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How is the ESG factor related to traditional factors?

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ABSTRACT

This master thesis discusses ESG effect on the portfolio performance and how this factor is related to conventional factors. First, ESG-related portfolios and the ESG factor portfolio are constructed based on ESG score. Second, return, standard deviation and Sharpe ratio are calculated to present portfolio performance. Finally, 12 asset pricing models are run on the portfolio and single-stocks level. ESG factor is added into base models. We observe that the higher ESG-scored portfolio does not lead to the better return compared to the lower ESG-scored portfolio. The analysis of asset pricing models on the portfolio level shows that the ESG factor does not enhance the explanatory power of traditional models. The analysis on single stocks illustrates that ESG factor can explain expected return better higher than CMA only, but worse than MKT, SMB+HML, WML, RMW and RMW+CMA.

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INTRODUCTION

There is an increasing number of investors integrating environmental, social and governance (ESG) factors into their investment decisions by various motivations. For example, some do it because they have the mandate to meet ESG goals; some do for reputation or trend; nevertheless, majority of investors expect that the ESG integration will lead to the higher rewards for the long run (Maiti, 2020). The numerous studies investigating the ESG integration and results show different evidence.

Although, Friede et al. (2015) found nearly 90% of studies illustrate a "nonnegative" in the relationship between the ESG performance and corporate financial performance. The ESG integration still raises a doubt in investors. Practitioners and researchers are continuing a debate of ESG and financial results. One of the most popular techniques they use to encourage investors to integrate ESG into their decision making is factor-based investment. In this approach, ESG is considered as a factor added into asset pricing models to combine with other factors aiming to predict the expected return for portfolios and stocks. Our thesis addresses this issue with the research question "How is the ESG factor related to traditional factors?". To solve the question, the ESG factor will be integrated in the model together with market-related factor, size factor, value factor, profitability factor, investment factor, momentum factor. The ESG factor will be examined and compared to other factors in terms of explaining returns.

This research consists of two main parts:

- Part 1: literature reviews are built from the basic knowledge until the more modern knowledge to give a better understanding theory of investment, portfolios, evolution of asset pricing models and responsible investment, ESG integration and related issues. The contribution of this thesis to literature of ESG integration is presented in this part.
- Part 2: in the empirical study part, the ESG factor is a hypothesized factor constructed and called as GMB (Good minus Bad). After that, we add this factor into each base model to investigate whether GMB can enhance the explanatory power and explain better than traditional risk factors and how large the exposure to each risk factor is. We will run regression on portfolios and single-stocks level to have a more precise answer. The relation between the ESG performance and returns, volatility and risk-return trade-off are examined.

Part I. LITERATURE REVIEW

Introduction of literature review

The literature review chapter will present from the foundation of portfolio theory to the specific case of ESG application in this paper. First, the efficient market hypothesis (hereafter, EMH) is considered as a cornerstone for a lot of modern financial theories, thereby, it is necessary to know about the history, the content and the practical application as well as the point of view of investors regarding this hypothesis. Next, the adaptive market hypothesis is coming up which is considered as a new version of the EMH. In this chapter, the difference between the adaptive market hypothesis (hereafter, AMH) and the EMH and the relationship to the responsible investment will be explained. The modern portfolio theory (hereafter, MPT) is growing from the base of the EMH. In the modern portfolio theory chapter, the relationship between risk and return in constructing a portfolio is analyzed. Next, the evolution of asset pricing models is presented. These are models on which investors can apply to an optimal portfolio, maximize expected returns and reduce risks. In such models, the conventional factors are mentioned. Going beyond the original purpose of profit maximizing, investors are more and more aware of whether the companies that they invest harm the environment, society and governance. The portfolio management and responsible investment chapter will show later. Moreover, this paper will consider the link between responsible investment with all theories mentioned above. Lastly, the application of ESG, the “ESG factor” in the research question and traditional factor are also defined. Other researches relating to ESG integration in Fama-French model with similar and different approaches from ours will be compared.

To sum up, the literature review aims to find the gap of previous studies, give basic concepts of portfolio management, recognize the transformation in the investor’s mind and the importance of ESG integration in the evolution of investment to answer the research question “How is the ESG factor related to traditional factors?”.

Chapter 1. Efficient Market Hypothesis (EMH)

The EMH is a base for a lot of financial theories regarding investment and portfolio. The structure of this part includes the history, studies supporting EMH and the arguments opposing the EMH. The knowledge of this hypothesis will be used to consider whether the EMH is in line with responsible investment, ESG integration or not, which is illustrated in responsible investment's chapter.

Both Paul A. Samuelson and Eugene F. Fama contributed to the EMH by publishing their independent researches with different agendas in the 1960s (Lo, 2007). Although they have the same purpose to analyze the random walk of an efficient market, they explain in dissimilar ways.

Fama was considered as the first person who contributed to the efficient market hypothesis when the term "efficient" was first mentioned in his first 1965 article (Delcey, 2017). Fama started the first article in 1965 by mentioning the question that many investors asked for many years whether the history of share price can predict the future price; and answered for this question by stating the theory of random walk which "implies that the price did not have memory and the past cannot help to predict the future" (Fama, 1965a). At the end, he concluded that the efficient market is one in which when the intrinsic value changes, the actual price will instantaneously change following and completely reflect new information (Fama, 1965a).

One more time, Fama emphasized the role of random walk pillar in the second article by pointing that "in the efficient market, the successive price changes in individual securities are independent" which is one of the main hypotheses of random walk theory (Fama, 1965b). Moreover, he mentioned in the competitive market where there are many intelligent traders who estimate intrinsic values based on the new information, these intrinsic values are close to actual prices to reinforce the EMH (Fama, 1965b).

Comparing Fama's outcome when approaching random walk theory, Samuelson (1965) had the same conclusion that the future price of stock is unpredictable because of price variation. However, Fama conducted the research by observing the independence, forming the efficient market theory (inductive approach) in while Samuelson used deductive approach, created the Theorem of Fair-game Future Pricing (Delcey, 2017). He concluded that the price converges all small independent variations of supply and demand that behaves as a random walk (Samuelson, 1965).

In 1970, Fama continued to discuss the efficient market in the article with the title "Efficient capital markets: a review of theory and empirical work". He reaffirmed that the market is called as efficient when prices of stocks "always fully affect all available information" (Fama, 1970). To strengthen and develop this phenomenon, the empirical works were conducted and categorized into 3 forms test: weak form, semi-strong form and strong form (Fama, 1970):

- Weak form market: the current prices converge the historical data of prices, therefore, there is no chance for technical analysts to beat the market. Whereas, the fundamentalist can calculate the intrinsic value on the publicly available information and make profit in the short term.
- Semi-strong form market: this form including the main characters of the weak form market, neither the fundamental nor the technical analysts gain any returns in the market because both historical prices data and available publicly information reflects the current price of stock.
- Strong form market: regardless of public or private information, all of them are involved in the current price of stocks so that there is no investor can take advantage of the market even trading on insider information (Malkiel, 2011).

Bearing the event study with Fisher, Jensen and Roll, Fama restated that the stock market is efficient by observing how rapidly the common stock prices react to information on a stock split (Fama et al., 1969). Fama also did the tests on new exchange listings and initial public offerings (Malkiel, 2003). Except for when Fama did the tests to support the EMH, other researchers also conducted the studies to prove it. Malkiel (1973) is one of the proponent of the EMH when he wrote the book "A Random Walk down Wall Street" and argued that, "because of this random walk, investors cannot consistently outperform the market as a whole". It is useless when investors use fundamental analysis or technical analysis to outperform the market. In the book "Forecasts of future prices, unbiased markets, and martingale model which was written by Mandelbrot in 1966, he "proved some of the first theorems showing how, in competitive markets with rational risk-neutral investors, returns are unpredictable" (Sewell, 2011). The famous economist Jensen (1978) wrote "I believe there is no other proposition in economics which has more solid empirical evidence supporting it than the Efficient Market Hypothesis" when introducing his special article for Journal of Financial Economics.

Beside the proponents, many opponents gave evidence against the EMH. Against Malkiel who supported the EMH and the main idea of the random walk theory, Lo and Mackinlay (2001) wrote the book in the totally opposed title. They applied the heavy technical analysis and powerful computers to show that there is not existence of random walk and the trend of stock price is predictable. Another argument is that the information is costly, the price therefore cannot obtain all the available information which leads to the inefficiency of the market, and investors require the return higher than the cost they paid for information (Grossman & Stiglitz, 1980). Shiller is one of the economists who strongly contradicted the EMH with the idea of excess volatility. He stated that there is an excess between the actual price and the calculated price based on the fundamental information (Degutis & Novickyte, 2014).

As we know Fama (1965b) said the stock market is efficient in which the investors are rational, and the stock prices reflect all the information. Nevertheless, this raises the question to behavioral finance that investors are irrational, and the prices are affected by the decision of investors who are impacted by their perception such as information bias or loss aversion (Degutis & Novickyte, 2014). Malkiel (2003) emphasized that the market is not always efficient, and he did not deny the impact of psychological factors on stock price. Shiller (2000) demonstrated the event of increasing stock price in the U.S. market in the 1990s is affected by the spread of this factor. In addition, earnings announcement is one of the anomalies in the market, Ball (1978) investigated that the abnormal return is not the result of market inefficiency and the non-zero return came from the deficiency of asset pricing model. In a while, following all the steps of Ball, Watts (1978) stated that abnormal returns came from market inefficiencies instead of inefficient markets.

To sum, there are two main tenets of the EMH which are (1) the available information reflected in the stock immediately; (2) it is impossible to get the higher return comparing average without accepting the above average risks. Beside many studies, tests and research support the EMH, there are various studies and investors showing the evidence against this theory, especially, the behavioral economists. This issue raises the question of whether there is a theory combining the EMH and behavioral finance to satisfy both two kinds of point of view and provide investors the larger framework to apply for their future investment.

Chapter 2. Adaptive Market Hypothesis (AMH)

The question about if there is any joining theory reflects both the EMH and behavioral finance is answered in this chapter. Andrew Lo (2017) solved this matter by introducing the new theory with the principle of evolutionary biology which is Adaptive Market Hypothesis. The AMH chapter presents key tenets, the difference from the EMH, the tests and the relationship of the AMH to the sustainable investment.

Lo (2004) emphasized the conflict between the EMH and behavioral economics, finance when the EMH has the idea that the market is rational (include rational investors) and the prices reflects all the available and instantaneous information, in while behavioral side argued people are not rational and "driven by fear and greed". He started the article with this argument to open the new hypothesis for investors' approach with a bigger picture. Lo looked back on the original principle of economics and argued that the interaction among the Three P including prices, preferences and probabilities is fundamental for people to make decisions (Lo, 2007).

He said that the critiques of behavioral finance to the EMH mainly focus on preferences and behavior of market participants and argued that people always would like to make decisions that guarantee to optimize the expected utility in a relative risk. However, many psychologists found that their decision is impacted by behavioral biases such as overconfidence, overreaction, loss aversion, etc. (Lo, 2007). This makes the actual outcome different from the individual's desired outcome. Thus, they conclude that investors are often irrational. He stated that human behavior is "heuristic, adaptive and not completely predictable" and the model obtaining many individuals is much more challenging than the one with a single individual. This idea combined with the EMH continues to lead to the new synthesis. That is an adaptive market. The evolutionary approach is strongly impacted by the discipline of Wilson to apply competition reproduction, natural selection to economic and financial contexts (Lo, 2004). Finally, we can integrate behavioral alternatives to the EMH and create the new synthesis which is the adaptive markets hypothesis (Lo, 2007).

Lo (2017) did not say the EMH is wrong but he recognized that individuals are not always rational and on the other hand, they are not always irrational. Investors are human-being, they are mainly rational but sometimes they are irrational when making decisions especially in the period with high volatility in the market. The "adaptive" here means the ability of people experiment, make decisions, make mistakes and learn from them to adapt. Lo (2017) summarized 5 tenets in the AMH:

- We are not always rational or irrational. Because we are biological, our behaviors are forced by evolution.
- We have bias when making decisions, it can be wrong, but we learn from mistakes.
- With those experiences, we can base them on the future and prepare for any changes in the environment (means adapt).
- Financial market dynamics come from both the way we interact with each other and with context where we live such as society, politics, economics and natural environments.
- Competition, innovation and adaptation are the key elements for survival.

The AMH is considered as a new version of the EMH using the lens of evolutionary biology. The prices still reflect all information but such information is affected by all elements in the market-ecosystem such as the number of participants, the conditions of the market and the nature of each species in the economy-ecology (Lo, 2007). When we see the market as an ecosystem, we can know how market participants like mutual funds, hedge funds, pension funds, investors, etc. behave (how often pension funds make decisions? How often do they revise them? How much risk they can accept? Etc.). By observing such things, we are likely to know the trend and what the way participants respond to the market shocks (Jaye, 2017). From that, we can focus on investing in the equity markets when these markets have a higher expected return or tilt to bond when equity markets have a lower expected return. According to Lo, by applying the AMH, we can describe what happens in markets, the trend of the market, how people react, and based on this, we can look again at our own mistakes, fix and adapt in the new circumstance. However, it is not easy to grasp all the information in the market to draw a big picture and analyze the trend of all market participants. Thus, this hypothesis is now skeptical, especially by academic researchers because it is not proved by any quantitative method or mathematical method thus it is not easy to measure the performance (Jaye, 2017).

In many years, the EMH is the dominant theory of the financial economy, which is the framework used broadly in investment. The AMH is the new approach that makes investors and other market participants are curious. There are some studies investigating the accuracy of this theory in several markets.

Urquhart and McGroarty (2016) conducted the study in the S&P500, FTSE100, NIKKEI225 and EURO STOXX 50 to examine the relationship between the market conditions and the level of predictability in stock returns. They observed that in some periods, the relationship between market conditions and predictability of returns are very strong but some periods it is not significant. They also found that this relationship is strongly related in specific markets, not in the whole market. They recommended investors should look at each market separately because depending on each market conditions, the level of predictability of return is different. They concluded that the predictability of return is varied over time on the specific condition of each market and it reflects the content of the AMH.

In the other context of Vietnamese stock market including Ho Chi Minh Stock Exchange and Hanoi Stock Exchange, Dzung and Hung (2019) also examined whether the AMH aligns in the Vietnamese stock market. They studied the relationship between current stock returns and historical stock returns and came to the conclusion that the behavior of the stock market in Vietnam is "in line with the AMH". One more evidence from Dow Jones Industrial Average index from 1900 to 2009 showed that the return predictability is impacted by the market condition which is consistent with the AMH (Kim et al., 2011).

If the EMH is considered as the theory that applied in traditional investing, the AMH is the theory that should be applied in long-term investing. More studies prove the AMH is the framework for responsible investment or sustainable investment. We did not ignore the implications of the EMH but the AMH now is much more suitable for the new trend of investment.

According to Schoenmaker, the author of book Principles of Sustainable Finance, he chosen the AMH is the framework for long-term value creation investment (Schoenmaker, 2019) because the EMH contains some limitations that cannot adapt new prevailing risks meanwhile the AMH can adapt those risks (Schoenmaker, 2018). To be more specific, he argued that in terms of the neoclassical efficient market theory, individuals are rational to maximize expected utility whereas regarding the evolutionary view, individuals have more modest claims. The efficiency of the market is measured by the evolutionary model of individuals when adapting to the changing of environmental conditions.

One shining point of the AMH is the ability to explain new risks, like environmental risks which do not reflect in full price, because there are "not enough investors are examining these new risks" (Schoenmaker, 2018). For instance, the study of Andersson, Bolton and Samama (2018) proved that carbon risk is integrated in the market price because not too many investors are interested in this kind of risk. Meanwhile, another study examined the risk from climate change on the stock price and concluded that markets are inexperienced with such information, therefore, the price of stocks cannot reflect the risk caused by climate change and fully all information in the market as well (Hong et al., 2016). In the research paper of Badia, Serrats and Rodon (2018), they investigated the role of ethics factor in the process of price and came to the conclusion that the ethical emphasis contributes to the complex process of price determination on financial securities and helps markets overcome their limitations.

In conclusion, this part provides the basic knowledge of the AMH to help us understand the framework applied in the sustainable investment, especially in case of ESG integration. It is still an efficient market but with new versions and use ecological eyes to look through. This hypothesis is quite new to many investors but up to now can be proved by some studies. Because of the "adaptive" element, therefore, investors can use it to make their investment more sense and adapt the changes in investment which tend to focus more on the sustainability or long-term value creation fashion. This framework is used more in responsible investment; however, we do not have integrated it in our empirical research.

Chapter 3. Modern portfolio theory (MPT)

If the efficient market hypothesis is a theory that a lot of investors have applied in investment, the modern portfolio theory is a framework has a long history contributing to the finance, economic in generals and investment separately.

It cannot be denied that modern portfolio theory is one of the most influential and prescriptive theories in the investment field especially in portfolio landscape. To know how this theory works, some points will be presented in this part: the purpose (history, motivation), assumptions, Risk-return, efficient frontier, and reasons why to choose this theory in the paper, does it conflict with the EMH?

Accounting for a major contribution to financial economics, Harry Markowitz is the father of modern portfolio theory (Lhabitant, 2017). He introduced “Portfolio Selection” in 1952 for his dissertation and it then became the most influential theory applied for investors which is the Modern Portfolio Theory (Fabozzi et at., 2002). Before 1952, investors had a ‘portfolio’ in investing but their perceptions of each are different. According to John Burr William who is the author of book “The theory of investment value”, investors should consider the net present value of dividend collected from stocks (William, 1964). Therefore, most investors just aim to seek good stocks and purchase at the good price or managers just care how to pick the best individual securities in their ‘portfolios’ (Pfau, 2020).

Markowitz found that “the investor places all his funds in the security with the greatest discounted values” with the uncertainty of return or discount rates for different securities (Markowitz, 1952). He saw the missing concern in this thought and wrote the paper to change the way to select portfolios to caring returns, risks and the correlation among securities in the overall portfolio (Elton & Gruber, 1997). Markowitz mentioned portfolio with the statement that by considering the portfolio as a whole, it reduces the volatility than the total sum of individual security (Markowitz, 1952).

The MPT gives the concept to investors before they would like to maximize their portfolio by considering the trade-off between reward expectation and risk tolerance or return-risk rule (Markowitz, 1952). Investors always desire to maximize the return but the fact that, they also think about their risk appetite. In order words, the higher return investors want, the higher risk they accept and vice versa.

The MPT attempts to maximize the expected return at a given portfolio risk or minimize risk for a given expected return (Omisore et al., 2012). Return here means the basic motivating force of investors that they anticipate or desire to happen in the future. Meanwhile the actual return is defined from the event that occurs in reality. Risk is described as the probability between the actual outcome and expected one (Omisore et al., 2012).

Markowitz built the expected return-variance rule by mathematical formula in which calculating the mean of return (expected return), the variance or standard deviation (risk) for each stock before calculating the expected return and standard deviation for the whole portfolio with consideration of correlation amongst securities (Markowitz, 1952, 1959). That framework aims to optimize portfolios which are the "combination of assets that have maximum return for a given level of risk or minimum risk for a given level of return" (Jobson & Korkie, 1980). According to the MPT, portfolio return is the proportion-weighted combination of all securities' within, which is defined by the following equation:

$$E(R_p) = \sum_i w_i E(R_i)$$

Where E(Rp) is the expected return of portfolio, Ri is the return on asset i and w_i is the weighting of asset i in the portfolio.

Portfolio return variance is calculated by this equation:

$$\sigma_p^2 = \sum_i w_i^2\, \sigma_i^2 + \sum_i \sum_{j \neq 1} w_i\, w_j \sigma_i \sigma_j \rho_{ij}$$

Where σ_p^2 is the variance of the portfolio; σ_i^2 is the variance of asset i; σ_i is the standard deviation of asset i; ρ_{ij} is the correlation coefficient between the return of asset i and asset j.

The equation can be written in another way:

$$\sigma_p^2 = \sum_i \sum_j w_i\, w_j \sigma_i \sigma_i \rho_{ij}$$

Where ρ_{ij} = 1 for i=j

Portfolio return volatility is the risk of the portfolio, measured by standard deviation which is equal the square root of the variance (Markowitz, 1959):

$$\sigma_p = \sqrt{\sigma_p^2}$$

Covariance is a crucial point in the MPT that Markowitz advised investors to care more about the relationship among assets in portfolios than just focusing on returns of individual security (Markowitz, 1952). According to Markowitz, covariance is "a measure of the extent to which two sets of numbers tend to move up and down together" which simply means the covariance dedicates the movement of pairs of assets in the portfolios (Markowitz, 1959). This measure factor lies between -∞ and +∞ to show that two assets move together (positive) and move inversely (negative). To reduce the risk of portfolios, investors should avoid high covariance (Markowitz,

1952) because the higher covariance portfolios have, the higher volatility they suffer. Moreover, the MPT also said that it is better to invest in different industries with different economic characteristics in order to have lower covariance aiming to lessen the volatility (Markowitz, 1952) or the negative covariance can help to reduce the risk of portfolios. This also implies the importance of diversification in a portfolio to maximize the expected returns. The covariance is computed by the formula (Markowitz, 1952):

$$Cov(i,j) = \rho_{ij}\sigma_i\sigma_j$$

Where $Cov(i,j)$ is the covariance of asset i and j; $\rho_{ij}$is correlation between the return of asset i and j; σ_i is the standard deviation of the return of asset i; σ_j is the standard deviation of the return of asset j.

Not only covariance but also correlation (known as correlation coefficient) is used to measure the volatility of the overall portfolio. The correlation coefficient is a special perspective retrieved from covariance and it measures the relationship's strength of the movement of pairs of assets or "measures the degree to which they fluctuate together" (Perold, 2004). It is between -1 and +1 if it is equal +1 that means two assets perfectly positively correlated or perfectly negatively correlated in the case of -1. If it is equal zero, it means two variables (assets) are uncorrelated. Correlation coefficient is defined by the following equation (Markowitz, 1959):

$$\rho_{ij} = \frac{Cov(i,j)}{\sigma_i\sigma_j}$$

Markowitz (1959) also said that in terms of two variables moving together, the correlation efficiency is easier for interpreting measurement than covariance, but the covariance is more convenient in terms of formulas and proofs.

Markowitz (1952) emphasized the importance of diversification to reduce the risks of portfolio but whether all the variance be eliminated by the diversification. The answer from the MPT is no. The reason will be presented in the chapter Evolution of Asset Pricing Models. The return-risk framework leads to form an efficient frontier from which the investor can choose his/her preferred portfolios based on individual risk appetite (Elton & Gruber, 1997). The figure below shows the efficient frontier:

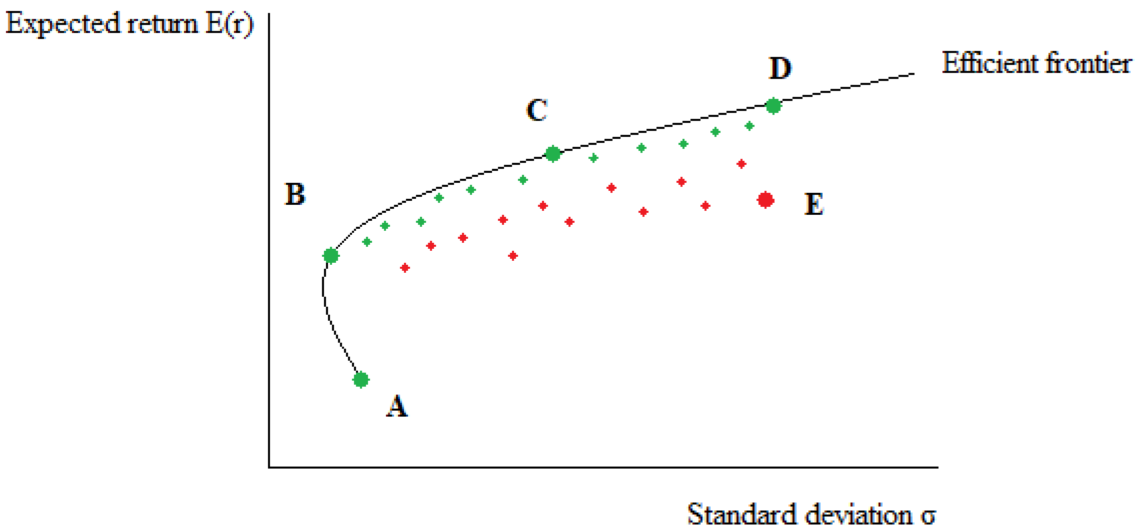

Figure 1. The efficient frontier

This figure presents the efficient frontier. Y-axis represents the expected returns of portfolio. X-axis represents the volatility of portfolios measured by standard deviation. A, B, C, D, E are portfolios. (Omisore et al., 2012; Grasse et al., 2016)

An efficient frontier is a curve illustrating the relationship between risk and return for a set of portfolios (Kierkegaard, 2006). This efficient frontier shows the best possible expected return the investor can gain from the portfolio at the given level of risk or the smallest possible risk for the given level of expected return (Fabozzi et al., 2002).

Markowitz (1959) invented this tradeoff graph between risk and return that is called the efficient frontier now. The line in the graph shows this relationship is not linear, it is a curve drawn from the bottom left to the top right (Kierkegaard, 2006).

It can be seen at figure 1, each portfolio is one dot in the graph. The green dots A, B, C, D are lying on the line, which are the efficient portfolios showing the highest return for a given level of risk (Grass et al., 2016) with different combinations among assets in the portfolio. “A” represents an efficient portfolio suitable for investors who are risk-averse, ignore high risk and gain the comparable return meanwhile, B with the lower risk but gain the higher return because of good combination between risky or non-risky assets. “C” and “D” represent portfolios of investors who tolerate the higher risk to gain the higher return. On the left-hand side, investors are risk-averse and on the right side, investors are risk-seeking. The small green dots are nearly efficient when sitting close to the efficient frontier. There are no portfolios above the efficient frontier, all dots below this line are inefficient portfolios and "E" illustrates the suboptimal portfolio with the same level of volatility as "D" but it cannot gain enough return to compensate for this given risk.

Although the MPT is acceptable widely in the investment world, it remains limited and this paper concentrates the drawbacks of the MPT in terms of responsible investment. First, the MPT assumes investors are rational and the theory just considers two main criteria which are risk and return with the purpose of getting the highest return for the lowest of volatility. Nevertheless, there are some researches that contradict these points of the MPT.

Omisore et al. (2012) pointed that the MPT does not take personal and social dimensions of investment decisions into account. Indeed, Webley, Lewis & Mackenzie (2001) investigated the behavior of ethical investors and they found that ethical investors generally commit to ethical investment although those investments performed badly. Moreover, the study of Ariely, Bracha & Meier (2009) illustrated that monetary incentives are more effective when investment facilitating the private activity, rather than public or prosocial activity however, people can accept the less effective incentive regardless that investments keep in line with their pro-social preferences (PRI, 2018). However, there is good news for investors who are interested in responsible investments. Some studies show they can get better rewards with lower risk for such investments (Moneva, Ortas & Burritt, 2013; Goyal & Aggarwal, 2014).

Second limitation of the MPT is that this theory does not consider environmental perspectives when making investment decisions (Omisore et al., 2012). According to *Principle Responsible Investment* (PRI), the investment community is vital in managing global risks because it determines which endeavors should be financed and form "the world we see today and, in the future,". If the investment community focuses on the environment, the world will pay attention to this field. However, the MPT does not guide investors how to make risk-return optimization in investment combined with climate goals (PRI, 2018). PRI also shows that the ESG risks are considered as unsystematic risks which can be reduced by diversification but ESG goes beyond the specific risk of the company, it is the global risk that has the huge impact on investment and the globe.

Finally, time horizon is another drawback of the MPT that investors' decisions are heavily relied on. Before responsible investment emerges, time horizon is also the subject that many studies illuminate as a factor that investors should consider when making decisions (Levy, 1972; Gollier & Zeckhauser, 2002). Alles and Murray (2009) investigated the practice of investors when they grow order and their investment horizons decrease and conclude that there is a difference in investment outcomes between short horizons and longer horizons. Moreover, they also give evidence to show the "favor of time diversification" up to a horizon of 5 years (Alles & Murray, 2009). The study shows evidence that "the time horizon matters when investors perceive sustainable investment to be volatile and when investors have a longer time horizon, their perceptions of sustainable investment to be volatile does not matter" (Falko & Timo, 2014). PRI (2018) takes an example of climate change, investors just would like to get the return from assets in the short term horizon but these assets affect the goal of climate change, therefore, in the long run, it harms a stable global economy and leads to lower potential returns.

To sum up, the MPT has a huge impact in investment with the known efficient frontier, risk-return framework. However, it also contains some drawbacks that are not appropriate in the new time of responsible investment. Investors nowadays not only care about risk-return optimization but also consider the environmental or social factor when making decisions.

Chapter 4. Evolution of asset pricing models

This chapter focuses on the evolution of asset pricing model from the basic Capital Asset Pricing Model (CAPM) to the Fama-French three-factor model (FF3FM), the Carhart four-factor model and the Fama-French five-factor model (FF5FM). This chapter describes components of single model; the comparison amongst 4 models, the limitations of FF5FM and the guessing future model to adapt the responsible investment.

4.1. CAPM

First and foremost, based on the portfolio theory of Markowitz (1952), the **Capital Asset Pricing Model** was designed on the framework of risk and return aiming to determine the association between risk and return of an investment (Erdinc, 2018; Bodie, Kane, & Marcus, 2014). The CAPM was developed by William Sharpe in 1964, Jack Treynor in 1962, John Lintner in 1965 and Jan Mossin in 1966 (Perold, 2004). The CAPM helps to formulate investment risk and define the return on the investment that an investor should desire. In this model, there are four main points mentioned such as the types of risk, the formula, the measurement of Beta, and the relationship between the efficient frontier and the capital market line.

As mentioned in the previous part regarding risks of portfolio, to answer the question regarding diversification and reduction or portfolio's risk, two types of risk will be illustrated here. Since, the total risk of an investment includes two components: unsystematic risk and systematic risk (Omisore et al., 2012). To be more specific, systematic risk is defined as a part of an asset's variability that is characterized into a common factor (Faborri & Grant, 2001). This type of risk can be known as undiversifiable risk or market risk because regardless of diversification, this risk remains in the portfolio as a result from general market and economic conditions (Faborri & Grant, 2001). In contradiction to systematic risk, the unsystematic can be reduced by a well-diversified portfolio (Lekovic, 2018), therefore, it is also called diversifiable risk or company-specific risk.

The CAPM contributes to investment practices as a way to measure systematic risk of assets (John, Ackora-Prah & Boateng, 2016). Sharpe found the linear relationship between the expected return of an asset and the risk of that asset which includes systematic and unsystematic risk (Fabozzi & Grant, 2001):

$$E(r_i) = r_f + \beta_i[E(r_M - r_f)]$$

where

$E(r_i)$ is the expected return on the asset

r_f is the risk-free rate

$E(r_M)$ is the expected return on the market portfolio

β_i is a term that relates the change in asset i's return to the change in the market portfolio (Fabozzi & Grant, 2001)

In words, Brealey, Myers and Marcus (2012) determine the CAPM as the "theory of the relationship between risk and return which states that the expected risk premium on any security equals its beta times the market risk premium.".

As an investor, when he invests in risky assets, he expects to have the higher return rate on these assets than the return on risk free-rate assets. Therefore, the minimum return is equal the risk-free rate. The investor would like to have a premium as a compensate for the risky investment that called premium market which is the divergence between expected return of market and the return on risk-free asset.

β or beta is the sensitivity of stock i to excess return on a market portfolio (Erdinc, 2018). It measures systematic risk or the volatility of an individual security or a portfolio when comparing to assets at a whole market (Fabozzi & Grant, 2001). The market portfolio has beta equal 1.0. If a stock has a beta less than 1.0, it means the security is less volatile than the market and vice versa.

The model of this equation can be built with the relationship between the efficient frontier and CML (Capital Market Line). The efficient frontier is illustrated in the previous chapter which shows the trade-off between risk and return of portfolio it means when an investor expects higher return, he has to sacrifice higher risk and vice versa. Sharpe (1964) defined capital market line is the line on which the investor can obtain "a higher expected rate of return on his holdings only by incurring additional risk". After that the risk-free investment is considered in his research, the CML now is understood as the concept represents the optimal portfolio in combining risk and return or in other word, it shows the portfolio that given the highest return for chosen level or risk, or the lowest risk for a chosen level of return (Lee & Su, 2014). However, the ultimate aim of an investor is to have the highest return at the lowest risk, and the combination of the CML and the efficient frontier can help investors identify a point that satisfies his expectation. The point is tangency between the efficient frontier and the CML can satisfy that expectation.

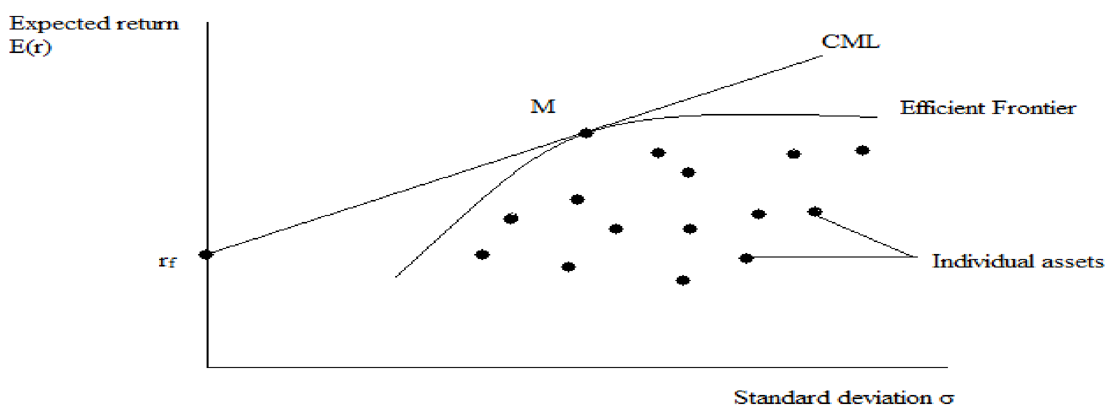

Figure 2. The CML and the efficient frontier (Perold, 2004)

This figure shows the CML and the efficient frontier. Y-axis represents expected return of portfolios. X-axis represents volatility of portfolios measured by standard deviation. Rf: risk-free rate. M: one portfolio at the tangency between the CML and the efficient frontier.

In this graph, the CML begins from the risk-free rate point and the efficient frontier including portfolios of risky assets, the investor finds the point that gives back to him the return higher than risk-free assets' return for their investment on risky assets. At point M, the investor can receive the return at highest level and has the highest Sharpe ratio[1]. However, point M can be different with the allocation between risky assets and risk-free assets and depended on the investor's risk tolerance (Perold, 2004) to build optimal portfolio on their appetite.

4.2. Fama – French three-factor model (FF3FM)

The CAPM is a useful tool to help investors find optimal portfolios for their investment; however, it faces some critiques (Womack & Zhang, 2003). In fact, there are some academic research articles that show that the actual return is different from the expected return calculated by the CAPM model. The most influential research stated the CAPM "has never been an empirical success" (Fama & French, 2004). As a result, the CAPM points that "if a security's beta is known, it is possible to calculate the corresponding expected return (Womack & Zhang, 2003). Nevertheless, Fama and French (1993) conducted a study to analyze 25 US based equity portfolio found that beta in CAPM just explain 70% of the return of the market or 70% actual return (Sekreter, 2017) and they made attempt to explain the rest 30% (Fama & French, 1993). Fama and French expanded the CAPM with two more other factors that strongly affect the performance of portfolios. They are "value" and "size" factors. Fama and French (1992, 1993) proved that the value stocks can bring abnormal returns compared to growth stocks, similarly small-cap stocks outperformance when in comparison with large-cap stocks. They constructed two factors: SMB to address size risk and HML to address value risk (Womack & Zhang, 2003). At this moment, the asset pricing model includes three factors including size of firms, book-to-market values and excess return on the market, in which, the SMB and HML is expanded risk factor to risk premium factor.

- Risk premium: the difference between the return of a risky asset and the return of a risk-free asset. This factor is presented in the CAPM.

- Small Minus Big (SMB) or size premium: SMB measures the additional return that investors received by investing in stocks with the small market capitalization (Karp & Vuuren, 2017).

[1] Sharpe ratio is the slope of the CML and it is calculated by the risk premium of risky asset dived by the risk of this asset. Sharpe ratio = $(Er_M - r_f)/\sigma_M$ (Perold, 2004).

- High Minus Low (HML) or value premium: measure the premium that investors gain when investing in high book-to-market stock values (Bartholdy & Peare, 2004).

By combining the original market risk factor and the new size risk and value risk factor the Fama-French 3 Factor (FF3F) model is the model that is familiar to investors. The formulate is calculated by (Womack & Zhang, 2003):

$$E(r_i) = r_f + \beta_1[E(r_M - r_f)] + \beta_2 SMB + \beta_3 HML$$

Where:

$E(r_i)$ is the expected return on the asset

r_f is the risk-free rate

$E(r_M)$ is the expected return on the market portfolio

$[E(r_M - r_f)]$ is risk premium which is divergence of market return and risk-free market return

SMB is a size risk factor, value is equal to the return of stock with small market capital minus return of stocks with large market capital.

HML is a value risk factor, value is equal to the return of stocks with high book-to-market value minus return of stocks with low book-to-market value.

β_1 is coefficient to measure the exposure an asset has to market risk, β_2 measures the level of exposure to size risk; and β_3 measures the level of exposure to value risk (Womack & Zhang, 2003).

By applying 2 new factors to expand the original CAPM, this model based on the cross – sector regression of average return (Fama & French, 1993), and there are many academic researches showing the efficiency of the FF3FM is better than the CAPM in predicting excess return. In fact, Womack and Zhang (2003) found that the CAPM has an R square (R^2) equals 0.85 in while, the FF3F model has R^2 0.95. Moreover, a research proving the effectiveness in explaining excess return from Dhaka Stock Exchange for five companies in the Cement industry is conducted by Sattar (2017) proves that the adjusted R square of the FF3F model is higher than the CAPM at confidence level 95% and very low p-value. Therefore, he stated that the ability of predicting exactly the 3-factor model is better than the CAPM model. Karp and Vuuren (2017) also show the

FF3F model (adjusted R^2 range: 11.32% to 50.00%) outperforming the CAPM (adjusted R^2 range: 3.14% to 6.25%) when doing study on 46 JSE stock from 2010 to 2015.

However, there are some empirical studies that show that the FF3F model is not much better than the CAPM in case of explaining return. Bartholdy & Peare (2004) found R^2 of the FF3F is very low with only 5% compared to the R^2 of the CAPM with 2%. Lam (2005) points that "the three-factor model may be better than the CAPM with the 25 portfolios but definitely not better than the CAPM with the 30 industries" after he conducts the empirical study of two data set: 25 portfolios formed on size and the book-to-market ratio and the 30 industries formed on the nature of the business over two time periods 1926-2004 and 1963 -2004.

4.3. Carhart four-factor model

The Carhart four-factor model is expanded from the 3-factor Fama-French model by adding the fourth factor which is the momentum factor (Kampman, 2011). This factor is proposed by Carhart to contribute more exactly to the performance prediction of securities. Fama-French (1996) stated that their equation with 3 factors "cannot explain the continuation of short-term returns" which is written in Jegadeesh and Titman (1993). In fact, Jegadeesh and Titman "uncovered a tendency for good or bad performance of stocks to persist over several months" which is momentum property or momentum effect in other words (Bodie et al., 2014). It means if in the past, stocks have the rising price or declining price, they continue that tendency in the future with positive return for up price and lost value for down price. Carhart (1997) built the model by adding momentum factor into the three-factor model of Fama-French to create the four-factor model and evaluate the mutual fund performance instead of stocks used in Fama – French's paper (Rehnby, 2014). The WML is created the same way with another risk factor of Fama French which is the excess return of Winner that went up minus Loser that lost value (Kampman, 2011) and this factor based on 1-12 months of past return (Bodie et al., 2014).

The formula of this model is shown as followed:

$$E(r_i) = r_f + \beta_1\left[E\left(r_M - r_f\right)\right] + \beta_2 SMB + \beta_3 HML + \beta_4 WML$$

Where:

$E(r_i)$ expected return on assets

r_f is the risk-free rate

$E(r_M)$ is the expected return on the market portfolio

SMB is value of Small (cap) Minus Big (size factor)

HML is value of high (Book/Price) Minus Low (BE/ME factor)

WML is value of Winners Minus Losers or return of the momentum factor

$\beta_{1,2,3,4}$ are beta values of three independent variable $(r_m - r_f), SMB, HML, WML$

As known before, the Carhart four-factor model considers the momentum effect to the FF3FM to predict the performance of securities better. However, some research studies point to the uncertainty of this model when comparing CAPM or FF3FM in case of predicting stocks performance. The study of An-Sing and Shih-Chuan (2009) showed the evidence in the Pacific Basin markets that the FF3FM have better performance than the CAPM but there is no evidence supporting the Carhart four-factor model outperform the FF3FM or the CAPM, even they found that the three-factor model was slightly better than the four-factor model (Rehnby, 2014).

In contrast, Bello (2008) had different statement when he evaluates mutual funds instead of stocks and come to conclusion that the four-factor model is "a significant improvement" over the FF3FM.

In another case, Lagvilava (2014) investigate the role of the four-factor model to the AAII (American Association of Individual Investors) generated portfolios. The author used Jensen alpha, CAPM and the Carhart four-factor model, but the Carhart four-factor model has the "highest explanatory power".

We cannot deny the fact that the Carhart four-factor model contributed to the investment decision of investors, we, nevertheless need to consider the circumstance and the stock market, objects we investigate to apply it or not. Because, at the very first study, Carhart used this model to evaluate mutual funds. Therefore, if we use this model for evaluating stocks performances, it can meet some problems.

4.4. Fama-French five-factor model

The Fama-French five-factor model is built on the base of the three-factor model with adding two factors naming profitability and investment (2015a). In this paper, Fama and French stated that the five-factor model can create better performance when compared to the three-factor model in terms of average stock returns. Profitability and investment are motivated to add to the market, size, value/growth factor of the Fama-French three-factor model by the dividend discount model (Fama & French, 2015a, b) which points that the value of stock today is relied on the future dividend. There are many anomalies to the three-factor model such as Novy-Marx (2013) showing the strong relation between expected profitability and average return; Ahroni, Grundy and Zeng (2013) with document presenting investment is related to average return; Fama and French (2008) illustrating momentum affects average return; or Ang et al. (2006) finding high volatility leading low average returns. However, Fama-French just chose two factors which are profitability and investment to integrate the three-factor model (Fama & French, 2015b). To be more specific, the profitability factor is understood that the firm has the higher profitability brings the higher return (Fama and French, 2006) or it means the sock belonging companies report the higher future earnings create the higher returns. In another case, suggesting companies use the profit to internal investment for projects that makes the return of stock on the market lower.

Two above factors are added to the three-factor model, there is a Fama-French five-factor model shown in following equation (Fama & French, 2015a, Kubota & Takehara, 2018).

$$E(r_i) = r_f + \beta_1\left[E\left(r_M - r_f\right)\right] + \beta_2 SMB + \beta_3 HML + \beta_4 RMW + \beta_5 CMA$$

In this equation:

$E(r_i)$ is the expected return on the asset

r_f is the risk-free rate

$E(r_M)$ is the expected return on the market portfolio

SMB is value of Small (cap) Minus Big (size factor)

HML is value of High (Book/Price) Minus Low (BE/ME factor)

RMW is value of Robust Minus Weak profitability.

CMA is value of Conservative and Aggressive or the divergence between returns on portfolios of the stocks belonging the companies focusing on low and high investment.

$\beta_{1,2,3,4,5}$ are beta values of three independent variable $(r_m - r_f), SMB, HML, RMW, CMA$

Not only helping investors in making investment decision but also emphasizing the application of cross-section regression for this model (Fama & French, 2006) in academic and practical circumstances.

In order to prove the efficiency of the five-factor model, there are many articles conducting this model in their specific market. For instance, in the Chinese stock market over the period 1994-2016, Huang (2019) confirmed the Fama-French five-factor model has outperformance compared to "the traditional asset pricing models in explaining individual stock returns". In another case, Sundqvist (2017) investigated whether a FF5FM has a better explanation of average return than FF3FM and CAPM on a sample of Nordic stock data and concluded that the five-factor model is "closest to a complete description of average return". A study on Indonesia stock market shows that the profitability is positively related to return but not significant; and the size and investment have a significant negative effect on return (Wijaya, Irawan & Mahadwartha, 2018). Kubota and Takehara (2018) investigated the explanation of the FF5FM in Japanese data during the period 1978 to 2018 and came to the conclusion that "the original version of the Fama and French five-factor model is not the best benchmark pricing model" for this market. In 2017, Fama and French checked their own model by investigating international regions such as North America, Europe and Asia Pacific. They concluded the average stock returns of such markets grow with the B/M and profitability and have a negative effect on investment. In the case of Japan, they found the average return showing little relation to profitability or investment which is similar to the conclusion of Kubota and Takehara (2018).

Although Fama and French shows the better prediction of stock returns on the five-factor model in their paper and many articles also show as well, it still meets anomalies. In their own research, they mentioned their model fails to capture the "low average returns on small stocks whose returns behave like those of firms that invest a lot despite low profitability" (Fama & French, 2015a). There are emerging concerns from the article of Blitz, Hanauer, Vidojevic and Vliet (2017) showing five anomalies of the five-factor model. The first concern is that the five-factor model still uses the CAPM which illustrates the relationship between risk and return meaning a higher market beta should lead to a higher expected return. However, there are a lot of literature showing otherwise (Robeco, 2018). The second concern is about momentum. Although many articles prove the impact of momentum on return and Carhart also added it in the Fama-French three-factor model, the Fama-French five-factor still skips this factor. The third concern is the robustness of the two new factors when the FF5FM has failure to explain the variables relating to two selected ones (Blitz et al., 2015). The fourth concern is the economic rationale behind the model. If the size and value factor are considered as priced risk which might capture the risk of financial distress, the profitability and investment are not proved as risk factors capturing distress risk. It is not clear when Fama and French retrieved these factors from the dividend discount model raising the refusion between distress risk and mispricing (Robeco, 2018). The fifth concern is that the five-factor model may not lead to consensus because more and more documents challenge each factor of this model and this has to compete with other models or alternative models (Blitz et al., 2015).

With this part, the evolution of asset pricing model is illustrated, we come from the basic model CAPM to Fama-French three-factor model, Carhart four-factor model and the Fama-French five-factor model; and see the improvement as well as the existing anomalies still containing in single model. It will not be exact when we say the latest model is the best model to predict the return of stocks and they are indeed to discuss more in the future. However, we cannot deny the fact that these models help investors much more in forecasting the expected returns of stocks and make the process of making investment decisions easier. This thesis uses all asset pricing models in this literature review to answer the research question.

Chapter 5. Portfolio management and responsible investment

As we already know portfolio management including the activities of selecting stocks and guarantee the maximization of portfolio, this work of portfolio managers (for others and for themselves) requires the skill of picking stocks and the better understanding of the model as well as theory to apply in their portfolio and meeting the expectation of the investors.

The previous chapters give the understanding basic portfolio theories for investors, which support in the process of portfolio management. This chapter will go further in portfolio management to see how portfolio theory is applied; and the shift to responsible investment as well as the linkage between performance management and responsible investment will be illustrated.

Portfolio management is not a skill or a mathematical method, it is a process of managing money or in order terms, it is a process of investment management, asset management and money management (Pachamanova & Fabozzi, 2016) aiming to maximize return and minimize risk.

The process of portfolio management including three main steps: planning step, execution step and feedback step (CFA, 2020). In the first step, investors or portfolio managers identify the target they want to achieve regarding the investment return requirement, risk tolerance, the time horizon (Levisauskaite, 2010). The next step is about portfolio construction with the work of analyzing the securities and evaluating them, how to diversify and allocate them (Rai, 2020). The portfolio theories and the asset pricing models are applied in phase. These theories are present in the previous chapters and they are used to link with the responsible investment in this chapter. The last step involves measurement of portfolio performance in terms of the return earned and the risk of the portfolio (JNU, 2014).

According to Levisauskaite (2010), there are two types of investment portfolio management which are active and passive portfolio management. Each kind has advantages and disadvantages that investors need to consider before choosing the mutual fund or choosing the portfolio manager. There are three key points reflecting the features of passive portfolio management which are: securities are hold in the portfolio for a long time and rarely changed; investors consider the market is efficient and they tend to choose index funds to follow (Barnes & Scott, 2008); and passive investor or passive manager will mimic the benchmark instead of trying to outperform this benchmark (JNU, 2014). By contrast, active managers believe the market is inefficient, and they earn abnormal returns through mispricing (Kremnitzer, 2012). Moreover, active fund managers aim to outperform the benchmark and they tolerate more change in the portfolio than passive managers (Levisauskaite, 2010). However, investors focused on actively managed funds will be charged more and it reduces the net investment returns (Barnes & Scott, 2008).

The next part in this chapter discusses responsible investment (RI) and the link to performance management. Responsible investment nowadays is not a new concept to investors, but to understand better, the definition of this term and why responsible investment matters are first presented.

The definition of RI is ongoing debate in different academic articles, they raise the heterogeneity in defining this terminology (Sandberg et al., 2009). This author also found that RI refers to the "integration of social, ethical, environmental and/or corporate governance concerns in the investment process" (Sandberg et al., 2009). Dumas and Louche (2016) summarized some different terms such as “ethical investment”, “green fund”, “socially responsible investment-SRI”, “sustainable investment” and “ESG investing” when talking about responsible investment.

PRI (Principles for Responsible Investment) defines responsible investment (investing) as “a strategy and practice to incorporate environmental, social and governance (ESG) factors in investment decisions and active ownership” (UN PRI, 2019). Moreover, this investment creates long-term social, environmental and economic value in the long term or generates both financial and non-financial value creation (ILG, 2014). Aligning in Sustainable Development Goals (SDGs), responsible investment is “the application of the concept of sustainable development to investment” (ILG, 2014). Sustainable Development is the Goal in 2030, specifically with 17 Goals need to be achieved in 2030 (UN, 2019). In such goals, the SDGs put the universal goals for society and all stakeholders including investors (UN PRI, 2020a)

According to UN PRI (2020a), the role of the financial system is important in shaping outcomes aligning with the SDGs. To be more detail, responsible investment is the specific case of the economy in contributing to sustainable global goals.

Regarding GSIA (Global Sustainable Investment Alliance), the *Sustainable Investment Review* summaries the status of sustainable investing assets in five major markets which are Europe, the US, Japan, Canada, Australia and New Zealand with the figure of USD 30.7 trillion in early of 2018 that increasing 34% when comparing to the figure in 2016 (GSIA, 2019). Before that, the number in this investment was USD 18.3 trillion in 2014 growing up to USD 22.9 trillion in two years later with 25.2% increase (GSIA, 2017; Colby, 2017). The figure of the amount of sustainable investment going up shows the development of this type of investment at the latest years.

There are three motivations driving responsible investment as an emerging issue in the financial market. The first is the context of the current world affecting the investment with climate change, the scarcity of resources, the prevalence of health and inequalities (ILG, 2014). Besides, since the 2008 financial crisis, there is an increasing regulation in RI in both national and international level relating to climate change, modern slavery, or tax avoidance (UN PRI, 2020b).

The second reason is about investors. Investors are more aware about the sustainability, ESG factors and they require more transparency about how and where their money is invested (UN PRI, 2020b). In fact, the habit of investors is changing when millennials are indeed interested in seeking financial advisors providing values-based investing or investing in companies using high quality ESG practices, or exiting an investment due to negative firm activities (Nanayakkara et al., 2017).

Finally, returns and risks are the matters to investors when they invest. Among different academic scholars, there are a lot of articles showing the benefits of responsible investments especially the positive impact of ESG factors on return and value creation of firms (PRI, 2020b). This motivates both companies and investors to integrate ESG issues in the decision of investment and corporation.

To invest responsibly, there are two prominent overarching ways which are ESG incorporation and active ownership or stewardship with five strategies in total (UN PRI, 2020b). ESG incorporation means that investors or portfolio managers consider ESG issues when constructing a portfolio. Three approaches used are integration, screening and thematic. In that case, "ESG integration" means putting ESG information in the process of investment such as analysis to create the higher return and manage the risk better (NGFS, 2019). Different from ESG integration, "screening" approach applies filters to the list of potential investments which can include the stocks of best-in-class companies or exclude the stocks presenting negative impact based on the preference of ethics and values of investors (Eurosif, 2020, UN PRI, 2020b). "Thematic" aims to find the investment that satisfies optimal return-risk as well as impact on the environment and society; impact investing belongs this category (UN PRI, 2020). Engagement and proxy voting are two approaches to drive investors to engage more in the activities of companies by discussing or voting in terms of ESG issues (UN PRI, 2020).

The last part of this chapter is talking about the linkage between portfolio management and responsibility with the observation in depth in the conflicts or the supporting points of portfolio theory to responsible investment. With the rise of responsible investment and the demand of clients (investors), conventional asset managers are forced/motivated to incorporate environmental, social and governance (ESG) factors in their investment management process (Duuren, Plantinga and Scholtens, 2016). Moreover, they found that ESG information is used to manage risk and for red flagging. In the investment process, to optimize the portfolio, theories and models are most used such as the EMH, the AMH, the MPT, the CAPM, the FF3FM, the Carhart 4-factor model and the FF5FM. In the revolution of sustainable investment, these theories can support or hinder this type of investment.

The efficient market hypothesis states that all the information in the market is involved in the price of stocks (Fama, 1965b), however, this statement meets the opposing opinion with evidence from the articles that are shown in the part of EMH in this thesis. Especially in the case of sustainability, "the price should become equal to sustainable value" which reflects the present value of future expectations and the impact of short-term shareholders (Badia, Serrats & Rodon, 2018). Moreover, in this article, they found that the ethical emphasis is involved in the process of price determination; and concluded that the price of stock is a combination of sustainability information and financial information.

The second tenet of the EMH is mentioned about the impossibility of creating abnormal return, however, there are many articles showing the contradict result in case of responsible investment. Ang and Weber (2018) analyzed the market efficiency of socially RI in Korea in the period of 2006 and 2015 and they found that the future price of socially responsible investment in Korea is dependent on historical data. This is against the theory of weak form in the EMH which presents that there is no relationship between the price of stock in future and the previous stock price. This evidence in Korea implies that it is possible to predict the future of socially responsible investment and from that, investors can get higher returns. The study on Indonesia market supported this result when they explored that the past stock prices can describe its future prices and investors can use adequate technical analysis to gain abnormal return (Agustin, 2019). More articles relating to ESG integration with positive and negative results will be presented in part of ESG integration and related issues.

The adaptive market hypothesis is considered as an alternative framework for sustainable finance or responsible investment and long-term investment instead of efficient market hypothesis for traditional investment (Schoenmaker & Schramade, 2019). The AMH is used as a theoretical framework in the study on the ESG performance in India to explain the investor behaviors because the AMH suggests that investors can adapt their behaviors when the market condition, risk and returns change (Johansson & Lundstrom, 2015). The changing investor behaviors toward sustainable investment aligning the sustainable development goals, the regulations which implies the adaptable ability of investors. The AMH, therefore, is the appropriate framework when investigating the ESG incorporation.

The modern portfolio theory of Makowitz (1952) is important for portfolio construction that every investor understands, but whether the suggestion of this theory can support responsible investment. In the chapter of the MPT, the limitations of this theory relating to environmental perspective or ESG issues were presented. The following paragraph discusses more the limitations of the MPT when it comes to environmental and societal issues and introduces the way to synchronize this theory with RI. Lydenberg (2009) drew limitations of the MPT in the context of current market context, the author stated the ability of this theory in measuring financial returns and financial risk. Whereas formulas do not help in case of climate change, or how to help investors allocate dollars in investments that bring benefits to society. He concluded that the MPT fails to measure "the complicated task of valuing the societal and environmental implications of investment". In the same vein, Peylo (2012) argued that the MPT excludes all nonmonetary aspects from view and thus creates the "rift between conventional and sustainable investment". In fact, in the process of the asset allocation, sustainability is applied by positive or negative screen strategy "but they have no effects on the actual composition of the portfolio in this process" (Peylo, 2012). By understanding that at the moment the financial analysis conducted based on the MPT which does not support sustainability criteria to integrate this analysis, he suggested the three-dimension framework to make sure the sustainability integration in the portfolio selection and optimize portfolio as the MPT.

In the marriage of the portfolio management and the RI, the theories can be supportive or opposed or upgraded to fit this type of investment. However, not only the theory but also asset pricing models as tools to help investors manage their investment by evaluating the expected return generated from the RI. This issue will be illuminated in the next chapter of the literature review.

Chapter 6. ESG integration and related issues with asset pricing model

Known as the first approach in the path of aligning responsible investment into the sustainable global goals, ESG integration plays an important role at the beginning and involves in the process of portfolio management. Especially, in the evaluation phase, the asset pricing model is applied to measure the expected return of the portfolio in terms of the RI. In this chapter, the definition of ESG integration and the method to conduct this approach into portfolio management is explained clearly. Then articles showing the results when integrating ESG related criteria into the portfolio and into the analysis will be illustrated. In the meantime, such results in comparison to the expected result of this thesis will be presented so as to illuminate the gap and contribute to the literature in the future.

ESG is known broadly that stands for environmental, social and governance issues but interestingly, there is no existence of a definitive list of each sub-category (UN PRI, 2017), instead, they provide examples of ESG issues. Environmental (E) is the issue correlated to “the quality and functioning of the natural environment and natural systems, including biodiversity loss, greenhouse gas (GHG) emission, climate change, renewable energy, etc. Social (S) is an issue relating to “the rights, well-being and interests of people and communities” such as human rights, labor standards in the supply chain, child, slave and bonded labor, etc. Governance (G) is considered as the issue connecting to the governance of companies and other investee entities, for example, board structure, size, diversity, skills and independence, etc. In the global context toward sustainable development with the urgent warning of climate change, investors play an important role to contribute to this tendency through their investment.

ESG integration is one of three approaches to engage responsible investment into investment decisions, beside screening and thematic investing (UN PRI, 2016). Eurosif (2014) defines ESG integration as “…the explicit inclusion by asset managers of ESG risks and opportunities into traditional financial analysis and investment decisions based on a systematic process and appropriate research sources”. According to ILG (2014), ESG integration is different from best-in-class because three dimensions of ESG factor of a company are “analyzed at a more fundamental level”. It means that the institutional investor and asset manager will investigate strictly the business model, product strategy, distribution system of the company to provide the trustworthy ESG analysis to clients (investors). UN PRI (2017) defines integration of ESG issues as “the systematic and explicit inclusion of material ESG factors into investment analysis and investment decisions”. This definition is closest to investment, investors and portfolio managers. To be more in depth, in the lens of active strategy, ESG integration means integrated analysis for “active stock-picking or other equity investment includes analyzing how ESG issues can affect financial performance of a company or how ESG issues can affect an issuer’s creditworthiness”. The fund can use quantitative modeling to pick stocks or bonds. When it comes to passive investing, integration of ESG issues means that the funds modify index constituent weights and exclude controversial stocks or choose stocks with less risk than the parent index (UN PRI, 2016). On the other hand, ESG integration can be understood from a company perspective. In this case, ESG with sub-categories may influence the financial performance of infrastructure companies. For instance, GHG emissions are linked to tax and provisions; physical climate change impacts, waste and stakeholder engagement impact revenues; raw materials and supply chain connect to CAPEX of company (Weber, B. & Rendlen, 2020).

This guidance note gives examples to support investors to develop ESG integration thoughts. To give more information for asset owners, UN PRI (2016) issued a practical guidance to ESG integration for equity investing. The integration model includes 4 stages in which there are following activities. The first stage is qualitative analysis meaning investors will collect information from different sources and determine important (material) factors influencing the firm. The second step is quantitative analysis in which investors consider the financial factors of their portfolio to modify financial forecasts or use a more suitable valuation model.

The next stage is the phase of investment decision making, investors are based on two above steps to decide to increase, remain or decrease weighting in responding to buy, hold or sell stocks. In the last phase, investors through their investment can support company engagement and voting (UN PRI, 2016).

To help the model is operating, there are four integration techniques in four different strategies, which are fundamental strategies, quantitative strategies, smart beta strategies and passive and enhanced passive strategies. Activities in the fundamental strategies are similar to stage two. Quantitative strategies are also considered as systematic strategies in which the ESG factor will be integrated next to other factors such as value, size, momentum, growth, and volatility. This is the strategy that this thesis is working on. Smart beta strategies focus on ESG scores which can be applied in portfolio construction to help investors gain higher risk-adjusted return. The enhanced passive strategies aim to improve performance by tracking an index that integrates ESG factor already (UN PRI, 2016).

After having the knowledge and understanding of the guidance to incorporate the ESG in investment, investors can look at research and practice cases to know how ESG integration works. Since this thesis investigates the efficiency of the ESG factor when integrating in the model together with other traditional factors. Most relevant articles, thus, emphasize on the evaluation model and analyze the performance of the portfolio after applying ESG factors.

Evidence from Taiwan shows there is a significantly positive relationship between the fulfilling corporate social responsibility and stock market performance (Wang, 2011)

Edman (2011) used monthly regressions of a portfolio including 100 best companies working in America and applied the 4-factor Carhart model to conduct his study. He concluded that the high employee satisfaction leads to the positive risk-adjusted returns at a statistically significant level.

In the guidance note of UN PRI (2016), there is a practical case of U.S. Large Cap Sustainable Alpha Fund conducted by Bertolotti and Hoepner. They combined ESG ratings risk-free rate, size factor and value factor on the Fama-French model to attribute ESG analysis and explain the portfolio's return. They showed that the S, E, G factor can explain 1.6%, 2.4% and 2.7% of the positive excess returns respectively.

In the discussion paper of Amundi, they found in the period 2014-2017, there was a source of outperformance in Europe and North America. In Eurozone, the positive returns can be generated by all dimensions of ESG and ESG score with the dominating position belonging to the governance aspect (Bennani et al., 2018). This article also shows that responsible investing has become a beta strategy in Europe, ESG is a risk factor however, in North America, this investing is still considered as alpha strategy. We have more clue to apply ESG as a risk factor to incorporate in the model and apply it to the European stock market in the empirical research.

Derwall et al. (2005) also applied performance attribution models in answering the question whether SRI brings the inferior or superior portfolio performance. Their results presented evidence that the portfolio with high-rank in eco-efficiency led to the substantially higher average return when compared to low-rank in the period of 1995 – 2003.

One study conducted by Cai and He (2014) found an equal-weighted environmentally responsible portfolio can gain alpha from the fourth year in the period of 20 year from 1992 to 2011. In terms of ethical investing, using the US data, there was a weak evidence of a slight outperformance of higher ESG-score-companies against lower ESG-score-companies (Traaseth, 2016). In the general case, Breuer and Nau (2014) found the positive relationship between ESG performance and financial performance when conducting study on 100 listed U.S. companies in technology factor and constructing the portfolio based on ESG score.

Friede et al. (2015) collected the evidence from more than 2000 empirical studies and they found that most studies present the positive relationship between ESG criteria and corporate financial performance (CFP). However, in case of responsible investing, the authors suggest investors should understand how to integrate ESG criteria into the investment process to benefit from ESG integration. Bush, Friede. Lewis and Bassen (2018) dug in depth into this relationship and came out with the highly significant ESG-CFP correlation. Moreover, this correlation is still positive when companies focus on environmental or social factors which is opposite to other empirical studies emphasizing that just social factors create the positive CFP.

To answer the question of how the ESG factor impacted the asset pricing in the equity market, Bennani et al. (2018) do a study to answer whether ESG is a new risk factor first. Authors regress stocks returns on the CAPM, five-factor model and five-factor model plus the ESG factor to compare the impact of ESG factor in explaining returns. The result showed that the plus factor accounted for a minority of impact in both areas including North America and the Eurozone. It implies that the ESG factor cannot help the five-factor model improve explanatory power significantly.

Tissen (2018) found that the ESG trading strategies neither create a significant positive alpha nor outperform conventional benchmark when it comes to monthly mean excess returns. However, with upper ESG trading strategies, the portfolio shows the outperformance against the conventional benchmark. This paper uses asset pricing models such as CAPM, the FF3FM, the FF5FM to investigate the efficiency of ESG portfolios which are constructed based on ESG ratings, nevertheless, it does not consider ESG as a factor to integrate directly in the model.

Drei et al. (2019) research is updated version of Bennani et al. (2018) by adding more periods to observe and they have the same results that in 2010-2013 period, ESG investing created the negative return for both passive and active ESG investors but outperformed from 2014 to 2019 in Europe and North America.

Kaiser (2018) with the same method with Bennani et al. (2018) in applying ESG factor in the evaluation model to see the impact of ESG factor. First, the author stated that investors in terms of value, growth and momentum can enhance the portfolio's sustainability performance in the U.S and Europe. Secondly, combining the sustainability aspect in the model, he found that there was a "significant reduction in systematic risk in the full spectrum except for value portfolios".

The latest version of examining ESG factor in Fama-French factor model to evaluate ESG effects on risk and return is conducted by Morningstar (Wang and Sargis, 2020). In this study, Morningstar constructed ESG BMW portfolio (Better Minus Worse portfolio) to incorporate this factor in Fama-French models and found that in the global equity market, there is no statistically significant monthly return coming from the ESG BMW portfolio compared to other portfolios in the same context. In contrast, investors investing in North America have no benefit from a good ESG score based on Sustainalytics' ESG score data.

In the stream of using Fama-French five-factor with ESG score but with opposite results, a study on the S&P 500 in a period 2002-2017 showed that the low ESG score-portfolios outperform the portfolio with high ESG score. Moreover, the high ESG score-portfolio leads to negative abnormal returns (Franzen, 2019).

More than 40 years ago, some authors had investigated the relationship between corporate social responsibility and stock market performance and the results imply that there is no significant relationship between them (Alexander and Buchholz, 1978; Aupperle, Carroll & Hatfield, 1985).

A study using the KLD ratings data of period 1991-2004 and the four-factor Carhart model brought a hope for investors that there is no loss for performance of the socially responsible portfolio. (Kempf and Osthoff, 2007)

Galema, Planinga and Scholtens (2008) stated that if each dimension of SRI has negative effects on performance that leads to the whole SRI scores reducing the relationship between this investment and stock returns. Secondly, by regressing on the Fama-French model, SRI is related to lower book-to-market ratios.

Heijden (2012) wondered if responsible investing is value creating or a waste of costs, then, constructed hypothetical portfolios based on ESG scores. However, he cannot find any evidence to conclude RI creates value or incurs a cost. He also used the CAPM and the FF3FM, but the results indicated that there is a negative alpha in the low beta segment and vice versa in case of the high beta segments. The important point is that the portfolio is sorted based on sustainability performance and did not impact return.

However, by developing the hand-mapping sustainability rating data based on the material issues of specific companies in each industry, Serafeim and other authors (2019) gives the first evidence of materiality with the positive results. The companies with good ratings on material issues outperform in comparison with poor ratings in the same issues. Conversely, in case of immaterial issues, the companies with good ratings cannot outperform firms with poor ratings on these issues.

Also using the SASB material items, Henriksson et al. (2018) classified companies into good and bad ESG and found that materially good ESG companies present better abnormal returns than materially bad ESG companies, but the difference was statistically insignificant. In contrast, when using all ESG items, bad ESG companies outperformed Good ESG companies and the differences were not statistically significant. Moreover, they created an ESG -Good-Minus-Bad (GMB) factor to add in Fama-French five-factor model, and found that the Good ESG companies with material SASB on exposures to the GMB factor have statistically higher mean annual abnormal return than that figures of Bad ESG companies. They also emphasized that the universe of Good and Bad companies is extended when using exposure instead of ratings (Henriksson et al., 2018). Hubel and Scholz (2020) supported the importance of ESG exposure than ESG ratings because they found evidence that the ESG factor adding in the model helps better explanation to predict performance.

In another practical case, Blackrock, the world's biggest asset manager, states that they cannot find evidence of a climate change risk premium for equities, but they hope in the future there may be (Allonby et al., 2015). Moreover, Ahlklo and Lind (2019) also gave the conclusion which does not support the relationship between ESG score and financial performance in both market and accounting perspective. They did analysis on the Nordic stocks and Sustainalytics ESG rank and they did not use the asset pricing model.

In the vein of ESG research comparing the performance of socially responsible investment versus conventional indices, Derwall et al. (2005) stated that SRI funds and conventional funds are different in style but similar in creating alphas. Renneboog et al. (2008) found that the SRI funds in Europe and Asia, which focus on the international market, underperform domestics factor models. Besides that, they also found in most countries, SRI funds outperform conventional funds. Utz and Wimmer (2014) examined SR and conventional mutual funds in terms of financial and ethical parameters and they concluded they cannot find the extreme differences in their financial performance but in case of ethical performance, they demonstrate that "SR mutual funds are not holding considerably more ethical assets on average". In the same year 2014, when it comes to indices, Belghitar, Clark and Deshmukh argued that the performance between SRI (FTSE4Good) and conventional investment is not significantly different covering the UK, US, Europe and Global geographical regions.

Conclusion of the literature review

In summary, the literature review shows the major concepts of portfolio and responsible investment. The important point is to find a way to integrate the sustainability-related factor into the available framework aiming to help investors align in the sustainable development of the globe as well as satisfy the portfolio-optimization purpose of their investment. To be more specific, the ESG-related factor plays two roles in this thesis. First, based on ESG score, the ESG GMB (Good minus Bad) portfolio is constructed. The performance of the high ESG-scored portfolio will be compared to the low-ESG score; the portfolio with ESG data is compared to the portfolio with non-ESG data. Secondly, the ESG-related factor is added in the asset pricing model to consider whether this factor can help the traditional model enhance the ability of explaining portfolio and stocks performance. The level of exposure of GMB is also compared to other factors in asset pricing models.

All in all, with the above findings, we still need a specific evidence to prove good ESG firms can earn higher returns or lower returns or the performance of portfolios including high ESG-scored portfolio can beat market and low ESG-scored portfolio. The power of explanation of the ESG factor comparing to enhance the traditional model. Such expected results of this thesis are a puzzle for the literature universe. We already know that some articles investigate whether the ESG factor is a risk factor, a systematic risk factor, a priced factor, a successful risk factor. Richardson (2019) stated that ESG may be considered as a risk factor if ESG characteristics do not overlap with established risk factors. Bennani et al. (2018) concluded that ESG could be a risk factor in the Eurozone, but not in North America. They use the Fama-French 5-factor model and combine the sixth factor – ESG factor. In my thesis, there is a combination of Fama-French 5-factor plus momentum and ESG factor to study the impact of ESG factor in asset pricing model, thus, there are seven factors in this case.

Wondering whether ESG is a systematic risk factor, Jin (2018) found that the exposure to ESG-related systematic risk is significantly priced in the market that implies ESG is a systematic risk factor for US equity mutual funds. Results from Lioui (2018) considered whether ESG risk is priced and his results showed that the "Environmental pillar of ESG is significantly relevant to the cross-sectional variation in returns and its beta risk is priced". Maiti (2020) sees ESG as a risk factor and examines it the succeeding risk factor, he found market, size and ESG factor perform better than the FF3FM, and the Sharpe ratios for ESG, E, S, G factors show better performance. Therefore, he concluded ESG, E, S, G should not be ignored while considering investment decision.

Our study has different approach when considering how the ESG factor is related to other factors. We first look at the ability of explaining excess return, second how significant exposure of ESG factor is. Hubel and Scholtz (2020) have the same method to investigate ESG role in terms of explanatory power. However, they focus on separate pillar of ESG instead of aggressive ESG score. We broaden the model into seven-factor model instead of six factor model or four factor model. Moreover, the ESG factor is created from stocks of index based on ESG score. Meanwhile Jin (2018) built ESG factor from responsible investment fund and conventional investment fund.

The role of GMB factor in explaining will be compared to other six factors (MKT, SMB, HML, RMW, CMA, WML) which are called as traditional factor in this thesis.

PART II. EMPIRICAL RESEARCH

Chapter 1. Introduction of the empirical research

1.1. Structure

This section aims to answer the research question "How is the ESG factor related to traditional factors?". To conquer this question, the empirical study is designed as the following process. First and foremost, four hypotheses are created in supporting responsible investment and the ESG-related factor. Then, the answer of how to select the sample, where to get data, and data description are presented. After that, the methodology with tools and models to solve data and drive the study in the right direction are applied. In this section, the portfolio construction is illustrated as well. With data and method already, the results of the empirical research in different perspectives will have appeared. To be more detailed, the performance of portfolios under consideration of ESG will be illustrated and compared in pairs in terms of returns, volatility and risk-return trade-off. The descriptive statistics and correlation between ESG factor with other factors are presented. The result of the explanatory power of the ESG factor will be drawn.

1.2. Hypothesis development

It cannot be denied the fact that the mission of developing the globe in a sustainable path is truly crucial and investment plays a vital role in this revolution by integrating ESG factor into investment process, analysis and evaluation. In the case of this research question, there are two main aspects to answers. The first answer to consider the performance of ESG-focused portfolios which are compared to others such as benchmark, non-ESG and among tercile portfolios. Moreover, the trade-off between risk and return will be shown after that. The second answer discusses the ability of ESG factor in case of improving explanatory power of asset pricing model in predicting return. From two key answers, four hypotheses are created and examined through empirical study.

Obviously, there are a wide range of articles showing the performance of responsible investment or ESG integration but in both stream of positive and negative return; or higher or lower return compared with conventional indices or traditional funds. With the hope that ESG integration approach can bring the better performance for high ESG-scored against benchmark, ESG portfolio against non-ESG portfolio we come to the first hypothesis:

Hypothesis 1:

1a. The higher ESG-scored equity portfolio outperforms the lower ESG-scored equity portfolio in terms of returns.

1b. The higher ESG-scored equity portfolio outperforms the benchmark in terms of returns.

1c. The low ESG-scored equity portfolio underperforms the benchmark in terms of returns.

1d. The ESG equity portfolio outperforms the non-ESG portfolio in terms of returns.

In the first hypothesis, the returns of ESG-related portfolios are compared to each other, but the second aspect of performance of the portfolios cannot be neglected, that is volatility of such returns. In 2014, Eccles, Iaonnou and Serafeim of Harvard Business School found evidence that the companies with 'high sustainability' not only exhibit higher abnormal return, but also have lower volatility compared to counterparts in many years. Similarly, Morgan Stanley (2019) conducted research on the performance of roughly 11.000 mutual funds in the period of 2004 to 2018 and they found that the sustainable funds experienced an equal or higher the median return and lower or equal volatility with traditional funds. The second hypothesis also underpins the positive findings in case of volatility of return of high ESG score portfolio and ESG portfolios.

Hypothesis 2:

2a. The higher ESG-scored equity portfolio exhibits lower volatility than the lower ESG-score equity portfolio.

2b. The high ESG-scored equity portfolio exhibits lower volatility than the benchmark.

2c. The low ESG-scored equity portfolio exhibits higher volatility than the benchmark.

2d. The ESG equity portfolios exhibit lower volatility the non-ESG portfolios.

Hypothesis 1 and 2 interested in the performance of portfolios under ESG consideration to show the importance of ESG score in choosing stocks but a question is raised that whether there is a shift from ESG strategy brings a better risk-return trade-off to investors. Thanks to Markowitz' (1952) mean-variance model, investors can choose the suitable portfolio to optimize return on a given risk in tradition. Nowadays, this model continues to be used in the case of responsible investment to expect the better trade-off between return and risk that the ESG-focused portfolio brings to investors, this leads to hypothesis 3:

Hypothesis 3: There is a shift to ESG-focus investment contributes to a better risk-return trade-off.

Finally, the research question of this thesis considers the impact of ESG factor and its relationship to other conventional factors. Considering if ESG is the succeeding risk factor, Maiti (2020) found that the ESG risk factor is significant at level 5% and the three-factor with market, size and ESG factors have better performance than the Fama-French three-factor model. Similarly, Hubel and Scholz (2020) argued that ESG-related factors enhance the ability of explaining stock returns of the CAPM, the FF3FM, the FF5F plus the momentum factor. Bennani et al. (2018) found that the ESG factor statistically significantly improved the six-factor model in Europe, but not in North America. They concluded that ESG could be a risk factor in the Eurozone, but not in North America. The added-ESG factor will be investigated whether it can improve the power of explanation of standard asset pricing models. This leads to the last hypothesis:

Hypothesis 4: The integrated-ESG factor enhances the explanatory power of traditional asset pricing model.

Chapter 2. Data

This chapter describes the data used in the empirical study. Firstly, price stock return and ESG ratings (scores) are presented. Then, the sample selection procedure is illustrated.

2.1. ESG ratings (score)

With the development of responsible investment, Bloomberg provides ESG score data for investors and users. In fact, there are some articles that use Bloomberg ESG data. For example, Henriksson et al. 2018 use ESG score data from Bloomberg to draw the materiality map before constructing portfolio; or this Bloomberg is used in the paper of Ahlklo and Lind (2019) to investigate the relationship between ESG score and financial performance in both case of market and accounting perspective. Tissen (2018) also uses information from Bloomberg to underline the securities of the MSCI ESG ratings data set so as to conduct the study on socially responsible investing when it comes to portfolio performance and asset allocation. Taking the advantage of the huge number of information from companies that Bloomberg can provide, this thesis uses closing prices of securities focusing on stocks from this provider.

Nevertheless, ESG scores or ESG ratings in this thesis are not retrieved directly from the ESG score database generated by Bloomberg, but from the third party which is Sustainalytics. Sustainalytics is an organization providing the ranking of listed companies on their ESG performance (Garz, Volk and Morrow, 2018). The ESG research assessments are available to all subscribers of Bloomberg from 2014 (Chase, 2014), this is also the reason why our sample period started in February 2014. Together with RobecoSAM, MSCI, CDP, Sustainalytics are mentioned most often as having the highest quality rating more than other ratings in 2018 (SustainAbility, 2019). In addition, the survey conducted on over 300 sustainability professionals also reported that Sustainalytics again at the top of usefulness rating. The quality, usefulness and reliability are important aspects when considering the ESG ratings and Sustainalytics can meet these criteria. Respecting the aggregated ESG scores from Sustainalytics, the European Centre for Corporate Engagement (ECCE) at Maastricht university cooperating with NN Investment Partners (NN IP) conducted an empirical study focusing on global equity portfolios performance using ESG criteria (NN IP & ECCE, 2016; Kim, Surroca and Tribo, 2014; Ahlklo and Lind, 2019; Auer, 2016). With the same reasons as Auer (2016), KLD Research & Analytics (Kempf and Osthoff, 2007) or ASSET4 from Thomson Reuter (Wimmer, 2013; Hubel and Scholz, 2020) are not be used, because they cannot cover the wide range of European stock markets like Sustainalytics, which is the region this thesis is working on.

There is one thing need to be clear about the ESG ratings and ESG exposures, ESG scores or ESG data used in this thesis is ESG ratings which deliver insights according to the ESG performance of a firm relative to its industry peers. In while ESG exposures present exposures to ESG risks in separate pillars (Hubel and Scholz, 2020). The ESG score from Sustainalytics is rated on the scale from 0 (worst) to 100 (best) (Surroca, Tribo and Waddock, 2010). The application of ESG score in investment through investment process, analysis of performance or portfolio construction (Henriksson et al., 2018; Hubel and Scholz, 2020; NN IP & ECCE, 2016; Franzen, 2019). Similarly, the portfolio in this thesis is formed based on ESG score. However, Henriksson et al. (2018) used the ESG ratings based on materiality map; Hubel and Scholz (2020) used ESG exposure. Like NN IP & ECCE, this thesis uses aggregated ESG scores (Lioui, 2018) but does not focus on materiality ESG. The ESG score by Sustainalytics is updated monthly which is the reason to rebalance for ESG portfolio every month. The monthly ESG score of stock is downloaded by the Bloomberg function in Excel.

2.2. Stock returns

To calculate stock return, we need the closing price information first, Bloomberg terminal is a powerful system to retrieve this data. Needless to say, Bloomberg is a news leader in the global business information providers because of huge, up-to-date, accurate and reliable information that influences maker decisions (Chase, 2014). Erik Penser Bank uses Bloomberg for their everyday trading (Ahlklo and Lind, 2019).

The monthly closing stock prices are downloaded by Excel add-in of Bloomberg and the monthly return of stock is calculated by dividing the old price from the new price minus one. The rating data is available from February 2014 to June 2020. The price data base runs from February 2014 to June 2020 and in reality, the return base comes from March 2014 to June 2020. However, based on monthly ESG ratings, stocks are chosen in portfolios, therefore, the return of chosen stock this month according to ESG score is reflected in the next month's return. In other words, the return is lagged a month, or the base case is to use returns of the month following the ratings. For example, return of stocks based on ratings on February 2014 results in March 2014. Thus, the returns in this month in the hypothesized portfolios are the real returns in the next month. Some stocks are not available with the closing price data, therefore, they are called as "missing price" in the table of sample selection.

2.3. Sample selection

Even though socially responsible investment is familiar and becomes momentum all over the world, there are some differences among regions. Especially, European market has signs of being mature because with the long time, sustainable investing in Europe has been broadly practiced and accepted (GSIA, 2018). Moreover, in terms of sustainable and responsible investing assets, Europe accounts for 46% in global market scale. According to Eurosif (2018), ESG integration is the fastest growing strategy from 2015 to 2017 with a CAGR of 27% (Compound Annual Growth Rates) compared to Best-In-Class with 9% and Engagement and Voting with 7%. From such evidence, we can see the predominant position of Europe in the globe as well as the growing trend of ESG integration. In this thesis, we choose European market to answer the research question of this thesis "How is the ESG factor related to traditional factors?". To be more specific, in order to analyze the European situation, we limited population with seven most trading markets such as UKX, AEX index, OMX, BEL20, CAC40, IBEX and DAX located seven countries which are the

United Kingdom, the Netherlands, Sweden, Belgium, France, Spain and Germany. Seven countries are also covered in the Kenneth French library which is a source of return for Fama-French factors. Regarding Eurosif (2018), such seven countries have the big numbers in ESG integration. There are 281 stocks in total. The choice of this combination was also influenced by the providing data ability of Bloomberg in terms of closing price and ESG score from Sustainalytics. Bloomberg can cover a huge range of stock to provide the closing price but in the case of ESG score we also have to depend on the relationship between Bloomberg and Sustainalytics.

Each index component was retrieved separately to see the overview of the closing price and ESG status of each market before combining to a big group. The details of each group are available in the appendix 1. Two lines below show the group composition of 281 stocks from seven indices.

UKX	AEX	OMX	BEL	IBEX	DAX	CAC	Total
101	25	30	20	35	30	40	281

We took the newly updated closing price and ESG information until the time working on empirical study in June 2020 with the hope a recent composition gives the best presentation of the situation of Europe today and takes advantages from higher confidence in the ESG data used (Bennani et al, 2018). Thanks to a huge source called Bloomberg, we would like to collect historical period data as long as possible. However, with the limitation of time when Sustainalytics cooperated with Bloomberg to provide ESG rating from 2014, we started to collect ESG data from February 2014. The market data or stock prices were collected at the same period from February 2014 until June 2020.

Table 1 shows the status of 281 stocks with and without ESG data according to the timeline. “Rated” means the stocks are ESG “rated” or have ESG-scored data. “Unrated” means the ESG data is not available for stock. “Missing price” is called for stocks without closing price data on Bloomberg terminal.

Table 1. Number of rated, unrated and missing price stocks.

Year	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Rated	198	214	219	219	233	245	245
Unrated	83	67	62	62	48	36	36
Missing price	18	12	11	8	4	1	0

This table shows the number of rated, unrated and missing price stocks in sample during 76 months from March 2014 to June 2020. The number of stocks is reported on December from 2014 to 2019 and June 2020

As we can see in table 1 there is an increasing number of ESG-rated stocks from 2014 to 2020, while the numbers of unrated stocks are declining from year to year. The numbers of missing price stocks also declined in the same period. Although Sustainalytics is the big provider of ESG data, in general, ESG ratings are not always available for all stocks. According to Hubel and Scholz (2020), in the empirical literature on equity funds, there are usually 20 to 40 percent of equity portfolios having unrated stocks. Compared to the availability of stock returns data, ESG ratings are limited in stocks and focused on large firms. In fact, our sample also has the same situation, therefore, starting with an initial sample of 281 stocks, we end up with a final sample of 245 rated stocks.

Chapter 3. Methodology

In this section, the research methodology will be illustrated. This study examines the impact of responsible investing on portfolio performance and the effect of ESG factor when integrating in the model in terms of enhancing the explanatory power and the relationship with other conventional factors. First, going further how ESG-related portfolios, non-ESG portfolios and benchmark are constructed. These portfolios are used to show their performance in comparison between high-low ESG score and with-without ESG score portfolios. Then, from ESG portfolios, the ESG GMB portfolio is formed, which is the ESG GMB integrating directly in the basic models. Next, the factor models will be described.

3.1. Portfolio construction

There are two types of portfolios need to be considered. Firstly, portfolios are run on asset pricing models and checked the performance such as benchmark, ESG portfolio, non-ESG portfolio, tercile 1, tercile 2, tercile 3 portfolios. Secondly, the GMB factor portfolio is formed and added to expand basic models so as to investigate the role of this factor in the explanatory power and correlation with other conditional factors. The ESG GMB portfolio is created after the first type of portfolio is established.

Table 2 summary the average numbers of stocks in each portfolio created in this empirical study. In which, the benchmark is a biggest portfolio including the ESG portfolio and non-ESG portfolio. The ESG portfolio is then divided into three parts following ESG score. Details are described in the next section.

Table 2. Structure of portfolios in the empirical study

Benchmark 271 stocks				
ESG portfolio (rated stocks) 219 stocks				Non-ESG portfolio (unrated stocks) 52 stocks
Tercile 1 167 stocks	Tercile 2 41 stocks	Tercile 3 11 stocks	GMB: T1-T3	

This table shows the structure of portfolios in the empirical study and the average numbers of stocks in each portfolio in 76 months (March 2014 to June 2020).

3.2. ESG portfolios and related portfolios construction

There are three steps in the ESG portfolio formation. The first step, ESG portfolio is constructed based on the ESG score retrieved from Sustainalytics. To be more specific, we create the ESG portfolio which includes all the stocks that have ESG ratings data excluding stocks without an ESG score and missing price market data each month. In the second step, the portfolio is using the ESG scores available at the end of month to choose stocks. Third step is to make sure the match between available return data and available ESG score of stocks. Especially, the returns for this portfolio is the lagged one month return that is explained in the ESG return part, it means the ESG-scored stocks this month will be resulted in the next month (as explained in the part Stock return data.). The idea of this process is to use the ESG data of stock i at month t to collect stock i in the month t + 1 (Tissen, 2018). The portfolio will be rebalanced on a monthly basis, because ESG-related portfolios are constructed based on ESG score. When ESG score changes, the portfolio is forced to be changed. In fact, Sustainalytics updates ESG score monthly, thus the rebalancing every month makes sense (Wang and Sargis, 2020).

There are also some articles that use ESG-related score, lagged returns and rebalancing method to form this type of portfolio. Derwall et al. (2005) investigated whether the socially responsible investing leading superior portfolio performance by constructing two equity portfolios which are high-ranked and low-rank based on eco-efficiency score. That score is ranked by themselves annually and portfolio is rebalanced at the end of June, they also took into consideration of "a one-month lag for ranking data to avoid look -ahead bias". They also noted that companies without rankings at the rebalancing data were excluded for the subsequent 12-month period. However, in our case, companies for which no ESG rankings of month t will be put out of the ESG portfolio for that month and they will appear in the ESG portfolio next month if they have available ESG data.

Auer (2016) conducted the empirical study to find the European stock portfolio performance and social responsibility. To examine this relationship, he constructed the portfolio based on Sustainalytics ESG ranking, then excluded the worst 5% of the stocks. After that, he formed an equally weighted portfolio on the rest stocks, but he just re-constructed when the changes in the ratings make its composition necessary to change which is different from our case. The equally weighted rule that Auer applied in 2016 is also used in our study for all portfolios.

Similarly to Hubel and Scholz (2020) when dividing the ESG portfolio into smaller pieces to see the performance of each small portfolio according to ESG ratings but they used quintile, we decided to divide ESG portfolio by three such as Tercile 1 (T1), Tercile 2 (T2), Tercile 3 (T3) according to ESG ratings. In which, T1 includes the high-ESG companies, T2 shows the medium ESG performance and T3 has the low ESG-performance stocks. This dividing way is similar to Wang and Sargis (2020) who represents Morningstar evaluating ESG effects on risk and return in North America. Other articles use quintile or decile as they have big sample such as Hubel and Scholz (2020) use quintile for his investigation with more than 1000 stocks or Heijden (2012) made sure a minimum amount of 30 companies in each sustainability quintile in each sector to analyze sectors with respect to responsible investing. The reason why ESG portfolios are divided into three not five or ten is to avoid the thin portfolio, because the sample in this thesis is limited compared to other papers (Serafeim, 2018). In our paper, the final sample includes 245 rated stocks, therefore, with the limited stocks, the tercile portfolio is the most suitable choice.

Like Hubel and Scholz (2020), Drei et al. (2019) ranked the stocks based on their score and built quintile portfolios, in which, portfolio Q1 reflects 20% best-ranked stocks, and portfolio Q5 represents the 20% worst-rated stocks. These portfolios are equally weighted and follow the long-short strategy in order to be easy to implement in Fama-French model. As we already know, the factor in the asset pricing model is constructed from the sorted portfolios that means they are long-short portfolios. For example, SMB is the return of a portfolio of long small stocks and short large stocks. HML is the same situation with long high book-to-market stocks and short low book-to-market stocks, etc. (Hong and Kacperczyk, 2009). Not only Drei et al. (2019) designed the equally weighted long-short portfolio to run on the asset pricing model, but Hong and Kacperczyk (2009) also did the same for long sin stocks and short comparable stocks to apply in asset pricing models. Traaseth (2016) used a long-short strategy and created equally weighted portfolios with the lowest 35% ESG-scored portfolio and the highest 35% ESG-scored portfolio. The idea is to create long-short portfolios aiming to be commensurate with factors in the asset pricing model.

However, contrary to academic literature, Bennani et al. (2018) and Drei et al. (2019) from Amundi Asset Management use long portfolios to apply asset pricing models. The reason is that factor investing has a huge number of long only portfolios and the choice of long-only reflects the realistic situation. Taking into account this reason, we treat T1, T2, T3 portfolios as long-only portfolios.

The ESG portfolio is designed into two types which are long-only portfolio and long-short portfolio. With the long-only portfolio, we will use the average return of all stocks with available ESG data regardless of high or low ESG scores. This ESG long-only portfolio will be compared with the non-ESG portfolio which is explained how to construct later. In the case of a long-short ESG portfolio, the average return of this portfolio is calculated by taking the average return of high ESG-scored stocks (T1) minus the low ESG-scored stocks' returns (T3). This portfolio is designed with the purpose of forming the ESG-related factor portfolio that will be presented in detail later.

When it comes to non-ESG portfolios, this portfolio is comparable to the ESG long-only portfolio. It is created from all stocks without available ESG information. The rules of equal weight and long-only portfolios are still applied for non-ESG portfolios. The monthly average return is the base to calculate excess return and run on the asset pricing model.

Benchmark in our case is a big portfolio of all stocks with available market data (closing price) regardless of rated or unrated ESG stocks. Like the rule to construct the non-ESG portfolio, each stock in this portfolio has equal weight which is not affected by small or big size. Benchmark is also a portfolio with long positions only. The stock's average return of each month is used to analyze and implement the model.

3.3. The ESG GMB factor portfolio construction and traditional factors

The second part of this section is about the ESG GMB portfolio construction. ESG factor formation to solve the research question is vital because it plays as a main character in our topic. Our purpose is to examine how ESG factor is related to traditional factors, and its effects in terms of explanatory power of asset pricing model. To achieve this mission, it is essential to construct ESG GMB factor construction to integrate in model together with traditional factors.

According to Maiti (2020), there are more than 300 risk factors identified by the researchers and many others. He stated that evolution of risk factor and factor models are continuous and endless development. From the basic standard model CAPM, Fama-French (1992, 1993) develops the Fama-French three-factor model with SMB and HML factor added. Then, Carhart (1997) built a 4-factor model from the FF3FM by adding momentum factor (WML) into the model. Fama-French (2015) continues to expand their own model to a five-factor model by adding two new factors: profitability (RMW) and investment (CMA). At the same time, Hou et al. (2015) also integrated such new factors into the FF3FM. Stambaugh and Yuan (2017) put “mispricing factor” to combine with existing factors, meanwhile Daniel et al. (2020) identified behavior factors.

In terms of responsible investment with ESG integration on a specific scale, ESG-related factors are a prevailing topic that the researchers and institutional investors are interested in. Serafeim (2018) had sentiment factor, Jin (2018) designed the UME factor, Lioui (2018) had ESG, E, S, G factor based on ESG concerns and ESG strength score of a company. Maiti (2020) put 4 new factors $L_{esg}MH_{esg}$, $L_{env}MH_{env}$, $L_{soc}MH_{soc}$, $L_{gov}MH_{gov}$; Hubel and Scholz (2020) created ESG and E, S, G factor based on ESG exposure and ESG ratings.

Lioui (2018) wondered whether ESG risk is priced, he created ESG related factors to test 15 anomalies and investigate the ability of these factors in explaining such anomalies. He sorted portfolios on two pillars which are *strength* and *concern* with the median as the breakpoint and two level high (H), low (L) for each dimension. Especially, the breakpoint for G is 60-40 instead of 50-50 to make sure the reasonable number of sin stocks a portfolio. The names of portfolios are by strength/concern, LH defines as low strength and high concerns portfolio. His ESG-related factors are based on aggregated ESG score and separate E, S, G score. In total, to create a factor portfolio, he had five smaller portfolios in every factor portfolio (LL, LH, HL, HH, LH-HL). The difference between long and short portfolios (LH-HL) is the factor portfolio which is added in the model. Portfolio returns are distributed in both types: equally weighted return and value weighted returns. Jin (2018) created the UME factor (underweight minus ESG-score weighted) by using the return difference between S&P500 and S&P 500 ESG Factor Weighted Index (SAP-ESG). He used this way to form an ESG-related factor because the lack of ESG data covered a huge number of securities by ESG providers, even RobecoSAM. He also noted that components of two portfolios are overlapped. And it contradicts SMB, HML and WML, which are "difference between returns on two portfolios containing mutually exclusive stocks". Maiti (2020) created factors following Fama and French (1993) methodology of a single sort. Market capitalization is a base to sort five equal-weighted portfolios from P1 to P5 in which P1 contains 20% small-sized stocks and P5 consists of 20% big-sized stocks. After that, with the same rule, five equal-weighted portfolios based on ESG, E, S, G port are constructed.

Looking around the methodologies of factor portfolio construction, in our case, we depend on my actual sample In order to integrate in the asset pricing model, our factor should be corresponding to traditional factors (MKT, SMB, HML, RMW, CMA, WML). We follow Fama and French (1993) methodology to sort portfolios into Good and Bad portfolios. Good portfolio contains all stocks that have high ESG scores or good ESG performance. Bad portfolio containing all stocks have low ESG scores. We should note that the meaning of Good – Bad portfolio here is not related to the performance of return, it reflects the ESG performance of company.

Moreover, as we can see three time slices of the ESG distribution in Appendix 2, there are three distinct groups that can reflect T1, T2, T3 at three points of time at the beginning, in the middle and the end of period. Like other factors constructed by Fama and French (1993), our ESG-related factor named the ESG GMB factor (Good minus Bad) which is the difference of return of Bad ESG portfolio subtracted from Good ESG portfolio with the hope that high ESG score stocks can bring the higher return than low ESG score stocks. That is exactly the long-short portfolio that we mentioned (T3 minus T1) in the ESG portfolio construction part. This long-short strategy, zero investment obeys the rule of factor construction of Fama and French (1993).

Jin (2018) also said about the overlap issue between two parts of the UME factor and in our case, although we choose two groups that have a far distance (33.33% bottom – 33.33% top) to create the factor, we still meet some overlapped stocks. Since, the ESG performance of company is better after or worse during 76 months. However, it is rare when one company that has the lowest ESG performance (T3) can move into the highest ESG performance group (T1) next month. Our approach is similar to Derwall (2005) when he distinguished two portfolios corresponding the high-rank (leaders) and low-rank (laggards) based on eco-efficiency score.

The ESG GMB factor portfolios are equally weighted, similar to Jin (2018) methodology. Major stocks in seven indices are big-sized. However, the large capitalization does not limit our result too much. According to Jin (2018), the corporate social performance has a positive relationship to financial performance only when firm size is controlled for across studies with average over 15.000 observations. In our case, we just have 75 observations (75 months on 245 ESG rated stocks). As the ESG GMB factor portfolio is constructed on the ESG portfolio mentioned above, therefore, it is rebalanced on a monthly basis based on the ESG score updated monthly.

The data for risk-free rate and traditional factors namely SMB, HML, RMW, CMA, WML (or UMD) are downloaded from the Kenneth French Data Library for the European region. Jin (2018), Lioui (2018) and Hubel and Scholz (2020) also used this source for their study.

3.4. Models

This section explains how models are constructed and expanded with additional factors. we can see the relationship and the explanatory ability of the ESG factor in these models in and to other factors.

As introduced in the literature review chapter, there are four conventional models such as CAPM, Fama-French 3-factor model, Fama-French Carhart 4-factor model and Fama-French 5 factor model. The ESG GMB factor will be integrated in each model that lead us to have 11 models in total to examine the explanatory power of the ESG factor at the portfolio level. To be more detailed, we "expand different baseline models" (Hubel and Scholz, 2020) with traditional factors in the standard models to compare the results with adding the ESG factor. The exposures to each factor are retrieved from running 12 models on the portfolio and single-stocks level.

Here are 12 models will be applied in our study:

CAPM:

$$E(r_{i,t}) = \alpha_i + \beta_i^{MKT} MKT_t + \varepsilon_{i,t}$$

GMB: 1-factor model:

$$E(r_{i,t}) = \alpha_i + \beta_i^{GMB} GMB_t + \varepsilon_{i,t}$$

CAPM + GMB:

$$E(r_{i,t}) = \alpha_i + \beta_i^{MKT} MKT_t + \beta_i^{GMB} GMB_t + \varepsilon_{i,t}$$

FF3FM:

$$E(r_{i,t}) = \alpha_i + \beta_i^{MKT} MKT_t + \beta_i^{SMB} SMB_t + \beta_i^{HML} HML_t + \varepsilon_{i,t}$$

FF3FM + GMB:

$$E(r_{i,t}) = \alpha_i + \beta_i^{MKT} MKT_t + \beta_i^{SMB} SMB_t + \beta_i^{HML} HML_t + \beta_i^{GMB} GMB_t + \varepsilon_{i,t}$$

FF3FM + WML (Carhart four-factor model):

$$E(r_{i,t}) = \alpha_i + \beta_i^{MKT} MKT_t + \beta_i^{SMB} SMB_t + \beta_i^{HML} HML_t + \beta_i^{WML} WML_t + \varepsilon_{i,t}$$

FF3FM + CMA:

$$E(r_{i,t}) = \alpha_i + \beta_i^{MKT} MKT_t + \beta_i^{SMB} SMB_t + \beta_i^{HML} HML_t + \beta_i^{CMA} CMA_t + \varepsilon_{i,t}$$

FF3FM + RMW:

$$E(r_{i,t}) = \alpha_i + \beta_i^{MKT} MKT_t + \beta_i^{SMB} SMB_t + \beta_i^{HML} HML_t + \beta_i^{RMW} RMW_t + \varepsilon_{i,t}$$

FF5FM:

$$E(r_{i,t}) = \alpha_i + \beta_i^{MKT} MKT_t + \beta_i^{SMB} SMB_t + \beta_i^{HML} HML_t + \beta_i^{RMW} RMW_t + \beta_i^{CMA} CMA_t + \varepsilon_{i,t}$$

FF5FM + WML:

$$E(r_{i,t}) = \alpha_i + \beta_i^{MKT} MKT_t + \beta_i^{SMB} SMB_t + \beta_i^{HML} HML_t + \beta_i^{RMW} WML_t + \beta_i^{CMA} CMA_t + \beta_i^{WML} WML_t + \varepsilon_{i,t}$$

FF5F + GMB:

$$E(r_{i,t}) = \alpha_i + \beta_i^{MKT} MKT_t + \beta_i^{SMB} SMB_t + \beta_i^{HML} HML_t + \beta_i^{RMW} WML_t + \beta_i^{CMA} CMA_t + \beta_i^{GMB} GMB_t + \varepsilon_{i,t}$$

FF5F + WML + GMB: seven-factor model

$$E(r_{i,t}) = \alpha_i + \beta_i^{MKT} MKT_t + \beta_i^{SMB} SMB_t + \beta_i^{HML} HML_t + \beta_i^{RMW} WML_t + \beta_i^{CMA} CMA_t + \beta_i^{WML} WML_t + \beta_i^{GMB} GMB_t + \varepsilon_{i,t}$$

$E(r_{i,t})$ is the excess return of stock i in month t

α_i can be interpreted as abnormal return of stocks i

MKT_t is the excess return of the market (market-related factor)

SMB is return of Small (cap) Minus Big (size factor)

HML is return of High (Book/Price) Minus Low (value factor)

RMW is return of Robust Minus Weak (profitability factor)

CMA is return of Conservative Minus Aggressive or the divergence between returns on portfolios of the stocks belonging the companies focusing on low and high investment. (investment factor)

GMB is return of Good Minus Bad (ESG factor)

$\beta_i^{MKT}, \beta_i^{SMB}, \beta_i^{HML}, \beta_i^{RMW}, \beta_i^{CMA}, \beta_i^{WML}, \beta_i^{GMB}$ are coefficients of corresponding risk factors

$\varepsilon_{i,t}$ is an error term with zero-mean

3.5. Tools

Similar to Jin (2018), we apply the cross-sectional regression. The regression function and many other functions are conducted on Excel.

Chapter 4. Empirical results

This chapter's purpose is to present the detailed results of our analysis. The first section is descriptive statistics of ESG score distribution; and factors including the ESG and traditional factors. Then, the portfolio performance under consideration of ESG is illustrated. In the third section shows the investigation of explanatory power of the ESG factor in asset pricing models. The last point is about risk exposures to ESG-related factors (GMB).

4.1. Descriptive statistics

In this section, the summary of ESG score distribution on overview and the specific number for each portfolio is illustrated. After that, the cumulative return of the GMB factor is shown. Then, the descriptive statistics of GMB factor, market-related factor, Fama-French factors and Carhart factor are presented. The last point is about the correlation matrix of seven factors.

ESG score distribution

As mentioned in section Sample selection, there are 281 stocks in total but not all of them are used in this study because of missing pricing. Some stocks do not have an ESG score (unrated) and most of them have an ESG score (rated). Table 1 shows the status of our sample selection.

Table 3. ESG disclosure score per year

Year	Min	Median	Max
2014	7.14	79.55	100
2015	2.35	79.11	100
2016	0.00	78.01	100
2017	0.00	77.15	100
2018	0.00	77.33	100
2019	0.00	76.72	100
2020	0.00	75.60	100

This table describe min, median and max ESG score every year from March 2014 to June 2020. Data is retrieved from Bloomberg and Sustainalytics.

Table 3 presents the summary statistics of samples every year. During the sample period, the maximum score of the sample is still 100, but the minimum score is decreasing until zero that leads the gap between highest and lowest score to increase and the median to decline.

Figure 3 shows the distribution of the ESG scores on each tercile based on the sample. The highest ESG-scored group (T1: ESG score from 66.67 to 100) contains the most numbers of stocks among rated stocks in our sample with average 167 stocks every month. The second position in this figure belongs to T2 (medium ESG-score group, 33.33-66.67) consisting average 41 stocks each month. Interestingly, the lowest ESG-score group (T3: 0-33.33) has the smallest numbers of stocks with average 11 stocks every month.

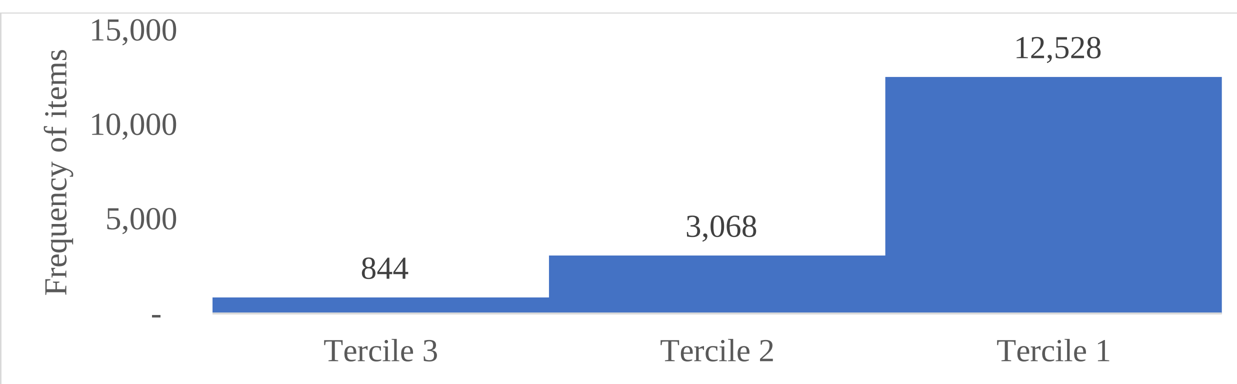

Figure 3. ESG score distribution into three terciles on rated stocks

This figure shows the distribution of ESG score in the sample by tercile for the period 76 months (March 2014 – June 2020).

Table 2 presents the structure of portfolios and the average number of stocks in each portfolio after creation. The details of how portfolios constructed are presented in the section Portfolio construction. The numbers of stocks in each portfolio is the average number during the sample period from March 2014 to June 2020. Benchmark includes the most average number of stocks with 271 stocks, followed by the ESG portfolio with 219 stocks and the non-ESG portfolio with 52 stocks monthly.

Cumulative return of GMB factor (ESG factor)

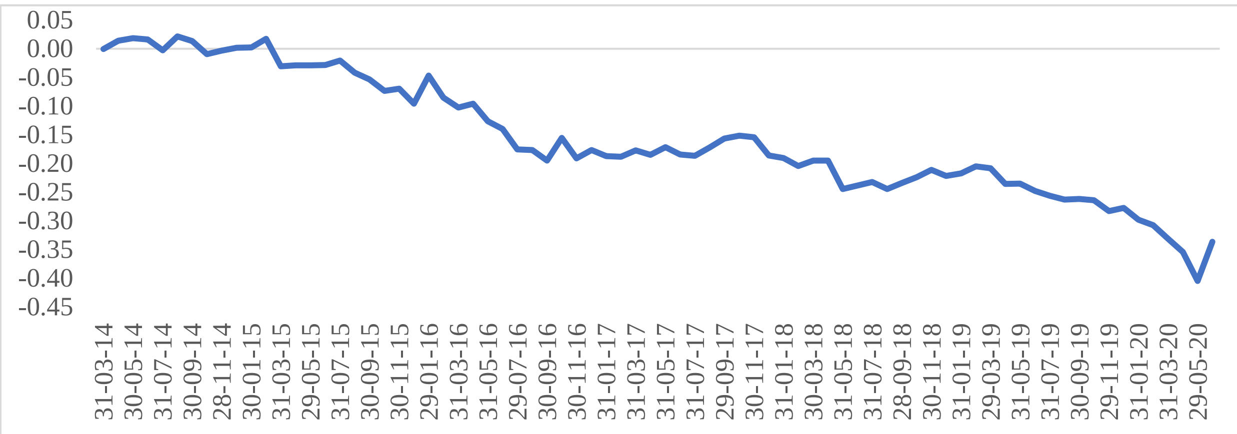

Figure 4. Cumulative return of the GMB factor

This figure shows the cumulative return of the GMB factor during 76 months from March 2014 to June 2020.

Figure 4 provides the first insight regarding the ESG factor that shows cumulative return of this factor from March 2014 to June 2020. The pattern describes the downward trend of the ESG factor that represents the low ESG firms outperform the high ESG firms. The period from September 2016 to September 2017 experienced a slight increase before there was a decline the whole next year. At the end of the sample period, the line tends to go up.

Descriptive statistics of factor portfolios

When it comes to the factors used in the investigation, table 4 reports descriptive statistics for seven factor portfolios. Firstly, the average return on MKT and SMB (both 3-factor and 5-factor models) are insignificant positive. Next, RMW and WML are significantly positive at the 5% and

1% level, respectively. In contrast, HML and CMA have significantly negative average returns for 76 months. The average return of GMB is significantly negative at the 10% level.

Table 4. Descriptive statistics of factor portfolios

Factor portfolio	N	Mean	SD	Skewness	Kurtosis	t-test for Mean = 0
						p-value
MKT	76	0.001	0.041	-0.789	1.482	0.798
SMB (3 factors)	76	0.001	0.017	0.237	0.449	0.576
SMB (5 factors)	76	0.001	0.016	0.036	0.897	0.594
HML	76	-0.006	0.023	-0.867	4.971	0.028**
RMW	76	0.004	0.014	-0.303	0.034	0.015**
CMA	76	-0.003	0.013	-0.342	1.837	0.019**
WML	76	0.008	0.025	0.546	0.802	0.007***
GMB	76	-0.005	0.026	0.960	5.596	0.096*

This table presents descriptive statistics for six factor portfolios. MKT is the excess return on Fama-French's (2015) market proxy (Jin, 2018). SMB (3-factor model, 5-factor model), HML, RMW and CMA are Fama-French factors for size, book-to-market value, profitability and investment equities. WML is Carhart factor (Momentum). GMB is a hypothesized factor portfolio for ESG in this paper. T-test for mean = 0 with p-value is provided. ***, ** and * indicate significance at the 1%, 5% and 10% level. Note: All the returns of Fama-French factors and Carhart factor are divided by 100 to make the parallel numbers with the returns of ESG factor. Data is retrieved from the Kenneth French library and calculated by author.

Table 5. Correlation among seven factors

	MKT	SMB	HML	RMW	CMA	WML	GMB
MKT	1.000 (0.000)						
SMB	0.201 (0.081)	1.000 (0.000)					
HML	0.321 (0.005)	0.103 (0.378)	1.000 (0.000)				
RMW	-0.086 (0.459)	-0.041 (0.723)	-0.735 (0.001)	1.000 (0.000)			
CMA	-0.092 (0.428)	-0.25 (0.030)	0.679 (0.000)	-0.504 (0.000)	1.000 (0.000)		
WML	-0.466 (0.000)	-0.002 (0.985)	-0.53 (0.000)	0.296 (0.009)	-0.185 (0.109)	1.000 (0.000)	
GMB	0.094 (0.420)	-0.278 (0.015)	0.390 (0.000)	-0.276 (0.016)	0.379 (0.001)	-0.198 (0.086)	1.000 (0.000)

This table presents the correlation coefficients among seven factors during the whole sample period (76 months). Numbers in bracket represent p-values against the null hypothesis. The null hypothesis here means the correlation coefficient is not statistically different from zero (H0: p = 0). Data is retrieved from the Kenneth French library and calculated by author.

Table 5 reports the correlation matrix of seven factors from March 2014 to June 2020. The GMB factor has negative correlation with SMB, RMW and WML and significant difference from zero at the 5%, 5% and 10% level of significance, respectively. The negative relationship between GMB and SMB implies high ESG firms tend to be big companies. It suggests that big companies suffer more stress reporting corporate social responsibility (CSR) to investors than small companies. Moreover, in terms of report, it is easier to take ESG data from large companies. This suggestion is supported by Drempetic, Klein and Zwergel (2019) when they show a significantly positive correlation between company size and CSR disclosure. The ESG factor also has a significantly negative relationship to profitability (RMW) at the 5% level. It implies that the companies with high profitability seem not companies with high ESG scores. Similarly, the momentum factor is significantly negative to the ESG factor. It means that the winning companies in the past may not be high ESG companies. This relationship is opposite to the findings of Kaiser (2020) and Hubel and Scholz (2020). Book-to-market factor is positively related to the ESG factor, which is different from findings of Dekhayser (2018). GMB is significantly positive to CMA that implies the ESG-related returns may move the same trend to CMA-related returns. Relationship between GMB and market shows the positive figure that is similar to findings of Hubel and Scholz (2020). It means firms with good ESG performance may generate low returns when the market goes up and receive high returns in downward moving markets.

Variance inflation factors (VIF) of seven factors show a maximum of 6.11, which implies that our results when applying the 7-factor model are not largely affected by multicollinearity.

Table 6. Variance inflation factor for seven factors

MKT	SMB	HML	RMW	CMA	WML	GMB
1.593	1.461	6.109	2.373	2.973	1.749	1.348

This table shows the variance inflation factor based on the seven-factor model. A VIF is higher than 10 present serious multicollinearity problems (Jin, 2018).

4.2. Portfolio performance under consideration of ESG

There are four pairs of portfolios which are T1 and T3, T1 and benchmark, T3 and benchmark, ESG portfolio and non-ESG portfolio. In each pair of portfolios, the performance of portfolios created in terms of return and volatility are demonstrated. The visual looking of portfolios is performed before the calculation with significance test comes up. The trade-off between risk and return of each equity portfolio is presented later**.**

Performance of ESG tercile portfolios

As mentioned in the section of Portfolio construction, ESG equally weighted tercile portfolios are composed based on ESG scores. These portfolios are rebalanced on a monthly basis. The risk and return are calculated based on monthly returns.

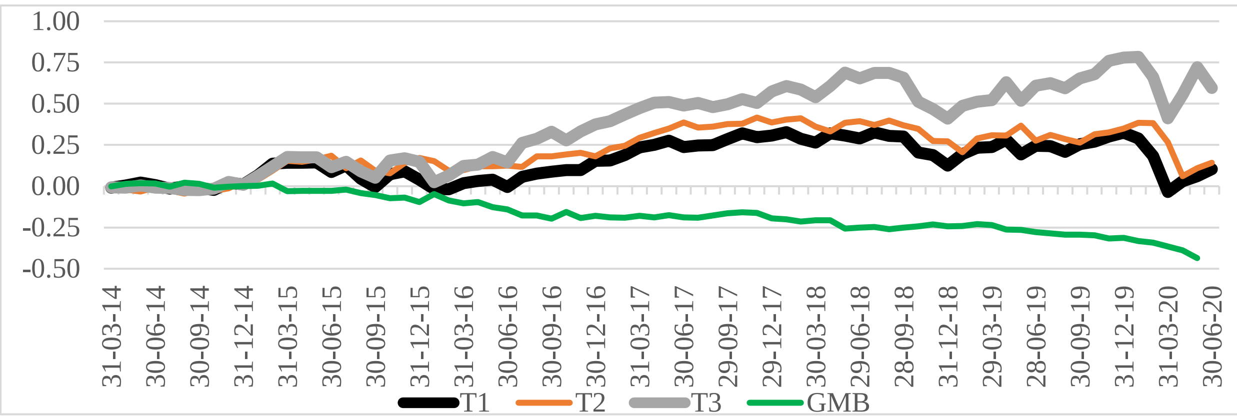

Figure 5. Cumulative excess returns of ESG tercile portfolios

This figure shows cumulative excess returns of each tercile portfolio for the period of 76 months (March 2014 to June 2020). Monthly excess return is the result of average return minus risk-free rate monthly. The risk-free rate is retrieved from Kenneth French library.

It can be seen in figure 5 that three lines representing three tercile portfolios tends to go up although in the sample period (76 months), the pattern continues to increase and decrease. At the starting point, all tercile portfolios have the same level, but from the end of 2015, the excess return of T3 grows strongest compared to excess returns of T1 and T2. Especially, the gap between excess return of tercile 1 and tercile 3 is increasing bigger from December 2016 to December 2019. It means low ESG firms outperform high ESG firms in terms of excess return. However, this conclusion needs to be tested significance through t-test.

Table 7. Risks, returns and risk-return trade-off of portfolios

Portfolio	Mean	SD	Sharpe ratio	Maximum monthly return	Minimum monthly return	p-value for mean (t-test)	p-value for variance (F-test)
T1 (best ESG)	0.024	0.143	0.182	0.077	-0.183	0.477 (T1 vs T3)	0.173 (T1 vs T3)
T2	0.036	0.127	0.279	0.071	-0.161		
T3 (worst ESG)	0.086	0.159	0.543	0.108	-0.149		
Benchmark (BM)	0.057	0.136	0.418	0.074	-0.172	0.696 (T1 vs BM) 0.72 (T3 vs BM)	0.329 (T1 vs BM) 0.083* (T3 vs BM)
ESG portfolio	0.030	0.138	0.221	0.075	-0.176	0.067* (ESG vs Non-ESG portfolio)	0.42 (ESG vs Non-ESG portfolio)
Non-ESG portfolio	0.186	0.135	1.274	0.117	-0.144		
GMB (T1-T3)	-0.063	0.091	-0.761	0.115	-0.078		

This table presents performance of portfolios created in this thesis. All values are calculated based on monthly return for the period from 2014 to 2020. The Sharpe ratio is ratio of the mean excess return to standard deviation of return. This ratio represents the risk-adjusted return of each portfolio. The mean return, the standard deviation (SD), and the Sharpe ratio are annualized. T-test is used to test the significant difference between portfolios in pair in terms of return. F-test is used to test significance of volatility between portfolio in pair.

Results in table 7 show annual returns and annual standard deviations of three tercile portfolios. The annual return of tercile 3 is 0.086 is much higher than that figure of tercile 2 and tercile 1. However, t-test shows that there is an insignificant difference between two means of tercile 1 and tercile 3. Therefore, we cannot conclude that low ESG firms significantly outperform high ESG firms in terms of return (hypothesis 1a). This finding is different from the study of Derwall et al. (2005) because they found that the portfolio with high-rank in eco-efficiency brings the higher average return win compared to low-rank portfolio. Breuer and Nau (2014) found the positive relationship between ESG performance and financial performance in 100 listed U.S companies in technology. However, our findings are different from them and similar to findings from Hubel and Scholz (2020). They found that stocks of the top quintile with highest ratings generated lower annual return than return of the bottom quintile and they also did not find evidence for significant differences.

Beside annual returns, the volatility also needs to be considered between high ESG portfolio and low ESG portfolio. It can be seen in figure 5 that the monthly return generated from low ESG firms has more volatility than monthly return from high ESG firms. After calculation based on monthly return of each tercile portfolio, the annual standard deviation of stocks with low ESG score is 0.159 that is higher than annual standard deviation of stocks with high ESG score (0.143). However, the variance comparison test provides evidence that there is no statistically significant difference between volatility of T1 and T3 portfolio (hypothesis 2a).

The risk-adjusted performance of high and low ESG rank portfolios is compared using the Sharpe ratio. Hypothesis 3 is expected that high ESG-scored stocks have the better risk-return tradeoff in comparison to the low ESG-scored stocks in hypothesis 3. The annualized Sharpe ratio of the different level ESG-scored portfolios in table 7 demonstrates the conclusion that stocks with low ESG score have better risk-return tradeoff than stocks with high ESG score. In line with Wang and Sargis (2020), they provided evidence that a low ESG-scored portfolio has a higher Sharpe ratio than a high ESG-scored portfolio. Our results cannot support hypothesis 3. It means that investors seem to sacrifice their returns when investing in firms with ESG score or high ESG score.

Performance of tercile 1 portfolio and tercile 3 portfolio versus benchmark

Hypothesis 1b predicts that an equity portfolio with higher ESG scores will outperform the benchmark in terms of return, and hypothesis 1c states that the portfolio with lower ESG score will underperform its benchmark in terms of return. Looking at figure 6, the patterns show the contradiction situation to above expectations.

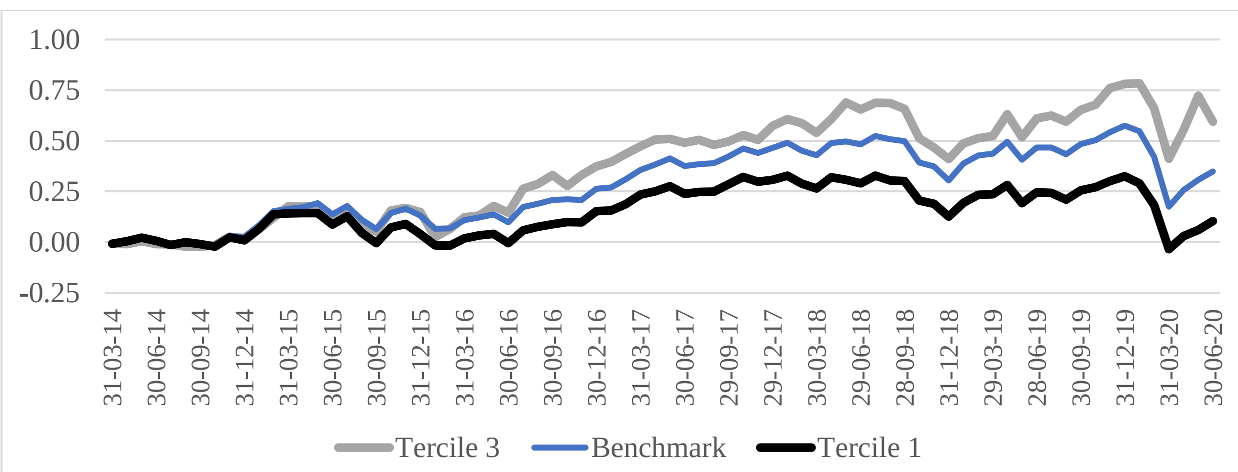

Figure 6. Cumulative monthly excess return of tercile 1, tercile 3 portfolio and benchmark

This figure shows the cumulative monthly excess return of tercile 1, tercile 3 portfolio and benchmark from March 2014 to June 2020. Monthly excess returns are equal the results of average returns minus risk-free rate every month. The risk-free rate is retrieved from Kenneth French library.

To be more precise, annualized returns and annualized standard deviations are calculated in the table 7. There is a higher return of lower ESG portfolio compared to return of benchmark but there is no evidence of statistically significant difference between them. The high ESG portfolio experienced the underperformance in comparison with benchmark in terms of return.

Our findings are consistent with the findings of Tissen (2018), he also concluded that there is no outperformance of ESG trading strategies to benchmarks in terms of monthly mean excess returns. Hypothesis 1b, 1c are not supported by our findings.

Next, the higher ESG portfolio is expected to have lower volatility than its benchmark in hypothesis 2b and the equity portfolio with lower ESG score is predicted to have higher volatility compared to its benchmark in hypothesis 2c. The annualized standard deviation of portfolio with higher ESG score is higher than the standard deviation of its conventional benchmark in table 7. By contrast, the F-test in this table provides evidence that there is a statistically significance difference between the standard deviation of tercile 3 portfolio and the benchmark in which the lower ESG portfolio exhibits significantly higher volatility compared to its benchmark. Aligning to findings of Tissen (2018), his results provide weak evidence for “an inverse relationship between volatility and ESG activity of the portfolio”.

The annualized Sharpe ratio of the benchmark is lower than the equity portfolio with low ESG score and higher than the equity portfolio with high ESG score in table 7. This result does not support hypothesis 3.

Performance of ESG portfolio (rated stocks) and non-ESG portfolio (unrated stocks).

The purpose of this section is to investigate returns and risks of portfolio to answer questions whether the rated stocks regardless of high or low ESG scores bring the better performance than unrated stocks. Hypothesis 1d and 2d are examined in this section. There is an increasing number of rated stocks compared to unrated stocks year by year (Table 3). However, until now, investors are still doubtful about the efficiency of rated stocks in comparison with unrated stocks performance in terms of risk, return and risk-return tradeoff. In order to compare two portfolios, the formation of this pair is illustrated in the Portfolio construction section. The unrated (Non-ESG) portfolio is more than four times smaller than the rated portfolio on average (Table 2). This situation is similar to Hubel and Scholz’s sample (2020).

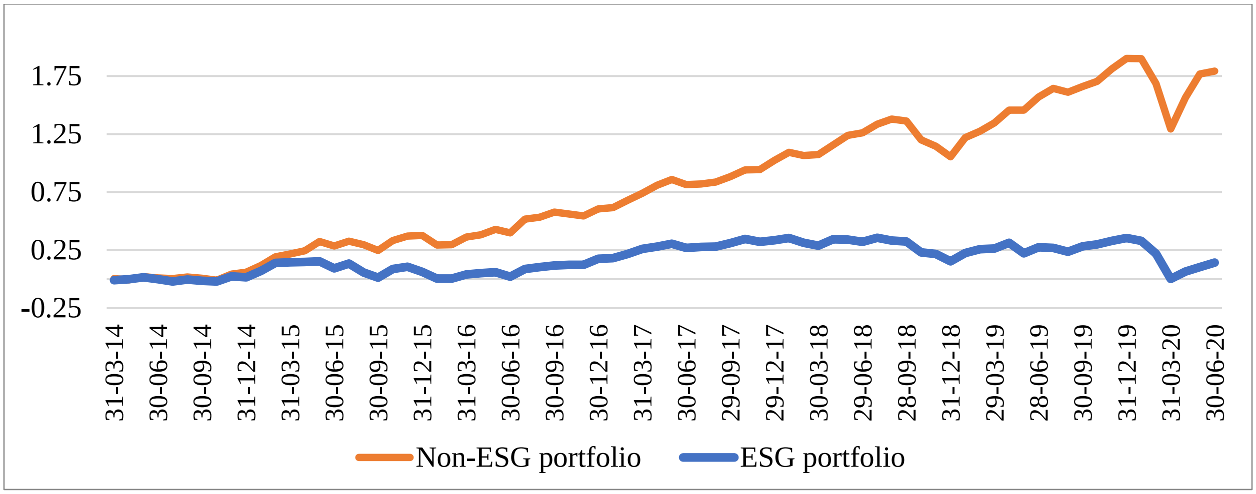

Figure 7. Cumulative monthly excess return of ESG portfolio and non-ESG portfolio

This figure shows the cumulative monthly excess return of ESG portfolio versus non-ESG portfolio from March 2014 to June 2020. Monthly excess returns are equal the results of average returns minus risk-free rate every month. ESG portfolio includes all stocks with ESG score whereas non-ESG portfolio consists all stocks without ESG score in the sample. The risk-free rate is retrieved from Kenneth French library.

During the sample period, the return of non-ESG portfolio is much higher than the return of ESG. Next, with the hope that there are stocks with ESG score will have better return than stocks without ESG score, we examine hypothesis 1d. However, this hypothesis is totally rejected because we find the evidence that the annual return of the non-ESG portfolio is significantly higher than return of the ESG portfolio at the 10% level. Hong and Kacperczyk (2009) showed evidence that sin stocks have higher expected returns than otherwise comparable stocks. Friede et al. (2015) found the majority of studies presents the positive relationship between ESG criteria and corporate financial performance in more than 2000 empirical studies in total, but it is not our case.

In terms of volatility, the result of table 7 shows the slightly higher annualized standard deviation of the ESG portfolio compared to non-ESG portfolio and there is no evidence of statistically significant difference between them.

Comparison of returns and risk above lead to the strongly higher Sharpe ratio of the non-ESG portfolio than the ESG portfolio. This does not support hypothesis 3.

To sum up the section of portfolio performance under consideration of ESG, it is not easy to find the evidence between ESG risk and average return except for the case of ESG and non-ESG portfolios. There is only one evidence supporting the hypothesis (2c) which shows the significantly higher volatility of the low ESG portfolios compared to its benchmark.

4.3. Explanatory power of the ESG factor (GMB)

We address the core of the study "How is the ESG factor related to other traditional factors?" To solve this research question, the ESG factor is created which is a hypothesized portfolio constructed from the sample of this study. Next, traditional factors are MKT (CAPM), Fama-French factors (SMB, HML, RMW, CMA) and Carhart factor (WML), the data of those factor returns are retrieved from Kenneth French library. There are 12 models designed in the section Models previously. We run 12 models on portfolios and on single stocks. The idea is to evaluate the added explanatory power of the ESG factor compared to each traditional factor by examining the change in adjusted R2 (adjusted R square) when expanding the different base models. Secondly, exposures of each factor in 12 models are disclosed.

Explanatory power of the ESG factor on portfolios and single stocks

Table 8 summarizes adjusted R^2 when adding factors into different base models on portfolios. On the portfolio level, we run 12 models on benchmark and the ESG portfolio to consider the ability of explaining expected return of the ESG factor.

Table 8. Explanatory power of factor on portfolios

Model	Portfolio			
	Benchmark		ESG	
	Adj. R2	p-value	Adj. R2	p-value
CAPM	0.786	**0.000**	0.783	**0.000**
GMB	-0.011	0.649	-0.006	0.454
CAPM + GMB	0.781	0.576	0.777	0.941
FF3F	0.781	0.299 SMB 0.763 HML	0.786	0.051 SMB 0.791 HML
FF3F+GMB	0.781	0.359	0.785	0.424
FF3F+WML	0.782	0.267	0.788	0.167
FF3F+CMA	0.779	0.599	0.783	0.633
FF3F+RMW	0.784	0.166	0.789	0.136
FF5F	0.781	0.174 RMW 0.649 CMA	0.785	0.131 RMW 0.683 CMA
FF5F+WML	0.782	0.248	0.789	0.156
FF5F+GMB	0.780	0.372	0.784	0.445
FF5F+WML+GMB	0.781	0.400	0.787	0.481

This table shows the explanatory power of ESG factor in comparison to common factors. Adjusted R square (Adj. R^2) in case of running regression on portfolios. P-value in each model of each portfolio is also presented. Both are retrieved from the output of regression function on Excel. Two portfolios are used to run regression are created from the Portfolio construction. The grey color presents base models.

Benchmark's return and ESG portfolio's return are explained well by the CAPM. The adjusted R^2 of the CAPM on BM and the ESG portfolio is 0.79 and 0.78, respectively. We found that the adjusted R^2 of the models with GMB added and other risk factors added slightly decline compared to the base model (CAPM, FF3FM, FF5FM). GMB one-factor model cannot explain any expected returns of the benchmark and the ESG portfolio.

To further check the explanatory power of the ESG factor and other factors, we run regression of 12 models on 258 single stocks with full periods in our sample. It means we run 258 times for single model. The percentage of missing data is 8% in total 281 stocks. These stocks can represent stocks of the benchmark.

We found that there is nearly a half of all stocks (49.61%) adjusted R^2 increase and 15.89% of all cases show the significant exposure of GMB at the 5% level when we add GMB into the CAPM. That is different from the result when we run models on the benchmark portfolio that the adjusted R^2 of the CAPM + GMB model is down from the CAPM model. We can find the evidence to show GMB contributes to explain returns of stocks. SMB and HML together are added in the CAPM to create the Fama-French 3-model factor, the explanatory power is significantly up with 71.71% case of positive changes in adjusted R^2. Moreover, the percent of significant case of these two factors are very high in 3 levels of significance. This finding is contradicted to the finding when we run CAPM + SMB + HML (FF3FM) on benchmark portfolio as a whole. The FF3FM explains returns very well on individual stocks.

Table 9. Explanatory power of the ESG factor of different models on single stocks

Base model	Added factors		Positive change adj. R2 (%)	Average change adj. R2 (%)	Significant at 1% (%)	Significant at 5% (%)	Significant at 10% (%)
CAPM	GMB		49.61	0.81	5.81	15.89	23.26
	SMB+HML	SMB	71.71	5.24	16.28	26.74	34.50
		HML			24.81	35.66	42.25
FF3F	GMB		38.37	0.53	3.49	11.24	18.99
	WML		43.80	0.50	2.33	13.57	21.32

	RMW		50.39	1.28	7.75	21.32	31.01
	CMA		34.11	0.25	1.94	10.47	15.12
	RMW+CMA	RMW	53.49	1.47	7.36	20.93	32.56
		CMA			1.55	8.91	15.50
FF5F	GMB		38.37	0.75	3.49	12.40	20.16
	WML		41.86	0.69	1.94	13.57	21.32
	WML + GMB	WML	51.55	1.08	2.71	12.79	20.93
		GMB			3.49	3.49	19.77

This table shows the average adjusted R^2 of each model based on monthly returns of 258 single stocks during the period from March 2014 to June 2020. Added factors are factor incorporated in the base model. Base models are the CAPM, the FF3F and the FF5F. Positive change adjusted R^2 (%) shows the rate of stocks have the positive change in adjusted R^2 when run by the expanding model. Average change adjusted R^2 is calculated base on the change of adjusted R^2 of 258 stocks including both positive and negative changes. The shares of significant changes in the adjusted R^2 are calculated based on the result of p-value in the output of regression in total 258 stocks.

There is 38.37% in total stocks having positive adjusted R^2 when the ESG factor is incorporated in the FF3FM. This figure is lower than the percentage that momentum factor (43.80%) or profitability factor (50.39%) or both (RMW + CMA) (53.49%) enhance the 3-factor model. However, the ability to explain returns of GMB is better than investment factor at individual stock level. The Fama-French 5-factor model explains expected returns better than the Fama-French 3-factor model and the Carhart 4-factor model as well on the single-stocks level. This finding is also contradicted to the finding when we run the FF5FM on the benchmark as the portfolio level.

GMB is added to the FF5FM leads to the increase in adjusted R^2 with 38.37% in total 258 stocks whereas WML accounts for 41.86% case of increased adjusted R^2. Momentum factor and the ESG factor both are integrated in the five-factor model help this model explain much better returns of stocks with more than a half of all cases growing the adjusted R^2.

Our result is different from Hubel and Scholz (2020) that they can find the added explanatory power of the ESG aggressive factor and the E, S, G factor both in portfolios and single stocks. However, we have the same result regarding the better explanation of the FF5FM comparing to conventional model in the study on Chinese individual stocks by Huang (2019).

Risk exposures on each portfolio and single stocks

Not only look at the adjusted R^2 change from the base model to the expanding model, but we also look at how large exposure is to see whether the ESG factor has a strong effect on the return of portfolios or stocks and compare the effect level of this factor with other traditional factors.

Let consider exposures of each factor in case of portfolio, we run 12 models on benchmark and result in table 10. Overall, we should look at adjusted R^2, 11 out of 12 models except for GMB one-factor model have high adjusted R square, it means the model can explain quite well the expected return of the portfolio. We look at the explanatory power of model as a whole first because when the model explains well, the number in exposure of each factor is more precise and meaningful.

Exposures to MKT have significant positive numbers roughly 1 (0.830-0.871) implies that the benchmark is well diversified. Moreover, MKT works very well in explaining the return of this portfolio because its exposure's figure increases from CAPM to FF3F, FF3F+GMB, FF3F+CMA. There is a strong evidence of statistical significance of market-related factor at the 1% level.

SMB has big negative figures to exposure in any models including this factor. It means that the return of the benchmark is affected strongly by the volatility of big-sized stocks. However, the p-value is insignificant. Exposures to HML do not show consistent patterns across models. Both RMW and CMA have a strong positive impact on the return of benchmark in any model they are within. Positive exposure to RMW means benchmark are exposed to stocks have high profitability. The positive figure of exposure to CMA implies the return of benchmark is affected by stocks having low investments. However, we also do not find the significant evidence for both profitability and investment factor. WML and GMB have negative figures of exposures in all models including them. The benchmark is exposed toward ‘loser’ stocks. Low ESG-scored stocks have affected benchmark’s return, but this impact is weak (-0.046; -0.085). The small negative figure of exposure to the ESG factor also reflects the weak ability of explanation of this factor in models that support the finding we found above. By considering exposures to each factor on the benchmark, we do not find the evidence of statistical significance for SMB, HML, RMW, CMA, WML and GMB as well, that support finding previously that such factor cannot help to explain better returns on the portfolio level.

Table 10. Exposures to each factor on benchmark (portfolio level)

	CAPM	GMB	CAPM+ GMB	FF3F	FF3F+ GMB	FF3F+ WML	FF3F+ RMW	FF3F+ CMA	FF5F	FF5F+ WML	FF5F+ GMB	FF5F+ WML+GMB
MKT	0.842		0.845	0.858	0.859	0.832	0.839	0.871	0.849	0.830	0.851	0.833
	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SMB				-0.137	-0.183	-0.115	-0.129	-0.104	-0.088	-0.049	-0.130	-0.090
				0.299	0.196	0.385	0.324	0.474	0.548	0.744	0.398	0.568
HML				-0.029	0.010	-0.085	0.124	-0.094	0.072	-0.038	0.111	0.003
				0.763	0.927	0.398	0.398	0.550	0.722	0.864	0.592	0.991
RMW							0.313		0.128	0.280	0.317	0.286
							0.166		0.174	0.223	0.167	0.214
CMA								0.149	0.311	0.206	0.136	0.211
								0.599	0.649	0.477	0.630	0.468
WML						-0.121				-0.129		-0.125
						0.267				0.248		0.400
GMB		0.080	-0.046		-0.087						-0.085	-0.080
		0.649	0.576		0.359						0.372	0.266
Adj. R2	0.783	-0.011	0.781	0.781	0.781	0.782	0.784	0.779	0.781	0.782	0.780	0.781

This table presents the correlation coefficients among seven factors of six portfolios during the period from March 2014 to June 2020 (67 months). Numbers under coefficients are p-value. P-value is also retrieved from the regression's output corresponding to each coefficient.

Table 11. Exposures to each factor on single-stocks level

		CAPM	GMB	CAPM+ GMB	FF3F	FF3F+ GMB	FF3F+ WML	FF3F+ RMW	FF3F+ CMA	FF5F	FF5F+ WML	FF5F+ GMB	FF5F+ WML+ GMB
MKT	Avg. beta	0.849		0.847	0.860	0.861	0.830	0.838	0.876	0.852	0.832	0.856	0.832
	Sig. at 1%	0.841		0.829	0.880	0.422	0.841	0.841	0.868	0.845	0.818	0.849	0.814
	Sig. at 5%	0.895		0.888	0.930	0.934	0.930	0.926	0.926	0.895	0.895	0.903	0.899
SMB	Avg. beta				-0.167	-0.217	-0.143	-0.158	-0.126	-0.109	-0.064	-0.156	-0.109
	Sig. at 1%				0.167	0.136	0.163	0.163	0.109	0.109	0.128	0.081	0.093
	Sig. at 5%				0.271	0.256	0.275	0.271	0.217	0.225	0.225	0.213	0.229
HML	Avg. beta				-0.015	0.027	-0.079	0.159	-0.097	0.092	-0.025	0.148	0.008
	Sig. at 1%				0.248	0.209	0.182	0.081	0.147	0.043	0.031	0.054	0.031
	Sig. at 5%				0.357	0.353	0.306	0.182	0.256	0.132	0.097	0.136	0.097
RMW	Avg. beta							0.356		0.353	0.326	0.369	0.324
	Sig. at 1%							0.023		0.074	0.078	0.093	0.081
	Sig. at 5%							0.039		0.209	0.213	0.213	0.213
CMA	Avg. beta								0.190	0.164	0.246	0.163	0.259
	Sig. at 1%								0.019	0.016	0.016	0.023	0.008
	Sig. at 5%								0.105	0.089	0.097	0.093	0.097
WML	Avg. beta						-0.138				-0.153		-0.145
	Sig. at 1%						0.023				0.019		0.027
	Sig. at 5%						0.136				0.136		0.128
GMB	Avg. beta		0.086	-0.040		-0.094						-0.092	-0.086
	Sig. at 1%		0.035	0.058		0.035						0.035	0.035
	Sig. at 5%		0.147	0.163		0.112						0.124	0.109
Average adj. R2		0.241	0.008	0.249	0.293	0.298	0.298	0.306	0.296	0.308	0.315	0.315	0.319

This table shows average coefficients (avg. beta) and the shares (%) of statistically significant case of each factor on 258 single stocks at the 1% and 5% level. The shares of significant exposures are calculated based on result of p-value in the output of regression (Sig. at 1%, sig. at 5%).

Next, we consider whether exposure on individual stocks can reflect the same characteristic of exposure on portfolio level. Exposures of 258 single stocks are in average numbers in table 11. Overall, the average adjusted R square of 258 stocks through each model are not high but it increases when adding more factors into the model. Average exposures to MKT remain strongly positive like in portfolio level with significant cases is very high (nearly 90% at the 5% level). That means most stocks are strongly affected by the volatility of market. Average exposures to SMB are big negative figures that align the finding in portfolios level. The percent of significant cases for SMB is biggest when it is in the Fama-French 3-factor model. When the size factor is joining with other factor, the ability of explaining return of stocks is weakened. HML continues to show the inconsistent pattern with positive and negative figures through 9 models. The large positive average exposures to RMW implies returns of single stocks are affected by the 'robust' side. The percent of significant cases to RMW risk factor are low in the FF3F+RMW, but high in the five-factor model and the expanded five-factor models. The average exposures to CMA are big positive figures however the percentage of significant case is very low in all five models. It means the effect of CMA is not highly confident. The pattern of WML and GMB is similar with negative average exposure in all models that they are within. The percent of significant cases is around 13% and 11% for WML and GML, respectively at the 5% level. However, the effect level of GMB (-0.040; -0.094) on stocks' returns is lower than that of WML (-0.138; -0.153).

To sum up for the final point, we can find the evidence of added explanatory power of GMB at single-stock level. However, when considering on the portfolio level, GMB does not show its power in explaining expected returns. GMB affects return of portfolio and individual stock in terms of 'low ESG-scored' side, but these effects are not strong on portfolio level. The ability to explain the return of GMB is not as strong as MKT, SMB+HML, RMW, RMW+CMA, WML but better than CMA only.

CONCLUSION

In order to apply the global development goals in investment, responsible investment is not a new concept that investors experience over the past decade. In fact, investors not only focus on the reward but also consider environmental, social and governance issues in their investment decisions. ESG integration is a strategy that investors screen and analyze the performance of stocks. Many researchers address this strategy to encourage investors to integrate the ESG factor in their investment process. Most popular technique is to use the factor model to incorporate the ESG factor into their investment portfolios. This thesis answers two questions: (1) Whether the higher ESG-scored portfolio leads to the higher return and lower volatility than the lower ESG-scored portfolio; (2) How the ESG factor is related to traditional factors.

To address the first question, we construct a benchmark, an ESG portfolio, a non-ESG portfolio, tercile 1, tercile 2 and tercile 3 portfolios. All portfolios with ESG scores are hypothesized portfolios in this thesis constructed following Fama-French rules and also from other researchers. The performance of such portfolios is compared. The rest question is solved by applying 12 asset pricing models on portfolios and single-stocks level. From the base model, the ESG factor and traditional factors are added. The added explanatory power of each factor in the expanding model is examined through the adjusted R^2 and how large exposures are.

After conducting the empirical research, there is no evidence that higher ESG-score portfolios give the rise to return. However, we found that the volatility of the low ESG portfolio is higher than the volatility of benchmark that confirms the hypothesis 2c. Another finding is that return of unrated (non-ESG) portfolio is significantly higher than the return of rated (ESG) portfolio. Therefore, we conclude that depending on the ESG score to choose stocks that cannot bring the reward for investors, otherwise they need to sacrifice their return to satisfy their mission toward environmental and societal issues. We still hope in the future with a longer period of ESG historical data and examine on a broader scale, we can find the signal of better score which leads to a better performance.

Regarding the relation of the ESG factor to traditional factors, we found that the ESG factor (GMB) can add the explanatory power to the base models such as the CAPM, the FF3FM and the FF5M. However, this evidence is generated from the regression on single-stock level. In the case of portfolios, we do not find the evidence to show ESG helps to enhance the base model in predicting returns. When comparing the ability to explain excess return to other factors, on a single-stock level, the contribution of GMB to explain the return of each stock is lower than MKT, SMB+HML, WML, RMW, RMW+CMA but higher than CMA. Exposures on portfolio to each factor reflect corresponding average exposure on single stocks level. In our sample, there is an evidence to show that the ESG factor helps traditional factors to explain better the return of individual stock and benchmark is exposed toward low ESG-scored stocks.

Although this thesis is based on much effort, it still encounters some limitations. First, the observation of the empirical study is low with only 76 months. This constraint comes from the historical ESG data on Bloomberg. Secondly, the sample is small with 281 stocks that makes the gap between the low ESG-scored portfolio and high ESG-scored portfolio very big. This issue affects the ability of the ESG factor to explain return.

Some articles such as Hubel and Scholz (2020), Bennani et al. (2018), UN PRI (2016) focus on three dimensions of ESG separated instead of aggregated ESG score like our study to see the relationship between E, S, G score and return. This will open the future research for us to be more specific about each pillar in terms of explanatory power. The model will be applied in more observations and bigger samples of stocks.

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APPENDICES

Appendix 1. Summary rated and unrated ESG rank stocks of each stock market (7 indices)

Name of index		**06/2014**	**06/2015**	**06/2016**	**06/2017**	**06/2018**	**06/2019**	**06/2020**
UKX	Rated	66	68	77	78	78	82	84
	Unrated	35	33	24	23	23	19	17
AEX25	Rated	14	15	16	16	16	22	22
	Unrated	11	10	9	9	9	3	3
OMX30	Rated	28	28	28	28	29	30	30
	Unrated	2	2	2	2	1	0	0
BEL20	Rated	10	11	11	11	11	14	14
	Unrated	10	9	9	9	9	6	6
IBEX35	Rated	19	21	22	22	23	26	27
	Unrated	16	14	13	13	12	9	8
DAX30	Rated	25	26	26	27	29	29	30
	Unrated	5	4	4	3	1	1	0
CAC40	Rated	36	37	37	37	37	38	38
	Unrated	4	3	3	3	3	2	2
SUM		281	281	281	281	281	281	281

Appendix 2. The time points of distribution of ESG score