategies in order to appreciate their actual and individual contribution, also in terms of stock performance. As a natural consequence, there will be ample room for future research useful to define the overall scenario.

Author Contributions: The authors contributed equally to the development of this research. Conceptualization: D.M., F.M., M.C., C.P. and L.B.; methodology: D.M., F.M., M.C., C.P. and L.B.; software: D.M., F.M., M.C., C.P. and L.B.; validation: D.M., F.M., M.C., C.P. and L.B.; formal analysis: D.M., F.M., M.C., C.P. and L.B.; investigation: D.M., F.M., M.C., C.P. and L.B.; resources: D.M., F.M., M.C., C.P. and L.B.; data curation: D.M., F.M., M.C., C.P. and L.B.; writing—original draft preparation: D.M., F.M., M.C., C.P. and L.B.; writing—review and editing: D.M., F.M., M.C., C.P. and L.B.; Visualization: D.M., F.M., M.C., C.P. and L.B.; supervision: D.M., F.M., M.C., C.P. and L.B.; project administration: D.M., F.M., M.C., C.P. and L.B. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data is contained within the article.

Conflicts of Interest: The authors declare no conflict of interest.

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