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Introducing ESG Into Characteristic-Based Benchmark Returns

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An abstract of
a thesis submitted to the Faculty of Emory College of Arts and Sciences
of Emory University in partial fulfillment
of the requirements of the degree of
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Abstract

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This paper introduce ESG as a new characteristic into the characteristic-based benchmark return following characteristic-based benchmark method developed by Ken Daniel, Mark Grinblatt, Sheridan Titman, and Russ Wermers (DGTW) in 1997. This paper finds that the ESG augmented DGTW return significantly better explains the stock returns than the conventional DGTW return. Moreover by testing the ESG augmented DGTW return during crisis periods, this significance in explanatory power still exists. Lastly, after accounting for difference firm sizes, this paper finds that for firms within the second to the fourth quintile, there exists an increase in the explanatory power of the ESG augmented DGTW return, while it holds constant for the top and bottom quintiles.

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1 Introduction

In the past several decades, SRI and ESG investing strategies have quickly gained the attention of investors as they have started to shift their focus from return and performance chasing to socially responsible investing (SRI) strategies. Originated in the late 1960 and early 1970s, SRI was heavily influence by the religious doctrines and the rise in "antiwar movement, the maturity on racial equality, women's rights, consumer protection, and the environment" (Townsend, 2020). At the beginning, SRI was simply being considered as "building a portfolio [...] without investing in alcohol, tobacco, weapons, gambling, pornography, and nuclear energy"(Townsend, 2020). But over the decades, the definition of sustainable investment has gradually broadened. In 1980s, due to the anti-apartheid movement, investors started to focus more on social issues and shareholders started to care more about corporate governance. Following this trend the U.S. Sustainable Investing Forum was founded in 1984, and Calvert Investments became the first to provide its investors with an investment resolution tied to a social issue. In the 1990s, global warming became the major issue that concerns the investors, and during this decade, the first index to track sustainable investments were founded: MSCI KLD 400 Social Index. By 1994, there were about 26 sustainable funds that were available to investors which roughly around $1.9 billion. Moving into the 21st century, SRI has gained global attention, the Global Compact launched by the United Nations further encouraged capital markets to consider environmental, social, and corporate governance when investing, which established the term ESG investing. By the 2010s, "as issues like climate change, labor practices, and environment degradation come to light," more and more asset managers started to consider ESG criteria into their investment decision and ESG investments start to proliferate(Townsend, 2020). Globally, since 2016, ESG investments have grown from USD $23 trillion to USD $35 trillion in 2020 [1], and within the U.S. the total asset under management using SRI strategies grew from $ 12.0 trillion in 2018 to to $17.1 trillion at the start of 2020, this is about 1 in 3 dollars of the total US assets under professional management[2].

With a rapid increase in funds flowing into ESG investing strategies, scholars and practitioners have started to investigate into the potential effect of ESG investing on the capital markets. Currently within the academia, there are two main approaches taken by scholars in trying to understand the effect of ESG investment on the capital market. The first examined and compared the performance between ESG assets' performance with their non-ESG counterparts. Early scholars like Shank et al. (2005) and Girard et al. (2007) have found that ESG stocks and funds tend to show no significant performance or negative performance when compared to conventional stocks and funds. Later researches, however, have found that ESG stocks and funds tend to outperform conventional stocks and funds although not significantly (Velte, 2017; Atz et al., 2020; Abate et al., 2021). This conflict within the results have gained attentions in the academia, several meta-analysis on the topic have tried to examine the cause of such ambiguity (Friede et al., 2015; Atz et al., 2020).

While the first group of scholars devote their time into comparing the difference between

[1]See 2020 Overall US SIF Trends Report

[2]See 2020 Global Sustainable Investment Review, page 9.

ESG investment and their counterparts, other scholars have focused on interpreting the relationship between ESG investing and risk. Early studies within this realm have found that corporate social responsibility tends to be negatively associated with systematic firm risk (Kim et al., 2014; Oikonomou et al., 2012). More recent studies have focused more specifically on ESG related aspects. For instance, Hoepner et al. (2018) in their paper found that engagement in ESG issues can reduce firm's downside risk. Jin (2018) also showed in his paper that responsible investing (RI) which includes ESG investing provides the downside protection against ESG-related systematic risk. Albuquerque et al. (2020); Czerwiǹska and Kaźmierkiewicz (2015) both found that firm with higher ESG/ES[3] ratings tends to have lower return volatility.

As scholars began to gain a better understanding of how ESG investment could affect the capital market, some scholars have proposed to include ESG as a factor into multi-factor asset pricing models. For instance, Maiti (2021) introduced ESG factor into the Fama-French three-factor model in replace of the book-to-market ratio and found that the new models performed better than the traditional Fama-French three-factor model by having a lower GRS F-statistics. Díaz et al. (2021) also found that by include ESG factor into the Fama-French three-factor model, the new model shows to significantly explain industry returns in addition to the conventional model. Other scholars have included ESG as a factor into the Fama-French five-fatcor model. For instance, Hübel and Scholz (2020) have found that by including each of the ESG pillar as a new factor into the model, the new model significantly better explains the return than the tradition model. However, on the other hand, in contrast to Maiti (2021)'s finding, Breedt et al. (2019) in their paper found that an "ESG-tilted process does not deliver higher risk-adjusted returns" and "ESG as an equity factor has returns compatible with noise". Moreover, Naffa and Fain (2021) found that after including ESG as the sixth factor into the five-factor model, they did not find significant evidence to support the inclusion of ESG as a valid additional factor.

[3]Czerwinska use ESG which Albuquerque focuse more on environmental and social (E and S)

This paper aims to add to the existing trend of literature on proposing ESG as a new risk factor into the multi-factor asset pricing model such that the new model enhance the explanatory power significantly when compared to the traditional model. However, instead of using multi-factor asset pricing models, this paper will include ESG as a characteristic into the characteristic-based benchmark returns method, also know as DGTW return Daniel et al. (1997). This paper will test if ESG as a characteristic could also enhance the explanatory power of ESG augmented characteristic-based benchmark return, when compare to the traditional characteristic-based benchmark return.

By using a sample that includes 1,448 ESG stocks covering the range from January 2003 to December 2021, the result shows that ESG augmented characteristic-based benchmark returns does significantly explain the stock return better than the traditional characteristic-based benchmark returns. Furthermore, I have also shown that this enhancement in explanatory power exists in crisis periods and after accounting for the size characteristics. Taken together, the result from this paper supports the conclusion that after including ESG as a factor/characteristics into the model/method, the new version does show an enhancement in the explanatory power than the traditional version.[4].

The rest of the paper is structured as follow. Section II is literature review and hypothesis development. Section III is the details of the data and methodology used in this research. Section IV presents the tables and main findings of the paper and provide possible interpretations of the results. The last section, Section V will discuss the significance of this paper and provide potential directions for future research.

[4]See Jin (2018); Hübel and Scholz (2020); Díaz et al. (2021); Maiti (2021)

2 Literature Review and Hypothesis Development

2.1 Literature Review

Numerous studies have been done of by scholars and investors on examining the relationship between ESG and corporate financial performance. Friede et al. (2015) found that over 2,000 studies have been done on this topic since 1970 while Atz et al. (2020) conducted a meta-analysis over 1,141 primary papers and 27 meta-reviews published between 2015 to 2020 covering this topic. Despite the popularity of these studies on understanding the relationship between ESG and corporate financial performance, a very few paper has been focused on proposing or examining if ESG should be included as a factor into the multi-factor asset pricing models.

Jin (2018) is among the very first to propose the idea to include ESG into the Fama-French five-factor model. In his paper, Jin has create a ESG-related factor (UME) by using the return difference between and ESG-score weighted portfolio and an unweighted market portfolio in order to measure the relationship between estimated risk premium (ERP) and UME. The result from the study has shown that "UME-beta compliments the explanation of conventional five factor betas" as the estimate coefficient on UME-beta is significant (Jin, 2018). Furthermore, the study has found a positive average coefficient on UME-beta which indicates that "the conventional five factor model seems to overestimate the required rate return" on responsible investing by ignoring UME.

Hübel and Scholz (2020) in their paper took one step further by examining each of the E, S, and G pillar and creating three risk factors representing each of the pillar. They have added the three risk factors into the Fama-French five-factor model augmented by the momentum factor, which resulted in a 9-factor model. Their results have shown that the adj. R^2 of the 9-factor model is much higher than the original 6-factor model which indicate a significant increase in explanatory power.

Díaz et al. (2021) in their paper also included ESG as a new factor into the Fama-French three-factor model in trying to test how ESG could help explain industry returns during the Covid-19. Díaz and her colleagues further investigates into each of the E, S, and G pillars in order better understand how ESG affect industry returns. The results from the paper have shown that "ESG factor shows to significantly explain industry returns in addition to the Fama-Frech three factors during the Covid pandemic" (Díaz et al., 2021). Moreover, by diving deeper into each of the pillars, the authors have found that environmental (E) and social (S) are the key drivers behind the observed patterns.

However, in contrast to the findings within the previous literature, Naffa and Fain (2021) constructed a ESG pure factor portfolios to test the risk-adjusted performance of these portfolios between 2015 to mid-2019. Their result contradicts the results found by Maiti (2021) in which Naffa indicates that these ESG portfolios did not generate significant alphas. Furthermore, they have "applied spanning regression approach following Fama and French" to test if ESG factors could explain the cross-section of expected returns. Their result has shown that there is no significant evidence in support of including ESG factors into the Fama-French 5-factors model.

2.2 Hypothesis Development

Given the ambiguity within existing studies on if there are significant evidence in supporting the inclusion of ESG as a new factor into the multi-factor asset pricing models, the paper wish to contribute to the existing literature by testing is ESG as a characteristic could enhance the explanatory power the ESG augmented characteristic-based benchmark return when compare to conventional characteristic-based benchmark returns (also known as DGTW value weighted returns). Furthermore, as Díaz et al. (2021) have shown in their paper, by including ESG as a new factor into the Fama-French three factor model, the new model better explains the industry returns during the Covid-19, I wish to further test this result using the ESG augmented DGTW value weighted returns to see if this enhancement in explanatory power exists in all crisis periods. Lastly, as Drempetic et al. (2020) found in their paper, there exists a positive correlation between the influence of firm size, a company's available resources for providing ESG data, and the availability of a company's ESG data on the ESG scores. I wish to test and possibly provide an answer to the question of "whether the way ESG score measures corporate sustainability gives an advantage to larger firms [...] while not providing SR investors with the information needed"(Drempetic et al., 2020). I will control for the size characteristic and test if the explanatory power of ESG augment DGTW value weighted returns is weakened when compared to the overall ESG augment DGTW value weighted returns as well as the conventional DGTW returns.

3 Data and Methodology

3.1 Data

This paper uses data from two major databases: (i) the CRSP database on stock returns, and (ii) the Thomson/Refinitive on the ESG scores of companies. I have also used the Compustat Fundamentals to calculate book-to-market ratios.

Refinitive ESG is the main data source used in this paper for the firm-level ESG scores. This database contains annual ESG information on over 9,000 companies globally that covers the period from January 2002 to December 2021. The ESG scores are calculated based on 10 categories that are summed together using industry weights. The ESG scores are divided into quartile with the lowest quartile being ESG laggards and the highest quartile being ESG leaders. This data is then merged with CRSP stock data. As this paper only focuses on U.S. stocks, I have confined my attention to NYSE/AMEX/Nasdaq stocks and use monthly returns from CRSP for the period covering January 2002 to December 2021. Market capitalization of each stock is constructed also using the CRSP database.

3.2 Main Sample

After merging the two data sets, the sample data I will be using in this paper covers a total of 1,448 unique stocks listed on NYSE, AMEX, and Nasdaq with non-missing ESG scores covering the period from January 2003 to December 2021. The period from January 2002 to December 2002 is being omitted as the Refinitive ESG data does not cover the entire time frame of the Dot-com bubble.

3.3 Methodology

The main methodology used in this paper is the **Characteristics-Based Benchmark** method developed by Kent Daniel, Mark Grinblatt, Sheridan Titman, and Russ Wermers in 1997 which is also known as the DGTW. The method measure the stock returns using benchmark portfolios created based on three characteristics of the stocks, size, book-to-market ratio, and momentum as each benchmark portfolio will contain stocks that have similar characteristics. Previous studies FAMA and FRENCH (1992, 1996) and Jegadeesh and Titman (1993) have shown that these three characteristics are the "best ex ante predictors of cross-sectional patterns in common stock returns" (Daniel et al., 1997). The rest of the section will describe how the original benchmark portfolios are being created, how the DGTW value weighted returns are being calculated, and how the new benchmark portfolios are being created with the ESG characteristic in order to test my hypotheses.

3.3.1 Benchmark Portfolios

As stated above, the benchmark portfolios are created based on the size, book-to-market ratio, and momentum of the stocks. Each of the benchmark portfolios will contain stocks that have similar size, book-to-market ratio, and momentum. Formation date is a term used by this method in which, on a specific date chosen, all of the stocks contain within the sample will be sorted based on the three characteristics in order to create the benchmark portfolios. In the original paper, the authors have chosen the formation date to be semi-annually which are June 30th and December 31st. So, on each of the formation date, all of the stocks within the sample will be first sorted into quintiles based on the firms' size, hence 5 portfolios. "The breakpoints for this sort are based on NYSE firms only", although I have also included AMEX and Nasdaq stocks (Daniel et al., 1997). Then, the firms within each size quintiles are being sorted again into quintiles based on their book-to-market ratio which gives a total of 25 portfolios. The book-to-market ratio are being calculated using the data from Compustat fundamentals and then adjusted by industry. Each firm's book-to-market ratio are being subtracted by the long-term industry average book-to-market ratio. Finally, after the firms are being sorted into 25 benchmark portfolios based on their size and industry adjusted book-to-market ratio, the firms within each of the portfolios are then sorted into quintiles "based on their preceding twelve-month return", which is the momentum and gives a total of 125 portfolios (Daniel et al., 1997).

3.3.2 DGTW Value Weighted Returns

After all of the 125 portfolios are being created, the returns of each of these 125 portfolios are being calculated by value weighting all of the stocks in the portfolio. The formula is defined as

$$R_t = \frac{\sum_{i=1}^{N} r_{ti} * w_{ti}}{\sum_{i=1}^{N} w_{ti}} \tag{1}$$

where t is the formation date and R_t is the DGTW value weighted return for the portfolio on the specific formation date. N is the total number of stocks in the portfolio and r_{ti} is the return of stock i on the formation date and w_{ti} is the weight of the stock i on formation date t which in this case is the market capitalization of the stock.

At the end, we should obtain a total of 125 DGTW value weighted returns, one for each of the portfolios and these returns could be used to test their explanatory power of the original stock returns.

3.3.3 Creating Benchmark Portfolios with ESG Characteristic

In order to test my main hypothesis of whether ESG augmented characteristic-based benchmark returns could better explain the stock returns, I have added ESG as a new characteristic into the original three characteristic-based benchmark return. Overall, the creation process of the benchmark portfolios is the same as the original method, however, instead of using quintiles, I have decided to use quartiles for book-to-market ratio, momentum, and ESG characteristics which gives a total of 320 benchmark portfolios. I have kept the size characteristic in quintiles as I wish test my second hypothesis that after accounting for size, ESG augmented DGTW value weighted returns still provide a better explanation to the stock returns than the original DGTW value weighted returns.

Although I have kept size the same as the original method, I have changed from quintiles to quartiles for book-to-market ratio, momentum, and ESG. There are two main reasons behind this change. The first lays in the number of stocks per portfolio. If I were to maintain quintiles for all four of the characteristics, I would obtain a total of 625 portfolios. Given that I only have 1,448 stocks in my sample data, assuming that the characteristics of the stock does not change, on average there would be only 2.5 stocks per portfolio and this would make the DGTW value weighted returns lying towards large size stocks which violated the purpose of value weighted returns. After changing from quintiles to quartiles, I have obtained a total of 320 portfolios which results in around 4 stocks per portfolio. Although this number is still two times smaller than the number of stock per portfolio for the original method, in reality, however, because stocks tend to change their characteristics after a certain time period do to operation, at the end, on average, I have about 14 stocks per portfolio which is slightly larger than the number of stocks per portfolio in the original method, assuming that stock characteristics does not change. On the other hand, I could change these characteristics from quartiles to trisection which would further increase the number of stocks per benchmark portfolios, however, I decided to kept the sections in quartiles due to the second reason. The other reason why I have decided to use quartiles rather than any lower number of sections is because the ESG scores from Refinitive ESG was originally separated into quartiles. Since I will also be testing and presenting the average return of ESG stocks within each quartile, I wish not to break this trend and reorganize the stocks in to trisection. Thus, I have decided to maintain and set the distribution in quartiles. However, as I have mentioned above, as book-to-market ratio and momentum does not serve a significant purpose for this particular paper, future studies could try to distribute these characteristics using trisection in order to increase the number of stocks per portfolio.

The creation process of the benchmark portfolios with ESG is the same as the original version. After the stocks are being sorted into quintiles based on their size, the stocks within each of the quintiles are then be sorted into quartiles based on their book-to-market ratio, momentum, and ESG scores which results in a total of 320 portfolios. After the portfolios are being created, the DGTW value weighted returns for each are being calculated using the same formula 1 which would result in 320 DGTW value weighted returns.

3.4 Crisis Periods

Crisis periods are usually characterized by a big fall in stock markets. In order to test my third hypothesis, I have consulted previous literature which also tested ESG during crisis periods and the National Bureau of Economic Research 2021 and identified two crisis periods of the stock market within the period from January 2003 to December 2021. According to Nofsinger and Varma (2014), the first crisis period is between October 2007 to March 2009 which revolved around the 2008 financial crisis. The second crisis period is from February 2020 to April 2020, based on Albuquerque et al. (2020); Díaz et al. (2021), which revolved around the Covid-pandemic. These crisis periods are further verified by the National Bureau of Economic Research (2021) which identifies two recessions during the period from 2003 to 2021. The first recession is from December 2007 to June 2009 and the second is from February 2020 to April 2020. These periods matches the periods identifies by Nofsinger and Varma (2014) and Albuquerque et al. (2020), thus I will be using these periods as crisis periods in testing my third hypothesis.

4 Empirical Results

Fama-MacBeth regression Fama and MacBeth (1973) has been used in this paper to obtain all of the results in order to test the hypotheses. Moreover, because stock returns are potentially serially auto-correlated; I have utilized the Newey-West Newey and West (1987) auto-correlation and heteroskedasticity adjustment to correct standard errors in this paper.

4.1 Overall Comparison

Table 1 presents the regression result of ESG augmented DGTW returns and the original DGTW returns over the stock returns [5] covering all of the stocks within the sample and the entire time period from January 2003 to December 2021. From the results presented in the table, we can see that ESG returns have a significantly higher R^2 then the original returns. This has provided support to our main hypothesis that ESG augmented characteristic-based benchmark returns do provide a better explanation on the initial stock returns than the conventional characteristic-based benchmark returns. Moreover, in order to further test my hypothesis and understand the results presented in this table, I have tested this relation during the crisis periods as well as accounting for the size characteristics.

[5]For simplicity reasons, from this point onward ESG augmented DGTW return will be abbreviated as ESG return and original DGTW return will be abbreviated as original return, unless otherwise specified.

Table 1: Overall Comparison Between ESG DGTW Returns and Original DGTW Returns

		ESG DGTW Returns		Original DGTW Returns	
Dep. Variable:	ret	R-squared:	0.5156	R-squared:	0.3860
Estimator:	FamaMacBeth	R-squared (Between):	0.4618	R-squared (Between):	0.4319
No. Obs:	126609	R-squared (Within):	0.5135	R-squared (Within):	0.3808
Date:	–	R-squared (Overall):	0.5156	R-squared (Overall):	0.3860
Time:	–	Log-likelihood	1.298e+05	Log-likelihood	1.148e+05
Cov. Estimator:	Newwy-West	–	–	–	–
–	–	F-statistic:	1.347e+05	F-statistic:	7.96e+04
Entities:	1448	P-value	0.0000	P-value	0.0000
Avg Obs:	87.437	Distribution:	F(1, 126608)	Distribution:	F(1, 126608)
Min Obs:	1.0000	–	–	–	–
Max Obs:	222.00	F-statistic (robust):	6.674e+04	F-statistic (robust):	3.66e+04
–	–	P-value	0.0000	P-value	0.0000
Time periods:	222	Distribution:	F(1, 126608)	Distribution:	F(1, 126608)
Avg Obs:	570.31	–	–	–	–
Min Obs:	244.00	–	–	–	–
Max Obs:	1048.0	–	–	–	–

Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
ESG_dgtw_vwret	0.9628	0.0037	258.34	0.0000	0.9555	0.9701
Original_dgtw_vwret	0.9525	0.0050	191.32	0.0000	0.9428	0.9623

4.2 Crisis Periods

In order to provide a better understanding of the overall increase in the explanatory power of ESG returns over the conventional returns and to further test my hypothesis regarding the persistence of the explanatory power during financial crisis periods, I have performed the Fama-MacBeth regression after restricting the time periods to the crisis periods identifies in Section 3.4.

Table 2 shows the result after the time period has been restricted to the 2008 financial crisis. The R^2 presented in this table further demonstrated that the ESG returns provides a significantly better explanation to the stock return data then original returns, which validates the fact that the explanatory power does exist during the crisis period. In order to further test this hypothesis, table 3 present the result after restricted the time period to the second crisis period identified: Covid-19 pandemic. The result from this table again presents that ESG returns better explains the stock returns than the original returns. Given that for both of the financial crisis periods identified within the time period covered by the sample the R^2 of ESG return is significantly higher than the original return, it is evident to conclude that the significantly better explanatory power of ESG returns still exists during crisis periods when compared to original returns.

Table 2: ESG Returns and Original Returns During 2008 Financial Crisis

		ESG DGTW Returns		Original DGTW Returns	
Dep. Variable:	ret	R-squared:	0.6736	R-squared:	0.5240
Estimator:	FamaMacBeth	R-squared (Between):	0.6773	R-squared (Between):	0.6326
No. Obs:	6663	R-squared (Within):	0.6764	R-squared (Within):	0.5249
Date:	–	R-squared (Overall):	0.6736	R-squared (Overall):	0.5240
Time:	–	Log-likelihood	6493.3	Log-likelihood	5235.8
Cov. Estimator:	Newwy-West	–	–	–	–
–	–	F-statistic:	1.375e+04	F-statistic:	7333.1
Entities:	383	P-value	0.0000	P-value	0.0000
Avg Obs:	17.397	Distribution:	F(1, 6662)	Distribution:	F(1, 6662)
Min Obs:	1.0000	–	–	–	–
Max Obs:	19.000	F-statistic (robust):	7464.7	F-statistic (robust):	1970.4
–	–	P-value	0.0000	P-value	0.0000
Time periods:	19	Distribution:	F(1, 6662)	Distribution:	F(1, 6662)
Avg Obs:	350.68	–	–	–	–
Min Obs:	339.00	–	–	–	–
Max Obs:	367.00	–	–	–	–

Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
ESG_dgtw_vwret	0.9611	0.0111	86.399	0.0000	0.9393	0.9829
Original_dgtw_vwret	0.9553	0.0215	44.389	0.0000	0.9131	0.9975

In addition to comparing ESG returns with original returns, I have also calculated the adjusted R^2 [6] using the formula included in 2 to test if ESG returns' explanatory power is being enhanced during crisis periods. By comparing the adjusted R^2 of the overall ESG returns to the 2008 financial crisis ESG returns and Covid-19 ESG returns, the result could help contribute to a better understanding in the relationship between ESG and crisis Albuquerque et al. (2020) found in their paper that firms with higher ES ratings tends to have lower return volatility during the Covid-19 pandemic. Nofsinger and Varma (2014) found in their paper the SRI stocks tends to outperform their counterparts during the crisis period and this out-performance is most driving by ESG factors. Thus, as we can see from the re-

[6]see Appendix Table 10

sult, the adjusted R^2 for both the 2008 financial crisis period and the 2020 pandemic period is significantly higher than the overall adjusted R^2 which indicates an enhancement in the explanatory power of ESG augmented returns during the crisis periods.

Table 3: ESG Returns and Original Returns During 2020 Covid-19 Pandemic

		ESG DGTW Returns		Original DGTW Returns	
Dep. Variable:	ret	R-squared:	0.7483	R-squared:	0.6733
Estimator:	FamaMacBeth	R-squared (Between):	0.8070	R-squared (Between):	0.7474
No. Obs:	1930	R-squared (Within):	0.5850	R-squared (Within):	0.4697
Date:	–	R-squared (Overall):	0.7483	R-squared (Overall):	0.6733
Time:	–	Log-likelihood	1328.9	Log-likelihood	1077.4
Cov. Estimator:	Newwy-West	–	–	–	–
–	–	F-statistic:	5733.4	F-statistic:	3975.9
Entities:	967	P-value	0.0000	P-value	0.0000
Avg Obs:	1.9959	Distribution:	F(1, 1929)	Distribution:	F(1, 1929)
Min Obs:	1.0000	–	–	–	–
Max Obs:	2.0000	F-statistic (robust):	1.292e+04	F-statistic (robust):	2.09e+04
–	–	P-value	0.0000	P-value	0.0000
Time periods:	2	Distribution:	F(1, 1929)	Distribution:	F(1, 1929)
Avg Obs:	965.00	–	–	–	–
Min Obs:	963.00	–	–	–	–
Max Obs:	967.00	–	–	–	–

Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
ESG_dgtw_vwret	0.9822	0.0086	113.67	0.0000	0.9652	0.9991
Original_dgtw_vwret	0.9939	0.0069	144.56	0.0000	0.9804	1.0074

4.3 Firm Size and ESG Scores

In order to propose a plausible answer to the question raise by Drempetic et al. (2020) regarding the possibility that ESG scores tends to be uninformative for the smaller firms and test my third hypothesis, I will analyze further into how the size characteristic might have affected the explanatory power by performing the regression test of ESG return over stock return for each of the size quintiles and compare them internally and to the results obtained using the original returns.

Table 4 to 8 contains the regression results of the ESG returns and original returns for firms with size in the top quintile to the bottom quintile respectively. The results we obtained

Table 4: Firm Size: Top Quintile

		ESG DGTW Returns		Original DGTW Returns	
Dep. Variable:	ret	R-squared:	0.4934	R-squared:	0.3713
Estimator:	FamaMacBeth	R-squared (Between):	0.4246	R-squared (Between):	0.4189
No. Obs:	44317	R-squared (Within):	0.4869	R-squared (Within):	0.3626
Date:	–	R-squared (Overall):	0.4934	R-squared (Overall):	0.3713
Time:	–	Log-likelihood	6.179e+04	Log-likelihood	5.701e+04
Cov. Estimator:	Newwy-West	–	–	–	–
–	–	F-statistic:	4.316e+04	F-statistic:	2.617e+04
Entities:	440	P-value	0.0000	P-value	0.0000
Avg Obs:	100.72	Distribution:	F(1, 44316)	Distribution:	F(1, 44316)
Min Obs:	1.0000	–	–	–	–
Max Obs:	222.00	F-statistic (robust):	1.651e+04	F-statistic (robust):	6301.8
–	–	P-value	0.0000	P-value	0.0000
Time periods:	222	Distribution:	F(1, 44316)	Distribution:	F(1, 44316)
Avg Obs:	199.63	–	–	–	–
Min Obs:	148.00	–	–	–	–
Max Obs:	240.00	–	–	–	–

Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
ESG_dgtw_vwret	0.8962	0.0070	128.48	0.0000	0.8826	0.9099
Original_dgtw_vwret	0.8677	0.0109	79.384	0.0000	0.8463	0.8892

presented a very descriptive picture in helping us to better understand the effect of size on the explanatory power of ESG returns. As we can see, the R^2 of the ESG returns for the firm in the top size quintlie is still significantly larger than the R^2 for the original returns. However, if we were to compare this R^2 to the overall R^2 obtained by the ESG returns, we will find that there exits no significant difference from the overall R^2. In fact if we were to look at the adjusted R^2, table 10, for the ESG returns on both the overall and restricted to largest firms, we will see that the adjusted R^2 for the largest firms will be lower than the overall adjusted R^2 which contradicts Drempetic et al. (2020)'s finding. Moreover, if we were to focus on the firms with size that falls within the 20% to 80% range, so mostly the mid-sized companies, we will see that the adjusted R^2 for those companies are significantly higher than the overall adjusted R^2 while the significance in explanatory power when compared to the corresponding original returns still exists. Although it seems that the concern regarding the informativeness of ESG scores tends to be contradicted by these results, the adjusted R^2 for the smallest firms provided support to the concern. By only considering firms with the smallest size, we find that the explanatory power of ESG returns dropped significantly when compared to other conditions, in fact it is the lowest adjusted R^2 within all of the test we have performed.

Table 5: Firm Size: 60% to 80%

		ESG DGTW Returns		Original DGTW Returns	
Dep. Variable:	ret	R-squared:	0.5858	R-squared:	0.4330
Estimator:	FamaMacBeth	R-squared (Between):	0.6250	R-squared (Between):	0.5078
No. Obs:	37929	R-squared (Within):	0.5800	R-squared (Within):	0.4247
Date:	–	R-squared (Overall):	0.5858	R-squared (Overall):	0.4330
Time:	–	Log-likelihood	5.257e+04	Log-likelihood	4.662e+04
Cov. Estimator:	Newwy-West	–	–	–	–
–	–	F-statistic:	5.363e+04	F-statistic:	2.896e+04
Entities:	624	P-value	0.0000	P-value	0.0000
Avg Obs:	60.784	Distribution:	F(1, 37928)	Distribution:	F(1, 37928)
Min Obs:	3.0000	–	–	–	–
Max Obs:	222.00	F-statistic (robust):	1.464e+05	F-statistic (robust):	1.714e+05
–	–	P-value	0.0000	P-value	0.0000
Time periods:	222	Distribution:	F(1, 37928)	Distribution:	F(1, 37928)
Avg Obs:	170.85	–	–	–	–
Min Obs:	78.000	–	–	–	–
Max Obs:	229.00	–	–	–	–

Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
ESG_dgtw_vwret	0.9783	0.0026	382.66	0.0000	0.9733	0.9834
Original_dgtw_vwret	0.9785	0.0024	413.97	0.0000	0.9739	0.9832

Yet, how does the results the paper have presented help to better understand the relationship between ESG and firm size and provide a plausible answer to the question "whether the way ESG score measures corporate sustainability gives an advantage to larger firms [...] while not providing SR investors with the information needed"(Drempetic et al., 2020).We would like to provide a possible interpretation to the result we have presented. As Drempetic et al. (2020) stated in their findings that there seems to exist a positive correlation between firm size, available resources for providing ESG data and the availability of a company's ESG data on the ESG scores, we believe that for the firms with largest and smallest size, this is the case. For very large firms, due to the amount of publicly available information, although ESG score serves as a new metric for better understanding the firm, the information covered by the ESG score is already available to the public which leads to a uninformative ESG score. This interpretation is supported by the overall similar adjusted R^2 for the largest firms and the entire sample. On the other hand, unlike the largest firms, where the uninformative

Table 6: Firm Size: 40% to 60%

		ESG DGTW Returns		Original DGTW Returns	
Dep. Variable:	ret	R-squared:	0.6543	R-squared:	0.5074
Estimator:	FamaMacBeth	R-squared (Between):	0.6584	R-squared (Between):	0.4921
No. Obs:	23506	R-squared (Within):	0.6495	R-squared (Within):	0.5017
Date:	–	R-squared (Overall):	0.6543	R-squared (Overall):	0.5074
Time:	–	Log-likelihood	2.97e+04	Log-likelihood	2.554e+04
Cov. Estimator:	Newwy-West	–	–	–	–
–	–	F-statistic:	4.449e+04	F-statistic:	2.421e+04
Entities:	580	P-value	0.0000	P-value	0.0000
Avg Obs:	40.528	Distribution:	F(1, 23505)	Distribution:	F(1, 2350)
Min Obs:	1.0000	–	–	–	–
Max Obs:	186.00	F-statistic (robust):	5.266e+05	F-statistic (robust):	1.378e+05
–	–	P-value	0.0000	P-value	0.0000
Time periods:	222	Distribution:	F(1, 2350)	Distribution:	F(1, 2350)
Avg Obs:	105.88	–	–	–	–
Min Obs:	16.000	–	–	–	–
Max Obs:	233.00	–	–	–	–

Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
ESG_dgtw_vwret	0.9974	0.0014	725.71	0.0000	0.9947	1.0001
Original_dgtw_vwret	0.9951	0.0027	371.23	0.0000	0.9898	1.0003

ESG scores are caused by too many publicly available information, the uninformative ESG scores for the smallest firms are due to the lack in ability to provide ESG data and in the availability of the data. The smallest firms usually tend to have very minimum resources in which they could use to provide ESG data, thus although there are still small companies that have a ESG score above 4 (Maximum 5) most of the companies tend to have ESG scores that underestimate their sustainability. Hence, the explanatory power of the ESG return weakens. However, neither like the largest firms nor the smallest firms, the ESG scores for companies within the 20% to 80% range tend to increase the explanatory power of the ESG returns significantly. One plausible explanation for the result is that firms within this range tends to have limited public information but not large enough that overlapped all of the information included by the ESG scores and these companies have the resource to provide rating agencies with their ESG data. Given the result, it seems that the ESG scores for firms with a size between 40% to 60% seems to add the most information to the companies by having the highest adjust R^2 amongst all. Based on this reasoning, firms with size between 60% to 80% tends to have too many publicly available information that overlaps with some

Table 7: Firm Size: 20% to 40%

		ESG DGTW Returns		Original DGTW Returns	
Dep. Variable:	ret	R-squared:	0.6038	R-squared:	0.4990
Estimator:	FamaMacBeth	R-squared (Between):	0.6850	R-squared (Between):	0.5824
No. Obs:	13735	R-squared (Within):	0.5985	R-squared (Within):	0.4935
Date:	–	R-squared (Overall):	0.6038	R-squared (Overall):	0.4990
Time:	–	Log-likelihood	1.275e+04	Log-likelihood	1.113e+04
Cov. Estimator:	Newwy-West	–	–	–	–
–	–	F-statistic:	2.093e+04	F-statistic:	1.3683+04
Entities:	459	P-value	0.0000	P-value	0.0000
Avg Obs:	29.924	Distribution:	F(1, 13734)	Distribution:	F(1, 13734)
Min Obs:	2.0000	–	–	–	–
Max Obs:	168.00	F-statistic (robust):	2.288e+05	F-statistic (robust):	1.386e+05
–	–	P-value	0.0000	P-value	0.0000
Time periods:	210	Distribution:	F(1, 13734)	Distribution:	F(1, 13734)
Avg Obs:	65.405	–	–	–	–
Min Obs:	2.0000	–	–	–	–
Max Obs:	208.00	–	–	–	–

Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
ESG_dgtw_vwret	0.9956	0.0021	478.30	0.0000	0.9915	0.9997
Original_dgtw_vwret	0.9941	0.0027	327.23	0.0000	0.9889	0.9993

conveyed by the ESG score, where are firms in the 20% to 40% range tends to have limited resources in providing their ESG data. However, despite the interpretation provided in this paper, further studies are needed to better understand the relationship between size and ESG scores.

4.4 Regression On Both Original and ESG DGTW Returns

After restricting the time range to crisis periods and size levels, we would like to test if the ESG augmented DGTW returns have captured all of the missing information within the original DGTW returns by preforming the Fama-MacBeth regression over stock returns on both the ESG return and the original return. Table 9 shows the result from this regression. As the parameter estimates indicate, ESG dgtw return does capture a majority of the information on the initial stock returns, yet there are still some information left within the original dgtw return in which the ESG dgtw return did not capture. One possible explanation to this would be that the original characteristic-based benchmark test only consists of three

Table 8: Firm Size: Bottom Quintile

		ESG DGTW Returns		Original DGTW Returns	
Dep. Variable:	ret	R-squared:	0.3815	R-squared:	0.2597
Estimator:	FamaMacBeth	R-squared (Between):	0.6536	R-squared (Between):	0.4292
No. Obs:	7122	R-squared (Within):	0.3724	R-squared (Within):	0.2522
Date:	–	R-squared (Overall):	0.3815	R-squared (Overall):	0.2597
Time:	–	Log-likelihood	-42.660	Log-likelihood	-682.84
Cov. Estimator:	Newwy-West	–	–	–	–
–	–	F-statistic:	4392.3	F-statistic:	2497.9
Entities:	261	P-value	0.0000	P-value	0.0000
Avg Obs:	27.287	Distribution:	F(1, 7121)	Distribution:	F(1, 7121)
Min Obs:	2.0000	–	–	–	–
Max Obs:	126.00	F-statistic (robust):	8128.6	F-statistic (robust):	4741.7
–	–	P-value	0.0000	P-value	0.0000
Time periods:	153	Distribution:	F(1, 7121)	Distribution:	F(1, 7121)
Avg Obs:	46.549	–	–	–	–
Min Obs:	1.0000	–	–	–	–
Max Obs:	158.00	–	–	–	–

Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
ESG_dgtw_vwret	0.9778	0.0108	90.158	0.0000	0.9565	0.9990
Original_dgtw_vwret	0.9654	0.0140	68.860	0.0000	0.9380	0.9929

characteristics, size, book-to-market ratio and momentum whereas in the Fama-French 5-factor model, profitability and investment are also included. Thus the remaining information within the original dgtw returns might be covered by including these characteristics.

[a] This table is different from the previous table as the previous tables are the combination of both ESG returns and original returns whereas this one, the FM regression is run on both returns to obtain on R^2, thus the parameter estimates obtain different meanings

5 Conclusion and Further Research Questions

5.1 Conclusion

As investors are shifting their focus onto companies that are environmentally friendly, socially responsible, and have good governance, I wish that this paper could contributed to the existing literature by showing how by including ESG as a factor into the characteristic-based benchmark returns could significantly better explains the stock returns than the conventional return. Furthermore, this paper has shown that after

Table 9: FM Regression Stock Return On Both Original and ESG DGTW Returns[a]

Dep. Variable:	ret	R-squared:	0.3815
Estimator:	FamaMacBeth	R-squared (Between):	0.6536
No. Obs:	7122	R-squared (Within):	0.3724
Date:	–	R-squared (Overall):	0.3815
Time:	–	Log-likelihood	-42.660
Cov. Estimator:	Newwy-West	–	–
–	–	F-statistic:	4392.3
Entities:	261	P-value	0.0000
Avg Obs:	27.287	Distribution:	F(1, 7121)
Min Obs:	2.0000	–	–
Max Obs:	126.00	F-statistic (robust):	8128.6
–	–	P-value	0.0000
Time periods:	153	Distribution:	F(1, 7121)
Avg Obs:	46.549	–	–
Min Obs:	1.0000	–	–
Max Obs:	158.00	–	–

Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
ESG_dgtw_vwret	0.8134	0.0063	128.11	0.0000	0.8010	0.8259
Original_dgtw_vwret	0.2607	0.0084	31.138	0.0000	0.2443	0.2771

restricting the firm size, and alternating the time range to crisis periods, the increase in the explanatory power within the ESG augmented DGTW returns still exists when compare to the original DGTW returns. In addition, after accounting for different firm size levels, this paper has provided a possible understanding to the relationship between ESG scores and firm size while also gave a plausible answer to the question raised by Drempetic et al. (2020). As the result from this paper has shown that the ESG augmented returns tends to increase its explanatory power when covering firms with size between the second and forth quintile while the explanatory power remains the same for the top and bottom size quintile. Lastly, the results from this paper has support the findings within Hübel and Scholz (2020); Díaz et al. (2021) that ESG could be included as a new factor into the multi-factor asset pricing model in order to enhance the explanatory power when compared to the traditional model.

5.2 Further Research Questions

Future researches conducted on this topic could try to include the remaining two factors from the Fama-French 5-factors model as characteristics into the DGTW method and test if the new DGTW return would better capture the missing information from the original DGTW return. Moreover, future studies could test if different distribution of the data would alternate the result as the distribution used in this paper covered only the minimum amount of stocks required. Lastly, the same test performed within the paper on the relationship between size and ESG augmented DGTW returns could also be implemented into multi-factor asset pricing models to evaluate if such effect exists in order to further provide a perspective in understanding the relationship between size and ESG scores.

As this study shows an alternative way in including ESG as a characteristic into the DGTW returns, future studies could expand this topic into models not limited to the Fama-French multi-factor models or the DGTW returns to test if the effect of include ESG as a new factor is universal. As stated in the literature review, despite the popularity within the academia about how ESG investing might affect the capital markets, only a very few paper has turned their focus onto including ESG as a possible factor, this paper wish to provide ideas and motivate future studies to further dive into this topic and hopefully.

6 Appendix

Table 10: Adjusted R^2

	ESG Adjusted R^2	Original Adjusted R^2
Overall	0.5143	0.3843
2008	0.6701	0.5190
2020	0.7473	0.6719
Largest Firms	0.4887	0.3655
60% to 80%	0.5831	0.4293
40% to 60%	0.6519	0.5040
20% to 40%	0.6003	0.4946
Smallest Firms	0.3718	0.2481

$$R^2_{adj} = 1 - \frac{(1 - R^2) * (n - 1)}{n - k - 1} \quad (2)$$

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