The Performance of Sustainably Driven Portfolios

An Investigation of Risks and Returns

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Abstract

This paper investigates the returns and risks of sustainably driven portfolios compared to non-sustainably driven portfolios through the lens of an everyday investor pursuing a buy-and-hold investment strategy. To do so, the authors use ESG risk ratings from *Sustainalytics* to establish portfolios of 25 stocks across 3 ESG risk rating buckets (low, medium, and high ESG risk) from the constituents of the *FTSE 350* market index. Using a single-factor CAPM and 5 years of historical data from 2015 to 2020, the authors create 3 portfolios for each ESG risk rating (9 portfolios in total) including an Equally Weighted, Global Minimum Variance and Optimal Tangency portfolio. Establishing said portfolios as of May 2020, the authors then track the performance of the 9 portfolios for 3 years, until March 2023, to investigate the risk and returns of the portfolios as of the date they were created, and upon the holding period's completion.

The authors found, in line with previous literature, that the low ESG risk rated portfolios (considered the most sustainable) outperformed their medium and high ESG risk rated counterparts during the holding period in providing higher realized returns. Additionally, the Equally Weighted and Optimal Tangency low ESG risk rated portfolios achieved superior realized returns compared to the *FTSE 350* during the same 3-year holding period. In the establishment of the portfolios in May 2020, the low ESG risk rated portfolios were found to provide superior tail-risk protection, as measured by Value-at-Risk and Expected Shortfall, but these findings did not sustain through the holding period. The increased risk, however, was more than offset by the realized returns as evidenced by the portfolios' superior Sharpe ratio (risk adjusted returns).

Overall, these findings align with previous literature on the superior return potential of sustainable portfolios compared to their non-sustainable counterparts and reaffirm ESG as a valid criterion for investors in the creation of their portfolios.

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1 Introduction

Investing with the goal of achieving more than just financial returns, namely social and environmental impact, is not a new phenomenon. This desire investors have to make money while doing good has existed in many forms and gone by many names including microfinance, Socially Responsible Investing (SRI) and impact investing, the latter being the preferred term used by the authors of this paper. A key question remains, however, in whether it is possible to achieve financial, social and environmental returns simultaneously? This is a longstanding question which researchers abound have attempted to answer. As investors continue to put ever increasing pressure on organizations to increase their disclosure and transparency surrounding their internal operations and practices, researchers have attempted to use this increased transparency to better understand the link between companies' sustainable practices and investors financial returns.

With increased transparency and disclosure comes a vast amount of information at an investor's disposal. Thus, while the increased disclosure satisfies investors desire for increased transparency, the sheer volume of information limits the ability of investors to make efficient and effective use of it. To mitigate this information overload, sustainable risk rating agencies have emerged. Through a variety of individualized measures, these ESG risk rating agencies provide investors with externally vetted insights into the sustainable nature of the companies they are interested in investing in.

Understanding and contributing to previous research pertaining to the return paradigm in which investing for impact meets investing for financial return, was the motivation behind the authors of this papers' investigation. Namely, the authors of this paper investigated the performance of portfolios receiving the most sustainable ESG risk ratings from the sustainable risk rating agency, *Sustainalytics*, and the returns and risk associated with such an investment strategy.

Interested in understanding the implications of a sustainably driven investment strategy on the everyday investor, the authors of this paper chose to investigate via a two-step process, namely, the creation and optimization of sustainably and non-sustainably driven portfolios using 5-years of historical data, followed by a 3-year holding period in which no rebalancing to the portfolios occurred. In this way, the authors investigated what return an everyday investor pursuing a buy-and-hold strategy would have achieved across both sustainable and non-sustainable portfolio creation strategies. Likewise, whether the sustainably conscious investment strategy, as favoured by an investor motivated by both impact and financial return, would outperform its non-sustainable counterparts.

In the way, the authors of this paper wish to investigate:

> How does the return and risk of sustainably driven portfolios compare to other non-sustainably driven portfolios through the lens of an everyday investor pursuing a buy-and-hold investment strategy?

1.1 Structure of the Paper

To answer the above research question, the authors of this paper follow the proceeding structure as it will be detailed here. As the above research question indicates, the authors of this paper are pursuing an open-ended approach whereby the literature, as will be presented in the following section, *Literature Review*, guides the authors in establishing a number of expectations as to how the returns and risks of sustainable portfolios compare to non-sustainable portfolios. These expectations are outlined in the *Takeaways from the Literature and Expectations of the Authors*. To then investigate these portfolio expectations as determined by the literature, the authors present, in the *Theoretical Background* section, the underpinnings of Modern Portfolio Theory which will be used to investigate the authors expectations. Specifications as to the data used and methodology are then presented in the *Data and Methodology* section. This section also outlines the chosen mathematical notation of the authors used in the calculation of various critical variables. Following this, the *Results and Analysis* section details how the critical variables were calculated using the theories and mathematical notation as well as a detailed investigation into the results through analyzing their implications. Then, the *Discussion* section compares and contrasts the findings of the authors with that of previous literature, before addressing the authors initial expectations, based on said literature, and how this paper's findings contribute to furthering the academic discussion surrounding the return and risk of sustainable portfolios compared to their non-sustainable counterparts in the *Reflections on the Authors Expectations* section. Finally, in the *Conclusion* section, the authors conclude with a summation of the paper's key findings, limitations to the research and how such limitations provide a focal point for future research in sustainable investing.

2 Literature Review

This literature review begins with the broad perspective of sustainability as everyone’s responsibility before continuing through the academic literature to obtain the understanding that such sustainably driven initiatives are not mutually exclusive from the potential to obtain financial returns. Thus, the proceeding sections start from a broad understanding of sustainability at large, guiding the authors of this paper through to the eventual focal point of this research, namely whether one can achieve sustainable and financial returns simultaneously.

2.1 The UN Sustainable Development Goals

The United Nations Sustainable Development Goals (SDGs) are a collection of 17 goals established by the United Nations in 2015 as part of the 2030 Agenda for Sustainable Development. The SDGs are interconnected and aim to address the root causes of poverty, inequality and environmental degradation while promoting social and economic development (United Nations, 2022).

In 2022, the UN SDG progress report warned that, “cascading and interlinked crises are putting the 2030 Agenda for sustainable development in grave danger,” (United Nations, 2022). With a series of crises currently converging, including climate change, numerous conflicts and an energy crisis in the West – the world is faced with pressing and severe social and environmental challenges. Together, these crises have the capacity to undermine food security, worsen global poverty and degrade some of the world’s most diverse ecosystems (United Nations, 2022).

Addressing these challenges and keeping the SDGs on track will require cooperation and collaboration among governments, the private sector and individuals in society. It will also require significant investments not only from the public sector but from private investors as well. In 2018, The United Nations Conference on Trade and Development estimated that the world would need between $5 and $7 trillion annually in investments to meet the SDGs by 2030 (Childs et al., 2018).

This figure demonstrates the importance that financing initiatives and investments can play in driving forward a more equitable and sustainable future. A large sum of this financing can come from the public sector in the form of, for example, government spending on renewable energy infrastructure. In addition, funds can also flow in the form of donations from individuals. However, it is possible for this financing to come from impact driven investors seeking to make positive social or environmental impacts alongside their financial returns.

2.2 Impact Investing – A Brief History

Impact investing is one of the financial tools that can be used to achieve the UN SDGs and thereby drive a more equitable and sustainable future. Under this form of investing, the investor intentionally invests to achieve positive and measurable social and environmental impacts in addition to financial returns (Hebb, 2013). The term impact investing was first coined in 2007, with the concept growing in popularity following the Global Financial Crisis of 2008 and the resulting collapse in public confidence in the financial industry (Agrawal & Hockerts, 2021). However, despite the term impact investing only recently growing in popularity, the idea of investing for positive social and environmental impacts can be traced back many decades.

An early example of investing for positive social impacts can be found in the microfinance industry, not least starting in the 1970’s, with an economist considered to be the father of microfinance, Muhammad Yunus. He founded Grameen Bank, which pioneered the concept of providing small micro loans to impoverished people, particularly women, who were unable to offer any collateral (Yunus, 1998). By the mid 90’s, the bank was lending to 2.3 million borrowers, 94% of whom were poor women, with a total lending size of $2 billion and an average loan size of $175 (Yunus, 1998). Through this initiative, Grameen Bank enabled people to start their own businesses while empowering women and promoting financial inclusion. Then, by the 1980’s, Socially Responsible Investing (SRI) had started to grow in popularity as another method for investing for positive social impact. Under this form of investing, investors either accept or disqualify investments based on certain ethical criteria with such investments typically excluding companies through negative screening (Steen et al., 2020). For example, an SRI investor may choose to avoid investing in firms which carry out animal testing or boycott entire industries such as arms manufacturing.

As of today, the impact investing market has grown rapidly to reach a significant value of Assets Under Management (AUM). According to the Global Impact Investing Network's (GIIN) sizing the market report, the worldwide impact investing market is worth USD 1.164 trillion as of 2022, making it the first year in which more than a trillion USD was invested (Hand et al., 2022). The same organization has also published insights detailing how impact investing can contribute to attaining the SDG's. Key examples include promoting financial inclusion by providing financial services to underserved markets as well as investing in renewable energy companies to support the transition to green energy (Pineiro et al., 2018).

In summary, the world is faced with pressing social and environmental challenges for which addressing them will require significant financing. The historical proclivity towards sustainability and the desire amongst investors today to achieve social and environmental returns in addition to financial returns, is one way to address the interconnectedness of today's global sustainability challenges. Impact investing (as will be the chosen term used throughout this paper) considers the desire of an investor to help tackle these global sustainability challenges and promote a more sustainable future wherein financial returns are weighted against their impact on society and the environment. To investigate this financial tradeoff between investing for returns and investing for impact, this paper considers a passive, everyday impact investor and the financial returns they would have realized during the last 3 years if they had consciously created portfolios by using ESG risk ratings as their main screening criterion. This investor profile is explained in more depth in the proceeding section.

2.3 Investor Profile – The Passive Impact Investor

Given the growing popularity in the concept of investing for both financial and sustainable reasons, the investor profiles interested in achieving a mix of financial, social and environmental returns are likely to be varied. To this end, this paper considers the investor profile as that of an everyday investor with a desire to achieve a financial return in addition to social and environmental impact. For the remainder of this paper, such an investor will be referred to as a passive impact investor, or simply an everyday investor.

As defined above, an impact investor is someone who seeks to create positive social and environmental outcomes alongside financial returns. Among the different impact investor types there is also a distinction between those who engage in actively influencing the direction of the company, also known as active ownership (Dimson et al., 2015) as well as passive impact investors who do not (Baines & Hager, 2022). As this paper focuses on everyday impact investors, actively influencing the governance of companies by encouraging social and environmental initiatives is unlikely. Passively investing in companies already considering social and environmental initiatives is, however, within the scope of an everyday impact investors capabilities.

The term passive impact investor additionally provides clarity as to the investment strategy, namely passive management, undertaken by the passive impact investor considered here. This strategy considers the efficient market hypothesis' belief that the trading costs outweigh the financial benefit of actively managing a portfolio; thus, a buy-and-hold strategy for a well-diversified portfolio is recommended (Bodie et al., 2021, p. 339). While index funds are often considered strategies for passive management (Bodie et al., 2021, p. 339), the passive impact investors defined here have the ability to customize individual stocks and optimize their own portfolios, rather than relying on an Exchange Traded Fund or Mutual Fund. Once the stocks and portfolio weights have been defined, a buy-and-hold strategy with no rebalancing of the chosen portfolio ensues.

With this definition of passive impact investors, there are a number of considerations surrounding these investors including reflections pertaining to their access to capital markets, the need impact investors have for reliable and consistent ESG risk rating metrics and whether it is possible to expect to be able to achieve social, environmental and financial returns simultaneously. These reflections are discussed in the following sections and lead the authors of this paper to the use of sustainable risk rating agencies (in this case *Sustainalytics*) as a tool to investigate the financial returns passive, everyday impact investors could expect to achieve by investing using ESG as their chief criterion.

2.4 Access to Capital Markets

Despite the relatively recent history of impact investing, the practice of investing to generate social and environmental impacts alongside financial returns is becoming increasingly popular amongst foundations, institutional funds and wealthy individuals (Mendell & Barbosa, 2013, p. 113; Mendell & Nogales, 2011). To that end, investigations into the impact investing landscape highlight the importance of intermediaries in reducing information asymmetries and risks to both the demand and supply of investment capital (Mendell & Barbosa, 2013). Interestingly, providing exit strategies to investors and increasing liquidity is noted as being the most critical differentiating factor to the attractiveness of any given impact investor market (Mendell & Barbosa, 2013). As Mendell & Barbosa (2013) determined, such need for exit opportunities and liquidity is served best by means of secondary markets, where investors buy and sell securities from and to one another.

Considering this paper's focus on passive, everyday impact investors, the takeaways from Mendell & Barbosa (2013) offer interesting insights for investing in capital markets. First, is the number of challenges facing impact driven investors in their need for reduced information asymmetries through measurement tools and methods. Second, is the need investors have for exit opportunities from their investments as well as increased liquidity. While Mendell & Barbosa (2013) investigated newly established sustainably driven, primary market alternatives, they do not meet either of the identified investor needs. Alternatively, traditional secondary markets, such as the *London Stock Exchange,* already meet the need for liquidity and exit opportunities. In this way, instead of impact driven, primary markets trying to imitate characteristics of traditional capital markets, it is much simpler for passive, everyday impact investors to investigate the impactful investment opportunities currently available by trading in traditional, secondary capital markets. While the challenge of reducing information asymmetries remains, the sustainable risk rating agencies discussed throughout the proceeding sections are an attempt to reduce such challenges through defining consistent metrics.

Reducing information asymmetries helps to ensure the validity of companies' sustainable claims, and thus reduce the real (or perceived risks) investors feel with respect to investing in companies for their sustainable agendas. Ideally, initiatives to reduce information asymmetries will make investments into already publicly traded companies more appealing from the perspective of an impact investor, facilitating more informed investments. This in turn, allows for a passive, everyday impact investor to confidently invest in stock markets which already provide liquidity and exit opportunities.

While the authors of this paper consider the initiatives of investors and private enterprises in the development of sustainable risk rating agencies which attempt to reduce information asymmetries, there are notable mentions within the literature citing the importance of governments in establishing sustainable policies. For example, Wood et al. (2013) cites the need for government policymakers to make clear the fiduciary duty that exists when considering social and environmental claims. Likewise, Mendell & Nogales (2011) stress the role governments play in setting policies to encourage investment into impact driven sectors through increasing contributions, mobilizing capital and enabling infrastructure. While the authors of this paper recognize the importance of government policy in establishing sustainable initiatives, further consideration is outside of the scope of this paper.

In addition to the information asymmetries that exist for impact investors as well as the need for consistent and transparent metrics as cited above by Mendell & Barbosa (2013), is the sheer mass of publicly available information at an impact investors disposal. Together, these have practical implications for the ease with which an impact investor can be expected to do their due diligence reasonably and efficiently. Impact investors would be required to spend hours reading and analyzing individual sustainability reports as well as remain up to date on all public controversies and news reports surrounding potential investment opportunities. These expectations are highly unrealistic for the passive, everyday impact investor and thus, the need for consistent, reliable, and easy to interpret metrics to assist them in their decision-making process continues to remain a top priority. The next section will extend upon the insights thus far to include additional academic appeals for consistent and reliable sustainability driven metrics.

2.5 A Call for Consistent Metrics

While there is a practical need for consistent and reliable metrics for everyday impact investors, there is also a noted need within the academic literature.

First is a call for consistent metrics and standards by Jackson (2013) with suggestions upon which one can address the difficult and time-consuming task of quantifying social and environmental returns, similarly to the ease with which one can use traditional methods of financial analysis. Jackson (2013) addresses this difficulty specifically by suggesting the need for developing a common set of standards and rating systems through the lens of the *theory of change* which would assist impact investors in three ways: comprehensively framing the full potential of the evaluation function of the impact investing industry, bringing developed data analysis methods, and reminding investors that what matters most is the extent investments lead to positive impacts. Applying this logic, Jackson (2013) suggests that at the level of individual investments, it would be ideal for investors to have access to standardized impactful metrics across the impact investing industry. Jackson (2013, p. 104) further indicates the need for *organizational assessment* tools which analyze a combination of a company's external environment such as the legal and economic landscape, a company's motivation for doing what they do, and a company's organizational capacity such as their strategic leadership and financial management.

Wood et al. (2013) also note the increasing interest and desire from institutional investors to make investment decisions which generate returns beyond the purely financial realm. Institutional asset owners report limited impactful options meeting their investment criteria and cite government policymakers as the catalyst in creating policies to include "social impact into conventional investment vehicles" (Wood et al., 2013, p. 90). In such a way, if impact is already built into a conventional investment vehicle, the intentions of the investor become "less relevant to the process of impact investing by making the social outcome something of a fait accompli" (Wood et al., 2013, p. 90). This is an interesting insight from the perspective of a passive impact investor as using such tools imply that impact is already considered from the onset. As such, while investors typically use "conventional asset class benchmarks and tools to make their decisions about investability" (Wood et al., 2013, p. 81), using an investment vehicle such as stocks which already considers impacts, will by definition establish an impactful portfolio which can be analyzed using conventional portfolio metrics on risk and return. In addition to this, while they criticize the use of traditional performance measurement strategies for measuring impactful investments, institutional investors continue to engage in selecting investments based on their financial performance (Wood et al., 2013).

The need for standardization and metrics to measure impactful outcomes is further stated by Mendell & Nogales (2011, p. 27) as “critical for this evolving market to attract investors.” It is further elaborated the need for “developing both homogeneous or universal measures with wide applicability, as well as differentiated measures to account for sectoral and national specificities.” (Mendell & Nogales, 2011, p. 27).

In summary, while Jackson (2013) cites a decided need for standardized impactful metrics and organizational assessment tools which consider a company’s internal and external environment, Wood et al. (2013) details the need for impactful considerations to be built into conventional investment vehicles in such a way that using such vehicles implies impact is pre-considered and inevitable to the outcome. Mendell & Nogales (2011) further indicate a need for standardized, universal metrics to attract potential investors. These considerations, combined with Mendell & Barbosa (2013) insights into the need for evaluation tools and intermediaries to reduce information asymmetries, summarize a need for consistent, reliable, uniform, accurate metrics which a passive everyday impact investor can use and rely on to provide trustworthy social and environmental takeaways. Standardized metrics such as sustainable risk rating agencies, satisfy this need for consistent metrics and evaluation tools while also extending upon Wood et al. (2013)’s takeaways that by considering impact from the onset of an investment based on a given sustainable risk rating, a portfolio of stocks receiving favourable ratings will, by definition, be impactful.

While using standardized metrics from a sustainable risk rating agency considers a company’s social and environmental impacts, this paper has yet to consider the potential financial returns of said investments. While social and environmental impacts are important for impact investors, they are also interested in the financial returns of their investments. The next section will investigate the relationship between these three forms of return to understand whether it is realistic for an everyday impact investor to desire to achieve social, environmental and financial returns simultaneously.

2.6 Can Firms Achieve Financial, Social and Environmental Returns Simultaneously?

Traditionally, firms are expected to focus only on maximizing the returns of their shareholders. While this remains important, there is a growing body of literature detailing the ability of firms to achieve not only greater financial returns, but social and environmental returns as well. Margolis & Walsh (2003) summarize that the widespread belief that these cannot exist concurrently is based on the belief that managers will misappropriate and misallocate resources. These assumptions do not withstand empirical studies however, as Margolis & Walsh (2003) conducted a review of 127 empirical publications published between 1972 and 2002, of which they found a clear positive association between social and financial performance within the literature. While this provides interesting insights, there are also additional, more recent, advocates for considering ESG within the risks and returns of investment portfolios due to the enhanced long-term performance of portfolios following macro trends including, but not limited to, climate change, urbanization and demographic shifts (Wood et al., 2013, p. 79). While these benefits exist, Wood et al. (2013) does indicate that some hesitance amongst investors remains due to the perception of impact investing as a niche, risky market.

Additionally, varying conclusions drawn within the literature include Barber et al. (2021) who found that impact venture capital funds achieve lower ex-post internal rates of return than traditional venture capital funds. On the other hand, Eccles et al. (2016) found that ESG screening improves risk-adjusted returns as well as lower volatility and CVaR when compared to an unscreened investment universe. The researchers also found that the risk introduced through lack of diversification by choosing stocks through ESG screening criteria is more than offset by excess risk-adjusted returns when compared to an unscreened investment universe (Eccles et al., 2016). An interesting takeaway from this paper is their consideration of an entire investment universe consisting of 85% of developed and emerging countries equities and concludes that ESG pre-screening using *Sustainalytics*, prior to picking stocks and establishing portfolios, can create a selection of stocks "with improved risk-return characteristics and diversification" (Eccles et al., 2016, p. 54). Interestingly, of the entire investment universe, it is noted that there is a high concentration of European and North American firms within the portfolios which had undergone ESG screening, indicating notable locational considerations (Eccles et al., 2016).

Additionally, Nofsinger & Varma (2014) found that mutual funds dedicated to socially responsible investing underperformed during periods of normal market activity, while they outperformed during times of market-crisis. Ruf et al. (2019) also found that mutual funds receiving a high ESG-rating from *Morningstar* (meaning that they were ranked the most sustainable) achieved higher risk adjusted returns during recessions than low and medium ESG-rated stocks and vice versa during times of market expansion. Their final takeaways indicate "that higher-ESG rated [Socially Responsible Mutual Funds] are likely to be attractive to socially responsible investors who prefer conscientious investments and greater stability during periods of market uncertainty" (Ruf et al., 2019, p. 60). Furthermore, Attig & Sy (2023) found that funds dedicated to investing within developed markets benefited from diversifying across industries, in contrast to them investing globally to achieve country-based diversification, and that these benefits sustained through times of market crisis. Lesser et al. (2016), on the other hand, found that the outperformance of internationally invested socially responsible funds (as rated by *Morningstar*) during periods of crisis only occurred for funds based in North America compared to firms domiciled in Europe and Asia-Pacific due to the superior management of North American funds.

Based on these takeaways, the varying conclusions drawn within the literature surrounding whether an impact investor can expect to achieve positive financial returns through their investment in socially and environmentally driven companies, appears somewhat ambiguous and locational dependent. The authors of this paper are attempting to better understand this ambiguity through the creation of portfolios using ESG risk ratings as a consistent and standardized metric to assist impact investors in their investment into traditional secondary markets. In addition to the above, this ambiguity has been attempted to be better understood by other researchers within the academic community through similarly combining portfolio creation through the use of ESG scores. An additional brief overview of three such papers and their conclusions will be summarized next providing further takeaways and insights for the authors of this paper.

The recent paper published by Pacelli et al. (2023) investigated whether ESG scores provide an acceptable addition to the optimization of portfolios. They selected portfolios composed of 30 stocks each with companies headquartered in a European country that received a *Refinitiv* ESG score for each day between 2017-2019 (Pacelli et al., 2023). Refinitiv ESG scores are cited as being used due to their "widespread application in the financial industry" (Pacelli et al., 2023, p. 32). Pacelli et al. (2023, p. 33) sought to understand "both the intensity and the direction of the link between the performance and the ESG score (considered overall, as well as in relation to its own main components E, S, G) of different sectoral funds composed entirely of ESG assets." To understand this relationship, the Conditional Value at Risk (CVaR) is used as a risk measure along with daily returns for the listed companies (Pacelli et al., 2023). The paper found that "the average return of all the minimum CVaR portfolios made up of the considered ESG securities is positive" (Pacelli et al., 2023, p. 34); however, "the securities that occupied the largest shares within them were not systematically characterised by a high ESG score" (Pacelli et al., 2023, p. 36). Please note that in this case, high ESG score is considered synonymous with a highly sustainable company.

Another paper published by Steen et al. (2020) investigated the ESG ratings and performance of Norwegian mutual funds. They selected 146 mutual funds with *Morningstar* ESG risk ratings and investigated their monthly returns over a five-year period from January 2014 to December 2018 (Steen et al., 2020). The benchmark chosen for their calculations was the Oslo Stock Exchange

Fund Index (OSEFX) which they note as the benchmark chosen for the majority of the mutual funds included in their investigation (Steen et al., 2020). The risk-free rate used was that of a three-year Norwegian sovereign bond (Steen et al., 2020). The authors created Equally Weighted portfolios of mutual funds receiving the top 20% and bottom 20% sustainability rating and proceeded to report on portfolio returns, standard deviations, betas and Sharpe Ratios for each (Steen et al., 2020). Overall, Steen et al. (2020) found no evidence of abnormal risk adjusted returns in the Norwegian mutual funds with high or low Morningstar's ESG ratings; however, noted that locational biases may be present as risk adjusted returns were positive when considering European funds.

A third paper published by Xiong (2021) used *Sustainalytics* ESG risk ratings to investigate both the return and tail-risk of US stocks receiving a low ESG risk rating (sustainable) compared to stocks receiving a high ESG risk rating (non-sustainable). The author considered a combination of "weekly and monthly returns, market capitalization and price-to-book ratios (P/Bs)" (Xiong, 2021, p. 8). They then created portfolios of the lowest and highest ESG rated stocks by separating them into five quartiles after ranking them from lowest to highest ESG risk rating (Xiong, 2021). Their findings were interesting in that the portfolio consisting of the lowest ESG risk rated stocks (most sustainable) realized higher returns and lower negative CVaR (implying less tail-risk) than did the portfolio of the highest ESG risk rated stocks (Xiong, 2021). In addition to CVaR, the author also found that the portfolio of the highest ESG risk rated stocks had the most negative skewness and highest kurtosis, further emphasizing the portfolios comparative greater tail-risk (Xiong, 2021). Lastly, higher arithmetic returns, lower standard deviation and a higher Sharpe ratio were also found in the lowest ESG risk rated stocks compared to the highest ESG risk rated (Xiong, 2021). The author concluded by further investigating and commenting on green mutual funds and passive ETFs attracting more capital than their low sustainability counterparts and that such funds, likewise, enjoyed higher returns and lower tail risk (Xiong, 2021).

Before summarizing the overall takeaways, it was an interesting observation by the authors of this paper, that previous literature favoured the use of multi-factor models in the calculation of critical variables (Eccles et al., 2016; Lesser et al., 2016; Nofsinger & Varma, 2014; Ruf et al., 2019; Steen et al., 2020; Xiong, 2021). The authors of this paper found such focus on multi-factor models driven by their focus on funds and stocks from varied markets and geographical locations, implying a greater need for more explanatory variables to account for such differences than is provided in a single-factor model.

Overall, the takeaways from the academic literature thus far are extensive and multifaceted. First, the literature detailed a need for impact investors to have access to reduced information asymmetries surrounding sustainable investment opportunities, as well as the need to mitigate investment risk and liquidity concerns (Mendell & Barbosa, 2013; Mendell & Nogales, 2011). Such concerns are most easily met through participation in traditional capital markets which everyday, passive impact investors already have easy access to. Second, is the recognized need for measurement tools to help impact investors perform their due diligence while being presented with a plethora of information with which to navigate. To assist such investors, there is a need within the literature for consistent, comparable metrics (Jackson, 2013; Mendell & Nogales, 2011; Wood et al., 2013). Collectively, these findings lay the foundation for the need impact investors have for assistance in understanding, analyzing and critically examining social and environmental impacts of various investment opportunities.

The desire impact investors have to achieve financial returns in addition to social and environmental impact is also noted by Margolis & Walsh (2003) as being realistic and that such returns are not mutually exclusive. Wood et al. (2013) advocates for considering ESG due to better long-term performance while Eccles et al. (2016) found ESG screening leads to greater returns and less volatility. Despite these positive findings, Barber et al. (2021) found sustainably driven venture capital funds achieved lower internal rates of return while both Nofsinger & Varma (2014) and Ruf et al. (2019) found that sustainably driven funds performed better during times of market crisis yet underperformed during periods of normal market activity. Lesser et al. (2016) also found socially responsible mutual funds outperformed during periods of market crisis but that these findings were unique for North American domiciled funds.

In conclusion, the literature appears somewhat ambiguous as to the return potential of investing for a combination of social, environmental and financial returns. In considering these takeaways the authors of this paper further outlined three additional papers by Pacelli et al. (2023), Steen et al. (2020) and Xiong (2021) who all investigated the link between portfolio returns and ESG risk ratings from external rating agencies. Using three different ESG risk rating agencies, *Refinitiv ESG Scores, Morningstar* and *Sustainalytics*, they used various methods of calculating portfolio returns, volatility and tail-risk. While their conclusions were broadly positive, they too remained somewhat ambiguous. As the conclusions within the academic literature remain ambiguous, there remains a need for further analysis surrounding consistent and reliable metrics coupled with an understanding as to whether or not the current ESG risk rating options are sufficient to satisfy this need.

As this paper will investigate the financial tradeoff between investing for returns and investing for impact, coupled with the recognized need within the literature for consistent ESG risk rating metrics to assist passive impact investors in their due diligence, the proceeding section will continue the academic investigation by outlining key considerations in the choice of such an ESG risk rating agency.

2.7 Sustainable Rating Agencies

In response to investors desire for easy-to-use quantifiable metrics, there have emerged various companies offering their own unique solutions to investors ever growing demand for sustainable ratings. Some, of the numerous that exist today, include *Sustainalytics*, *MSCI ESG Ratings*, *Refinitiv ESG Scores, Bloomberg ESG Ratings*, *Dow Jones Sustainability Index, Moody's ESG, FTSE Russell ESG Ratings*, among many others. The various ESG risk rating agencies at an investor's disposal provide ample opportunity for investors to better understand and critically analyze the environmental and social initiatives companies are undertaking, outsourcing in some manner their ESG due diligence by relying on ESG risk rating agencies to investigate companies' sustainable claims.

While sustainable risk rating agencies are more prevalent now than ever, research surrounding their credibility and applicability has long been of interest to researchers. Boiral (2013), for example, investigated the usefulness of the *GRI* rating system to understand the true sustainable impact of companies receiving the highest *GRI* ratings. *GRI* stands for "Global Reporting Initiative" and provides a sustainable reporting standards framework for companies globally (Boiral, 2013). While the *GRI* previously provided ratings on companies' sustainability disclosures (a practice which they have since forgone), Boiral (2013) investigated notable discrepancies in such ratings which provide notable learning takeaways.

This study on *GRI* ratings investigated companies within the energy and mining sectors which received the *GRI*'s highest ratings of either A or A+ with the goal of understanding the true sustainable impact of companies receiving the highest *GRI* ratings (Boiral, 2013). The study considered what companies disclosed within their sustainability reports and compared it to publicly available information on the company to determine if they chose to willfully omit certain sustainable controversies which would have reflected poorly on the organization (Boiral, 2013). It was concluded that while the sustainability reports received the highest *GRI* rating possible, the reports were found to willfully omit "significant adverse events" (Boiral, 2013, p. 1051) implying that despite the *GRI* emphasizing "principles of balance, completeness, transparency, stakeholder inclusiveness, etc." (Boiral, 2013, p. 1051), companies selectively chose to report only that which made them appear favourable while omitting, or vaguely mentioning, less favourable disclosures (Boiral, 2013). The reports are noted for being lengthy with unfavourable information mixed in with the favourable as well as "[t]he reported information's lack of completeness was apparent in the evasive, unspecified and biased nature of the disclosed negative information" (Boiral, 2013, p. 1053). This paper makes it clear the importance of considering all publicly available information when critically examining the true sustainable impact of a given company. While it is important to consider what a company chooses to disclose, it is equally important to consider what they choose not to. This appears to have been a critical limitation of the *GRI* rating system in that the companies were trusted to disclose transparent and complete information; however, their disclosures were not scrutinized for omitted or misleading information.

In addition to the takeaways from Boiral (2013), are a number of additional key considerations surrounding ESG risk rating agencies in general by Doyle (2018). Doyle (2018) came to a similar conclusion as Boiral (2013) in that companies publishing detailed sustainability reports tended to receive higher ESG risk ratings despite being party to considerable ESG controversy and weak sustainable practices, concluding that sustainable rating agencies tended to favour companies with robust ESG disclosure yet poor ESG practices. Stemming from this is the bias ESG risk rating companies exhibit in awarding more favourable ESG risk ratings to larger organizations with the resources at their disposal to publish robust ESG reports, a capability small and medium size companies do not have (Doyle, 2018). There are also noted geographic bias surrounding ESG risk ratings in that companies operating in certain countries (such as Europe) receive higher ESG risk ratings than others (such as North America), again due to their degree of disclosure, as local legislation demands greater levels of disclosure from the companies in some geographical regions (Doyle, 2018). Additional challenges surrounding the meaningful comparability of different sectors/industries as well as the lack of standardization within disclosure practices, add additional layers of complexity to the trustworthiness of ESG risk ratings (Doyle, 2018). With the lack of standardization comes the inconsistency in ESG risk ratings between various ESG risk rating agencies, due in part to the need for consistent reporting regulation, as well as the lack of disclosure from ESG risk rating agencies themselves as to their processes, evaluations and metrics (Doyle, 2018).

In summary, ESG risk rating agencies should learn from the shortcomings of the *GRI* rating system (Boiral, 2013) as well those defined by Doyle (2018) by improving their knowledge of a given company's sustainable operations, both positive and negative, through consideration of not only company disclosures, but publicly available information as well. Likewise, ESG risk rating agencies should consider more publicly available information and ESG related company controversies to mitigate both company size, and geographic bias. Lastly, ESG risk rating agencies must consider their own disclosure and transparency practices to allow for users of such ratings to better understand what the agency places material weight on, allowing industries to become more comparable to one another and inconsistencies in ESG risk ratings amongst agencies to dissipate.

Now notable considerations surrounding ESG risk rating agencies have been identified and outlined, the choice of ESG risk rating agency chosen by the authors of this paper, *Sustainalytics*, will be discussed. While *Sustainalytics* meets some of the criteria outlined above by Boiral (2013) and Doyle (2018), it falls short on others. These considerations will be made and outlined in the following definition of *Sustainalytics* as the authors of this paper detail why such ESG risk rating agency was chosen as a tool for a passive impact investor to use in the creation of their portfolio.

2.7.1 Sustainalytics

Sustainalytics is an ESG risk rating agency aimed at helping “asset managers and pension funds who incorporate ESG and corporate governance information assessments into their investment processes” (Sustainalytics, 2021, p. 2). *Sustainalytics*’ methodology is based on the belief that “a company’s economic value is at risk driven by ESG factors or, more technically speaking, the magnitude of a company’s unmanaged ESG risks” (Sustainalytics, 2021, p. 4). In other terms, *Sustainalytics* ESG risk ratings are based on the belief that a company’s long-term economic value is dependant on their exposure to ESG related risks and how effectively the company’s executive management works to mitigate said risks (Sustainalytics, 2021). A company’s ESG risk rating is composed of three categories: Corporate Governance, Material ESG issues, and Idiosyncratic issues (Sustainalytics, 2021, p. 5) with “the companies’ events track record, structured external data (e.g. CO_2 emissions), company reporting, and third-party research,” (Sustainalytics, 2021, p. 7) used to perform the assessment. This indicates that *Sustainalytics* not only relies on what company’s disclose themselves, but also on broader, external insights that are not necessarily attempting to portray the company favourably - a key consideration as noted by both Boiral (2013) and Doyle (2018). *Sustainalytics*’ aim is to create more meaningful investor-relevant insights which focus specifically on financial materiality, making it easier for them to incorporate ESG risks into their portfolio (Garz et al., 2018). *Sustainalytics* further believes that these insights can be useful for both “equity and fixed-income investors alike” as well as investors focused on “cross-sectoral comparability” and ESG impact (Garz et al., 2018, p. 3).

Sustainalytics rates companies along an absolute scale from most sustainable to least sustainable using the terminology “Negligible,” “Low,” “Medium,” “High,” and “Severe” risk meaning that all companies, regardless of sub-industry, are comparable to one another (Sustainalytics, 2021). Of course, there is the difficulty that companies operating in different sub-industries will be exposed to different ESG risks; however, the *Sustainalytics* risk ratings take this into account by considering the risks material to a company in a given sub-industry and comparing them to comparable risks in other sub-industries (Sustainalytics, 2021). This initiative is a direct attempt and fulfilling the critical insights of Doyle (2018) in creating meaningful comparisons between companies is different sectors and industries.

Sustainalytics uses several methods to ensure the quality of their ESG risk ratings. The first is an annual review, and adjustment where necessary, of industry specific material risks (Sustainalytics, 2021, p. 14). The second is an annual review of all rated companies for both specific company risk exposures and risk management (Sustainalytics, 2021, p. 14). This review includes publicly available information on the company and a "robust peer review and quality assurance process," (Sustainalytics, 2021, p. 14). The third method is event analysis' done on a continuous basis during the year based on relevant news that has implications for the company's sustainable risks (Sustainalytics, 2021, p. 14).

With respect to portfolio returns specifically, *Sustainalytics* has conducted (and briefly detailed) their own internal analysis as to the portfolio returns using a "Carhart multifactor model" and found that their best performing strategies achieved abnormal returns (alpha) between 4.1% and 13.2% from January 2010 to June 2018 (Garz et al., 2018, p. 4). These findings are interesting as they point to the usability of *Sustainalytics* in helping investors improve the risk return trade-offs of their portfolios, yet one must remain critical of said findings in so much as they are self-reported by *Sustainalytics* and may, as a result, hold inherent positive bias.

While there are many options and considerations when choosing an ESG risk rating agency, there are several considerations outlined in the literature, and detailed in the above sections, which are helpful to use as guidelines in picking the best agency to suit an impact investor's needs.

Sustainalytics use of both publicly available information (done on a continuous basis throughout the year) and company disclosures satisfies both Boiral (2013) and Doyle (2018) takeaways that a rating agency should consider both positive and negative information on a given company. Also, final *Sustainalytics* ratings are made comparable across industries in an attempt to satisfy Doyle (2018)'s additional takeaways.

While *Sustainalytics* does fulfill some of the criteria, a number of notable shortcomings remain. Doyle (2018) details a shortcoming of current ESG risk rating agencies are their tendency to award more favourable ratings to larger companies (with more resources) and domiciled in areas with more rigorous sustainability disclosure regulation. As the authors of this paper are only considering those companies included in the *FTSE 350* (discussed in more detail in the proceeding sections), limiting the investment widow to the largest, most publicly traded stocks on the *London Stock Exchange*, this bias is somewhat mitigated. Additionally, while outside of the scope of this analysis in aligning ESG risk ratings across rating agencies, future government policy and disclosure regulation by governments globally will help to strengthen and further align ESG risk ratings across companies. Consistency amongst financial credit rating agencies such as *Moody*'s and *S&P500* is accredited to their use of standardized financial disclosures (Doyle, 2018). While governmental policy leading to more detailed and comparable sustainability disclosure is important and relevant to the world of ESG reporting, further consideration remains outside of the scope of this paper. As such, while this limitation of sustainable rating agencies exists, and which continuing governmental initiatives will help reduce in the future, it was not deemed applicable to the decision of the authors of this paper's choice of *Sustainalytics* as these shortcomings remain, regardless of the ESG risk rating agency chosen.

Overall, *Sustainalytics* provides impact investors with consistent and comparable metrics which consider many of the takeaways of Boiral (2013) and Doyle (2018) while also considering the importance of financial materiality. As such, the authors of this paper have chosen *Sustainalytics* as the ESG risk rating agency of choice to provide the sustainable risk ratings required in the first step of the portfolio creation process. While the authors have outlined a number of descriptive characterizations which are important for consideration in one's choice of sustainable risk rating agency, further investigation into the validity of *Sustainalytics* individual ESG risk ratings at the company level is outside of the scope of this analysis. As such, *Sustainalytics* is the preferred choice of rating agency in carrying out this analysis, while the focus of this paper remains on the relation between sustainably driven portfolios and their financial risks and returns as opposed to appraising *Sustainalytics* itself.

The next section will provide a summation of the above literature and how it has led the authors of this paper to a number of expectations surrounding both the risks and returns of sustainably driven portfolios compared to their non-sustainable counterparts.

3 Takeaways from the Literature and Expectations of the Authors

As the authors of this paper wish to investigate the financial tradeoff between investing for returns and investing for impact within the scope of a passive, everyday impact investor profile pursuing a buy-and-hold strategy, the above literature has led the authors of this paper to a number of expectations surrounding the performance of sustainably driven portfolios compared to other non-sustainably driven portfolios.

First, the authors of this paper expect that the ESG driven portfolios will achieve superior returns compared to their non-ESG driven counterparts. This is based on the combination of findings by Eccles et al. (2016), Steen et al. (2020) and Xiong (2021), which found that ESG pre-screening in the creation of portfolios led to higher returns across a number of measurement types. While the authors of this paper note that Steen et al. (2020) found no evidence of abnormal risk adjusted returns in Norwegian mutual funds, they did find such returns within Europe, findings which the authors of this paper are interested in investigating further within the context of the United Kingdom.

In addition to this, notable studies by Lesser et al. (2016), Nofsinger & Varma (2014) and Ruf et al. (2019) all found that sustainably driven portfolios outperformed during periods of market volatility. As markets have been notably volatile over the last number of years, these findings led the authors of this paper to further expect the sustainably driven portfolios to achieve superior returns compared to their less sustainable counterparts during this time period. In this way, it is expected by the authors that the more sustainable portfolios will achieve superior realized and risk adjusted returns during the investment horizon.

Second, the authors of this paper expect the more sustainable portfolios to achieve lower risk measurements than their non-sustainable counterparts. This expectation aligns with the findings of

Eccles et al. (2016), in that ESG screening was associated with lower volatility and CVaR, as well as the findings of Xiong (2021) in that more sustainable portfolios also achieved lower standard deviation and CVaR.

To investigate the expectations outlined above, the authors of this paper established 9 portfolios using *Sustainalytics* ESG risk ratings. Numerous critical variables will be calculated to align with the literature presented and obtain insights into the performance of each portfolio to understand the returns and risks of sustainably conscious portfolios vs. non-sustainably conscious portfolios pursuing a buy-and-hold strategy. In the proceeding *Theoretical Background* and *Data and Methodology* sections, this paper will outline the choice of Modern Portfolio Theory, and the methodology surrounding how the portfolio returns, volatilities, and risk factors are calculated such as to create an Equally Weighted, Global Minimum Variance and Tangency portfolio for each of the 3 *Sustainalytics* ESG risk rating portfolios (low, medium and high).

4 Theoretical Background

In order to address the research question and evaluate the performance of ESG risk rated portfolios, this paper will use models derived from Harry Markowitz's Modern Portfolio Theory (MPT). This section will provide a background to MPT, an overview of mean-variance optimization as well as an introduction to the Capital Asset Pricing Model (CAPM) – a financial model that this paper will use to estimate the expected returns of all stocks across the portfolios. The *Theoretical Background* section will serve to ground readers in the key models and theories being used in this paper, before transitioning into the *Data and Methodology* sections.

4.1 Modern Portfolio Theory

In order to analyze and compare the performances of the 9 portfolios created in this paper which are based on ESG risk ratings, this paper will present the descriptive statistics, expected returns and risk measures associated with an Equally Weighted, Global Minimum Variance (GMV), and Optimal Tangency portfolios across each of the three ESG risk rating categories (low, medium, and high). The latter two portfolios, the GMV and Optimal Tangency portfolios, are both derived from MPT, thus, providing an overview of the theory is useful to readers before the *Methodology* and *Results* are presented.

A key issue for any investor, including impact investors, is how to allocate wealth among alternative assets (Elton & Gruber, 1997). Herein lies the source of inspiration for the work of Harry Markowitz, who investigated how investors could optimally trade off risk against return and formulated his ideas into what is today known as Modern Portfolio Theory (Perold, 2004).

Portfolio allocation theory provides investors with models on how to combine various assets, each with varying levels of risk and return, in a way which supports the financial goals of the investor. For example, an investor may choose to select portfolio weights which maximize expected returns for a given level of risk or minimize their risk for a given level of expected return. Both the Global Minimum Variance portfolio and the Optimal Tangency portfolio have their roots in the work of Harry Markowitz and his Portfolio Optimization Model (Bodie et al., 2021).

The first step of this model is to create the Minimum Variance Frontier by identifying all combinations of risk and return available to an investor from a set of risky assets. Using inputs for expected returns, variances and covariances, it is possible to find the combination of assets which minimizes the volatility of the portfolio for any given rate of return (Bodie et al., 2021). That is to say, that a Mean-Variance Efficient portfolio, which sits on the Efficient Frontier, is any such portfolio where standard deviation is minimized for a given expected return or in other terms, expected return is maximized for a given level of risk.

This can be visualized as in *Figure 1* below. In this graph, the curved line represents the Minimum Variance Frontier. This frontier shows the expected return and volatility values, as given by the standard deviation, for mean-variance optimized portfolios of risky assets. As can be seen, the Global Minimum Variance portfolio (GMV) has the lowest standard deviation of all Mean-Variance Efficient portfolios. All points above the GMV represent the Efficient Frontier, whereas portfolios below the GMV are not considered efficient, as they take on the same level of risk for lower expected returns than could be achieved by investing in a portfolio with the same volatility on the Efficient Frontier.

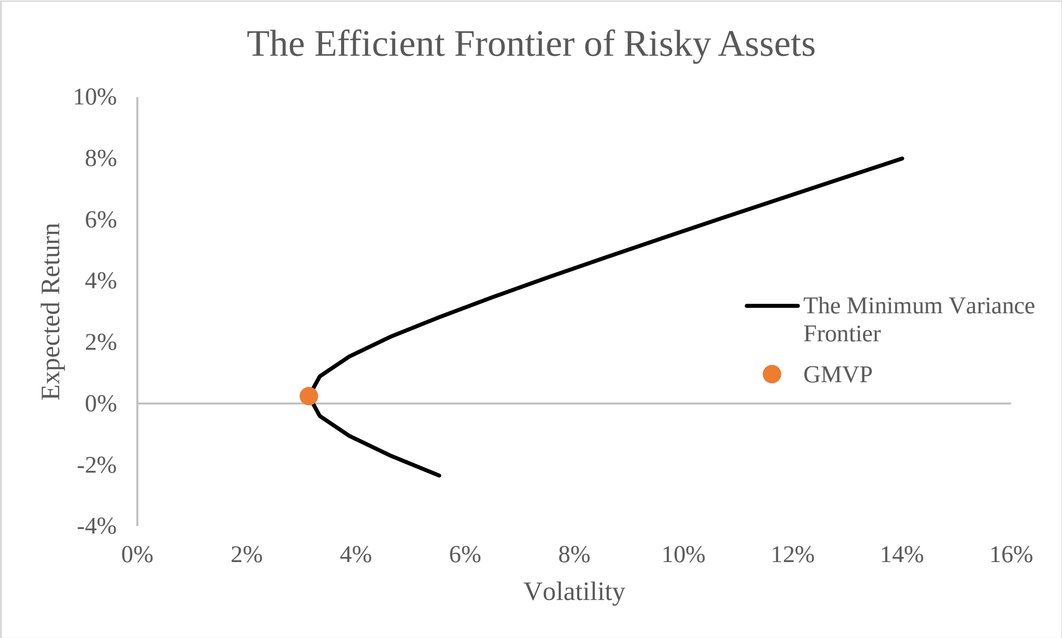

Figure 1

4.2 The Capital Allocation Line and Tangency Portfolio

The Capital Allocation Line (CAL) is a straight line drawn from the risk-free rate that depicts all the risk-return combinations available to investors looking to allocate their wealth between risk-free assets and risky assets (Bodie et al., 2021). The slope of the CAL denotes the increase in expected return for a portfolio relative to a per unit increase in standard deviation. This slope is equivalent to the Sharpe ratio, denoted as:

$$\frac{E(r_p) - r_f}{\sigma_p}$$

The CAL is used by investors to determine the optimal allocation of risky assets. At the point where the CAL is tangent to the Efficient Frontier, the Sharpe ratio of the portfolio is equal to the slope of the CAL. This point represents the expected return and standard deviation values of the portfolio with the highest Sharpe ratio on the Efficient Frontier. Thus, it represents the portfolio allocation that results in the best risk-return tradeoff, given that the Sharpe ratio, which measures risk adjusted performance, is maximized.

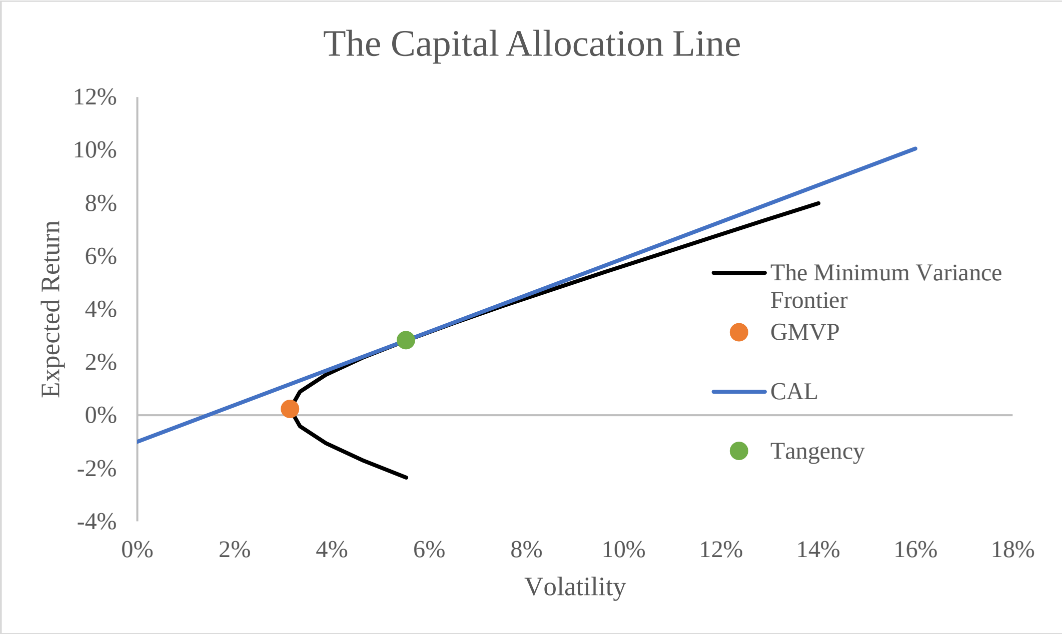

Figure 2

The significance of Modern Portfolio Theory is that it provides a model for investors to allocate their wealth across risky assets in a way that suits their preference. The GMV allows comparatively more risk averse investors to comprise their portfolio in such a way that risk, given as the variance of the portfolio, is minimized. Investors with a larger risk appetite can, on the other hand, look towards the Tangency portfolio to obtain the best risk-return tradeoff. However, all of these models are only as strong as the data inputs used. To this end, the expected return on assets and their portfolios can be measured in varying ways and with varying degrees of accuracy. This paper turns towards the single-factor CAPM as a method to estimate expected returns.

4.3 The Capital Asset Pricing Model (CAPM)

The capital asset pricing model was introduced as an extension to Markowitz's portfolio theory work in influential articles by William Sharpe (1964), John Litner (1965) and Jan Mossin (1966). Rooted in understanding the relationship between risk and return, the key contribution of the model is that it provides, "a set of predictions concerning equilibrium expected returns on risky assets," (Bodie et al., 2021).

As adapted from the book *Investments* by Bodie, Kane, & Marcus (2021), the assumptions of the model can, broadly speaking, be categorized into two areas: individual behavior and market structure. Regarding individual behavior, CAPM assumes that all investors are rational mean-variance optimizers with a common planning period of a single horizon and that they use identical input lists (homogeneous expectations) derived from relevant information that is assumed to be publicly available. With regards to the market structure, all assets are assumed to be publicly held and traded on public stock exchanges, investors can borrow and lend at the risk-free rate as well as being able to take short positions, and there are no taxes and no transaction costs (Bodie et al., 2021). In summary, all investors are mean-variance optimizers taking part in a well-functioning stock market with few barriers to trading.

A key implication of these assumptions is that all investors will hold identical risky portfolios, given that they are all mean-variance optimizers investing in the same investable universe using the same data inputs. This means that, in equilibrium, the market portfolio becomes the unique Tangency portfolio held by all investors (Bodie et al., 2021). The Capital Allocation Line referred to in the Modern Portfolio Theory section, therefore, becomes the Capital Market Line.

Within the scope of this paper, the CAPM provides useful insights into estimating the expected returns on individual securities. The CAPM is built on the premise that the "appropriate risk premium on an asset will be determined by its contribution to the risk of investors' overall portfolios," (Bodie et al., 2021, p. 280). Given that the market is the optimal risky portfolio for all investors, the risk-to-reward ratio of an individual security *i* relative to the optimal portfolio is given as:

$$\frac{E(R_i)}{Cov(R_{i,}R_M)}$$

Where $E(R_i)$ = The risk premium of security *i* = $E(r_i) - r_f$

In equilibrium, the risk-to-reward ratio of an individual security must match that of the market portfolio, such that:

$$\frac{E(R_i)}{Cov(R_{i,}R_M)} = \frac{E(R_M)}{\sigma_M^2}$$

Where $E(R_M)$ = The market risk premium = $E(r_m) - r_f$

This equation can be simplified further to show the expected return-beta relationship, which is given as:

$$E(r_i) = r_f + \beta_i(E(r_m) - r_f)$$

Where:

r_f = the risk-free rate

$E(r_m)$ = the expected return of the overall market

β_i = *Beta* = A ratio that measures the contribution of security *i* to the variance of the market portfolio as a fraction of the total variance of the market portfolio. Mathematically, this is denoted as:

$$\beta_i = \frac{Cov(R_i, R_m)}{\sigma_m^2}$$

The expected return-beta equation shows that the expected return of a security *i* is the risk-free rate plus a risk premium, wherein the size of the risk premium depends on beta, the contribution of an individual security's *i* to the risk of the overall portfolio. This equation will be introduced again in the *Mathematical Notation* section which will follow – but in the context of this paper, it will be used by the authors to estimate the expected return of each individual asset across the ESG risk rated portfolios.

The CAPM, however, is not without its drawbacks and limitations that have been noted by academics over the years. In his review of the CAPM, André Perold notes that the key prediction, that all investors will hold the same market portfolio of risky assets, is not observed in real life (Perold, 2004). In addition, it is also not observed that most investors hold even broadly diversified portfolios, which he attributes to the costs associated with broad diversification, such as taxes and direct costs, as well as investor behavioral biases, such as the home bias (Perold, 2004). These shortcomings can be attributed to the strong nature of the assumptions of the model. Academics have looked to extend the CAPM to account for, for example, heterogeneous beliefs or allowing for multiple time periods (Perold, 2004), but the single-index CAPM remains a centerpiece of modern finance and remains by and large in use by the investment industry (Bodie et al., 2021).

5 Data and Methodology

The subsequent sections will provide an overview of the data inputs used in this paper as well as their sources, and a *Mathematical Notation* section for the key equations used throughout the paper.

5.1 Data

Multiple indexes and stock exchanges across the Nordics and Europe were considered as the basis for providing the universe of securities and for calculating the market return. Following careful consideration, the *FTSE 350* index was chosen. The *FTSE 350* is a share index comprised of the 350 largest companies listed on the *London Stock Exchange* based on market capitalization (The London Stock Exchange Group, 2023). This index was picked for several reasons, all of which positively contribute to the ability to compose well diversified and mean-variance optimized portfolios.

Firstly, the *FTSE 350* index is comprised of many stocks that are classified into a multitude of different sectors, which amount to more than 80 industries when using Sustainalytics' sub-industry classifications. The benefit of this large data set is that it allows for diversification across stocks and industries. Numerous studies have demonstrated the benefits of diversification, although no consensus exists on the precise number of stocks sufficient for diversification (Zaimovic et al., 2021). Nonetheless, a widely quoted seminal study by Meir Statman found that diversification benefits from the perspective of reducing expected portfolio standard deviation accelerate rapidly with the addition of the first few stocks, before levelling off between 25 and 30 stocks (Statman, 1987). Choosing the *FTSE 350* index therefore allows for sufficient portfolio diversification as well as effective portfolio optimization due to the expansive industry coverage and large data set. The second reason for picking the *FTSE 350*, is that it is a well tracked and documented index that provides abundant trading data that reaches far back into history. This allows for many years' worth of trading data to be downloaded and analyzed, which helps to strengthen the values for the models' inputs, including expected return, volatility, correlation, and covariance.

The data inputs used to compute the model include weekly returns data (Friday-to-Friday) for each individual stock, as well as weekly returns data (Friday-to-Friday) for the *FTSE 350* index. Both sets of data are downloaded from *Bloomberg* using the *Bloomberg* terminals available in the CBS Data Lab. The weekly returns are calculated using the adjusted closing price for each stock such that movements in dividends and stock splits are already reflected in the closing price.

Weekly returns were chosen as opposed to monthly returns after considering past research in this area. A recent study on interval frequency and beta estimation in CAPM found that betas estimated using shorter return intervals, namely daily and weekly returns, yielded lower tracking errors than betas estimated using monthly or annual returns (Agrrawal et al., 2022). Furthermore, estimates of standard deviation can also be made more precise by increasing the number of observations (Bodie et al., 2021), hence favoring weekly returns data over monthly returns. Lastly, working with daily returns runs the risk of producing non-synchronous data – hence the authors settled on working with weekly returns as it provides both robust and workable data.

The same study on CAPM estimators also concluded by recommending four to five years of historical data as being optimal for robustly estimating the beta coefficient by reducing tracking errors (Agrrawal et al., 2022). In addition, pedagogical material on portfolio theory and the CAPM further suggest that using five years of historical data for estimation is a common time horizon (Bodie et al., 2021). As such, the authors of this paper chose to follow the above recommendation and use 5 years of historical price data from the last Friday in 2014 to the last Friday in 2019.

With regards to the time horizon, historical *Sustainalytics* ESG risk ratings are available from *Morningstar* as of March 2020 with additional companies added in April 2020. As such, this paper takes the perspective of a passive, everyday impact investor using the initial ratings as of April 2020 to create their ESG risk rated portfolios on the first Friday of May 2020. To avoid the various market shocks and abnormalities which took place as a result of the COVID-19 pandemic during the first months of 2020, historical returns for a five-year period starting at the beginning of 2015 to the end of 2019 are chosen. Thus, this paper has used returns data for a five-year time horizon from the first Friday in January 2015 to the last Friday in December 2019. In turn, as one additional observation is required when calculating returns, the adjusted closing prices from the last Friday in December 2014 to the last Friday in December 2019 are used.

The final input necessary for carrying out the portfolio optimization process is the risk-free rate, which is required to determine the return an investor can expect to achieve from their portfolio in excess of what they could achieve through investing in a risk-free asset. The risk-free rate is the rate an investor would earn on assets with "zero" risk such as government bonds, market funds or banks (Bodie et al., 2021), which are considered risk-free due to their low probability of default. This paper focuses on stocks traded on the *London Stock Exchange* and has, therefore, selected UK Government Bonds (*"Gilts"*) as the risk-free rate. With regards to appraising the performance of the Equally Weighted, Global Minimum Variance and Tangency portfolios, the investment horizon runs from when the passive impact investor first establishes their portfolio on the first Friday of May 2020 to the first Friday of March 2023. This establishes an investment horizon for the passive impact investor of approximately 3 years. Generally, the maturity on a risk-free rate should match the horizon of the investment (Bodie et al., 2021) in order to accurately reflect the risk associated with the investments. Therefore, this paper will use the weekly yield of a 3-year Gilt on the first Friday of May 2020 as the basis for the risk-free rate.

Data on *Sustainalytics* ESG Risk Ratings for each of the firms comprised in the *FTSE 350* was pulled from *Morningstar*. As a recap from earlier, ESG risk ratings provided by *Sustainalytics* measure a company's exposure to industry-specific material risks and how well the company is managing those risks (Sustainalytics, 2021). Based on their criteria, a score is awarded which puts a firm in one of five ESG risk rating buckets: negligible, low, medium, high, and severe. As this paper takes the perspective of a passive impact investor creating a portfolio when the *Sustainalytics* scores are originally available on *Morningstar* in March and April 2020, the ESG risk ratings used are from that date. Of the 350 companies included in the *FTSE 350*, 120 were not rated as of March and April 2020. Of the 230 remaining stocks the distribution across the ratings of negligible, low, medium, high, and severe are 5, 83, 92, 43 and 7, respectively. Due to the small number of firms receiving a sustainability rating on either extreme, negligible (5) and severe (7), these firms are included in the low and high categories, respectively. The 230 rated stocks are additionally separated into 82 different *Sustainalytics* sub-industries. Due to some industry overlap in terms of companies included in the same sub-industry receiving different ESG risk ratings, the three established buckets of low, medium, and high have a total of 44, 45 and 28 *Sustainalytics* sub-industries represented.

In aligning with the diversification of the 3 ESG risk rated portfolios as outlined above, each ESG risk rated portfolio is presented in *Tables 1 to 3* below. As can be observed in the high ESG risk rated portfolio, there is some industry overlap which is due to only 28 *Sustainalytics* subindustries being represented as well as the additional constraint that each stock must be publicly traded as of December 2014.

Table 1 *High ESG Risk Rated Portfolio Constituents*		
Ticker	**Company Name**	**Sustainalytic's Sub-Industry**
BA/	BAE SYSTEMS PLC	Aerospace and Defence
EZJ	EASYJET PLC	Airlines
SMIN	SMITHS GROUP PLC	Conglomerates
BARC	BARCLAYS PLC	Diversified Banks
ANTO	ANTOFAGASTA PLC	Diversified Metals Mining
SSE	SSE PLC	Electric Utilities
CEY	CENTAMIN PLC	Gold
WEIR	WEIR GROUP PLC	Heavy Machinery and Trucks
DRX	DRAX GROUP PLC	Independent Power Production and Traders
BOY	BODYCOTE PLC	Industrial Machinery
BP/	BP PLC	Integrated Oil & Gas
JUST	JUST GROUP PLC	Life and Health Insurance
SPI	SPIRE HEALTHCARE GROUP PLC	Medical Facilities
BBY	BALFOUR BEATTY PLC	Non-Residential Construction
HTG	HUNTING PLC	Oil & Gas Equipment
VCT	VICTREX PLC	Specialty Chemicals
CNE	CAPRICORN ENERGY PLC	Oil & Gas Exploration and Production
DCC	DCC PLC	Oil & Gas Refining and Marketing
HFG	HILTON FOOD GROUP PLC	Packaged Foods
DPH	DECHRA PHARMACEUTICALS PLC	Pharmaceuticals
FRES	FRESNILLO PLC	Precious Metals Mining
ELM	ELEMENTIS PLC	Specialty Chemicals
FXPO	FERREXPO PLC	Steel
GLEN	GLENCORE PLC	Diversified Metals Mining
MGNS	MORGAN SINDALL GROUP PLC	Non-Residential Construction

Table 2
Medium ESG Risk Rated Portfolio Constituents

Ticker	Company Name	Sustainalytic's Sub-Industry
RR/	ROLLS-ROYCE HOLDINGS PLC	Aerospace and Defence
IAG	INTL CONSOLIDATED AIRLINES GROUP	Airlines
ABDN	ABRDN PLC	Asset Management and Custody Services
ENT	ENTAIN PLC	Casinos and Gaming
MRO	MELROSE INDUSTRIES PLC	Conglomerates
CRH	CRH PLC	Construction Materials
HSBA	HSBC HLDGS PLC	Diversified Banks
BEZ	BEAZLEY PLC	Diversified Insurance Services
AAL	ANGLO AMERICAN PLC	Diversified Metals Mining
SPX	SPIRAX-SARCO ENGINEERING PLC	Industrial Machinery
MONY	MONEYSUPERMARKET.COM GROUP PLC	Internet Software and Services
PHNX	PHOENIX GROUP HOLDINGS PLC	Life and Health Insurance
SN/	SMITH & NEPHEW PLC	Medical Devices
CNA	CENTRICA PLC	Multi-Utilities
OCDO	OCADO GROUP PLC	Online and Direct Marketing Retail
RKT	RECKITT BENCKISER GROUP PLC	Personal Products
GSK	GSK PLC	Pharmaceuticals
HSX	HISCOX LD	Property and Casualty Insurance
EXPN	EXPERIAN PLC	Research and Consulting
CRDA	CRODA INTERNATIONAL PLC	Specialty Chemicals
FRAS	FRASERS GROUP PLC	Specialty Retail
BT/A	BT GROUP PLC	Telecommunication Services
BATS	BRITISH AMERICAN TOBACCO PLC	Tobacco
IHG	INTERCONTINENTAL HOTELS GROUP PLC	Travel, Lodging and Amusement
UU/	UNITED UTILITIES GROUP PLC	Water Utilities

Table 3 *Low ESG Risk Rated Portfolio Constituents*		
Ticker	**Company Name**	**Sustainalytic's Sub-Industry**
WPP	WPP PLC	Advertising
DGE	DIAGEO PLC	Beer, Wine and Spirits
RTO	RENTOKIL INITIAL PLC	Business Support Services
BME	B&M EUROPEAN VALUE RETAIL S.A.	Department Stores
HLMA	HALMA PLC	Electronics Equipment
SGE	SAGE GROUP PLC	Enterprise and Infrastructure Software
TSCO	TESCO PLC	Food Retail
BDEV	BARRATT DEVELOPMENTS PLC	Homebuilding
RMV	RIGHTMOVE PLC	Internet Software and Services
BRBY	BURBERRY GROUP PLC	Luxury Apparel
SMDS	SMITH (DS) PLC	Paper Packaging
GAW	GAMES WORKSHOP GROUP PLC	Toys and Sporting Goods
LGEN	LEGAL & GENERAL GROUP PLC	Life and Health Insurance
INF	INFORMA PLC	Publishing
UTG	UNITE GROUP PLC	Real Estate Management
LAND	LAND SECURITIES GROUP PLC	REITs
CPG	COMPASS GROUP PLC	Restaurants
CCH	COCA-COLA HBC AG	Soft Drinks
F/	JD SPORTS FASHION PLC	Specialty Retail
RS1	RS GROUP PLC	Technology Distribution
VOD	VODAFONE GROUP PLC	Telecommunication Services
AHT	ASHTEAD GROUP PLC	Trading and Distribution
WTB	WHITBREAD PLC	Travel, Lodging and Amusement
SVT	SEVERN TRENT PLC	Water Utilities
IWG	IWG PLC	Office Services

5.2 Methodology

The primary focus of this paper is to ascertain how portfolio optimizations based on ESG risk ratings perform over a three-year investment horizon - and thereby discussing the potential financial implications for impact investors. To that end, this paper will use 5 years of historic returns from January 2015 to December 2019 as the basis to carry out an analysis of returns for an Equally Weighted, Global Minimum Variance and Optimal Tangency portfolio for a three-year investment horizon from May 2020 to March 2023. This section will layout and further detail the methodology used.

5.2.1 Investable Universe and Portfolio Composition

The investable universe is derived from the constituents of the *FTSE 350* index, which as of May 2020 had ESG Risk Ratings for all but 120 firms, narrowing the universe to 230. The remaining 230 stocks were split into three ESG Risk Rating buckets, (i) Negligible and Low Risk, (ii) Medium Risk, and (iii) High & Severe Risk. The three ESG risk rating buckets for the portfolios are therefore denoted as the low, medium, and high ESG risk rated portfolios, with the low ESG risk rated bucket representing the most sustainable stocks. Within impact investing, the two main portfolio selection techniques are positive screening and negative screening. In this selection process, positive screening was applied such that all firms with negligible and low ESG risk ratings were eligible for the low ESG risk rated portfolio. This stands in contrast to the negative screening methodology used by some impact investors, wherein specific firms and sectors, such as the oil and gas sector, are excluded due to the harm caused to the environment, regardless of their ESG risk rating.

After assigning all eligible stocks to each of the three ESG risk ratings buckets, the next step was to diversify the portfolios based on industry. As mentioned in the *Data* section, the benefits of diversification in reducing portfolio standard deviation and thereby mitigating risk are well documented (Statman, 1987). From the perspective of an everyday impact investor engaging in a buy-and-hold investment strategy, it is reasonable to assume that that they would avoid concentration risk by diversifying their portfolios across industries. Using the data set, the authors of this paper narrowed down the investable assets such that there was full industry diversification across the medium and low ESG risk rated portfolios – i.e., no two firms from the same *Sustainalytics* sub-industry classification were included in one portfolio. This was made possible by the large number of *Sustainalytics* sub-industries included in each classification (45 and 44, respectively).

In the case of the high ESG risk rated portfolio, there was a large concentration of similar industries, notably oil and gas-based sectors, in the already limited number of *Sustainalytics* sub-industries (28) making this portfolio less diversified across said sub-industries. When additionally constrained to consider only those companies trading on the *London Stock Exchange* as of the last Friday in December 2014, some sub-industries were not included because the company in said sub-industry was not publicly traded in December 2014. Both constraints led to a high risk rated portfolio with multiple companies operating within the same sub-industry implying less diversification. Overall, by narrowing down the investment universe to the investable stocks based on sub-industry classification, 3 portfolios composed of 25 stocks each were created, which keep in line with studies demonstrating the benefits of diversification (Statman, 1987).

With the portfolios established, the proceeding mathematical notations were used in the calculation of the portfolios' critical variables and the eventual calculation of their respective risk and returns.

5.2.2 Mathematical Notation

This section will present the equations and notations used throughout the portfolio optimization process. Subsequently, the results section will describe the computing of these equations as done in Excel.

The weekly return for a security *i* at time *t* is denoted as:

$$r_i = \frac{p_t}{p_{t-1}} - 1 \quad \textbf{(1)}$$

Where p_t represents the price of security *i* at time *t*.

This portfolio optimization will use the Capital Asset Pricing Model (CAPM) in order to estimate the expected returns for each asset. The equation for the expected return for security *i*, also known as the mean-beta relationship, is denoted as:

$$E(r_i) = r_f + \beta_i(E(r_m) - r_f) \quad \textbf{(2)}$$

Where:

r_f = the risk-free rate, which represents the rate of a return on a risk-free asset, such as a government bond or money market fund. As per the *Data* section, the paper uses the yield on a 3-year UK Government Bond (Gilt) as of the first Friday in May 2020. As bond yields are quoted at an annualized rate, yet the expected return on the market used in this paper is based on weekly returns, this paper will take the annualized yield and convert it into a weekly figure using the below equation:

$$Weekly\ Yield = \left(1 + Annualized\ Yield^{\left(\frac{1}{N}\right)}\right) - 1 \quad \textbf{(3)}$$

Where N = number of periods measured = 52 weeks

$E(r_m)$ = the expected return of the overall market. As all portfolio constituents are listed on the *FTSE 350*, the expected return of this index is used, which is computed as the average of the index's weekly returns over five years from the beginning of 2015 to the end of 2019.

β_i = *Beta* = A ratio that measures the contribution of stock *i* to the variance of the market portfolio as a fraction of the total variance of the market portfolio. Mathematically, this is denoted as:

$$\beta_i = \frac{Cov(R_i, R_m)}{\sigma_m^2} \quad \textbf{(4)}$$

The expected return of the portfolio is the weighted average of the expected returns of the constituents of the portfolio. For an entire portfolio to the *n* number, this is denoted as:

$$E(r_p) = \sum_{i=1}^{n} w_i E(r_i) + w_j E(r_j) + \cdots + w_n E(r_n) \quad \textbf{(5)}$$

With w_i and w_j denoting the portfolio weights for securities *i* and *j*, respectively, whereas the expected return of a single security $E(r_i)$ is derived from the CAPM mean-beta relationship.

The variance of the portfolio is given as the weighted sum of covariances with each weight as the product of the portfolio proportions of the pair of assets in the covariance term (Bodie et al., 2021). A two-stock example of portfolio *p* comprised of security *i* and *j* is given by:

$$\sigma_p^2 = w_i^2\sigma_i^2 + w_j^2\sigma_j^2 + 2w_iw_jCov(r_i, r_j) \qquad \textbf{(6)}$$

Where:

$Cov(r_i, r_j)$ = The Covariance of stock *i* and *j* which can be computed as follows:

$$Cov(r_i, r_j) = E(r_i, r_j) - E(r_i)E(r_j) \qquad \textbf{(7)}$$

Which can be further simplified and calculated using the correlation between two stocks *i* and *j*.

$$Cov(r_i, r_j) = \rho_{ij}\sigma_i\sigma_j \qquad \textbf{(8)}$$

Where ρ_{ij} is the correlation coefficient and is given by:

$$\rho_{ij} = \frac{Cov(r_i, r_j)}{\sigma_i\sigma_j} \qquad \textbf{(9)}$$

The optimization of each portfolio in the creation of the Tangency portfolios will be carried out using the Sharpe ratio. The Sharpe ratio calculates the risk adjusted return of an asset or portfolio by dividing the risk premium of an asset by the risk of that asset (Perold, 2004). For a portfolio *p*, the Sharpe ratio is calculated as:

$$Sharpe\ Ratio = \frac{E(r_p) - r_f}{\sigma_p} \qquad \textbf{(10)}$$

This paper will also make use of the Holding Period Return (HPR) in order to appraise each portfolios' performance from May 2020 to March 2023. The HPR is the total return from holding each portfolio over the investment horizon.

$$Holding\ Period\ Return = \frac{VP_{t+1} - VP_t}{VP_t} \quad \textbf{(11)}$$

Where:

> VP_t = The value of the portfolio at time *t* - given as the weighted sum of the price *p* of the portfolio constituents.

$$VP_t = \sum_{i=1}^{n} w_i p_i + w_j p_j + \cdots + w_n p_n \quad \textbf{(12)}$$

Finally, this portfolio will look to make use of two widely used risk measures, Value-at-Risk (VaR) and Conditional Value-at-Risk (CVaR), referred to by the authors of this paper as Expected Shortfall (ES), in order to quantify the risk associated with each portfolio across ESG risk ratings.

The Value-at-Risk (VaR) is a percentile of a loss distribution, which is a loss level during a time period, *T*, that is *X%* certain to not be exceeded (Hull, 2018). Following the notation of (Hull, 2018), when a loss in a portfolio value has a mean μ and standard deviation of σ, VaR is denoted as:

$$VaR = \mu + \sigma N^{-1}(X) \quad \textbf{(13)}$$

The mean, μ, is assumed zero for relatively short time horizons, following then that VaR, and ES, are proportional to the standard deviation, σ (Hull, 2018).

When analyzing the tail end of the worst-case scenarios, then the Conditional Value-at-Risk (CVaR), otherwise denoted Expected Shortfall (ES), is a comprehensive risk measure that can be used. It is the expected loss for a given period greater than a certain percentile of the loss distribution (Xiong, 2021).

$$ES = \mu + \sigma \frac{e^{-Z^2/2}}{\sqrt{2\pi}(1-X)} \qquad \textbf{(14)}$$

This section has presented the key mathematics and equations that are used in the optimization of portfolios. Below, the paper will further delve into the models that will be used, before presenting the results for the 9 ESG risk rating portfolios.

6 Results and Analysis

6.1 Calculation of Critical Variables

Once the first step in the portfolio creation process was complete, namely the establishment of diversified portfolios of 25 stocks in each ESG risk rating category (as discussed in the *Data* section), the authors of this paper proceeded to calculate each of the 75 stock's return over the 5-year time horizon from January 2015 to December 2020. As indicated in the *Data* section, historical weekly adjusted closing prices (Friday-to-Friday) were downloaded from *Bloomberg* for each individual stock as well as the *FTSE 350*. Due to the need for one additional observation in the calculation of the historical returns, weekly historical prices were used from December 26th, 2014, to December 27th, 2019. As a result, a total of 262 weekly adjusted closing prices yielded 261 weekly returns per stock. An example of such calculation using *equation 1* from the mathematical notation section is as follows for the high ESG risk rated stock BA/ using historical prices as of December 26th, 2014 (£474.1), and January 2nd, 2015 (£469.2). Note that, while the below return value is rounded, all calculations were done in Excel and therefore consider all decimal places. Rounding is only used in the presentation of the results of this paper for simplicity and readability.

$$r_{BA/} = \frac{469.1}{474.1} - 1 = -0.01034$$

Following the calculation of weekly returns for all stocks and the *FTSE 350*, a number of Excel functions were used in the calculation of various descriptive statistics. First, to understand more about the distribution of each stocks return, both skewness and kurtosis were calculated. The use of Modern Portfolio Theory and CAPM presuppose that returns follow a normal distribution. In order to add validity to their use, skewness and kurtosis were calculated using Excel's functions SKEW() and KURT() which are both used when considering a sample, rather than an entire population. While skewness alters the distribution left and right (with positive skewness indicating standard deviation is overestimated and vice versa), kurtosis considers how fat the tails of the distribution are and thus, the likelihood of extreme outcomes (Bodie et al., 2021, pp. 138–139). While assuming a normal distribution is considered sufficient for shorter-term stock returns such as those considered here (Bodie et al., 2021, p. 149), Tabachnick & Fidell (2001, pp. 74–75) additionally define samples of more than 200 as sufficient while Kline (2011, p. 63) define absolute values for skewness and kurtosis lower than 3 and 10, respectively, as sufficient to assume a normal distribution for the purpose of analysis. To this end, only one stock in the medium ESG risk rated portfolio had a skewness outside of the threshold while 2 in the medium ESG risk rated portfolio and one in the low ESG risk rated portfolio had values outside of the kurtosis threshold. Given the short investment horizon of 5 years, the number of each stock's returns exceeding the threshold of 200 (261>200), and only 4 out of a total of 75 stocks considered outliers by Kline (2011), there was sufficient evidence to proceed in assuming a normal distribution for the use of Modern Portfolio Theory and CAPM.

Following the calculations of the historical weekly returns, the skewness, and the kurtosis for each stock, it was possible to use the weekly returns data to compute the risk associated with each stock. This quantification of risk comes in the form of the historical volatility of the stock, which is given by the standard deviation of the stocks' historical weekly returns. The standard deviation tells an investor the deviations of the historical returns of the stock from the mean of said historical returns. Within Excel, the standard deviations of the individual stocks, as well as the *FTSE 350*, can be calculated using the STDEV.S() function. A sample standard deviation was used as it takes into consideration the degrees of freedom bias which in an estimation error which arises when a sample's arithmetic average is used instead of the true population mean (Bodie et al., 2021, p. 134).

Although there are multiple methods to calculate volatility, calculating the standard deviation of historical returns remains a widely used method. For an investor, an assessment of the deviations of historical weekly returns around the mean can be used to gauge the level of risk associated with that security as well as providing a basis to predict future movements in expected return. Within the context of this paper, the standard deviation of each security forms an important component in calculating the volatility of the entire portfolio, relative to the weights of each portfolio constituent. The results for the weekly volatility are displayed in *Tables 6, 7 and 8* below.

Following the calculations of the volatility, the authors were able to compute the beta values for each stock. When using Excel, there are two ways in which beta can be calculated. The first is via the Data Analysis Tool, "Regression" and the other is via *equation 4* as presented in the *Mathematical Notation* section. As the covariance of each stock to one another is required in the later calculation of each portfolio's standard deviation (thus facilitating the easy calculation of beta using *equation 4*), each method will be explained in turn.

The first method will explain the process by which one can use *equation 4*. The first step in this method is to develop a correlation matrix of each stock to themselves and well as to each other and to the *FTSE 350* market. Such matrix is 26 by 26 cells in Excel (including the 25 stocks and the *FTSE 350*'s returns). An abbreviated correlation matrix for the high ESG risk rated stocks is shown below.

Table 4 - Abbreviated Correlation Matrix

Correlation Matrix	BA/	EZJ	MGNS	*FTSE 350*
BA/	1	0.091562	0.086575	0.557008
EZJ	0.091562	1	0.180394	0.124719
MGNS	0.086575	0.180394	1	0.181102
FTSE 350	0.557008	0.124719	0.181102	1

Using the Excel function CORREL(Stock Returns BA/;Stock Returns EZJ), as an example, one can observe above the correlation between any two stocks' returns is recorded twice, once vertically and once horizontally. One can additionally observe that the correlation between any stock's return with itself is always one.

After creating the correlation matrix, it was possible to create the covariance matrix using both the correlation matrix and the standard deviations values for each stock. Creating the covariance matrix from the correlation matrix requires the following formula in Excel {=TRANSPOSE(Standard Deviations)*Correlation Matrix*Standard Deviations} and produces the same size 26 by 26 matrix. The creation of a covariance matrix using the Excel formula above is built around *equation 8* as presented in the *Mathematical Notation* section above and presented here.

$$Cov(r_i, r_j) = \rho_{ij}\sigma_i\sigma_j$$

An abbreviated covariance matrix for the high ESG risk rated stocks is shown below in *Table 5*. As can be observed from *Table 5*, the covariance between any stock's returns and itself is simply the variance of the stock's returns.

Table 5 – Abbreviated Covariance Matrix

Covariance Matrix	BA/	EZJ	MGNS	*FTSE 350*
BA/	0.000810	0.000116	9.786E-05	0.000269
EZJ	0.000116	0.001974	0.000318	9.390E-05
MGNS	9.786E-05	0.000318	0.001578	0.000122
FTSE 350	0.000269	9.390E-05	0.000122	0.000287

Following the creation of the covariance matrix, the beta for each stock was then calculated. An example beta calculation for the high ESG risk rated stock BA/ using *equation 4* is shown below using the results from the covariance matrix. It can also be observed from the covariance matrix that the beta of the *FTSE 350* is 1, as is always the case when any number is divided by itself (following the intuition of *equation 4*). Once again note that the values presented below are rounded to five decimal places. The actual beta calculations were done in Excel using all decimal places.

$$\beta_{BA/} = \frac{0.000269}{0.000287} = 0.93533$$

As the significance of each beta was additionally of interest to the authors of this paper, the second method for calculating beta using a regression for each stock and *FTSE 350* returns was calculated using Excel's Data Analysis Tool. Each stock's regression output attempts to understand the relationship between the given stock's returns and the returns of the *FTSE 350*. Each regression was run independently for every stock as the dependent variable (Y) while the *FTSE 350* was the independent variable (X). This led to a total of 75 separate regression outputs, the results of which are summarized below in *Tables 6, 7 and 8*.

Tables 6, 7 and *8* show each stock's beta accompanied by its corresponding p-value, of which all are found significant at the 95% confidence level. Additionally, 73 betas are found significant at the 99% confidence level with only 2 stocks in the high ESG risk rated portfolio excluded. The smaller the p-value, the smaller the chance that the relationship between the stock and the *FTSE 350* is coincidental. The small p-values thus indicate that the movements in the individual stocks are affected by movements in the *FTSE 350* with 95% confidence. In this way, using the beta coefficient in CAPM is realistic for the purposes of this analysis as the betas are found to be highly significant in explaining the changes to each stock corresponding to a one-unit change in the market. Additionally, it is interesting to observe that all 75 betas are positive. The positive betas indicate that all 75 stocks have a positive relationship with the market meaning that when the *FTSE 350* returns increase, so do the stock's returns and vice versa. This indicates that in the event of a downturn in the market (*FTSE 350*), the entire portfolio returns are likely to decrease as there are no stocks to offset the decline by moving in the inverse direction.

In addition to the above takeaways are those of the R^2. R^2 in this case, is a measure of how much of the variance in the given stock's returns is explained by the variance of the *FTSE 350*. Interestingly, all R^2s are below 0.5 (except one which is only marginally greater than 0.5). While the small R^2 values can be interpreted to mean that the stocks variance is not greatly explained by the variance of the *FTSE 350*, they do not imply that the relationship is not significant (as is evident by the extremely small p-values for each beta). Rather, the small R^2 values indicate that there are other factors which exist as well. In this way, it can be summarized that the small R^2 values indicate other factors exist to explain the variance of each stock in addition to the variance of the *FTSE 350*, yet the movements of each stock (as implied by the highly significant positive betas) are directly influenced by the movements in the *FTSE 350*. The other factors which exist to explain the variance in each stock's returns are outside of the scope of this analysis, but various macro-economic trends and internal company operations are possible explanations.

Table 6 – Descriptive Statistics
High ESG Risk Rated Stocks

Ticker	Skewness	Kurtosis	Volatility	R^2	Beta	P-value	p<0.05
BA/	0.13844	1.72145	0.02845	0.31026	0.93533	1.1358E-22	Significant
EZJ	-0.23133	0.54105	0.04443	0.01555	0.32706	4.4105E-02	Significant
SMIN	0.05942	0.49229	0.02902	0.42842	1.12103	2.6213E-33	Significant
BARC	0.36549	0.79640	0.03691	0.27137	1.13475	1.4729E-19	Significant
ANTO	0.87202	4.27976	0.05619	0.24399	1.63810	1.8417E-17	Significant
SSE	-0.20775	2.84247	0.02743	0.17840	0.68375	1.0239E-12	Significant
CEY	-0.61671	3.65266	0.05976	0.01861	0.48108	2.7562E-02	Significant
WEIR	-0.13476	0.41178	0.04930	0.30082	1.59581	6.7035E-22	Significant
DRX	-0.17432	2.93503	0.05287	0.17716	1.31324	1.2500E-12	Significant
BOY	0.32135	1.70936	0.03770	0.26059	1.13586	1.0072E-18	Significant
BP/	0.28996	1.42120	0.03136	0.51508	1.32840	1.3535E-42	Significant
JUST	0.24362	1.98358	0.05982	0.03196	0.63116	3.7603E-03	Significant
SPI	-1.08708	7.01830	0.05398	0.05912	0.77456	7.2211E-05	Significant
BBY	0.32159	0.79300	0.03638	0.14958	0.83025	9.6880E-11	Significant
HTG	0.33321	1.63669	0.07129	0.21807	1.96475	1.5312E-15	Significant
VCT	-0.27712	1.73519	0.03676	0.33576	1.25702	8.3139E-25	Significant
CNE	-0.23155	1.45527	0.05245	0.15998	1.23806	1.9069E-11	Significant
DCC	0.47284	4.46864	0.03051	0.24323	0.88814	2.1037E-17	Significant
HFG	0.19705	1.15788	0.03001	0.04574	0.37881	5.0378E-04	Significant
DPH	-0.36916	5.89356	0.03733	0.12348	0.77416	5.3172E-09	Significant
FRES	0.17804	2.44371	0.05693	0.08561	0.98303	1.5107E-06	Significant
ELM	-0.19178	1.43681	0.04048	0.20715	1.08727	9.4544E-15	Significant
FXPO	0.87243	5.71218	0.09375	0.07577	1.52293	6.3896E-06	Significant
GLEN	0.75184	4.85995	0.06442	0.32392	2.16387	8.3306E-24	Significant
MGNS	0.31992	2.02128	0.03973	0.03280	0.42460	3.3241E-03	Significant

Table 7 – Descriptive Statistics Medium ESG Risk Rated Stocks							
Ticker	**Skewness**	**Kurtosis**	**Volatility**	**R^2**	**Beta**	**P-value**	**p<0.05**
RR/	-0.35824	5.59769	0.04405	0.24396	1.28398	1.8540E-17	Significant
IAG	0.03903	1.04765	0.03970	0.11435	0.79232	2.1100E-08	Significant
ABDN	-0.26670	1.68532	0.03797	0.25358	1.12839	3.4632E-18	Significant
ENT	-0.15910	0.62886	0.04159	0.04105	0.49725	9.9584E-04	Significant
MRO	-6.68371	87.02034	0.06929	0.04974	0.91203	2.8157E-04	Significant
CRH	0.19312	0.46135	0.03049	0.45489	1.21362	5.4751E-36	Significant
HSBA	0.08821	0.34402	0.02745	0.49835	1.14375	1.1131E-40	Significant
BEZ	-0.13025	1.45442	0.02910	0.09179	0.52035	6.0765E-07	Significant
AAL	0.97014	4.28659	0.07113	0.22111	1.97389	9.1792E-16	Significant
SPX	0.05246	1.99267	0.02904	0.37597	1.05079	2.4215E-28	Significant
MONY	-0.64069	3.01188	0.03681	0.07154	0.58099	1.1840E-05	Significant
PHNX	0.13071	0.60285	0.02578	0.26507	0.78342	4.5477E-19	Significant
SN/	0.05700	0.99018	0.02648	0.25223	0.78481	4.3898E-18	Significant
CNA	-0.08224	3.02972	0.03945	0.15500	0.91660	4.1573E-11	Significant
OCDO	2.41498	14.42163	0.07170	0.06019	1.03813	6.1771E-05	Significant
RKT	-0.17057	1.39087	0.02719	0.22776	0.76586	2.9810E-16	Significant
GSK	-0.30368	2.01367	0.02644	0.35614	0.93134	1.4262E-26	Significant
HSX	-0.25804	3.11600	0.02888	0.11525	0.57870	1.8416E-08	Significant
EXPN	-0.29383	0.76241	0.02511	0.37310	0.90533	4.3972E-28	Significant
CRDA	-0.17817	2.00042	0.02605	0.31894	0.86833	2.1730E-23	Significant
FRAS	0.23153	9.60615	0.05018	0.06652	0.76386	2.4597E-05	Significant
BT/A	-0.37114	6.04857	0.03535	0.13497	0.76634	9.2272E-10	Significant
BATS	-0.15421	3.79478	0.03506	0.27722	1.08934	5.1336E-20	Significant
IHG	-0.69934	4.66527	0.03153	0.38052	1.14801	9.3294E-29	Significant
UU/	0.28624	0.64775	0.02842	0.17549	0.70262	1.6323E-12	Significant

Table 8 – Descriptive Statistics Low ESG Risk Rated Stocks							
Ticker	**Skewness**	**Kurtosis**	**Volatility**	**R^2**	**Beta**	**P-value**	**p<0.05**
WPP	-0.06336	3.07656	0.03333	0.27642	1.03430	5.9334E-20	Significant
DGE	0.61359	2.21046	0.02398	0.34130	0.82667	2.7892E-25	Significant
RTO	-0.48969	1.27257	0.02547	0.20714	0.68404	9.4743E-15	Significant
BME	-0.45067	2.50078	0.03614	0.10389	0.68744	1.0097E-07	Significant
HLMA	0.18521	2.56491	0.02566	0.32696	0.86597	4.6340E-24	Significant
SGE	-0.07350	1.47451	0.02945	0.27635	0.91368	6.0082E-20	Significant
TSCO	0.39929	1.56321	0.03772	0.25149	1.11627	4.9949E-18	Significant
BDEV	-0.18647	1.95211	0.03836	0.11983	0.78377	9.2338E-09	Significant
RMV	0.35437	2.58575	0.03111	0.13977	0.68633	4.4182E-10	Significant
BRBY	-0.04545	1.78508	0.03822	0.29636	1.22777	1.5380E-21	Significant
SMDS	-0.12555	0.55548	0.03419	0.34369	1.18304	1.7348E-25	Significant
GAW	1.14686	3.60486	0.04382	0.06804	0.67459	1.9714E-05	Significant
LGEN	-0.26929	2.00659	0.03272	0.34925	1.14128	5.7216E-26	Significant
INF	0.29186	1.54843	0.02587	0.31244	0.85326	7.5108E-23	Significant
UTG	-0.18879	0.23927	0.02386	0.13092	0.50939	1.7154E-09	Significant
LAND	-0.12114	0.30707	0.02664	0.20873	0.71841	7.2777E-15	Significant
CPG	-0.08558	0.35260	0.02567	0.23016	0.72681	1.9835E-16	Significant
CCH	0.42797	1.13840	0.03245	0.26503	0.98583	4.5756E-19	Significant
JD/	0.68016	2.25690	0.04251	0.05584	0.59287	1.1625E-04	Significant
RS1	1.17618	6.54152	0.04305	0.19342	1.11745	9.0323E-14	Significant
VOD	-0.04090	1.85147	0.02972	0.26704	0.90636	3.2004E-19	Significant
AHT	-0.10605	1.04775	0.04232	0.29831	1.36427	1.0704E-21	Significant
WTB	0.74076	2.90517	0.03030	0.14478	0.68036	2.0391E-10	Significant
SVT	0.09186	0.21271	0.02812	0.19108	0.72540	1.3221E-13	Significant
IWG	-0.23372	11.69625	0.05149	0.14769	1.16774	1.2977E-10	Significant

Once the above descriptive statistics were calculated and each stock's beta was found to be significant at the 95% confidence level, the authors proceeded with using the betas to calculate the expected return of each stock. Before *equation 2* from the *Mathematical Notation* section could be used, a number of additional variables were required. The first is that of the risk-free rate. As described above in the *Data* section the passive impact investor described here established their portfolio on the first Friday of May 2020 (May 1st, 2020). Using data downloaded from *Bloomberg*, the annual yield on a 3-year UK Government Bond (Gilt) was 0.071% on this date. As the yield is expressed as a percentage in *Bloomberg*, the value was divided by 100 such that the number be expressed in the same way as the other returns calculated, as a matter of notation. In addition, yields are expressed in an annualized form, yet this paper works with weekly data. As such, the weekly risk-free rate was derived using *equation 3* and is given as: 0.00001365.

Once the risk-free rate was determined, the market return was required. The market return calculated here was that of the average *FTSE 350* return over the 5-year time horizon from January 2nd, 2015, to December 27th, 2019. The weekly returns were calculated along with the other stock returns outlined above using *equation 1* with the average weekly return on the *FTSE 350* found to be 0.00081. With both the expected return on the market and the risk-free rate, the expected return of each stock could then be calculated using the CAPM.

An example of the calculation of the expected return using the mean-beta relationship from CAPM (*equation 2*) for the high ESG risk rated stock BA/ is as follows:

$$E(r_{BA/}) = r_f + \beta_{BA/}(E(r_m) - r_f)$$

$$E(r_{BA/}) = 0.00001365 + 0.93532747(0.00080993 - 0.00001365) = 0.00075843$$

It should be noted that the risk-free rate and expected return on the market remain fixed for all individual expected return calculations while the β coefficient (beta) for each stock is unique. Thus, the differences in expected return of each stock are the result of each stocks' unique beta.

The expected returns for each of the 75 stocks are summarized below in *Tables 9, 10 and 11* in the section *Portfolio Summary Statistics*.

Once the beta, expected return and volatility of each of the 75 stocks included in the high, medium and low ESG risk rated portfolios was determined, the portfolio weights for each risk rated portfolio (Equally Weighted, GMV and Tangency) could be calculated. A brief summary as to how the weights for each portfolio are calculated is explained in the proceeding section, *Portfolio Creation*. Each portfolio's summary statistics will then be presented in the section following titled *Portfolio*

Summary Statistics. The portfolio summary statistics (namely portfolio weights) will be briefly analyzed in turn for each ESG risk rated portfolio to determine if their weights make sense. Each portfolio's summary values including portfolio expected return, volatility, Sharpe ratio, VaR and ES will then be compared, contrasted and analyzed in the section titled *Summary ESG Risk Rated Portfolio Comparisons*.

6.2 Portfolio Creation

The creation of each ESG risk rated portfolio's weights will each be explained in turn within their respective sections. In total, 9 portfolios were created, 3 portfolio types of Equally Weighted, GMV, and Tangency for each ESG risk rating bucket. Please additionally note that the expected return of each portfolio is calculated in the same way for each portfolio using the Excel function SUMPRODUCT(). This function multiplies each stock weight by the stock's expected return and then adds each weighted return together. This Excel function calculates the expected return of each portfolio as *equation 5* in the *Mathematical Notation* section indicates.

6.2.1 Equally Weighted

The Equally Weighted portfolio was calculated first. No Excel tools were required to fulfil the calculation of the weight distribution as equal weight was placed in each stock. As there are 25 stocks in each portfolio, it was concluded that each stock should have a weight of 0.04 (1/25=0.04) in the portfolio.

6.2.2 GMV Portfolio

The GMV portfolio was calculated after the Equally Weighted portfolio. The GMV portfolio is the portfolio which places weight in the various stocks in such a way that the resulting portfolio will have the lowest volatility (standard deviation) of all other portfolio combinations on the Minimum Variance Frontier. In this way, the portfolio weights were determined by minimizing the volatility of the portfolio. To do this, the portfolio volatility was required to be calculated. Please note that the portfolio volatility was calculated in the same way for all 9 portfolios; however, its calculation is explained here due to the need to minimize such volatility in the creation of the GMV portfolios.

To calculate the volatility (standard deviation) of a portfolio, the Excel function SQRT(SUMPRODUCT(Portfolio Weights;MMULT(Covariance Matrix;Portfolio Weights))) is used. SQRT is required because without it, the result would indicate the portfolio's variance rather than its standard deviation. This function is used due to the large number of stocks (25 in each portfolio) making *equation 6* in the *Mathematical Notation* section not possible to use. A visual representation of this matrix multiplication is as follows for 4 of the high ESG risk rated stocks.

$$\sigma_p^2 = \left(W_{BA/} \;\; W_{EZJ} \; W_{GLEN} \;\; W_{MGNS}\right)\begin{pmatrix} \sigma_{BA/BA/} \; \sigma_{BA/EZJ} \; \sigma_{BA/GLEN} \; \sigma_{BA/MGNS} \\ \sigma_{EZJBA/} \; \sigma_{EZJEZJ} \; \sigma_{EZJGLEN} \; \sigma_{EZJMGNS} \\ \sigma_{GLENBA/} \; \sigma_{GLENEZJ} \; \sigma_{GLENGLEN} \; \sigma_{GLENMGNS} \\ \sigma_{MGNSBA/} \; \sigma_{MGNSEZJ} \; \sigma_{MGNSGLEN} \; \sigma_{MGNSMGNS} \end{pmatrix}\begin{pmatrix} W_{BA/} \\ W_{EZJ} \\ W_{GLEN} \\ W_{MGNS} \end{pmatrix}$$

Once the volatility of each portfolio was calculated, Excel's Solver Tool was used. Solver was set to minimize volatility by changing the portfolio weights subject to the constraint that the portfolio weights must sum to one. Please additionally note that in using Solver, the authors of this paper did not allow Excel to "Make Unconstrained Variables Non-Negative" implying that shorting of stocks was not allowed. It was the decision of the authors of this paper not to allow for shorting of stocks due to the definition of a passive, everyday impact investor. Shorting puts an investor into an incredibly risky position whereby their lose potential is even greater than their initial investment. As the investor profile only considers passive, everyday investors interested in pursuing a buy-and-hold strategy, shorting was deemed too risky and outside of the scope of a reasonable, everyday private investor's capabilities. As such, shorting is outside of the scope of this paper resulting in some stocks receiving zero weighting in the GMV portfolios created. These findings will be further discussed in the section *Portfolio Summary Statistics*.

Upon finalizing the Solver inputs, keeping the default "Solving Method" as "GRG Nonlinear," Solver was instructed to "Solve" returning a combination of portfolio weights which resulted in the lowest volatility for the given combination of stocks. This process was repeated three times to create a GMV portfolio for each ESG risk rating.

6.2.3 Tangency Portfolio

The Tangency portfolio was calculated last. Such a portfolio assigns weights to stocks in a portfolio in such a way that the portfolio has the greatest expected return for a given level of risk (volatility). In other words, the portfolio is constructed such that it has the best risk-reward tradeoff. The Tangency portfolio weights are calculated similarly to the GMV portfolios weights using Excel's Solver Tool. As noted within the *Methodology* section, the Sharpe ratio is used to calculate the risk-reward tradeoff of a given stock or portfolio. To this end, by maximizing the Sharpe ratio of a portfolio by changing each stock's weight in said portfolio, the resulting portfolio weights will result in a Tangency portfolio.

To use *equation 10* for the Sharpe ratio, the portfolio volatility (standard deviation) is first required to be calculated using the same matrix multiplication as detailed in the previous *GMV Portfolio* section. Each portfolio's expected return is then calculated using the SUMPRODUCT() Excel formula explained at the beginning of the *Portfolio Creation* section. With the addition of the risk-free rate identified above as 0.00001365, the Sharpe ratio was then calculated for each portfolio. Please note that in addition to portfolios, it is also possible to calculate a Sharpe ratio for each stock. Each stock's Sharpe ratio is additionally included in *Tables 9, 10 and 11* below.

Once the Sharpe ratio was calculated, Excel's Solver Tool could be used. In contrast to the GMV portfolio optimization above, Solver was instructed to maximize the Sharpe ratio of the portfolio by changing the portfolio weights, subject to the constraint that the portfolio weights all summed to one. Once again, Solver was instructed not to allow for shorting. In the same manner as above, upon finalizing the Solver inputs and keeping the default "Solving Method" as "GRG Nonlinear," Solver was instructed to "Solve" returning a combination of portfolio weights which resulted in the best risk-reward trade-off (highest Sharpe ratio) for the given combination of stocks in each portfolio. Once again, as shorting was not allowed, Solver assigned zero weighting to some stocks during the optimization process, the results of which will be further analyzed in the *Portfolio Summary Statistics* section. This process was also repeated three times to create a Tangency portfolio for each ESG risk rating.

After the creation of the Tangency portfolio, all 9 portfolios (3 for each ESG risk rating) were complete. The next section, *Portfolio Summary Statistics*, will present the expected return, volatility and Sharpe Ratio for all 75 stocks included in this analysis. The portfolio weights in each stock for the Equally Weighted, GMV and Tangency portfolios are also presented and analyzed such as to determine if their weightings make intuitive sense given the volatility and Sharpe ratio optimization constraints of the GMV and Tangency portfolios, respectively.

6.3 Portfolio Summary Statistics

Now that the above descriptions as to how the Equally Weighted, GMV and Tangency portfolio weights are calculated, the authors of this paper will consider if, based on the definitions of each portfolio's optimization, the allocated weighting of each stock makes intuitive sense. It is a limitation of the GMV and Tangency optimization that, by not allowing shorting, a weight of zero was assigned to some of the stocks in each portfolio. Assigning a weight of zero to a stock in the portfolio reduces the benefits of diversification across industries; however, was required to satisfy the volatility and Sharpe ratio constraints of the GMV and Tangency portfolios.

6.3.1 High ESG Risk Rated Portfolios

Table 9 – Portfolio Weights High ESG Risk Rated Stocks							
Ticker	**Beta**	**Expected Return**	**Volatility**	**Sharpe Ratio**	**Equally Weighted**	**GMV**	**Tangency**
BA/	0.935327	0.000758	0.028453	0.026176	0.04	0.111979	0.101255
EZJ	0.327061	0.000274	0.044435	0.005861	0.04	0.090562	0.019095
SMIN	1.121035	0.000906	0.029021	0.030759	0.04	0.021510	0.087126
BARC	1.134747	0.000917	0.036910	0.024480	0.04	0.025694	0.113264
ANTO	1.638102	0.001318	0.056193	0.023213	0.04	0	0.024804
SSE	0.683750	0.000558	0.027430	0.019849	0.04	0.170388	0.103936
CEY	0.481083	0.000397	0.059760	0.006410	0.04	0.066178	0.006136
WEIR	1.595806	0.001284	0.049301	0.025774	0.04	0	0
DRX	1.313244	0.001059	0.052868	0.019779	0.04	0	0.002759
BOY	1.135865	0.000918	0.037703	0.023989	0.04	0.008881	0.027595
BP/	1.328403	0.001071	0.031363	0.033727	0.04	0.041813	0.230234
JUST	0.631158	0.000516	0.059824	0.008401	0.04	0.008840	0.005114
SPI	0.774563	0.000630	0.053980	0.011426	0.04	0.007280	0.014344
BBY	0.830245	0.000675	0.036375	0.018175	0.04	0.042805	0
HTG	1.964753	0.001578	0.071292	0.021945	0.04	0	0
VCT	1.257018	0.001015	0.036758	0.027230	0.04	0	0.046281
CNE	1.238060	0.000999	0.052450	0.018796	0.04	0	0
DCC	0.888145	0.000721	0.030515	0.023176	0.04	0.033321	0.056272
HFG	0.378809	0.000315	0.030014	0.010050	0.04	0.206877	0.048673
DPH	0.774163	0.000630	0.037330	0.016513	0.04	0.079999	0.073143
FRES	0.983035	0.000796	0.056931	0.013749	0.04	0	0.023410
ELM	1.087269	0.000879	0.040478	0.021389	0.04	0.007927	0.008417
FXPO	1.522928	0.001226	0.093749	0.012935	0.04	0	0.000177
GLEN	2.163868	0.001737	0.064422	0.026746	0.04	0	0.007963
MGNS	0.424599	0.000352	0.039727	0.008511	0.04	0.075948	0

The high ESG risk rated portfolio weights are outlined in *Table 9* above. The Equally Weighted portfolio is shown with a weight of 0.04 assigned to each stock, maintaining the Sustainalytics subindustry diversification. To this end, the stocks within the high ESG risk rated portfolio remain somewhat concentrated in the oil and gas industry and are, thus, less diversified across industries. The GMV portfolio in contrast, only assigns weight to 16 of the 25 available stocks, further reducing industry diversification yet also decreasing the overall portfolio's expected volatility. As the GMV portfolio assigned weight to the stocks in such a way that the volatility of the overall portfolio was lowest, observing the volatility of the stocks excluded provides intuitive insights. FXPO, for example, has the highest volatility of all the stocks at 9.38%, which is incredibly high, especially when compared to the next highest volatilities of 7.13% (HTG) and 6.44% (GLEN), also excluded.

When considering the Tangency portfolio, the portfolio was constructed in such a way that the risk return tradeoff of the portfolio, given by the Sharpe ratio, is maximized. 20 of the 25 stocks were assigned weight in this portfolio while 3 of those which received no weight, likewise, received no weight in the GMV portfolio (WEIR, HTG, CNE). These three stocks tend to be those with high comparative volatilities, implying both that they do not satisfy the volatility constraints of the GMV portfolio, and do not provide enough return to compensate for the high risk in the Tangency portfolio. While the Sharpe ratios of each of the stocks excluded are not always the lowest, it is important to remember that it is each stock's contribution to the overall portfolio that is important. Interestingly, the stock receiving the largest weight in the Tangency portfolio was BP/ (23.02%), a stock which likewise had a considerably higher weekly Sharpe ratio of 0.033727 when compared to the other 25 stocks.

The graph below provides a graphic illustration of where each portfolio will plot relative to one another and the Efficient Frontier. The GMV and the Tangency portfolios plot as per their definitions, the GMV with the lowest volatility and the Tangency with the best risk-return tradeoff where the CML touches the Efficient Frontier. It can also be observed that the Equally Weighted portfolio is not optimized, plotting below the Minimum Variance Frontier indicating that there is an improved portfolio configuration providing greater expected return for the same level of risk. This is not surprising for the Equally Weighted portfolio however, as no intentional optimization of the portfolio was pursued. The portfolio expected returns and volatility will be further discussed in the next section *Summary ESG Risk Rated Portfolio Comparisons*.

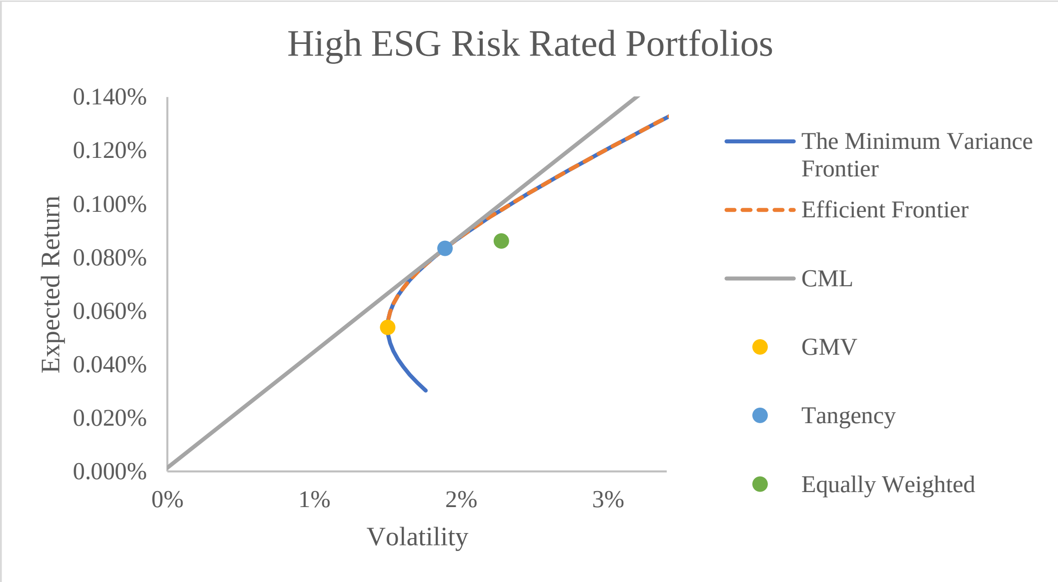

Figure 3

6.3.2 Medium ESG Risk Rated Portfolios

Table 10 – Portfolio Weights
Medium ESG Risk Rated Stocks

Ticker	Beta	Expected Return	Volatility	Sharpe Ratio	Equally Weighted	GMV	Tangency
RR/	1.283983	0.001036	0.044049	0.023211	0.04	0	0.026953
IAG	0.792324	0.000645	0.039702	0.015891	0.04	0.028217	0.029973
ABDN	1.128388	0.000912	0.037969	0.023664	0.04	0	0.026542
ENT	0.497249	0.000410	0.041586	0.009521	0.04	0.055534	0.001174
MRO	0.912026	0.000740	0.069291	0.010481	0.04	0.001889	0
CRH	1.213621	0.000980	0.030490	0.031695	0.04	0	0.085532
HSBA	1.143752	0.000924	0.027453	0.033175	0.04	0.049169	0.161765
BEZ	0.520347	0.000428	0.029103	0.014237	0.04	0.110928	0.002911
AAL	1.973889	0.001585	0.071128	0.022098	0.04	0.000688	0.043582
SPX	1.050788	0.000850	0.029038	0.028815	0.04	0.012557	0.051661
MONY	0.580990	0.000476	0.036806	0.012570	0.04	0.071840	0.022053
PHNX	0.783418	0.000637	0.025784	0.024194	0.04	0.055817	0.040168
SN/	0.784812	0.000639	0.026479	0.023601	0.04	0.061159	0.028068
CNA	0.916601	0.000744	0.039449	0.018502	0.04	0.061244	0.016610
OCDO	1.038125	0.000840	0.071699	0.011529	0.04	0	0.006465
RKT	0.765857	0.000623	0.027192	0.022427	0.04	0.087735	0.032428
GSK	0.931338	0.000755	0.026444	0.028045	0.04	0.053675	0.103274
HSX	0.578700	0.000474	0.028884	0.015954	0.04	0.041869	0.003257
EXPN	0.905332	0.000735	0.025114	0.028705	0.04	0.129757	0.086897
CRDA	0.868327	0.000705	0.026053	0.026539	0.04	0.048070	0.030145
FRAS	0.763858	0.000622	0.050182	0.012121	0.04	0.022184	0.015817
BT/A	0.766341	0.000624	0.035345	0.017265	0.04	0.042071	0.033380
BATS	1.089342	0.000881	0.035057	0.024743	0.04	0	0.063126
IHG	1.148006	0.000928	0.031534	0.028988	0.04	0	0.027235
UU/	0.702617	0.000573	0.028420	0.019686	0.04	0.065596	0.060983

The above breakdown of the weight distribution of the medium ESG risk rated portfolios in *Table 10* yields similar takeaways as the above high ESG risk rated portfolios. The Equally Weighted portfolio assigns the same 0.04 weighting to each stock while the GMV portfolio assigns weight to 19 of the 25 stocks. Interestingly, while the stock with the highest volatility, OCDO (7.17%), receives a weight of zero, the three stocks with the next highest volatilities AAL, MRO and FRAS receive weights in favour of other, less volatile stocks. The weights assigned to MRO and AAL are notably smaller, however, than all other assigned weights. These findings are interesting in so much as they speak to the power of diversification and that combinations of stocks with varying volatilities (some high and some low) can be combined in such a way that they yield the lowest possible portfolio volatility.

Another interesting observation is that of the Tangency portfolio. As is shown in *Table 10*, only 1 of the 25 stocks received a weight of 0. This particular stock, MRO, has the second lowest Sharpe ratio of all of the stocks within the ESG risk rated portfolio, yet also has the 3rd highest volatility and only a comparatively average expected return. Based on these observations, a weight of 0 appears reasonable.

By plotting each portfolio in comparison to one another and the Efficient Frontier as shown in *Figure 4*, it can be observed that, as above in the high ESG risk rated portfolios, the GMV portfolio plots along the Minimum Variance Frontier at the point in which the Efficient Frontier begins. The Tangency portfolio, likewise, plots where the CML and the Efficient Frontier meet. Interestingly, the Equally Weighted portfolio is plotted very close to the Tangency portfolio and the Efficient Frontier. This is in stark contrast to the Equally Weighted high ESG risk rated portfolio shown in *Figure 3*. It is interesting to observe that without any active portfolio optimization and very different weight distributions, the risk-reward tradeoff of the Equally Weighted and Tangency portfolios resulted in expected risk-reward tradeoffs that are very close to one another. It will be further discussed in the *Holding Period Returns* section below whether these expectations surrounding expected returns were translated into similar realized returns.

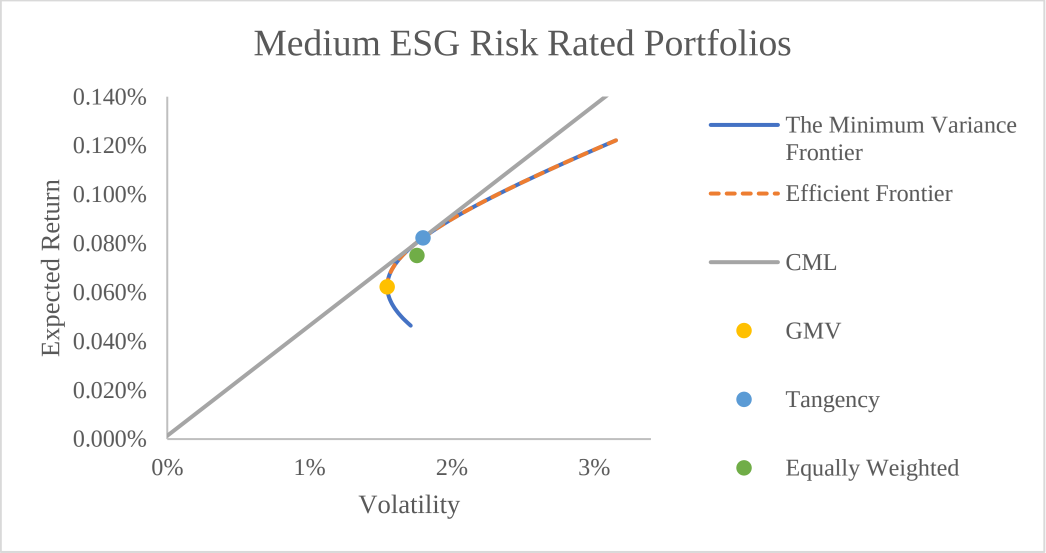

Figure 4

6.3.3 Low ESG Risk Rated Portfolios

Table 11 – Portfolio Weights Low ESG Risk Rated Stocks							
Ticker	**Beta**	**Expected Return**	**Volatility**	**Sharpe Ratio**	**Equally Weighted**	**GMV**	**Tangency**
WPP	1.034305	0.000837	0.033334	0.024707	0.04	0	0.036749
DGE	0.826668	0.000672	0.023977	0.027454	0.04	0.077857	0.128905
RTO	0.684041	0.000558	0.025467	0.021388	0.04	0.094482	0
BME	0.687444	0.000561	0.036140	0.015147	0.04	0.056188	0.003389
HLMA	0.865972	0.000703	0.025662	0.026871	0.04	0.050869	0.030631
SGE	0.913676	0.000741	0.029450	0.024704	0.04	0	0.047674
TSCO	1.116273	0.000903	0.037717	0.023567	0.04	0.018225	0.064198
BDEV	0.783768	0.000638	0.038365	0.016268	0.04	0	0
RMV	0.686331	0.000560	0.031107	0.017569	0.04	0	0
BRBY	1.227767	0.000991	0.038215	0.025583	0.04	0	0.049779
SMDS	1.183037	0.000956	0.034193	0.027550	0.04	0	0.029744
GAW	0.674590	0.000551	0.043820	0.012258	0.04	0.060270	0.013058
LGEN	1.141285	0.000922	0.032723	0.027772	0.04	0	0.136700
INF	0.853259	0.000693	0.025866	0.026268	0.04	0.074758	0.047850
UTG	0.509390	0.000419	0.023855	0.017003	0.04	0.175578	0
LAND	0.718409	0.000586	0.026644	0.021470	0.04	0.050142	0.016017
CPG	0.726813	0.000592	0.025671	0.022545	0.04	0.104101	0.058308
CCH	0.985825	0.000799	0.032447	0.024193	0.04	0	0.044508
JD/	0.592872	0.000486	0.042514	0.011104	0.04	0.035696	0
RS1	1.117452	0.000903	0.043053	0.020668	0.04	0	0
VOD	0.906360	0.000735	0.029720	0.024284	0.04	0.077296	0.105202
AHT	1.364269	0.001100	0.042325	0.025667	0.04	0	0.082475
WTB	0.680359	0.000555	0.030298	0.017881	0.04	0.052873	0
SVT	0.725404	0.000591	0.028119	0.020542	0.04	0.071663	0.078456
IWG	1.167740	0.000943	0.051486	0.018060	0.04	0	0.026355

The low ESG risk rated portfolios yield yet again very different and interesting results. The Equally Weighted portfolio once again assigns a weight of 0.04 to each stock while the GMV only assigns weight to 14 out of the 25 stocks. Assigning weight to only 14 stocks significantly reduces the benefits from industry diversification inherent to the originally chosen portfolio of 25 stocks. This lack of diversification will be considered in the *Holding Period Returns* section below to observe if it created any inherently exaggerated market fluctuations. It is also interesting to observe how heavily invested the GMV portfolio is in stock UTG (17.56%), which will also be considered in the

Holding Period Returns section if this heavy concentration in one stock, affected the realized returns of the portfolio.

Observing the weights assigned to the Tangency portfolio is also interesting in that only 18 of the 25 stocks received any weighting. Interestingly, the low ESG risk rated GMV, and Tangency portfolios are less diversified than their medium and high ESG risk rated counterparts. As will be discussed in the *Holding Period Returns* section below, this lack of diversification did not appear to have a negative effect on the low ESG risk rated portfolios realized returns nor risk adjusted returns compared to their more diversified counterparts.

It is also interesting to observe in *Figure 5* below, that the Equally Weighted portfolio plots close to the Tangency portfolio, similar to the medium ESG risk rated portfolio illustrated above. Once again, it is interesting that with no portfolio optimization technique, the Equally Weighted portfolio managed to obtain a risk-return tradeoff that plotted close to that of the Tangency portfolio and close to the Efficient Frontier. It is additionally interesting to consider that the portfolios are composed of very different underlying stocks, as the Tangency portfolio optimization chose not to assign weight to 7 stocks, all of which remain included in the Equally Weighted portfolio.

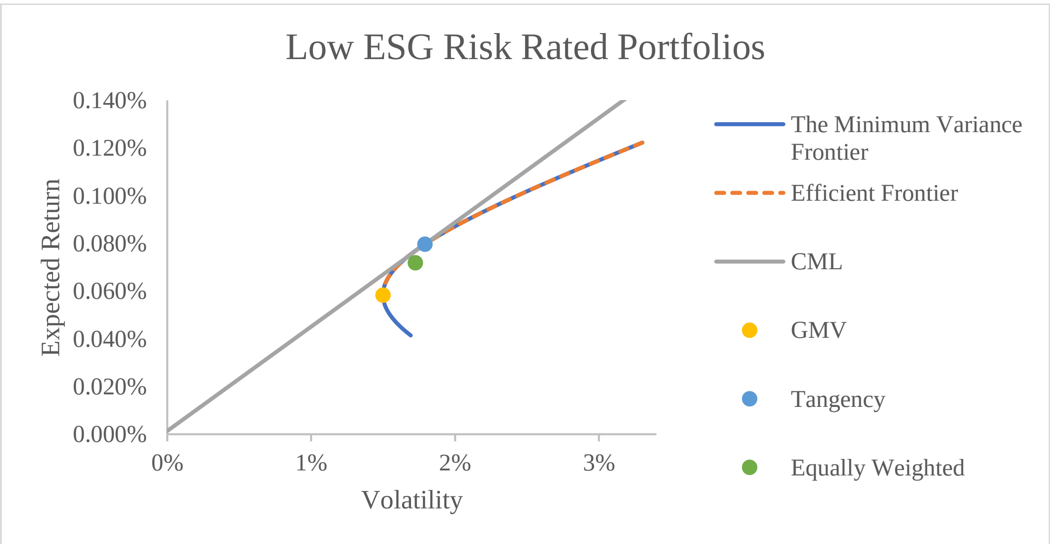

Figure 5

In conclusion to the above analysis of each portfolios weight distribution, the authors of this paper can make a number of first underlying assumptions as to how the realized returns (holding period returns for the 3-year time horizon) of each portfolio might materialize. The Tangency portfolios of each ESG risk rating plot higher and along the Efficient Frontier, thus, while this could imply that these portfolios are likely to achieve the highest realized returns, both the low and high ESG risk rated Tangency portfolios are much less diversified across Sustainalytics subindustries than their respective Equally Weighted portfolios. Additionally, as the Equally Weighted low ESG risk rated portfolio plots closely to the Tangency portfolio with respect to both expected returns and risk, it could be expected that the diversification effects of the Equally Weighted portfolio cause said portfolio to achieve greater realized returns than the Tangency portfolio. The same cannot necessarily be said for the Equally Weighted high ESG risk rated portfolio as said portfolio plots well below the Minimum Variance Frontier and nowhere near the Tangency portfolio. As such, it is expected that the high ESG risk rated Tangency portfolio will perform superior to the Equally Weighted portfolio despite its reduced diversification. Likewise, as the medium ESG risk rated Tangency portfolio remains diversified across 24 stocks, it is also expected that this portfolio will perform superior to the Equally Weighted portfolio (though not necessarily substantially superior given they plot so closely) due to the combination of weight optimization and diversification.

The GMV portfolios of each stock are expected to perform the worst out of three optimization types across low, medium and high ESG risk rated portfolios. This is due to the GMV's desire to reduce portfolio volatility and as such, reduce the portfolio expected returns. All GMV portfolios plot well below both the Equally Weighted and Tangency portfolios while also being the least diversified across subindustries of the 3 portfolio weighting types. The next section will delve deeper into the various portfolio expected returns, volatility and Sharpe ratios and introduce the calculation of the portfolios' Value-at-Risk and Expected Shortfall. These will provide the authors of this paper further insights into the portfolio expectations before proceeding into the calculation of the realized portfolio returns (Holding Period Returns) a passive, everyday impact investor would have achieved given they had invested in each of the 9 portfolios with a buy-and-hold strategy in May 2020.

6.4 Summary ESG Risk Rated Portfolio Comparisons

This section will further outline for comparison, amongst the 9 portfolios created above, the final portfolio expected return, volatility and Sharpe ratio values. For added robustness to the calculations in both enhancing understanding of the tail-risk inherent in each portfolio, as well as in accordance with similar studies of its kind by the likes of Eccles et al. (2016) and Xiong (2021), the Value-at-Risk (VaR) and Expected Shortfall (ES) are also presented for each portfolio. The calculation of each will be briefly explained before portfolio findings are analyzed in comparison of one another.

6.4.1 Calculation of VaR and ES

Once the portfolio weights were calculated, as presented in the above *Portfolio Creation* section, the VaR was calculated. As per *equation 13* from the *Mathematical Notation* section, the standard deviation (volatility) for each portfolio is needed. Each portfolios' volatility was already calculated in the creation of the 9 portfolios, as was detailed in the previous sections. In addition to the volatility for each portfolio the mean (μ) is required. According to Hull (2018, p. 278), the mean is often assumed zero given a normal distribution and a relatively short time horizon. Thus, the authors of this paper have likewise assumed a mean of zero due to the normal distribution assumptions previously outlined in the *Calculation of Critical Variables* section above.

The final element in the calculation of VaR is the Z-score for a given confidence level. In line with the further recommendations of Hull (2018, p. 282) which indicate that "it is very difficult to estimate a VaR directly when the confidence level is very high", a one-sided z-score with a 95%

confidence level was considered in the calculation of both VaR and ES. The calculation of such Z-score in Excel requires the following NORMSINV() function. Please note that this Excel function will return a one-sided Z-score which is sufficient for the purposes of this calculation as the VaR only considers the downside risk and is not concerned with the upside potential. It is additionally noted that the NORMSINV(95%) is indicative that in *equation 13*, X is equal to 95%. An example calculation of the Equally Weighted, high ESG risk rated portfolio is presented below. The portfolio volatility used is presented in *Table 12*. Please note once again that values presented are subject to rounding error as calculations were done using all decimal places in Excel.

$$VaR = 0.022733 * 1.644854 = 0.037393$$

The above calculation for the VaR was done similarly for each of the 9 portfolios. While the volatility was replaced for each VaR calculation by each unique portfolio volatility, the Z-score remained the same for each portfolio (in line with the notation presented in *equation 13*). A key takeaway in the final representation of the VaR is the choice of notation chosen by the authors. While VaR is a risk measurement (indicating a 95% loss threshold) the value is presented as a positive value. Irrespective of notation, the VaR (and ES) should be interpreted as a weekly loss.

After the VaR, the ES could be calculated using *equation 14*. As noted in the calculation of the VaR, and following the recommendations of Hull (2018), the mean is once again assumed zero. Additionally, as in the VaR, each portfolio's volatility is required and should be assumed as was calculated above in previous sections. In addition to this, the calculation of the ES requires an additional Excel function than was required for the calculation of the VaR, namely NORM.S.DIST(Z,Distribution). This function replaces the standard normal density function denoted $\frac{e^{-z^2/2}}{\sqrt{2\pi}}$. As the Z-score is required for such a calculation (indicated by both the superscript Z and the Excel function), the previously calculated NORMSINV(95%) should be included as the Z-score to ensure there is no rounding error. This is modeled as NORM.S.DIST(NORMSINV(95%); FALSE). FALSE in the NORM.S.DIST function, indicates a probability mass function (which contrasts TRUE, a cumulative distribution function which, if used, would return the probability considered here of 95%). X, as considered above in the calculation of VaR, is 95%, indicative of a 95% confidence level. Thus, the final Excel function representing *equation 14* is expressed below.

$$ES = \sigma * \frac{NORM.S.DIST(NORMSINV(95\%); FALSE)}{(1 - 0.95)}$$

The ES for each of the 9 portfolios was calculated using the formula above and are summarized below in *Tables 12, 13 and 14*. As noted above, while the ES is expressed as a positive number due to the notational preferences of the authors of this paper, it should be interpreted, along with the VaR, as a weekly loss potential.

Before the presentation and analysis of the final portfolio calculations, there are notable differences between the interpretation of the VaR and ES which should be considered before proceeding to the analysis of the portfolio outcomes. Both are measures of the tail-risk (i.e. loss potential) in a given portfolio. Where they differ, however, is in what they measure. VaR is a threshold measurement which measures a singular loss value at the 95th percentile of the distribution of losses over one week (as one week is the time sequence considered here). ES, in contrast, considers all losses within the 5% tail, averaging said losses to define a singular value for the ES. In this way, while VaR defines the 95th percentile threshold losses, ES considers the magnitude of potential losses to an investor in the unlikely scenario their portfolio was to end up in the worst 5% of the distribution (the tail). As a result, ES should always be larger than VaR for any given portfolio distribution as it considers how “fat” the tails of the distribution are (i.e. the average magnitude of the losses in the tail).

6.4.2 Summary Calculations

Table 12

Summary Calculations for Equally Weighted Portfolios					
Portfolio	**Expected Return**	**Volatility**	**Sharpe Ratio**	**VaR**	**ES**
Low	0.000720	0.017256	0.040927	0.028384	0.035595
Medium	0.000751	0.017553	0.041990	0.028872	0.036207
High	0.000861	0.022733	0.037287	0.037393	0.046893

Table 13

Summary Calculations for GMV Portfolios					
Portfolio	**Expected Return**	**Volatility**	**Sharpe Ratio**	**VaR**	**ES**
Low	0.000584	0.014994	0.038065	0.024663	0.030928
Medium	0.000623	0.015462	0.039434	0.025432	0.031893
High	0.000538	0.015005	0.034977	0.024681	0.030951

Table 14

Summary Calculations for Tangency Portfolios					
Portfolio	**Expected Return**	**Volatility**	**Sharpe Ratio**	**VaR**	**ES**
Low	0.000797	0.017917	0.043729	0.029470	0.036957
Medium	0.000823	0.017973	0.045017	0.029564	0.037074
High	0.000834	0.018890	0.043410	0.031072	0.038966

The summary results of the risk calculations for the various portfolios leave much for an investor to consider. Firstly, the results show that the low ESG risk rated portfolio has the lowest Value-At-Risk and Expected Shortfall across all three portfolio types – Equally Weighted, Global Minimum Variance and Tangency. This implies that portfolios comprised of low ESG risk rated stocks also have lower financial risk associated with them. As an example, for the GMV portfolios, the low ESG risk rated portfolio has a VaR of 2.4663% at the 95% confidence interval – suggesting that there is a 5% chance that losses will exceed 2.4663% in a one-week period. This compares with losses exceeding 2.5432% and 2.4681% for the medium and high ESG risk rated GMV portfolios, respectively. Thus, at a 95% confidence interval, the low ESG risk rated portfolio has the smallest potential loss which can be exceeded.

The same holds true for ES, which measures the average of the losses in the 5% tail. Here again, the low ESG risk rated portfolio has the lowest ES across the three portfolio types, suggesting that in the 5% worst case, the losses in the low ESG risk rated portfolio will be less than that of the medium and high ESG risk rated portfolios. The implication for investors is that low ESG risk rated stocks not only provide a way for impact investors to engage in socially responsible investing, but can also provide portfolios with lower levels of tail risk.

In addition, when isolating the low and high ESG risk rated portfolios, the results show large differences between the portfolios. Across the three portfolio weighting strategies, the low ESG risk rated portfolios have a higher Sharpe ratio than the high ESG risk rated portfolios. This suggests that the portfolios comprised of low ESG risk rated stocks provide better reward-to-risk trade-offs, thereby providing higher levels of expected returns for a given level of risk. This is further reinforced by the lower level of volatility for the low ESG risk rated portfolios observed across all portfolio weighting strategies in comparison to the high ESG risk rated portfolios. These results confirm that, given a 5-year analysis of historical weekly returns data, the low ESG risk rated portfolios are associated with less risk (when considering VaR, ES and volatility) and achieve better levels of returns per unit of risk (higher Sharpe ratio).

In contrast to the distinct differences between the low and high ESG risk rated portfolios, the results additionally show that the medium ESG risk rated portfolio consistently has the highest Sharpe ratio across portfolio weighting strategies, thereby offering the best risk adjusted return to investors. However, as discussed above, the medium ESG risk rated portfolios are also associated with a higher VaR and ES compared to the low ESG risk rated portfolios, suggesting higher losses in worst-case scenarios.

Combining the conclusions from this section and the *Portfolio Summary Statistics* section above, the authors of this paper have extended upon a number of expectations surrounding the realized returns (Holding Period Returns) which are likely to be achieved during the 3-year holding period. First, it is expected that the Tangency portfolio of high ESG risk rated stocks will perform better than their Equally Weighted and GMV counterparts. Second, the Tangency and Equally Weighted portfolios of the low and medium ESG risk rated portfolios are expected to achieve similar returns due to the combination of diversification and optimization, with the Tangency likely to achieve slightly greater returns as per its definition. The GMV portfolios are expected to perform the worst of the 3 portfolio weighting strategies due to their comparatively lower Sharpe ratios and expected returns. In addition to the above expectations surrounding which of the optimized portfolios will perform better for each given ESG risk rated portfolio, there are number of assumptions to be made surrounding how the low, medium and high ESG risk rated portfolio returns will compare to one another. Due to the low ESG risk rated portfolio's lower loss potential and superior Sharpe ratio (compared to the high ESG risk rated portfolio), and in conjunction with the findings of Eccles et al. (2016) and Xiong (2021) it is expected that the low ESG risk rated portfolio will perform superior to both the high and medium ESG risk rated portfolios. Likewise, due to the medium ESG risk rated portfolio achieving the highest Sharpe ratio across optimized portfolios while also achieving expected returns which are both below and above the low and high ESG risk rated portfolios, coupled with the comparatively higher diversification across optimized portfolios, the medium ESG risk rated portfolio is expected to perform between the high and low ESG risk rated portfolios. Lastly, the high ESG risk rated portfolio is expected to perform the worst due to the comparatively higher VaR, ES, and volatility as well as lower Sharpe ratio.

Before proceeding, it should additionally be noted that the focus of these expectations on risk and reward are coupled with the literature by the likes of Lesser et al. (2016), Nofsinger & Varma

(2014) and Ruf et al. (2019) as detailed in the *Literature Review*, namely that during periods of market uncertainty, the low ESG risk rated portfolios achieved superior returns to those of their high ESG risk rated counterparts. As the period from May 2020 to March 2023 is marked with notable crises, this time period can be considered one of market uncertainty and thus, focusing on market risks and diversification in making expectations surrounding realized returns, was particularly important. Such considerations surrounding market uncertainties will be discussed in more detail in the *Macroeconomic Considerations* section below.

The next section will detail how the holding period returns for each portfolio were calculated and whether the realized returns met the expectations of the authors of this paper both in terms of the initial expectations based on previous literature as well as the initial findings based on 5 years of historical returns.

6.5 Holding Period Returns

Upon completing the portfolio optimizations, analyzing the statistics above and forming expectations for the 9 portfolios, the authors of this paper proceeded to evaluate the performance of the portfolios by calculating the holding period returns. The passive, everyday impact investor defined in this paper established their portfolio as of May 1st, 2020, and proceeded to pursue a buy-and-hold strategy for approximately 3-years until March 3rd, 2023.

In order to calculate the holding period returns, *equation 11* was used to calculate the weighted prices for each portfolio of stocks. The Excel function SUMPRODUCT() simulates *equation 11*, by multiplying the weekly price of each stock by its calculated portfolio weight (the weights being those calculated in the *Portfolio Creation* section). Each weighted price is then summed to define the weighted weekly price of the portfolio. There was a total of 149 weekly weighted prices calculated for each of the 9 portfolios. Once the weekly weighted prices were calculated, the holding period returns could be calculated using *equation 11*. To illustrate the calculation, the Equally Weighted, high ESG risk rated portfolio's HPR is shown below. Please note that the weighted price denoted VP_{t+1} is the weighted sale price of the portfolio as of March 3rd, 2023, while the weighted price denoted VP_t is the weighted purchase price of the portfolio on May 1st, 2020.

$$HPR\ High, Equally\ Weighted = \frac{1008.883 - 837.429}{837.429} = 20.47\%$$

Table 15

HPR from May 2020 to March 2023			
Portfolio	**Equally Weighted**	**GMV**	**Tangency**
Low	41.65%	31.06%	49.32%
Medium	27.75%	13.11%	29.76%
High	20.47%	6.75%	14.77%

Before outlining whether the realized returns (Holding Period Returns) align with the authors of this paper's expectations, they will first be compared to the HPR of that of the *FTSE 350*, namely what an investor would have achieved during the same holding period from May 2020 to March 2023 if they had invested in the market, rather than the 9 portfolios created. Using *equation 11*, the HPR for the *FTSE 350* was 35.75% from May 2020 to March 2023. Of the 9 portfolios created, 2 HPRs managed to "beat" the market, the low ESG risk rated Equally Weighted and Tangency portfolios.

This is incredibly interesting considering that both portfolios were significantly less diversified than the *FTSE 350*. That being said, the proceeding sections will show that many of the 9 portfolios outperformed the *FTSE 350* for half of the observation period, from May 2020 up to the Russian invasion of Ukraine in February 2022, whereafter the *FTSE 350* began to perform better.

Broadly speaking, the results demonstrate holding period returns which are in-line with expectations. Across the three portfolio weighting strategies (Equally Weighted, GMV and Tangency), the low ESG risk rated portfolios achieved the greatest realized returns, followed by the medium ESG risk rated portfolios and lastly, by the high ESG risk rated portfolios which achieved the lowest realized returns in each portfolio weighting strategy. Considering only realized returns in each ESG risk rating category, the Optimal Tangency portfolios of the low and medium ESG risk aligned with expectations yielding the highest holding period returns over the 3-year investment period at 49.32% and 29.75%, respectively, when compared to their Equally Weighted and GMV counterparts. This compares with slightly lower returns for the Equally Weighted portfolios at 41.65% and 27.75%, as well as significantly lower returns for the GMV portfolios at 31.06% and 13.11%.

These finding also align somewhat with expectations in that while the low ESG risk rated Tangency portfolio performed superior, the Equally Weighted portfolio also achieved the second largest returns (and both higher than the *FTSE 350*) yet the returns were not as close to one another as the medium ESG risk rated Tangency and Equally Weighted portfolios realized returns were. Overall, as the Tangency portfolios are optimized to provide the best risk-return trade-off, given the performance of historical returns, it makes sense that a buy-and-hold strategy over three years would yield the highest return for investors in both the medium and low ESG risk rated buckets. Along with the same reasoning, given that the GMV portfolios are optimized to minimize the volatility of the portfolio, it is also intuitive that these portfolios yielded the lowest returns (in line with the expectations of the authors). The volatility of a portfolio is a measure of risk, with investors rewarded by earnings premiums for taking on higher levels of risk. Therefore, if the risk of the portfolio is minimized, it makes sense that the returns will also be constrained for the GMV portfolios.

The holding period returns for the high ESG risk rated portfolio, however, did not follow the same trend across optimized portfolios and yielded interesting results for investors to consider. The first observation which stands out from the results is that the high ESG risk rated portfolio has comparatively lower realized returns than the low and medium ESG risk rated portfolios across all portfolio weighting strategies (in line with the expectations of the authors). Furthermore, the results demonstrate that the Optimal Tangency portfolio yields lower holding period returns over the investment period than the Equally Weighted portfolio, contrary to the authors of this paper's expectations. To an extent however, this aligns with expectations given that, during the estimation period, the high ESG risk-rated portfolio was associated with higher levels of volatility and lower Sharpe ratios. However, it is also likely that various macroeconomic factors have been influential in impacting the performance of all portfolios. The authors of this paper note that the investment period, May 2020 to March 2023, has coincided with a period of significant volatility in global stock markets, owed to both the COVID-19 pandemic as well as the Russian invasion of Ukraine and the impact this has had on fueling inflation and the accompanying interest rate hikes. The macroeconomic background over the investment horizon will be investigated further in the section titled *Macroeconomic Considerations*.

6.5.1 Development by ESG Risk Rating

While the above conclusions relate to the final realized returns of an impact investor if the portfolios had been purchased and sold in May 2020 and March 2023 respectively, it is additionally of interest to understand the development of the Holding Period Returns (HPR) throughout the 3-year holding period to better understand each portfolios overall performance. The development of the holding period returns, across each of the portfolios (low, medium and high), can further be visualized in the graphs below. These graphs have been segmented based on ESG risk rating and show the holding period return for each period relative to the purchase prices in the starting period of May 2020.

6.5.1.a Graphically Illustrated High ESG Risk Rated Portfolios

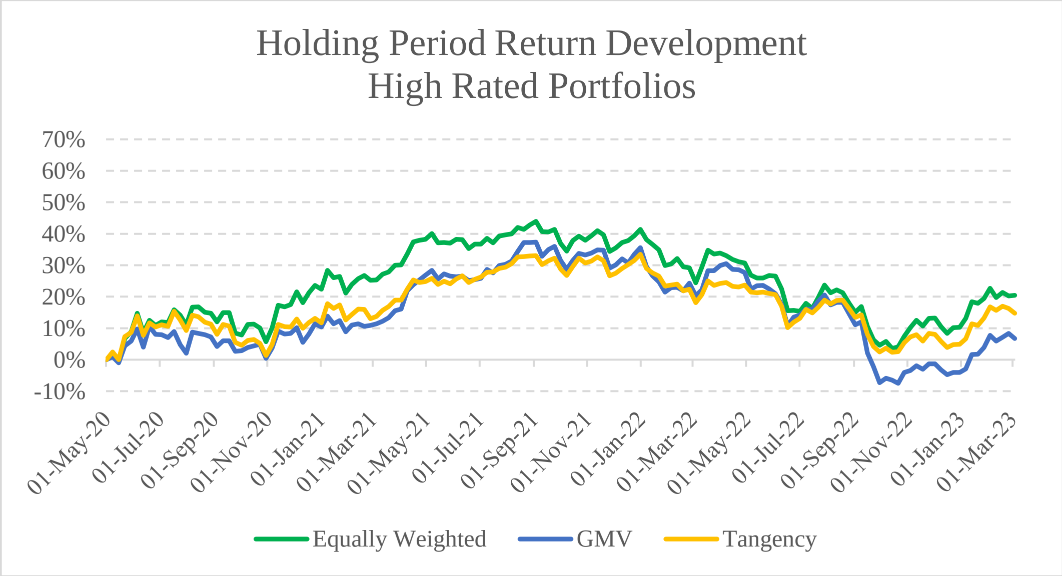

Figure 6

As commented on earlier, the results for the high ESG risk rated portfolios in *Figure 6* show interesting trends for investors to consider. The primary factor for consideration, is that the Tangency portfolio yields lower returns relative to the Equally Weighted portfolio, not only for the final investment period in March 2023 but also, as the graph shows, throughout the entire investment period. The Equally Weighted portfolio, on the other hand, yields the strongest returns throughout the investment period. Furthermore, the graph also shows a large decrease in the returns for the GMV portfolio in September 2022, decreases which were more pronounced than both the Tangency and Equally Weighted portfolio, which also both decreased in this period. One reason for this decrease is due to the heavy investment assigned to the Hilton Food Group (HFG) in the GMV portfolio (20.89%), a stock which reacted poorly to the war in Ukraine. HFG's effect on the portfolios realized returns will be further discussed below when discussing *Figure 9*.

Closer analysis of the performances of each high ESG risk rated stock provides further insight into why the Equally Weighted portfolio performed better than the GMV and Tangency portfolios. The three strongest performing stocks in the high ESG risk rated bucket were commodity trading and mining firm Glencore (GLEN) (↑274.16%), power generation company Drax Group (DRX) (↑211.82%) and healthcare group Spire Healthcare (SPI) (↑135.78%). Despite delivering strong returns over the investment period, these stocks had very low weightings across the GMV and Tangency portfolios, with only 0.80% invested in GLEN, 0.28% in DRX and 1.43% in SPI in the Tangency portfolio and even less weight assigned to the stocks in the GMV portfolio. This compares with the 4% weighting assigned to each stock in the Equally Weighted portfolio, thereby helping the Equally Weighted portfolio to perform strongly.

Additionally, the stocks with strong weightings in the GMV and Tangency portfolios also performed well. This includes an 80.52% growth in the stock of British Aerospace (BA/) (11.20% weighting in the GMV and 10.16% weighting in the Tangency), an increase of 85% for British Petroleum (BP/) (23.02% weighting in the Tangency), a 66.91% increase for Barclays Bank (BARC) (11.33% weighting in the Tangency) and a growth of 38.48% for energy company SSE (17.04% weighting in the GMV and 10.39% in the Tangency). An interesting fact to note is that some of these companies benefited from the Russian invasion of Ukraine, an aspect which will be explored further in the *Macroeconomic Considerations* section.

6.5.1.b Graphically Illustrated Medium ESG Risk Rated Portfolios

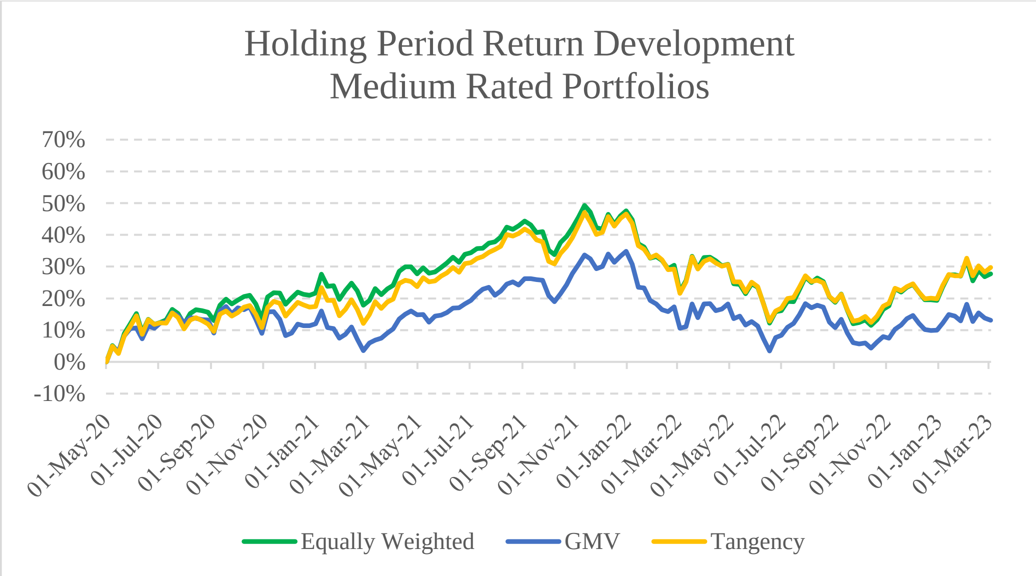

Figure 7

The results for the medium ESG risk rated stocks show a pronounced underperformance in the returns for the GMV portfolio relative to the Tangency and Equally Weighted portfolio throughout the investment period, as shown above in *Figure 7*. Furthermore, the development of the holding period returns also show a strong correlation between the Tangency and Equally Weighted portfolio, with the two HPRs almost moving in lockstep during the latter half of the investment period. In fact, using the CORREL(Equal Weighted; Tangency) function in Excel to compute the correlation coefficient between the Equally Weighted and Tangency HPR's, the returns were found to be 98.19% correlated. This indicates a very strong positive correlation between the returns of the two portfolios, with the returns moving in the same direction 98.19% of the time. The results align with the expectations of the authors in that based on the expected risk-to-reward trade-offs, the Tangency and Equally Weighted portfolios were expected to perform similarly to one another. This high correlation is made particularly noticeable when compared to the correlation coefficient of 90.06% between the Equally Weighted and GMV portfolio and 89.30% between the GMV and Tangency portfolio.

Regarding the medium ESG risk rated portfolios, a notable constituent in the Tangency portfolio is the global bank HSBC Holdings (HSBA) with a 16.18% weighting and a stock price increase of 53.63%. In addition, another interesting stock to note in the Tangency portfolio is that of pharmaceutical company GlaxoSmithKline (GSK) (10.32% weighting), whose stock price fell 11.51% over the investment period. This can be attributed to a spike in its stock price at the start of the investment period, May 2020, which coincides with the early stages of the COVID-19 crisis.

For the GMV portfolio, notable constituents include data analytics company Experian (EXPN) with a total weighting of 12.98% in the portfolio and an appreciation in stock price of 19.87%, as well as insurance provider Beazley (BEZ) with a strong appreciation of stock price of 64.53%. An interesting stock to note in the medium ESG risk rated bucket is that of sports retailer Frasers Group (FRAS), whose share price grew an astounding 209.42%, but whose comparatively high volatility (0.050182) and thereby low Sharpe ratio (0.012121) meant low allocations of only 2.22% in the GMV and 1.58% in the Tangency portfolio.

6.5.1.c Graphically Illustrated Low ESG Risk Rated Portfolios

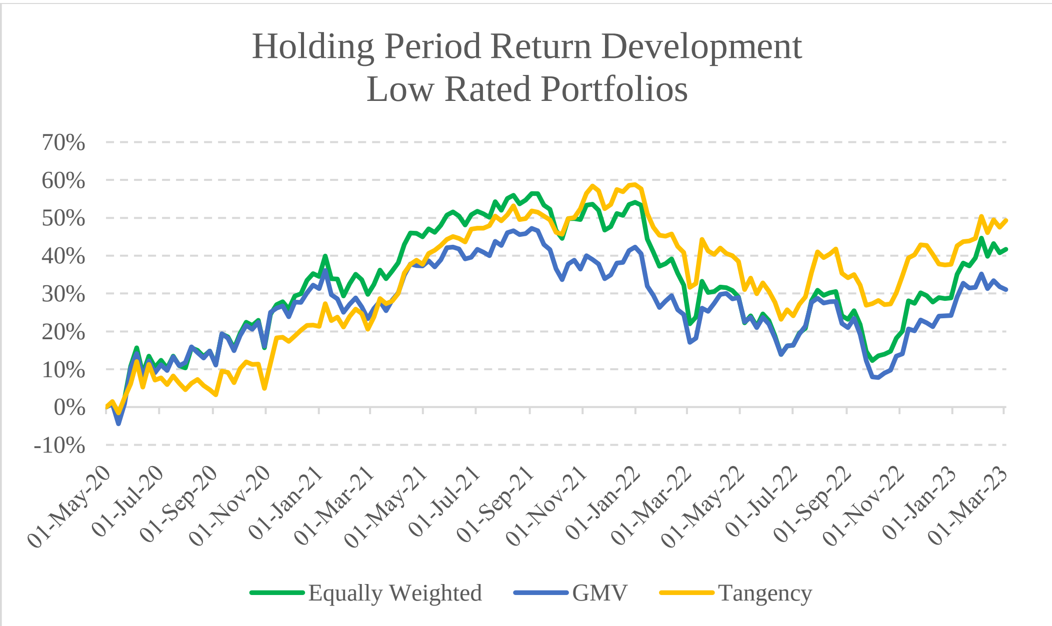

Figure 8

The results for the holding period return of the low ESG risk rated portfolios are plotted above in *Figure 8*. An interesting development is that the Tangency portfolio underperforms relative to the Equally Weighted and GMV portfolios for the first year of the investment period, before taking the lead as the portfolio with the strongest returns in October 2021. This indicates that if the HPR had been shorter than the 3-years considered here, the Tangency portfolio would have performed worse compared to the two other portfolio types. The results further demonstrate that, in line with observations noted in the wider stock markets, the returns in all 3 portfolios decreased heavily at the start of the Ukrainian war in February 2022, with significant volatility in returns noted thereafter.

Closer analysis of the constituents in the low ESG risk rated portfolios shows that the top performing stock was industrial equipment rental company Ashtead Group (AHT) whose stock price grew 171.18% over the holding period and which carried a weight of 8.25% in the Tangency portfolio, 4% in the Equally Weighted and nothing in the GMV portfolio. For the Tangency portfolio, the highest invested stocks were financial services firm Legal & General (LGEN) (13.67% weighting with a 34.68% appreciation), beverage company Diageo (DGE) (12.89% weighting with a 28.33% appreciation), and telecommunications firm Vodafone (VOD) (10.52% weighting with a depreciation of 8.97%). Additionally, as alluded to in the *Portfolio Summary Statistics* section, was the high weighting of 17.56% in Unite Group (UTG) in the GMV portfolio. Although the GMV portfolio was the least diversified of the 9 portfolios, assigning weight to only 14 of the 25 stocks, the UTG stock appeared to have a positive impact on the development of the HPR of the portfolio with a HPR of UTG of 17.23%. The performance of the GMV was further aided by a 10.41% weighting in food service company Compass Group (CPG) which grew 50.75%.

6.5.2 Development Across Portfolio Weighting Strategies

To provide further analysis and comparability to the graphs above, each individual portfolio weighting strategy (Equally Weighted, GMV and Tangency), is plotted together in order to show the contrasts between the ESG risk ratings. Furthermore, the graphs are useful to show how these individual portfolios have performed in comparison with the market portfolio, the *FTSE 350*.

6.5.2.a Graphically Illustrated Equally Weighted Portfolios

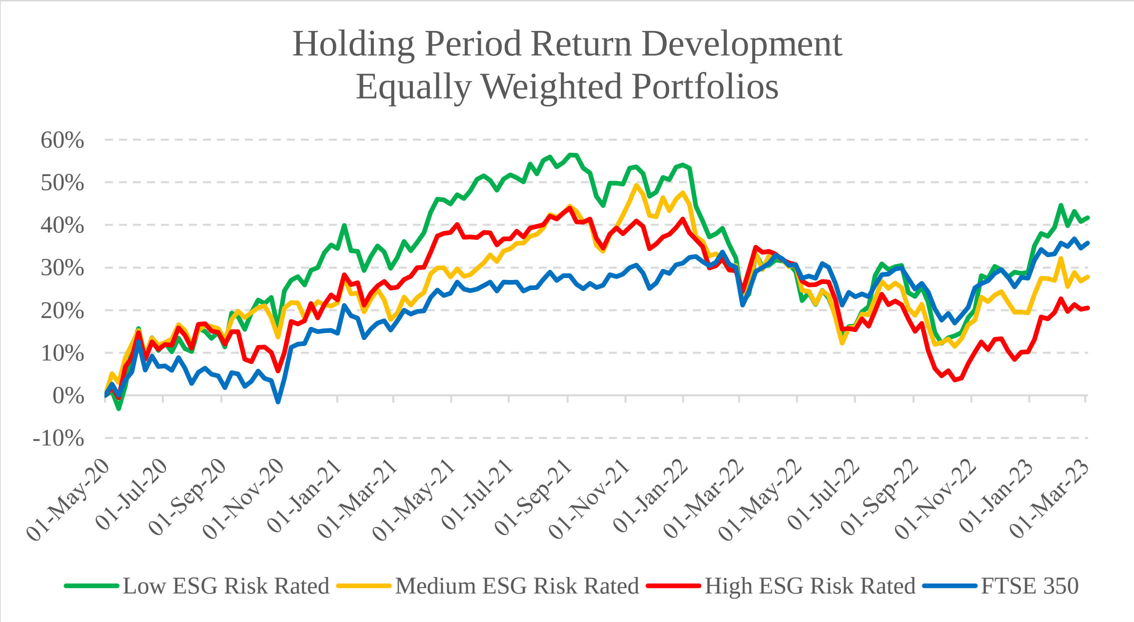

Figure 9

The graph above in *Figure 9* shows the performance of the holding period return for all the Equally Weighted portfolios plotted alongside the holding period return for the *FTSE 350*. The first key observation is that the low ESG risk rated portfolio outperforms its medium and high counterparts as well as the *FTSE 350* market index for much of the investment horizon, and in particular up to February 2022, the start of the Russian invasion of Ukraine. The peak return for the low and high ESG risk rated portfolios both occur in the first week of September 2021 with HPRs of 56.41% and 43.94% respectively, while the medium portfolio peaks in the middle of November 2021 with a

HPR of 49.29%. The *FTSE 350* records its highest HPR in the third week of February 2023, shortly before the end of the investment period, with 36.75%.

The second notable observation is that all the Equally Weighted portfolios outperform the *FTSE 350* up until the Russian invasion of Ukraine in February 2022, at which point all portfolios converge toward comparatively low HPRs of between 21% and 25% in the first week of March 2022. Thereafter, and for the remainder of the investment period, it becomes evident that the *FTSE 350* improves its performance relative to the Equally Weighted portfolios, finishing the investment period with lower returns than the low ESG risk rated portfolio, but higher returns than the medium and high ESG risk rated portfolios.

The improvement in performance of the *FTSE 350* following the market turmoil and economic uncertainty created by the Russian invasion of Ukraine could, in part, be due to the diversification benefit associated with investing in a market index, wherein investors are exposed to less industry and firm specific risks and can minimize losses by holding various stocks, each which may react differently to a given event. As will be explored further in the *Macroeconomic Considerations* section below, not all stocks reacted negatively to the invasion of Ukraine, with energy and arms companies receiving high ESG risk ratings, benefitting from the war and seeing notable appreciations in their stock prices.

Another key takeaway from the results is the notable deterioration in performance of the high ESG risk rated portfolio following February 2022 and in particular in the month of September 2022. This pronounced underperformance, though somewhat cushioned by investments in defense firm British Aerospace (BA/) and energy company SSE, is due to the especially poor performance of a few stocks including food packaging company Hilton Food Group (HFG) (↓42.47% in September 2022) and pharmaceutical company Dechra Pharmaceuticals (DPH) (↓25% in September 2022). While the investments in these stocks for the Equally Weighted portfolio is constrained to only 4% of the total investment, the GMV portfolio and Tangency portfolio graphical representations below will illustrate the risks of being heavily invested in these poorly performing stocks.

6.5.2.b Graphically Illustrated GMV Portfolios

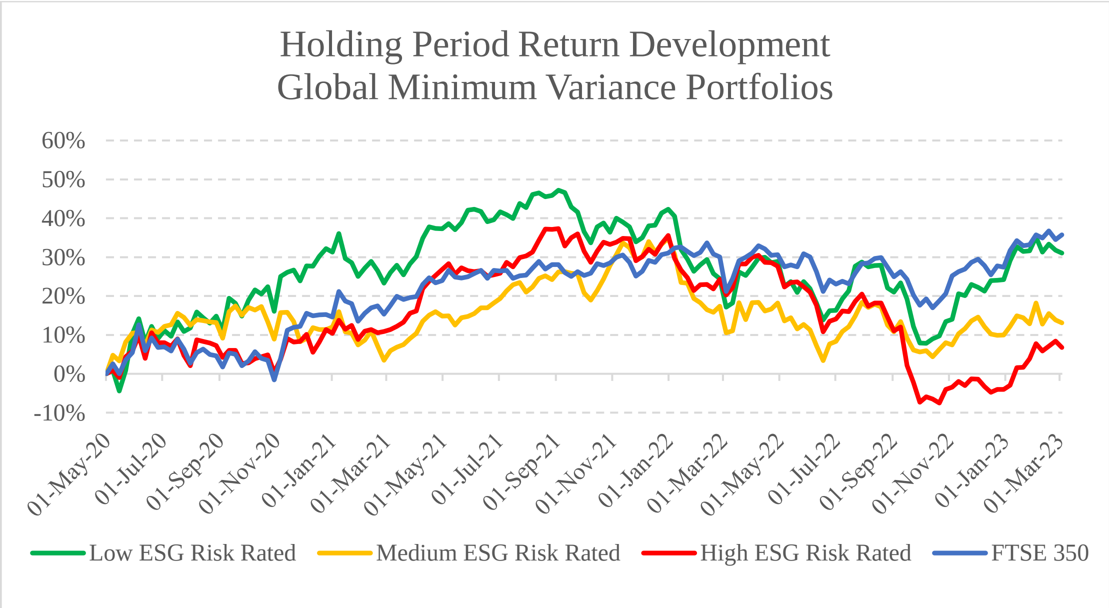

Figure 10

The results above in *Figure 10* show a somewhat similar trend for the GMV portfolios as with the Equally Weighted portfolios in that the low ESG risk rated portfolio performs strongly up until the invasion of Ukraine, whereafter the market index (*FTSE 350*) performs better. As observed across the Equally Weighted portfolios, the low and high ESG risk rated portfolios record their peak returns in the first week of September 2021 with 47.21% and 37.34% respectively, whereas the medium ESG risk rated portfolio peaks in the last week of 2021 with a HPR of 34.84%. To recap, the *FTSE 350* peaks in the third week of February 2023, shortly before the end of the investment period, with a HPR of 36.75%. When compared with the results for the Equally Weighted portfolios, the peak returns are smaller across the ESG risk ratings, which makes sense given that the GMV portfolios are optimized to minimize volatility.

The results also shed light on another key factor which was also noted in the Equally Weighted portfolios - the strong decline in the high ESG risk rated portfolio in September 2022. Deeper analysis shows that this is due to the large weighting of this portfolio (20.68%) in the same stock discussed above, Hilton Food Group (HFG), which fell 42.47% during the month of September 2022. On the topic of diversification, this large drop in a GMV portfolio demonstrates the risks associated with low levels of diversification. Although HFG performed well during the estimation period with a comparatively low weekly volatility of 0.03001, compared with an average volatility of 0.04629 for all high ESG risk rated stocks, this firm proved highly susceptible to the energy crisis with rising energy costs and slowing consumer spending having a negative impact on profits and thereby putting downward pressure on the stock price.

6.5.2.c Graphically Illustrated Tangency Portfolios

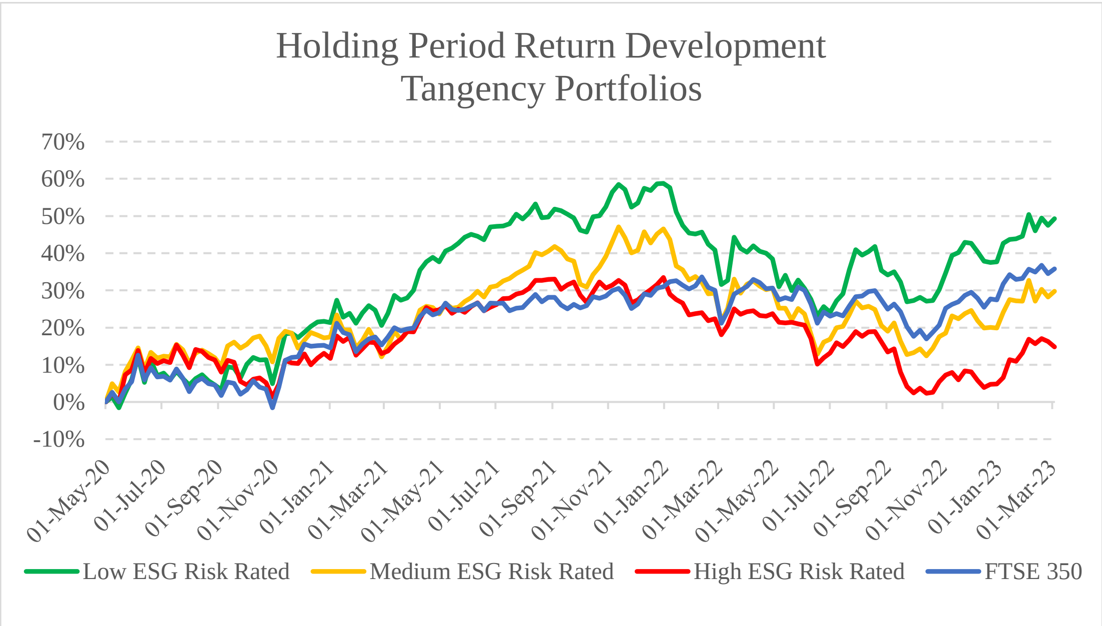

Figure 11

Once more, a comparison of the Tangency portfolios across the ESG risk ratings shows a similar trend (as shown above in *Figure 11*), namely a strong performance by the low ESG risk rated portfolio for most of the investment horizon, as well as an outperformance of the *FTSE 350* against the medium and high ESG risk rated portfolios following February 2022. In contrast to the previous portfolio weighting strategies, the low ESG risk rated portfolio maintains its rank as the strongest performing portfolio from the last week of November 2020 until the end of the entire investment period. Peak returns for the low ESG risk rated portfolio occur in the last week of 2021 with 58.77%, followed by the medium ESG risk rated portfolio with an HPR of 47.09% in the second week of November 2021, and the high ESG risk rated portfolio with 33.47%, also in the last week of 2021.

Once more, the results show a large decrease for the high ESG risk rated portfolio in September 2022, which can again be attributed to a significant weighting in the previously discussed HFG stock of 4.87% (↓42.47% in September 2022) as well as a 7.31% weighting in pharmaceutical company Dechra Pharmaceuticals (DPH) (↓25% in September 2022). These takeaways once again highlight the risks associated with using historic returns to predict the future while also showcasing the benefits of stock diversification and the risks of being heavily invested in a smaller number of stocks.

Overall, comparing the holding period returns for each portfolio weighting strategy shows a strong performance by low ESG risk rated portfolios relative to their medium and high ESG risk rated counterparts. This speaks to the strength in using ESG pre-screening, not only to identify socially responsible investments, but also as a way of comprising portfolios with strong holding period returns. The results for the HPR also demonstrate the strength associated with broad market diversification, particularly in times of crisis, as demonstrated by the performance of the *FTSE 350*, particularly after February 2022.

6.5.3 HPR Volatility

In addition to the analysis surrounding the holding period returns above, it is also of interest to consider the volatilities of the weekly realized returns for each portfolio weighting strategy across the ESG risk rating buckets. This is calculated, as above, by taking the standard deviation of the weighted weekly returns using the STDEV.S() function in Excel.

Table 16

Holding Period Volatility			
Portfolio	**Equally Weighted**	**GMV**	**Tangency**
Low	0.028090	0.027090	0.025223
Medium	0.024713	0.023846	0.024586
High	0.023626	0.024236	0.022003

The results are interesting and show a clear trend in that the low ESG risk rated portfolios are associated with marginally higher levels of volatility across each portfolio weighting strategy – suggesting that these portfolios are riskier for investors to hold. However, this also needs to be taken together with the superior holding period returns for the low ESG risk rated portfolios noted above. While more volatile, the low ESG risk rated portfolio still provided by far the best HPRs for a potential investor, both measured by the peak return and by the ending holding period return – which the authors of this paper consider to be the key measure of success in the eyes of a passive, everyday impact investor.

Another interesting observation to note is that the GMV portfolios, in contrast to the way they were optimized, were only able to provide the lowest volatilities in the medium ESG risk rated bucket, whereas the Tangency portfolios yielded the lowest volatilities for the low and high ESG risk rated buckets. In fact, in the high ESG risk rated bucket, the GMV yielded the highest volatility of the three weighting strategies. This speaks to the risks associated with using historical returns data to predict future performance, especially in periods with significant market turmoil, such as the period measured in this study.

Lastly, these figures can also be compared with the volatility in weekly returns of 0.021149 for the *FTSE 350*, showing that the market index had a marginally lower volatility than all of the 9 portfolios. These results make sense, given that the *FTSE 350* is broadly diversified across 350 stocks, thereby yielding a higher diversification benefit. This speaks to the benefits of maintaining a well-diversified portfolio as a way of minimizing risk.

However, volatilities are not enough to fully appraise the performance of these portfolios on their own. Next, this paper will turn to how the volatility values feed into the Value-at-Risk and Expected Shortfalls for each portfolio, before rounding off the analysis with a look at the Sharpe Ratios for each portfolio, based on their realized weekly weighted returns.

6.5.4 HPR Value-at-Risk (VaR) and Expected Shortfall (ES)

As highlighted in the analysis above, a surprising result over the investment period was that the low ESG risk rated portfolios were marked by higher levels of volatility, as measured by the standard deviation of their weekly returns. This, in turn, also implies that the low ESG risk rated portfolios were also associated with higher levels of VaR, the results of which are summarized below. Note that VaR was calculated here using the same *equation 13* as detailed above in the *Calculation of VaR and ES* section.

Table 16

Holding Period Value-at-Risk			
Portfolio	**Equally Weighted**	**GMV**	**Tangency**
Low	0.046204	0.044559	0.041487
Medium	0.040651	0.039223	0.040441
High	0.038861	0.039865	0.036191

The results show that, at a 95% confidence level, the low ESG risk rated portfolios are associated with a higher VaR across all portfolio weighting strategies. For the most part, the high ESG risk rated portfolios are actually associated with better tail-risk protection, with the exception of the GMV portfolio where the medium ESG risk rated portfolio performs best. Furthermore, the results also show no clear pattern between portfolio weighting strategies within the ESG risk rating buckets.

In addition to the above, it was useful to analyze the ES of each portfolio, defined above as the average loss in the tail of the distribution in the 5% worst-case scenario. ES was once again calculated as above in the *Calculation of VaR and ES* section using *equation 14*.

Table 17

Holding Period Expected Shortfall			
Portfolio	**Equally Weighted**	**GMV**	**Tangency**
Low	0.057941	0.055879	0.052027
Medium	0.050977	0.049188	0.050714
High	0.048733	0.049992	0.045386

Similar with the VaR results, the results for the ES show that the low ESG risk rated portfolios are associated with higher levels of ES, suggesting that on a weekly returns basis, investors who have invested in the low ESG risk rated portfolio are exposed to a higher expected loss if they find themselves in the 5% worst case-scenario.

As follows from the results for the portfolio volatilities, the *FTSE 350* has a lower VaR and ES than all of the 9 portfolios at 0.034788 and 0.043625 respectively – again speaking to the benefits of remaining broadly diversified as a way of reducing portfolio risk.

These results are interesting and stand in contrast to the results for VaR and ES during the estimation period from 2015-2020. However, the authors of this paper also note that the investment period took place during a time of significant market volatility with numerous adverse events, as will be discussed in the *Macroeconomic Considerations* section below, having a strong impact on global stock markets. Furthermore, it must also be noted that although exhibiting higher expected losses in the worst-case scenario, the holding period return graphs show a clear outperformance of the low ESG rated portfolios over the investment period. To delve deeper into these results, the authors of this paper outline next the risk-adjusted returns of each portfolio through the calculation of the portfolios Sharpe ratios so as to investigate whether the higher levels of volatility are off-set by the superior realized returns.

6.5.5 HPR Sharpe Ratio

To better understand the surprising development of the realized volatility experienced in the portfolios during the holding period from 2020 to 2023, the authors of this paper computed the realized, risk adjusted returns (Sharpe ratios) for each of the 9 portfolios. The Sharpe ratios were calculated in the same way as described in the *Portfolio Creation* section above using *equation 10*. First, the weighted weekly prices for each of the portfolios, as calculated in the *Holding Period Returns* section, were used to calculate the weekly weighted returns using *equation 1*. Then, the average of the weekly weighted returns could be calculated for each of the 9 portfolios using the AVERAGE() function in Excel. The volatility (standard deviation) of each of the 9 portfolios weighted weekly returns was additionally required in the calculation of the realized portfolio Sharpe ratios, and was calculated, as above, using the Excel function STDEV.S(). Using the same risk-free rate as introduced in the *Calculation of Critical Variables* section, 0.00001365, the weekly yield on a 3-year UK Government Bond (Gilt) as of the first week of May 2020, each weekly weighted portfolio Sharpe ratio could then be calculated using *equation 10*. Each portfolio's realized Sharpe ratio for the holding period from May 2020 to March 2023 is included in *Table 18* below.

Table 18

Holding Period Sharpe Ratios			
Portfolio	**Equally Weighted**	**GMV**	**Tangency**
Low	0.097265	0.080405	0.119475
Medium	0.078757	0.046205	0.083311
High	0.064432	0.029763	0.052616

The first takeaway from the results is the strong outperformance of all low ESG risk rated portfolios relative to their medium and high ESG risk rated counterparts. The results show that the low ESG risk rated portfolios consistently achieve the highest Sharpe ratios across all weighting strategies, thereby delivering the strongest risk-adjusted returns. In addition, the results also show a clear pattern across the ESG risk rated buckets, with the high ESG risk rated portfolios consistently delivering the lowest Sharpe ratios, and the medium ESG risk rated portfolios consistently performing in between the low and high ESG risk rated buckets.

The second key observation for the Sharpe ratio results has to do with the values within the respective ESG risk rating buckets and across portfolio weighting strategies. For the low and medium ESG risk rated buckets, the results show that the Tangency portfolios, which are optimized to maximize the Sharpe ratio, delivered the highest Sharpe ratios of the three possible weighting strategies. Furthermore, the GMV portfolios, which are optimized to minimize volatility, delivered the lowest Sharpe ratios. An interesting observation is that for the high ESG risk rated bucket, the Tangency portfolio performs worse than the Equally Weighted, whereas the GMV portfolio delivers the worst Sharpe Ratio of all 9 portfolios. As discussed in the *Holding Period Returns* section, these results are the result of the poor performance of a small number of stocks carrying considerable weight. Once again, this speaks to the risks associated with using historic returns to predict the future, especially in times of market crisis where adverse events can have uneven impacts on different firms.

Further insight can also be drawn from comparing the risk adjusted performances of the 9 portfolios relative to the *FTSE 350* market index. In fact, the *FTSE 350* “beats” the majority of the portfolios with a weekly Sharpe Ratio of 0.108960. Only the low ESG risk rated Tangency portfolio, which is optimized to maximize the Sharpe ratio, “beat” the *FTSE 350*. This again speaks to the benefits of remaining broadly diversified across industries in order to reduce volatility and increase risk adjusted returns. It also, however, shows that an optimized portfolio consisting of low ESG risk rated stocks, despite being less diversified, is able to “beat” the market on both a realized and risk-adjusted return basis.

Overall, these results are interesting and align with previous literature on the topic, as will be explored further in the *Discussion* section. Although the low ESG risk rated portfolios exhibited higher levels of volatility during the investment period, the high Sharpe ratio demonstrated that on a risk-adjusted basis, the returns for the low ESG risk rated portfolios outperformed that of the medium and high ESG risk rated portfolios. This suggests that ESG pre-screening may play a considerable role in optimizing a portfolio to generate stronger returns, in addition to financial risk screening.

As the final piece of the results for this paper, the authors find it prudent to comment on the irregular market backdrop under which the performance of the portfolios were measured. The investment period from May 2020 to March 2023 coincided with numerous macroeconomic events and crises which have impacted global economies and influenced global stock prices. Many of these macroeconomic events are evident in the results of this paper and can be seen in the HPR development graphs. The next section will provide an overview of these key events, as well as the impact they have had on this paper’s results and what discussion points can be drawn from these impacts.

6.6 Macroeconomic Considerations

The primary focus of this paper is to ascertain how portfolio optimizations based on ESG risk ratings perform over a three-year investment horizon - and thereby discussing the potential financial implications for impact investors. Nonetheless, it is a fact that the investment period chosen, which runs from May 2020 to March 2023, coincides with numerous macroeconomic events that have had strong impacts on global stock markets – namely the market turmoil caused by the global COVID-19 pandemic at the start of the investment period, as well as the global energy crisis triggered by the Russian invasion of Ukraine from February 2022 onward.

The start of the investment period, May 2020, occurs a few months after the start of the COVID-19 pandemic. Although this period avoids the initial collapse in global stock prices in February and March of 2020, it does coincide with the volatility which was caused by the pandemic for the following two years. Although the initial shock of the crisis saw global equity values tumble, the strong fiscal stimulus programs introduced by governments across the world, including the United Kingdom, helped markets to rebound strongly as economies recovered (Carlsson-Szlezak et al., 2020). Within the results, this is demonstrated by the strong returns noted across all portfolios a year after the initial investment (May 2021) – including returns in excess of 25% for high ESG risk rated portfolios and as high as 47% in the Equally Weighted low ESG risk rated portfolios. These returns are based on the good timing decision of investing in May 2020, when global stock prices were still suffering from the initial shock of the pandemic, and the strong recovery in global stock prices in the years thereafter.

The most impactful event on equity markets in the period following the COVID-19 pandemic has been the Russian invasion of Ukraine in February 2022. The result of the invasion was a strong increase in energy and food prices which fed into inflation and harmed economic growth (Liadze et al., 2023). The initial impact of the invasion saw a drop in equities in February and March 2022 as investors digested the economic fallout of the war. This sharp downward trend in February and early-March of 2022 is evidenced across all three ESG risk rated buckets and across all portfolios, as seen in *Figures 9, 10 and 11*.

An interesting fact to note, however, is that the return declines were less pronounced in the high ESG risk rated portfolios in February 2022 specifically. This can be explained by the prevalence of stocks from industries which went against the wider market decline and increased in value as a result of the war, including arms manufacturer British Aerospace (BA/) (↑20.78% between 04/02/22 → 04/03/22), mining company Centamin (CEY) (↑12.84% between 04/02/22 → 04/03/22) and energy company SSE (↑2.34% between 04/02/22 → 04/03/22), all of which constitute significant weightings across all high ESG risk rated portfolio weighting strategies. The months following this and up to the end of the holding period in March of 2023, however, saw the high ESG risk rated portfolio's performance no longer cushioned by the outperformance of these stocks.

After the initial shock, the primary driver in markets has been the worsening inflation and the uncertainty around how central banks will respond to this. Increases in interest rates starting in January 2022 to date have had strong impacts on equity markets, with rising rates making returns on stocks look less appealing compared to yields on bonds. In the UK, where the *FTSE 350* constituents are traded, the interest rate increased from 0.25% at the start of 2022 to 4.25% as of April 2023 as per data pulled from the *Bloomberg* terminals. The uncertainty around inflation and interest rate expectations caused volatility in markets, which is evidenced across all ESG risk rating buckets, with the portfolios in the holding period yielding higher levels of volatility of between 2.20% and 2.81% compared with the estimation period where volatilities ranged from 1.50% to a peak of 2.27%.

7 Discussion

The authors of this paper will now discuss how the findings outlined in the previous section, *Results and Analysis*, add to the current body of literature aimed at understanding the financial returns an investor can expect to achieve through establishing sustainably driven portfolios. Interestingly, the findings of this paper not only align with previous research in this area, but also extend upon it to establish new insights. The findings of this paper will be discussed in parallel to the authors initial expectations based on the literature presented in the *Literature Review* and summarized in the *Takeaways from the Literature and Expectations of the Authors* section.

7.1 Use of CAPM

While previous studies by the likes of Eccles et al. (2016), Lesser et al. (2016), Nofsinger & Varma (2014), Ruf et al. (2019), Steen et al. (2020) and Xiong (2021) considered multi-factor models in the calculation of their critical variables, the authors of this paper extended on this research by considering a single-factor CAPM. Previous literature looked at broad, sometimes global funds and stocks, thus, including multiple additional explanatory variables (independent variables) was intuitive to understanding the movements in the underlying funds/stocks (dependent variables). Examples of this include Steen et al. (2020)'s consideration of all mutual funds domiciled in Norway (as well as the addition of Europe later in their study), Xiong (2021)'s consideration of all stocks trading within the US and which received a ESG risk rating, Eccles et al. (2016)'s consideration of global stocks representing 85% of the world's investable equities, Nofsinger & Varma (2014) and Ruf et al. (2019)'s consideration of US mutual funds, and finally Lesser et al. (2016)'s consideration of internationally diversified mutual funds. What all of these studies have in common is their desire to investigate a broad set of stocks or funds transcending markets and geographical boundaries. As such, it would have been unrealistic in any of these studies to use a single-factor CAPM due to the varied nature, often globally, of the funds and stocks included within the studies.

In contrast to the above studies, the authors of this paper chose to focus on a subset of the largest most publicly traded stocks on the *London Stock Exchange*, namely the *FTSE 350*. Movements in the "market," considered in this study as the *FTSE 350*, are a culmination of all the movements of the stocks within it. As the 75 stocks included in this study are included in said index, movements in the *FTSE 350* are more closely relevant in explaining movements in the underlying stocks chosen here, as evidenced by the positive and highly significant betas of all 75 stocks. As such, the authors choice to limit the scope of the paper to the largest publicly traded companies on the *London Stock Exchange*, made the single-factor index model a sufficient choice for the purpose of this investigation and added to the current literature on the topic by considering a different market scope (United Kingdom's *London Stock Exchange*) and factor-model.

7.2 Comparison of Returns and Sharpe Ratio

The findings of this paper additionally add to the previously outlined findings by the likes of Eccles et al. (2016), Pacelli et al. (2023), Steen et al. (2020) and Xiong (2021) in understanding the returns and Sharpe ratios of sustainably driven portfolios compared to non-sustainably driven portfolios. While the authors of this paper found that low ESG risk rated portfolios achieved superior realized and risk-adjusted returns across the three portfolio weighting types (Equally Weighted, GMV and Tangency), the expected returns of said portfolios over the estimation period were not the highest. Expected returns did not provide many insights for comparison as they varied as to which portfolio (low, medium or high ESG risk rated) was expected to preform superior. In addition, it was interesting to observe that the low ESG risk rated portfolio achieved superior Sharpe ratios across portfolio weighting strategies in both the portfolios creation and holding period when compared to their high ESG risk rated counterparts. Interestingly, the medium ESG risk rated portfolio achieved the highest Sharpe ratio across portfolio weighting strategies during the estimation period, yet during the holding period, the Sharpe ratio was found to fall in the middle of the high and low ESG risk rated portfolios across portfolio weighting strategies.

The findings of this paper are first found to align with the findings of Eccles et al. (2016), who found that both the realized returns of the ESG screened portfolios and the risk adjusted returns (Sharpe ratios) outperformed their unscreened counterparts. It is additionally interesting in that Eccles et al. (2016) was also able to conclude that these returns more than offset the reduced diversification of the ESG screened portfolios as the ESG screened portfolios were less diversified compared to their unscreened counterparts. This is intuitive in that Eccles et al. (2016) started with a baseline universe of stocks (the unscreened universe) and then reduced the sample size of the universe by applying ESG screening criteria. Interestingly, these results align with the results of this paper in that the GMV and Tangency portfolio of the low ESG risk rated portfolio were the least diversified portfolios, compared to their medium and high ESG risk rated counterparts, yet achieved the highest realized returns (HPR) and highest risk adjusted returns (Sharpe ratios) during the holding period. Thus, the authors of this paper can make similar conclusions to those of Eccles et al. (2016), namely that reduced diversification of more sustainable portfolios was not found to hinder the performance of the portfolios (in realized returns nor risk-adjusted returns) and that the returns of such, less diversified yet more sustainable portfolios are found superior to their non-sustainable counterparts.

In addition to the findings of Eccles et al. (2016), Xiong (2021) also found that sustainably driven funds outperformed other non-sustainable funds in achieving higher realized returns and higher Sharpe ratios. When isolating for the energy sector, Xiong (2021) additionally found that this sector was responsible for much of the non-sustainable portfolio’s underperformance. Upon removing the energy sector however, the non-sustainable portfolio’s realized returns increased such that the difference in the portfolios' realized returns became less pronounced, yet the sustainable portfolio still performed superior in terms of realized returns and Sharpe ratios.

The effect of energy companies on the realized returns of the high ESG risk rated portfolios, as investigated by the authors of this paper, were also found to have a profound impact on the realized returns of the high ESG risk rated portfolios. Assigning comparatively little weight to high performing energy sector stocks such as DRX and GLEN in the GMV and Tangency portfolio caused both portfolios to underperform compared to their Equally Weighted counterpart, which was comparatively more invested in each stock. This parallel with the findings of Xiong (2021) is interesting as the authors of this paper found that lack of investment in energy companies led to the high ESG risk rated portfolios' underperformance in contrast to the findings of Xiong (2021) in which the opposite was found. These opposite findings are likely driven by the market timing of the two studies, namely Xiong (2021) using data from 2009 to 2019, well before the global energy crisis as triggered by Russia's invasion of Ukraine.

Additionally, the underperformance of energy-based companies during the time period studied by Xiong (2021), coincides with the time period used by the authors of this paper (2015-2020) to optimize the GMV and Tangency portfolios. Using this time period explains why the portfolio optimization of the GMV and Tangency portfolios assigned comparatively little weight to the energy-based stocks, as Xiong (2021)'s findings indicate, they did not perform well during this period. As the global energy crisis came as a surprise well into the holding period of the impact investor considered in this paper (2020-2023), the Equally Weighted portfolio performed best as it was most invested in the now overperforming stocks. Overall, these findings exhibit the limitations of using historical data to predict future returns as past performance is not necessarily a good indication of how a given stock will perform in the future. More on the effect these macroeconomic events had on the high ESG risk rated portfolios and the literature on the topic will be discussed in the proceeding sections, *Comparison of Volatility, VaR and ES* as well as the section *Comparison of Macroeconomic Considerations*.

Pacelli et al. (2023) also sought to investigate if ESG scores could be used as an additional criterion in the portfolio creation process. To do so, the paper minimized CVaR for portfolios of 30 stocks each across various industries. While it was determined that each of the minimum CVaR portfolios achieved positive returns, the authors had only established portfolios across industries of stocks with a *Refinitiv* ESG score, irrespective of what that score was, thus, each portfolio was a mixture of both sustainable and non-sustainable stocks. While each of the portfolios were found to have positive average returns, the stocks with the most weight in each portfolio were not necessarily rated sustainable by *Refinitiv*.

The findings of Pacelli et al. (2023) are interesting in that by establishing portfolios of stocks by industry, optimizing said portfolios does indicate to some extent which stocks within that industry can contribute most to the establishment of a minimum CVaR portfolio in direct comparison of one another. Where the findings of Pacelli et al. (2023) fall short however, is in their establishment of portfolios strictly by industry. It is unrealistic for an intelligent investor to invest exclusively in companies concentrated in one industry. It is also unrealistic for an investor interested in investing sustainably and for impact to not consider the ESG risk rating of companies across industries before including them in their portfolio. As such, the authors of this paper's approach to the establishment of diversified portfolios across industries, concentrated in one ESG risk rating category, was a direct attempt to extend on the findings of Pacelli et al. (2023) and delve deeper to better understand how portfolios composed exclusively of one ESG risk rating compare. In this way, the authors of this paper have directly considered the diversification tendencies of investors as well as an understanding into how impactful, sustainably driven investor portfolios compare to their non-sustainable counterparts. In line with Pacelli et al. (2023)'s findings, all portfolios established by the authors of this paper in their investigation here achieved positive realized returns and extended upon said findings to include the superior positive returns achieved by low ESG risk rated portfolios compared to their non-sustainable counterparts.

In tying together the above findings by the authors of this paper and the other papers referenced thus far, a number of locational tendencies exist. While Xiong (2021) only considered US stocks, Eccles et al. (2016) noted the high concentration of European and North American stocks within their ESG screened portfolios. Additionally, Pacelli et al. (2023) only considered stocks with headquarters in a European country. This tendency to remain concentrated within the Western world was additionally investigated by Steen et al. (2020), however, with a much narrower focus in the Norwegian market. In investigating 146 mutual funds in Norway, no abnormal risk-adjusted returns were observed. While these funds were domiciled in Norway, they were not restricted to operating exclusively in the Norwegian market. The findings were such that neither returns, standard deviations, nor Sharpe ratios differed significantly between sustainable and non-sustainable portfolios as well as the Oslo Stock Exchange Fund Index (OSEFX) (Steen et al., 2020). While these findings were interesting for the Norwegian market, when Steen et al. (2020) redid the analysis to account for geographical bias, namely by changing the focus from Norwegian to European funds, the more sustainable portfolios outperformed their non-sustainable counterparts.

Overall, these locational considerations were extended upon by the authors of this paper in so much as the focus remains within the Western world, yet with a different market focus, namely the largest stocks traded on the *London Stock Exchange*. In this way, the authors of this paper have added to the current body of literature to consider both the returns and risk adjusted returns (calculated here via Sharpe ratios) of a geographical sub-area of the broader Western world. This consideration further takes into account governmental ESG reporting regulation which remains varied by country, and which is cited by Doyle (2018) as a key limitation of Sustainable risk rating agencies today, namely their bias in rating companies more favourably if they disclose more in their ESG reports than companies that do not disclose as much.

These findings provide interesting insights for a passive, everyday impact investor with a number of takeaways as to the positive implications of considering ESG risk ratings to support their investment decisions. The results reenforce and extend previous research in the area that pre-screening for ESG criteria in the development of portfolios following a buy-and-hold portfolio strategy have a positive association with higher realized returns and risk adjusted returns than their non-sustainable counterparts.

7.3 Comparison of Volatility, VaR and ES

The findings of this paper also add to the body of knowledge surrounding ESG risk ratings and their correlation with tail-risk protection for investors. The results for the historic weekly returns measured over the estimation period show that the low ESG risk rated portfolios performed better than their medium and high ESG risk rated peers in providing tail-risk protection, as measured by the lower Value-at-Risk (VaR) and Expected Shortfall (ES) values across all portfolio weighting strategies. These results align with the findings of James Xiong, who noted a significant outperformance of stocks with lower ESG risk ratings relative to stocks with higher ESG risk ratings in providing tail-risk protection as measured by ES (Xiong, 2021). Furthermore, the results of this paper also align with the findings of Eccles et al. (2016), who noted that ESG screening was associated with lower volatility and expected shortfall in addition to the higher risk-adjusted returns as discussed in the preceding section (Eccles et al., 2016).

A possible explanation for the findings above is that ESG risk ratings by *Sustainalytics* are based on the exposure of a firm to material and industry-specific ESG risks, as well as the firm's management of those risks (Sustainalytics, 2021). Thus, firms with lower ESG risk ratings may have strong risk management practices in place, which would help to minimize the volatility and tail-risk associated with their stock.

In addition, there may also be sub-industry specific considerations that can have an impact on the risk measures of the portfolios, in particular when comparing the constituents of the low ESG risk rated portfolios with the constituents of the high ESG risk rated portfolios. As discussed in the *Portfolio Creation* section, the constituents of the high ESG risk rated portfolios are less diversified across *Sustainalytics* sub-industry classifications, while also being more concentrated in the oil and gas sector. The implications of this are that the lack of diversification benefit across sub-industries may lead to poorer results for volatility, VaR and ES.

When considering the investment horizon (2020-2023), however, the results showed that the low ESG risk rated portfolios were associated with higher levels of volatility, VaR and ES, thereby providing worse tail-risk protection to investors. The authors of this paper note that the investment period took place during a period of significant market turmoil and global geo-political events, which had strong impacts on the performance of stocks and can account for a portion of the volatility. Nonetheless, despite being associated with higher levels of VaR and ES, the low ESG risk rated portfolios provided strong holding period returns for investors throughout the entire investment period leading to superior risk adjusted returns (Sharpe ratios) when compared to their medium and high ESG risk rated counterparts.

The findings have numerous implications for impact investors and their use of ESG risk ratings to support their investment decisions. Most notably, the results reinforce the idea that under less volatile market conditions (such as was evident during the estimation period from 2015 to 2020), pre-screening based on ESG risk ratings can have positive impacts on reducing the risk associated with portfolios, as measured by volatility, VaR and ES. Additionally, during times of market turmoil, pre-screening based on ESG risk ratings can provide investors with superior risk adjusted returns. For an impact investor, this suggests that using ESG risk ratings can not only support the investor as a method of positive screening for socially responsible investments, but also provide financial benefits for the investors in providing an additional layer of risk screening.

7.4 Comparison of Macroeconomic Considerations

Given that the investment period of this paper from May 2020 to March 2023 coincided with two big macroeconomic events, the COVID-19 pandemic and the Russian invasion of Ukraine, the results also shed light on the performance of ESG risk rating-derived portfolios through times of crisis and market turmoil. The results for the holding period return development, calculated as the percentage change in the weighted price from the first day of the investment, showed that both the Equally Weighted and Tangency low ESG risk rated portfolios outperformed the *FTSE 350* by the end of the investment period (41.65% and 49.32% vs 35.75%). In fact, of the low ESG risk rated portfolios, it was only the GMV portfolio which yielded HPRs less than the *FTSE 350* (31.06% vs 35.75%), which is not surprising given that the portfolio is optimized to minimize volatility rather than to maximize risk-adjusted returns. Additionally, the results also showed that the low ESG risk rated portfolios outperformed both the high and medium ESG risk rated portfolios across all portfolio weighting strategies (Equally Weighted, GMV and Tangency) during the holding period, suggesting that ESG portfolio screening is a useful method for impact investors during times of crises.

The observation that the low ESG risk rated portfolios performed better than their medium and high ESG risk rated counterparts during this market crisis is in line with observations by other researchers in this area, including Nofsinger & Varma (2014) and Ruf et al. (2019), both of whom found that socially responsible mutual funds outperformed conventional mutual funds during market crises, most notably during the 2008 financial crisis. The results of this paper also challenge the findings of Lesser et al. (2016), who suggested that the superior performance of socially responsible funds during times of crises are only observed in US domiciled funds – as well as their conclusion that this is down to the superior stock picking ability of US fund managers.

In addition to the outperformance of the low ESG risk rated portfolios in comparison to the medium and high ESG risk rated portfolios, the results of this paper also provide insights into the benefits of diversification during times of market crises. As noted in the results, the 9 portfolios evaluated in this paper have varying levels of diversification, with the Equally Weighted portfolios being the most diversified with 25 stocks. Furthermore, the results have also highlighted the risks associated with being heavily concentrated into a small number of stocks, such as the large fall in the high ESG risk rated GMV portfolio in September 2022 due to a 20.69% weighting in the Hilton Food Group (HFG) stock that fell 42.47% in that month. The overall trend of the HPR development shows the benefit of being heavily diversified by investing in the *FTSE 350* market index during this time of crisis, with the HPR for this market index outperforming the medium and high ESG risk rated portfolios particularly after the Russian invasion of Ukraine in February 2022.

In addition, an analysis of the volatility showed that the weekly returns for the *FTSE 350* had lower volatility, VaR and ES than all of the 9 portfolios, demonstrating the benefits of being broadly diversified. These results are in line with a recent study by Attig & Sy (2023) who investigated the benefits of diversification in reducing volatility during times of market crises when investing within developed markets. With a study using data spanning from 1995 to 2021, and thereby covering numerous economic crises, Attig & Sy (2023) found that the benefits of industry diversification tended to increase during crises, recession, bear markets and times of higher market fear. With the weekly returns of the *FTSE 350* achieving a lower volatility than all of the 9 portfolios, as well as an outperformance in returns across all medium and high ESG risk rated portfolios, the results of this paper demonstrate that market indexes and their accompanying broad diversification can indeed provide investors with benefits during times of market turmoil due to their increased diversification.

This paper adds to the body of knowledge that already exists in this area by providing specific insights into stocks listed on the *London Stock Exchange*, as well as by combining Modern Portfolio Theory and single-factor CAPM to pick individual ESG risk rated stocks in contrast to much of the existing literature which focuses on the performance of ESG risk rated funds. The paper confirms the findings of earlier studies, in that portfolios comprised of low ESG risk rated stocks can provide benefits to investors during times of crisis by providing higher realized and risk adjusted returns. In addition, the results also shed light on the benefits of diversification in showing that market indexes, in this case the *FTSE 350*, can help to reduce volatility in weekly returns and even outperform medium and high ESG risk rated optimized portfolios by providing higher realized holding period returns during times of crises, in this case given by the COVID-19 pandemic and the Russian invasion of Ukraine. More interestingly however, is the findings in line with previous research by Eccles et al. (2016) that the reduced diversification of the low ESG risk rated portfolio did not inhibit the portfolios' returns, with the Equally Weighted and Tangency portfolios outperforming the *FTSE 350* in terms of realized returns.

For everyday, passive impact investors, the implications of the results are that ESG pre-screening can be beneficial during times of market turmoil and economic crises, with low ESG risk rated portfolios providing higher realized and risk adjusted returns. Thus, passive everyday impact investors can use ESG risk ratings not only as a filter for socially responsible investments, but also as a criterion to boost returns during times of crises. Whereas previous studies, such as by Lesser et al. (2016), Nofsinger & Varma (2014) and Ruf et al. (2019) have focused on portfolio performance during past periods of economic turmoil, this paper has shown that low ESG risk rated portfolios have also outperformed during the economic turmoil caused by the Russian invasion of Ukraine.

8 Reflections on the Authors Expectations

Overall, the findings of this paper yielded interesting results in line with previous literature on the topic, and as such likewise aligned with the expectations of the authors of this paper.

The first expectation of the authors of this paper was that ESG driven portfolios would achieve superior returns compared to their non-ESG driven counterparts, extending on the findings of Eccles et al. (2016), Steen et al. (2020) and Xiong (2021). These expectations extended upon the understanding that the holding period returns from 2020 to 2023 were characterized as a time of great market uncertainty, likewise, adding to the authors expectation that the more sustainable portfolio would achieve greater returns in line with the findings of Nofsinger & Varma (2014) and Ruf et al. (2019) and extending upon the findings of Lesser et al. (2016) to include the United Kingdom. Overall, these expectations were met as evidenced by the higher realized and risk adjusted returns of the low ESG risk rated portfolio.

The second expectation of the authors was that the sustainable portfolios would achieve lower measures of risk, namely lower volatility, VaR and ES in line with the findings of Eccles et al. (2016) and Xiong (2021). Overall, these expectations were also met during the portfolio creation process with the low ESG risk rated portfolios achieving the lowest volatility and tail-risk; however, the opposite was found during the holding period. As such, these expectations were broadly met and only partially align with the literature.

In investigating these expectations, the authors of this paper used an alternative approach to that done by previous authors, namely the use of a single-factor CAPM model as well as two optimization methods (Global Minimum Variance and Optimal Tangency) to investigate the varying returns and risk measures of portfolios assigned equal weighting to each stock, and those optimized for the lowest volatility and the highest risk-reward trade off. To further extend on previous research, the authors investigated portfolios on both ends of the sustainability spectrum, as well as one in the middle, labelling each low, medium and high for their respective ESG risk rating. In establishing portfolios of stocks receiving the same ESG risk rating, the authors of this paper furthered the investigation by Pacelli et al. (2023), while also establishing portfolios diversified across industries, in line with Attig & Sy (2023) in citing the need for portfolio diversification across industries to reduce risk.

The findings of this study are positive in that both the realized and risk adjusted returns during the holding period from 2020 to 2023 were highest in the low ESG risk rated portfolios. Additionally, the expected VaR and ES were found to be the lowest for the same low ESG risk rated portfolios compared to their medium and high ESG risk rated counterparts. Interestingly, while the low ESG risk rated portfolios had the lowest expected risk when the portfolios were created in May 2020, they had higher realized volatility and tail-risk during the 3-year holding period. Despite the higher realized volatility and tail-risk however, the low ESG risk rated portfolio provided superior realized risk adjusted return, as measured by Sharpe ratio, implying that the increased volatility was more than offset by the higher returns. In addition to the above surprising takeaways, the unique macroeconomic events occurring from 2020 to 2023 were also unprecedented and caused unexpected increases in the stock prices of various oil and gas companies leading to the Equally Weighted high ESG risk rated portfolio outperforming its GMV and Tangency counterparts. Together, the unexpected development of these stocks and the volatility of the low ESG risk rated portfolio illustrates the limitations of using historical data to forecast future returns.

9 Conclusion

This paper has used the single-factor CAPM to investigate the performance of portfolios constructed of stocks based on ESG risk ratings. In total, 9 portfolios were analyzed and split between three ESG risk rating buckets, low, medium, and high (wherein the low ESG risk rated portfolios are considered the most sustainable), and across three different portfolio weighting strategies: Equally Weighted, Global Minimum Variance, and Optimal Tangency. The aim of this paper was to investigate how sustainably driven portfolios performed compared to their non-sustainable counterparts both in delivering realized holding period returns and in reducing risk, as well as discussing the implications of these results for investors.

To address the research question, the authors comprised three portfolios of 25 stocks each based on ESG risk ratings for individual stocks as well as sub-industry classification diversification. Weekly returns data over a period of 5 years, from January 2015 to December 2019, were then used to optimize the weights of each portfolio to create a volatility minimizing portfolio, the Global Minimum Variance portfolio, and a Sharpe ratio maximizing portfolio, the Optimal Tangency portfolio, for each ESG risk rating. Taking the view of a passive, everyday impact investor, the portfolios were optimized subject to a no shorting constraint in May 2020 and kept as a buy-and-hold investment with no rebalancing until March 2023. Summary statistics were provided for both the estimation window from 2015-2020 as well as the investment period from May 2020 until March 2023.

The results for the estimation period showed that the low ESG risk rated portfolios had lower levels of risk associated with them, as measured by VaR and ES, which sustained across all portfolio weighting types and when compared to their medium and high ESG risk rated counterparts. In addition, when isolating the low and the high ESG risk rated portfolios, the low ESG risk rated portfolios had higher expected risk adjusted returns as measured by Sharpe ratio. Across all portfolio weighting strategies, the medium ESG risk rated portfolios had the highest Sharpe ratio, although were also associated with higher levels of VaR and ES relative to the low ESG risk rated portfolios.

The results for the investment period showed a strong outperformance of the low ESG risk rated portfolios across portfolio weighting strategies in delivering higher realized holding period returns relative to their medium and high ESG risk rated counterparts. An interesting takeaway from the results was that, contrary to expectations, the low ESG risk rated portfolios exhibited higher levels of volatility and thereby higher levels of VaR and ES than their medium and high ESG risk rated counterparts, suggesting that the portfolios were riskier. However, on a risk-adjusted basis, the returns for the low ESG risk rated portfolios were far superior to the medium and high ESG risk rated portfolios, as demonstrated by the higher Sharpe ratios. Additionally, the high ESG risk rated portfolio achieved the lowest risk adjusted returns across portfolio weighting strategies.

Given that the investment period coincided with a period of notable macroeconomic events, notably the COVID-19 pandemic at the start of the investment period and leading into the Russian invasion of Ukraine during the middle of the investment period, this paper also provides insights into the performance of sustainably driven portfolios during times of crises. In addition to the general observations noted for the superior risk adjusted returns of low ESG risk rated portfolios, the results also show that the weekly returns for the market index, the *FTSE 350*, provided the lowest volatility relative to the 9 ESG portfolios and, in fact, was able to provide superior returns relative to the medium and high ESG risk rated portfolios. This outperformance by the *FTSE 350* was especially notable following the invasion of Ukraine and speaks to the power of being broadly diversified during times of crisis. The benefit to being broadly diversified, though indicative of the low ESG risk rated portfolios' greater volatility, was not found to have an effect on its return performance however, as both the Equally Weighted and Tangency portfolios achieved superior returns to that of the much more diversified *FTSE 350*, with the Tangency portfolio also outperforming on a risk-adjusted basis.

By and large, the results of this paper were in line with previous research in suggesting that sustainable portfolios provide superior returns and risk adjusted returns for investors and in doing so, answer the authors of this papers' research question. The results for the estimation period showed that the sustainable portfolios provide better tail-risk protection, as noted by the lower values for VaR and ES, although the results for the investment period showed greater volatility and higher values of VaR and ES for the sustainable portfolios when compared to their non-sustainable counterparts. Additionally, while outperforming the non-sustainable portfolios in realized returns, the sustainable Equally Weighted and Tangency portfolios also outperformed the *FTSE 350* in realized returns, with the Tangency portfolio also outperforming the *FTSE 350* on a risk adjusted basis. By-and-large these results have practical implications for not only the passive, everyday impact investors considered here but also general investors in demonstrating that ESG pre-screening is a valid criterion for maximizing the holding period returns of investors pursuing a buy-and-hold investment strategy.

9.1 Limitations and Areas for Future Research

A limitation noted throughout this paper was the use of historical returns to predict the future performance of portfolios. This is a limitation that exists throughout financial modeling and academia at large and was thus, also a factor in the above *Results and Analysis and Discussion* sections.

Additionally, as the authors of this paper chose to focus on the United Kingdom, and more specifically, a subset of the *London Stock Exchange* (*FTSE 350*), the scope of this paper was limited. An interesting opportunity for future research would be in the extension of the above analysis to include notable other markets such as the Frankfurt Stock Exchange in Germany to determine if the findings of this paper are unique to the United Kingdom, or if they are applicable more broadly. This paper extended on the findings of Lesser et al. (2016), Nofsinger & Varma (2014) and Ruf et al. (2019) to include the *London Stock Exchange*, determining that, outperformance of sustainably driven portfolios is not unique to US domiciled portfolio managers during times of market uncertainty. Thus, continuing this investigation to markets more broadly would provide additional insights and understanding into the performance of sustainably driven portfolios across markets.

The authors of this paper additionally, limited the scope of research to investigating the financial returns of portfolios considering ESG risk ratings from an externally sourced rating agency. Outside of this scope was the investigation of ESG risk rating agencies themselves, to determine the validity of their claims that companies are, in fact, as sustainable as the risk agency says they are. An interesting extension of the research as presented here would thus be to investigate the sustainable ratings these ESG risk rating agencies provide for validity as to the true sustainable nature of the companies receiving the most and least favourable ESG risk ratings.

Finally, as the paper was written following the announcement by the European Union of new Directives aimed towards increasing transparency and audited validity to company's sustainable disclosures, but before the release of the first sustainably reports required to comply with these new Directives, an interesting area for future research will be in understanding the effect these new Directives will have on company's sustainable risk ratings and, by extension, their financial returns.

10 References

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