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Investment strategy using Adjusted ESG rating: Focusing on a Korean Market

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Abstract

Purpose: This study used ESG grade, but defined AESG (Adjusted ESG), adjusted to the size of a company and examines whether it can be used as an investment strategy. **Research design, data and methodology:** The analysis sample in this study is a company that has given an ESG rating among companies listed on the Korea Stock Exchange. We examine the results through portfolio analysis and Fama-macbeth regression analysis. **Results:** As result of examining the long-only performance and the long-short performance by constructing quintile portfolios, it was observed that a significant positive return was shown. It was observed that there was an alpha that could not be explained in asset pricing models. Also, AESG had a return prediction effect in the result of a Fama-Macbeth regression that controlled corporate characteristic variables in individual stocks. Next, we confirmed AESG's usage through various portfolio composition. In the portfolio optimization, the Risk Efficient method was the most superior in terms of sharpe ratio and the construct multi-factor model with Value, Momentum and Low Vol showed statistically significant performance improvement. **Conclusions:** The results of this study suggest that it can be helpful in ESG investment to reflect the ESG rating of relatively small companies more through the scale adjustment of the ESG rating (i.e.AESG).

Keywords ESG; investment strategy; Multifactor; Optimization

JEL Classification Code: C1, C5, Q5

1. Introduction[1]

ESG investment refers to a method for investing in various asset classes in the financial market based on the environment (E), society (S), and governance (G). ESG-based investment strategies are one of the fastest growing and most sought-after strategies in the world. In Korea, the Korea Corporate Governance Service (KCGS) develops its own ESG model, evaluates domestic listed companies, and publishes the results. Interest in domestic ESG investment began to expand with the implementation of the Stewardship Code in December 2016 and the emphasis on the responsibilities and roles of institutional investors. As of 2019, about 114 domestic institutional investors, including the National Pension Service, have declared membership in the stewardship code. In particular, the National Pension Fund Management Committee decided to promote socially responsible investment (SRI) to comprehensively review ESG for the entire asset class, and the Korea Exchange (KRX) also disclosed ESG-related indices.

Recently, many researchers in academia and finance are

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conducting research on ESG ratings, financial risks and performance of listed companies. This study verifies that a portfolio strategy based on the ESG rating that adjusts the size of a company, rather than using the ESG rating as a simple investment index, produces sufficiently meaningful results. Most of the related studies are limited to the overseas market, not the domestic market, and there are not many studies on whether ESG grades can be used in actual investment portfolio strategies in the domestic market.

This study aims to examine whether ESG investment can be useful in the Korean market. In particular, there are not many studies on investments using ESG grades in the existing domestic market, but Park (2017) reported that investments using ESG grades are not meaningful. In this study, we reaffirmed these results and reported Drempetic et al. (2019), investment strategies were developed to reflect the fact that large enterprises are more likely to maintain relatively high ESG ratings and SMEs are more difficult to raise ESG ratings. In other words, for the same ESG rating, the ESG rating is readjusted to give more weight to the score in the case of SMEs to construct an investment strategy. Additionally, it is empirically verified that various investment strategies can be devised using ESG. To this end, various portfolio optimization techniques are applied to the top group companies with high AESG (Adjusted ESG) ratings proposed in this study. These techniques makes it possible to utilize a portfolio that considers various investment purposes. Furthermore, we present a portfolio that combines momentum, size, value, quality, and low-ball factors that are typically used in factor investing. It is expected to be applied to actual investment strategies by examining whether the AESG factor improves performance when combined with any factors.

The structure of this study is as follows. Chapter 2 examines the data covered in the study and the main analysis methods. In Chapter 3, we find the AESG proposed in this study, and apply various portfolio configurations through portfolio optimization and multi-factor models. Chapter 4 summarizes the findings of the study.

2. Literature Review

Many studies have been reported on the ESG rating of companies. The effect of ESG ratings on economic and corporate financial performance and corporate value has been a subject of long debate. According to the traditional approach of Palmer et al. (1995), investment for corporate social responsibility was perceived as a negative factor in performance because it incurs additional costs to the firm and can generally adversely affect the firm's competitiveness. Also, Jacobs et al. (2011) and Fisher-Vanden and Thorburn (2011) showed that firms that invested in ESG-related activities showed negative returns. Barnett and Salomon (2006) found that best- and worst-class stocks outperformed other stocks based on ESG ratings and observed a U-shape between ESG ratings and risk-adjusted returns. However, Berg at al. (2014) is rather neutral. They tried interpreting ESG as a risk premium, but concluded that being an ESG investor is difficult to find a premium in terms of risk and benefit. Kruger (2015) argued that there is a positive correlation between ESG ratings and financial market performance, independent of where the actual causes of performance come from. Additionally, Dunn et el (2016) observed that risk and performance of portfolios constructed based on ESG ratings published by MSCI were positive.

There are not many studies on investment performance using ESG in the Korean market, but according to Park (2017), the most recent study, we looked at the performance of a portfolio that buys companies with high ESG ratings and sells companies with low ESG ratings. In this study, it was shown that a negative (-) return was realized for the equal-weighted (EW) portfolio, but the performance was improved by constructing the value-weighted (VW) portfolio. These results suggest that it is necessary to analyze profitability based on the ESG rating controlling for the effect of firm size.

A study by Akgun et al. (2021) points out that a size bias is to exist in ESG scores from the investor's viewpoint. In large firms, there is a tendency to prioritize research in media or analysis organizations (Burke et al, 1986). Larger firms also have many resources to address ESG-related issues (Orlitzky, 2001). Therefore, as Drempetic et al (2019) assert since the ESG evaluation process is advantageous for large companies with many resources, it is difficult to evaluate the sustainability of a company on its own, and it is necessary to adjust the effect of the size of the company. This study intends to construct an investment strategy using Adjusted ESG (Kim et al, 2020) with the ESG rating adjusted for the size of the company considering these biases.

The first is to optimize your portfolio. A representative portfolio construction method is Markowitz (1952)'s Mean-Variance Portfolio. Average variance optimization is a methodology to find the optimal performance portfolio by considering the balance between risk and return. Recently, various portfolio optimization methods such as the risk parity model proposed by Qian (2011) have been proposed. Next, Bender and Wang (2016) showed that when a portfolio was constructed by combining factors, information ratio was superior to that of individual factor portfolios. Likewise, Factors such as momentum (Jegadeesh and Titman, 1993), size, value (Fama and French 1992), quality (Novy-Marx, 2013) and low-volatility (Baker at el. 2011) could be dealt with in factor investing. In this study, we try combining a portfolio using ESG with five representative factors. Especially, this study intends to derive the analysis results

by applying various portfolio weight optimizations when constructing a portfolio for ESG investment, and to seek the optimal composition method.

3. Research Methods and Materials

3.1. Data

As for the current ESG rating in Korea, the Korea Corporate Governance Service develops its own ESG model, evaluates domestic listed companies, and announces the results. The analysis sample in this study is a company that has given an ESG rating among companies listed on the Korea Stock Exchange, and the ESG rating in an index that combines the ratings of Environment, Society, and Governance. The rate of return is extracted from DataGuide serviced by FnGuide, and companies that do not have a rate of return and ESG rating are excluded. At this time, the rate of return was calculated as one month based on the calendar (adjusted stock price at the time of comparison / adjusted stock price at baseline - 1).

Table 1 shows the current status of ESG rating and market cap by year. No companies that received S, the highest grade during the sample period in this study, so only four ESG grades below A+, A, B+, B or less exist in the sample data. Also, the market cap is expressed in units of million won. In table, it can be seen that the total number of companies with ESG ratings is increasing. However, the number of companies receiving A+ is the least, and the number of companies tends to increase as it goes to A, B+, B or less. Because of such bias, it is difficult to expect a great effect in the Korean market to use the ESG grade as it is.

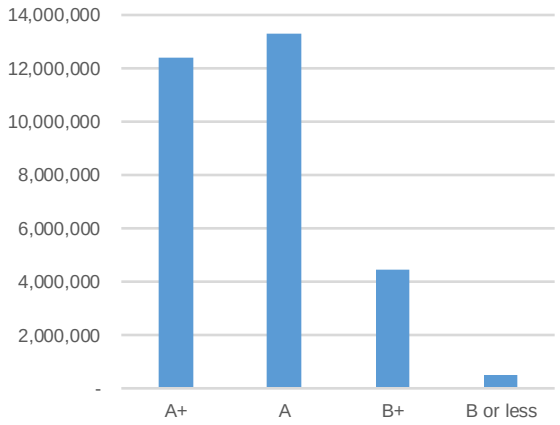

Figure 1: Average Market Capitalization by ESG Rating

Figure 1 shows the average market cap size by ESG grade. In the graph, the unit of market capitalization is one million won. Looking at this Figure, it can be seen that in the Korean market, companies with an ESG rating of A or higher have a large market capitalization, and companies with an ESG rating of B+ or lower have a remarkably small market capitalization. It shows that a size bias exists for ESG ratings in the Korean market. Therefore, this study intends to construct a more effective investment strategy by adjusting the size of the ESG grade.

Table 1: Elementary Statistic of Sample Data

Year	Number of Firms	A+	A	B+	B or less	Average of Marker cap	Maximum of Marker cap	Minimum of Marker cap
2011	525	11	39	58	417	1,295,027	115,482,680	7,134
2012	659	6	37	78	538	1,087,353	109,590,707	4,939
2013	688	6	33	90	559	1,128,412	120,490,858	7,332
2014	690	2	43	88	557	1,174,631	125,057,137	8,176
2015	691	1	27	77	586	1,146,221	114,304,286	7,728
2016	709	8	33	106	562	1,177,876	114,009,687	6,936
2017	732	5	38	115	574	1,216,682	119,312,463	6,388
2018	726	8	41	100	577	1,197,352	111,358,299	6,836
2019	875	8	51	144	672	1,130,537	114,451,585	7,240

Giese, G et al. (2019) adjusted the ESG rating to the size of firm, and this study goes through the same adjustment process. The AESG proposed in this study does not simply use the ESG grade as it is. Given the same ESG rating, it would have been more difficult for SMEs to achieve a good grade of ESG rating than for large companies, so we give SMEs more weight. It also reflects Drempetic et al. (2019) argument that it is difficult to evaluate the sustainability of a company by itself, because the ESG rating process has advantages for large companies with more resources.

Therefore, we calculate AESG, which is the ESG grade adjusted according to the size of the company's market cap. First, to use the ESG grade, it is necessary to convert the ESG grade provided by the Korea Corporate Governance Service into a number. So, A+ is converted into 4 points, A is 3 points, B+ is 2 points, and B or less is converted into 1 point. The size of the market cap is calculated through the size of the market caps of the companies at the time of calculating AESG.

$$Adjusted\ \ ESG = \frac{ESG\ \ rating}{Quintile\ \ Score\ \ of\ \ Market\ \ Value} \quad (1)$$

As shown in Equation (1), the adjusted ESG grade, AESG, is calculated by dividing the ESG grade by the quintile score of the company's market capitalization. The ESG rating applies data from the previous year to the current year, considering the time of publication. For example, ESG rating published during 2015 will be used conservatively from 2016. Additionally, the decile market value score of the denominator divides the stock into the decile based on the market cap, and the highest decile is given a value of 5, and the lowest decile is given a value of 1. The reason why the score is calculated by dividing the market cap into the decile rather than the value itself is because most of the AESG values are highly influenced by the market cap value of the denominator because the size of the denominator and numerator are highly different. In other words, the purpose is to adjust purely according to the size of the market capitalization using the selection for each size of the market cap, not the market cap value itself. The AESG value calculated in this way refers to the ESG rating relative to the size of the market value, allowing large and small caps to be compared collectively.

Table 2 shows the basic statistics of the calculated AESG values. The minimum value is 0.1 when the market is in the 10th decile, and the ESG grade is 1. Also, maximum value can be 4 because market value is 1st decile and the rating is 4. As can be seen in Table 1, the number of grades A+, the highest grade defined in this study, is tiny, and since most of them have a high market cap, the maximum value remains at 1.5. It has an AESG value of about 0.3097 on average over the entire period, and the average skewness is 1.863, which has a long tail in the right part, and the data are distributed more to the left. The average value of kurtosis is 2.7688, showing a sharper leptokurtic than the normal distribution.

Table 2: Elementary Statistic of AESG Sample Data

Year	Average	Std. Dev	Median	Max	Min	Skewness	Kurtosis
2012	0.3970	0.2352	0.2	1	0.2	1.5001	1.3058
2013	0.3987	0.2324	0.2	1	0.2	1.5412	1.5410
2014	0.3843	0.2125	0.25	1	0.2	1.7123	2.4854
2015	0.3779	0.2087	0.25	1	0.2	1.7904	2.8260
2016	0.3725	0.2132	0.2	1	0.2	1.8429	2.9086
2017	0.3938	0.2234	0.25	1	0.2	1.6400	1.9705
2018	0.4061	0.2303	0.2	1	0.2	1.5062	1.4831
2019	0.3992	0.2261	0.25	1	0.2	1.5549	1.6761
2020	0.4312	0.2389	0.33	2	0.2	1.5886	3.0588
Average	0.3957	0.2245	0.24	1	0.2	1.6307	2.1395

3.2. Portfolio Construction

In this study, we proposed two ways to construct a portfolio using AESG grade. The first way is portfolio optimization. After selecting stocks with excellent ESG rating, various optimization methods are applied to the proportion of the portfolio. The second is to build a multi-factor portfolio. It composes a multi-factor portfolio with representative factor investment factors such as Momentum, Quality, Value, Size and low-volatility (Bender et al, 2013).

In addition to the typical Equal Weight, Value weight and Mean Variance as a portfolio weight optimization method, Maximum Diversification, Risk Efficient, and Risk Parity are additionally used. The method for optimizing the weight of each portfolio is as shown in Equation (2) to (6) below.

$$EW: w^{EW} = \frac{1}{n} \quad (2)$$

$$VW: w_i^{VW} = \frac{1}{n} * MarketValue_i \quad (3)$$

$$MV: w^{MV} \equiv argminw'\sum w \quad (4)$$

$$MD:\ \ w^{MD} \equiv argmax\frac{w\times\sigma}{\sqrt{w'\sum w}} \quad (5)$$

$$RE:\ \ w^{\Re} \equiv argmax\frac{w'u}{\sqrt{w'\sum w}} \quad (6)$$

$$RP:\ \ w^{RP} \equiv argmin\frac{1}{2}w^T Aw - \frac{1}{n}\sum_i^n ln(w_i) \quad (7)$$

In the above equations, w means the weight of individual stocks and n means the number of stocks. Also, $\sum$ denotes a covariance matrix, σ denotes a volatility vector, A denotes a Correlation Matrix and u denotes an

expected return vector. The Equal Weight (EW) portfolio means that all constituent stocks are equally weighted. Value Weight (VW) refers to the weighting of the market cap to the weight of each stock. Mean-Variance (MV) means the Mean-Variance Portfolio of Markowitz (1952). Maximum Diversification (MD) is the maximum diversification portfolio that maximizes the variance of systematic risk in the portfolio Choueifaty and Coignard, 2008). Risk Efficient (RE) is a methodology proposed by Amenc et al (2011), and is optimized to derive the highest expected return per unit of risk. Risk Parity (RP) is a method for organizing a portfolio so that each stock has the same level of risk.

Next is how to construct multi-factor portfolio. Multi-factor portfolio refers to diversifying investments into each factor by combining two or more factors. In this study, AESG factor and five representatives (Momentum, Quality, Value, Size and Low-Vol) are combined.

In this study, the signals of each factor are integrated according to the method of Ghayer (2018). The Multi-factor configuration calculates a multi-factor score, as shown in Equation (8).

$$MultiFactorScore = \frac{(Z\text{-}Score_{factor1} + Z\text{-}Score_{factor2})}{2} \quad (8)$$

In the equation, Z-Score means standardizing the characteristic values of each company in a cross-section. After that, the multifactor score is calculated by equally weighting the Z-Score of each factor, and a portfolio is formed on the basis of this value. In this study, the rebalancing cycle for both portfolio optimization and multi-factor portfolio is monthly. In other words, through monthly rebalancing, the ratio of each portfolio optimization can be maintained.

4. Empirical Analysis

4.1. Analysis of ESG Investment Strategy Performance in Korea Stock Market

We examine whether the AESG proposed in this study is effective as an investment strategy. We construct a quintile portfolio according to the AESG value and look at the results of a long-short portfolio that buys the 5th quintile portfolio and sell the 1st quintile portfolio. Also, to avoid the effect of large-cap stocks with high market capitalization, the portfolio is constructed as an equal-weighted portfolio. We select KOSPI Index and equal-weighted portfolio as benchmarks.

Table 3: ESG Factor Portfolio Summary

Portfolio	Average Return	Std. Dev	Sharpe Ratio	MDD	Win Ratio
Panel A: ESG portfolio					
5Q (High)	0.0046 (1.1814)	0.0471	0.0977	0.4284	0.5182
4Q	0.0097* (2.4198)	0.0515	0.1892	0.3717	0.5545
3Q	0.0112** (2.8935)	0.0510	0.2197	0.3261	0.5636
2Q	0.0094* (2.413)	0.0506	0.1854	0.3523	0.6182
1Q (Low)	0.0062 (1.7757)	0.0457	0.1353	0.3616	0.5545
Long - Short	-0.0016 (-0.9446)	0.0212	-0.0749	0.2264	0.4545
Panel B: A ESG portfolio					
5Q (High)	0.0167*** (4.2475)	0.0540	0.3105	0.3026	0.6481
4Q	0.0088** (2.1601)	0.0516	0.1698	0.3706	0.5741
3Q	0.0086** (2.0802)	0.0514	0.1680	0.3864	0.5648
2Q	0.0051 (1.2485)	0.0513	0.1001	0.4450	0.5556
1Q (Low)	0.0044 (1.2906)	0.0417	0.1056	0.3475	0.5556
Long - Short	0.0123*** (3.9098)	0.0290	0.4264	0.1426	0.6296
Panel C: Benchmark					
Universe Portfolio	0.0099	0.0496	0.1993	0.3660	0.5926
KOSPI	0.0053	0.0424	0.1248	0.3405	0.5833

Note: This table shows the performance of each portfolio during the sample period from January 2012 to December 2020. The values in the table below are monthly, and the values in parentheses in the yield are Newey and West (1987) t-statistics of delayed lag of 12. *** p value < 0.001, ** p value < 0.01, * p value < 0.05

Panel A of Table 3 is the result of portfolio calculation based on the ESG factor. The average monthly return of the quintile is 1.67% (t-statistic 4.2475), indicating a statistically significant positive return, and it can be seen that the portfolio in the first quartile is 0.28% (t-statistic 1.2906). Additionally, the average return of the long-short portfolio is 1.23% (t-statistic 3.9098), so the return is insignificant. This result is similar to that Park (2017) does not consider it as a strategic tool in constructing a buy-sell portfolio based on a simple ESG rating in the Korean stock market. Panel B is the result of the portfolio calculated based on AESG Factor. It can be seen that the monthly average return of 5th quintile is 1.67% (t-statistic of 4.2475), which has a statistically significant positive return, and the portfolio in the first quartile is 0.28% (t-statistic of 1.2906). Moreover, the average return of the long-short portfolio is 1.23% (t-statistic of 3.9098), indicating that the return value is significant. Therefore, both the 5th quintile portfolio, the long-only strategies that select top stocks based on the AESG value and Long-Short portfolio shows excess returns compared to the benchmark.

It can be seen that the higher the AESG rating, the higher the portfolio's performance and average return, as well as the sharpe ratio, which represents risk-adjusted returns. It also shows that the performance of equal-weighted portfolio of stocks with ESG rating is superior to KOSPI Index, a representative index of Korean stock market. This means that if it is difficult to evaluate ESG rating, it is possible to beat the market returns by constructing the simplest equally weighted portfolio.

We verify whether these returns can be explained in asset pricing models or is inexplicable excess return. For verification, we measure the alpha of CAPM (1964), Fama and French (1993)'s 3-factor model (hereinafter "FF3F"), the Carhart 4-factor model (hereinafter "Carhart 4F"), and the Fama and French 5-factor Model (hereinafter "FF5F").

$$CAPM: R - R_f = \alpha + \beta_{MKT} MKT + \epsilon \quad (9)$$

$$FF3F: R - R_f = \alpha + \beta_{MKT} MKT + \beta_{SMB} SMB + \beta_{HML} HML + \epsilon \quad (10)$$

$$Carhart\ \ 4F: R - R_f = \alpha + \beta_{MKT} MKT + \beta_{SMB} SMB + \beta_{HML} HML + \beta_{MOM} MOM + \epsilon \quad (11)$$

$$FF5F: R - R_f = \alpha + \beta_{MKT} MKT + \beta_{SMB} SMB + \beta_{HML} HML + \beta_{RMW} RMW + \beta_{CMA} CMA + \epsilon \quad (12)$$

Equation (9) to (12) represent the asset pricing models for measuring alpha. MKT represents market premium, SMB is the return spread of small minus large stocks (i.e. the size effect), HML is the return spread of cheap minus expensive stocks (i.e. the value effect), RMW is the return spread of the most profitable firms minus the least profitable (i.e. Quality factor), CMA is the return spread of firms that invest conservatively minus aggressively (i.e. Low-Vol) and MOM represents momentum factor. In each equation, alpha means excess return that cannot be explained by the risk factors included in the model, and ϵ represents the error term. In this analysis, the existence of alpha in the AESG portfolio is confirmed through the above four asset pricing models.

Table 4: Regression for Measuring Alpha

Model	CAPM	FF3F	Carhart 4F	FF5F
Alpha	0.0117*** (3.708)	0.008*** (3.071)	0.0090*** (3.147)	0.0089*** (3.116)
MKT	0.1424 (1.676)*	0.0737 (0.976)	0.6027 (0.818)	0.0755 (0.985)
SMB		0.2913*** (3.479)	0.2961*** (3.524)	0.2819*** (3.054)
HML		0.4006*** (4.781)	0.3894*** (4.586)	0.4296*** (4.222)
UMD			-0.0670 (-0.862)	
RMW				-0.1102 (-0.829)
CMA				-0.0959 (-0.519)
R^2	0.0273	0.2684	0.2740	0.2622
Adj. R^2	0.0175	0.2460	0.2441	0.2237
F-statistic	2.808	11.99	9.153	6.822

Note: To examine the excess return of ESG portfolio, the results of estimating the alpha value of the CAPM (1964), Fama and French (1993) 3 factor, Carhart (1997) 4 factor, and Fama French (2015) 5 factor models are shown. *** p value < 0.001, ** p value < 0.01, * p value < 0.05

Table 4 performs a regression analysis with the asset pricing model to examine whether the excess return is significant for the AESG portfolio return. The result of analysis shows that the alpha of CAPM is 0.0117% (t-statistics 3.708), the alpha of FF3F is 0.008% (t-statistics 3.071), the alpha of Carhart 4 Factor is 0.0090 (t-statistics 3.147) and the alpha of FF5F is 0.0089% (t-statistic 3.116). Also, AESG's excess return can yield a valid excess return even if the explanatory power of the factors of the well-known asset pricing model is excluded.

It shows that buying stocks with high AESG values can generate returns. Additionally, it can be seen that this excess return is alpha, which cannot be explained as representative asset pricing models. Moreover, the AESG proposed in this study contains the logic of giving SMEs more points than large companies if they have the same ESG rating. Therefore, it is suspected that the excess return of AESG portfolio is driven by the size effect, but the results of <Table 5> confirms that there are excess returns that cannot be explained by the size effect. It can be seen indirectly that AESG contains additional information unlike existing risk factors and shows that it can be effective in achieving excess returns.

4.2. Forecasting Effect of AESG's return

We verify whether AESG's return prediction effect exists. To verify, we calculate IC value and apply Fama-Macbeth's cross-sectional regression. First, Information Coefficient (hereinafter "IC") proposed by Grinold (1989) is examined to calculate the effect of predicting the return of AESG. IC is calculated as shown in Equation (13) below.

$$IC(InformationCoefficient) = Corr_{r_t, z_{t-1}} \quad (13)$$

In other words, it is the correlation between the factor score at time t-1 and the return on investment at time t. At this time, if the Spearman correlation that considers the rank of the values rather than each value itself is used, it is called Rank IC. It is judged that the higher the absolute value of the correlation between the factor value at time t-1 and the return at time t, the more the effect of predicting return of that factor exists. This means that if the IC value is high, a relatively high return can be expected in the future by investing according to the value of the factor. Therefore, IC and Rank IC are indicators that can verify the effectiveness of investments based on factors.

Table 5: Information Coefficient

Name	Coefficient	Std. Error	t-value
IC	0.03991***	0.0088	4.5049
Rank IC	0.0175*	0.0098	1.7873

Note: This table shows the IC and Rank IC of the AESG factor in the sample period from January 2012 to December 2020 and t-statistics are used. *** p value < 0.001, ** p value < 0.01, * p value < 0.05

Table 5 is a table in which IC and Rank IC values are calculated to examine the effect of predicting AESG's returns. The IC value was observed very significantly as 0.3991 (t-statistic 4.5049). Also, in the case of Rank IC, it has a statistically significant positive value as 0.0175 (t-statistic of 1.783). It means that the relationship between the AESG rating and the future rate of return is positive and it can be judged that a price prediction effect exists.

Next, we look at how a company's AESG affects a company's return in stock market on an individual company level. For this, we conduct a cross-sectional regression of Fama and Macbeth (1973) with AESG and corporate characteristic variables as explanatory variables and stock returns as dependent variables. Fama-Macbeth regression is an estimation method that obtains the time series mean, standard error, and test statistics (t-statistics) based on the set of regression coefficient estimates obtained by performing cross-sectional regression at each observation point of the data. This analysis confirms how significant AESG has an explanatory power for stock returns.

$$R_{i,t+1} = \lambda_{0,t} + \lambda_{1,t} AESG_{i,t} \quad (14)$$

$$R_{i,t+1} = \lambda_{0,t} + \lambda_{1,t} AESG_{i,t} + \lambda_{2,t} MKTbeta_{i,t} \quad (15)$$

$$R_{i,t+1} = \lambda_{0,t} + \lambda_{1,t} AESG_{i,t} + \lambda_{2,t} MKTbeta_{i,t} + \lambda_{3,t} ln(MV) + \lambda_{4,t} ln(BM)_{i,t} \quad (16)$$

$$R_{i,t+1} = \lambda_{0,t} + \lambda_{1,t} AESG_{i,t} + \lambda_{2,t} MKTbeta_{i,t} + \lambda_{3,t} ln(MV) + \lambda_{4,t} ln(BM)_{i,t} + \lambda_{5,t} MOM_{i,t} \quad (17)$$

In this study, Fama-Macbeth regression is performed by constructing 4 models as shown in Equation (14) – (17). Ln (MV) representing size, Ln (BM) representing value effect, and MOM representing a 12-month momentum effect were considered enterprise characteristic variables.

Table 6: Regression of Fama-MacBeth

Name	Reg (1)	Reg (2)	Reg (3)	Reg (4)
Intercept	0.0094 (1.9523)*	0.0101 (3.4281)***	0.0410 (2.2209)**	0.0424 (2.2977)**
Market beta		-0.0014 (-0.3595)	-0.0010 (-0.2663)	-0.0005 (-0.1306)
Ln (MV)			-0.0028*** (-3.5995)	-0.0028*** (-3.6817)
Ln (BM)			0.0006 (0.3806)	0.0004 (0.2895)
MOM				0.0011 (0.2637)
ESG	0.0056 (5.0337)***	0.0052 (4.7303)***	0.0037 (3.8306)***	0.0037 (3.8411)***
R-square	0.1478	0.1832	0.2002	0.2149
obs	67936	67936	67936	67936

Note: This table represents the results of the cross-sectional regression analysis of Fama and Macbeth (1973), using the individual firm's returns as the dependent variable and the individual firm's characteristic variable as the explanatory variable. Values in parentheses are Newey and West (1987) t-statistics of delay lag of 12. ***, **, * indicate significance at 1%, 5% and 10% levels, respectively.

Table 6 shows the results of the Fama-Macbeth regression. In the case of Ln (MV), there was a negative relationship and a significant relationship. This means that the larger the size of the company, the lower the expected rate of return. In other words, the smaller the size of a company, the more the small-cap effect exits, which increases the expected rate of return. The AESG, which is important in this study, has a statistically positive significance in all Reg (1) – Reg (4). This means the larger the AESG value adjusted to the market cap, the higher the expected rate of return of the company.

To summarize the above results again, a significant excess return was confirmed through the quintile portfolio

analysis based on the AESG standard, and the effect of predicting the rate of return exists through the IC value. Additionally, it was shown that all of the alpha measured by the representative asset pricing model is significant. This means that AESG has a risk premium that cannot be explained by the factors of the existing asset pricing model. Also, the result of Fama-Macbeth regression shows AESG and stock returns have a statistically significant positive relationship. In other words, it means that AESG can generate excess returns, has a predictive effect on stock return, and can be an important indicator of investment.

4.3. Portfolio Construction with AESG

Next, by examining the construction of various portfolios using AESG adjusted to the size of a company, we confirm its usage. To examine the rate of return that reflecting the transaction cost incurred from the actual investment, a transaction cost of 30bp is applied to both buy and sell. Portfolio optimization and multi-factor strategies are examined as portfolio construction methods.

Portfolio optimization looks at the simplest EW and VW portfolios, as well as the MV portfolio, MD portfolio, RE portfolio and RP portfolio. Each strategy constitutes a portfolio of the top 200 stocks with high AESG values. As a benchmark, we set the KOSPI index and Universe portfolio.

Table 7: Performance of Portfolio Optimization

Portfolio	Monthly Avg Return	Std. Dev	Sharpe Ratio	MDD	Win Ratio
Universe Portfolio	0.0097	0.0518	0.1883	0.3662	0.6071
KOSPI	0.0054	0.0447	0.1203	0.3405	0.5833
EW	0.0147*** (3.4299)	0.0549	0.2673	0.3262	0.6548
VW	0.0036 (0.7325)	0.0439	0.0809	0.4116	0.5595
MV	0.0025* (1.7699)	0.0411	0.0606	0.3916	0.5476
MD	0.0058* (1.878)	0.0447	0.1290	0.3306	0.5357
RE	0.0139*** (3.504)	0.0495	0.2800	0.2923	0.6429
RP	0.0137*** (3.0949)	0.0493	0.2773	0.3022	0.6786

Note: This table shows the performance of each portfolio in the sample period from January 2014 to December 2020. The values in the table below are monthly values, and the values in parentheses are Newey and West (1987) t-statistics of delay time difference 12. *** p value < 0.001, ** p value < 0.01, * p value < 0.05

Table 7 shows the results of portfolio optimization. As shown in the results in Table 3, it shows that performance of the universe given ESG grade is superior to KOSPI Index, which is the representative index of Korean stock market. In the case of the monthly average return, the EW portfolio is the largest at 1.47%. On the other hand, the sharpe ratio, an indicator of risk adjustment performance, shows the largest RE portfolio at 0.28. The win ratio, which means the ratio in which the rate of return is positive, is the largest in the RP portfolio. MD's return exceeds the KOSPI Index, but it underperforms the equal-weighted portfolio performance, the benchmark of this study.

Table 8: Information Ratio of Optimized Portfolio

Portfolios	Ann Avg Return	Excess Return	Tracking Error	Information Ratio
Benchmark	0.0241	-	-	-
EW	0.1543	0.1303	0.0753	1.7304
VW	0.0273	0.0033	0.1293	0.0253
MV	0.0655	0.0414	0.1099	0.3769
MD	0.0782	0.0514	0.2111	0.2565
RE	0.1286	0.1046	0.0678	1.5433

Note: This table shows the information ratio of optimization portfolios covered in Table 7. The information ratio refers to the value obtained by dividing the excess return rate by the tracking error and the benchmark is an equal-weighted portfolio of universe stocks.

Table 8 shows the information ratio of optimized portfolios. The value obtained by dividing the excess return against the benchmark by the tracking error with the benchmark is called the information ratio and is a criterion to measure how consistently a portfolio outperforms the benchmark (Bacon, 2008). As for the information ratio, RP is the largest at 1.7822 and EW is the second largest at 1.7304. However, in the case of VW, it is the lowest at 0.0253. Since the information ratio of all strategies is positive, it can be a more efficient ESG investment if the proportion of the portfolio is adjusted according to the investment purposes.

Next, we construct multi-factor portfolios using AESG. In the case of multi-factor investment, there is an advantage that relatively stable investment results can be obtained because the risk is distributed for each factor. Kim, S.R. and Kim, D.H. (2015) showed that in the Korean Stock Market, investment using factors such as size, value, and Momentum can show superior performance. This study focuses on five factors (Momentum, Quality, Value, Size and Low Vol) that are commonly used in factor investments. The company's AESG and five factors each form a multi-factor portfolio.

Table 9 shows the results of the AESG factor, the five representative factors, and the multi-factor portfolio with the AESG factor. Each portfolio is the result of constructing an equal weighted portfolio by selecting the top 200 based on the factor value. Rebalancing was conducted monthly. Looking at the results, in the case of the size factor of Panel C and the quality factor of Panel D, even if a multi-factor portfolio was formed, there was no significant difference in return from the simple factor portfolio. On the other hand, in the case of the Value of Panel A, the Momentum of Panel B and the Low vol of Panel E, the multi-factor portfolio shows a significant positive return.

In the case of Panel A the results of the value factor portfolio and multi-factor portfolio with the value factor are shown. The Value + ESG portfolio showed a monthly return of 1.52%, which was a simple value factor portfolio and 0.74% (t-statistic of 5.49), showing a significant increase in return. Panel B's Momentum portfolio was 0.74% (t-statistics 5.49), showing a significant difference, and Panel E's Low vol was 0.49% (t-statistics 3.07). This result suggests that the strategy of pursuing alpha through the combination with ESG factor is possible in factor investment.

Table 9: Performace of Multi-Factor Portfolio

Portfolio	Monthly Avg Return	Difference of Returns	Std. Dev	Sharpe Ratio	MDD	Win Ratio
Panel A: Value						
Value	0.0078	0.0074*** (5.49)	0.0529	0.1470	0.4126	0.5648
Value +ESG	0.0152		0.0531	0.2867	0.3401	0.6389
Panel B: Momentum						
Momentum	0.0105	0.0028* (1.80)	0.0567	0.1853	0.4177	0.5741
Momentum +ESG	0.0133		0.0540	0.2465	0.3556	0.5926
Panel C: Size						
Size	0.0200	-0.0013 (-1.10)	0.0587	0.3405	0.2502	0.6204
Size + ESG	0.0186		0.0581	0.3205	0.2808	0.6204
Panel D: Quality						
Quality	0.0128	0.0013 (0.73)	0.0435	0.2952	0.2945	0.6204
Quality +ESG	0.0142		0.0491	0.2884	0.2917	0.6481
Panel E: Low vol						
Low vol	0.0067	0.0049*** (3.07)	0.0384	0.1745	0.3440	0.5741
Low vol +ESG	0.0116		0.0434	0.2679	0.3149	0.6389

Note: This table shows the performance of each portfolio in the sample period from January 2012 to December 2020. The values in the table below are monthly values, and the values in parentheses are Newey and West (1987) t-statistics of delay time difference 12. *** p value < 0.001, ** p value < 0.01, * p value < 0.05

It shows that when portfolio optimization and multi-factor strategy was conducted, significant excess returns can be obtained compared to the benchmarks. There is a lot of room for these results to be usefully used in actual fund management. A portion of portfolio weight could be allocated to an AESG optimized portfolio or similar to a multi-factor portfolio, tilted a portion of the AESG factor. Therefore, this study is meaningful in that it proposes a useful investment strategy by using the ESG rating in the Korean market.

5. Conclusions

To analyze the investment performance using the ESG grade, this study calculated AESG, the ESG grade whose company size was adjusted through market value. The AESG value was calculated by dividing the market value of each company by the decile and dividing the ESG grade by the decile. First, to check the investment effectiveness of factor, a quintile portfolio was constructed based on the Z-Score of AESG. As a result, the higher the AESG value, the higher the performance. Additionally, the return of a long-short portfolio that buys the 5th quintile and sells the 1st quintile has a statistically significant positive value. Also, alphas were significant in CAPM, FF3F, Carhart 4 Factors and FF5F. This means that even if we exclude the explanatory power of well-known factors, the AESG portfolio can get a valid positive return. To further verify, Fama-Macbeth Regression analysis was performed. It was shown that the value of AESG can explain the future return even when several corporate characteristics are considered. This means that AESG can generate excess returns, has a predictive effect on stock price returns, and is an important indicator of investment.

For using this AESG more actively in investment strategies, this study proposed two methods. The first is to secure additional returns stably through portfolio optimization, and the second is to present a multi-factor portfolio that combines with other factors. It can be seen that each performance indicator is differently depending on the portfolio optimization method, which means that the portfolio optimization method can be selected according to the investment goal. We also looked at the five most commonly used factors and multi-factor portfolio performance. As a result of the analysis, when constructing the multi-factor of Value, Momentum and Low Vol and AESG, statistically significant performance improvement was shown. These points show that various investment methods can be used for future ESG investments.

The results of this study show that it can be helpful in ESG investment to reflect the ESG grade of SMEs more greatly by using the adjusted ESG grade through the market value. This was to give more points to companies with high ESG rating compared to the size of firms, as most of the companies with high ESG rating were concentrated on large-scale firms.

The limitation of this study is that the time series of ESG rating published by the Korea Corporate Governance Service is relatively short. Therefore, the data of the entire analysis sample are insufficient. Moreover, there are currently not many companies that have been given high ESG rating promulgated by Korea Corporate Governance Service, and only 800 companies have been given the ESG rating. Therefore, more meaningful results can be expected if more companies are evaluated by the Korea Corporate Governance Service.

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