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«**PORTFOLIO APPROACH TO ESG-INVESTING: EVIDENCE FROM CENTRAL AND EASTERN EUROPE MARKETS**»

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INTRODUCTION

Over the last decade, there has been a growing interest of investors in the investment segment named ESG-investing. Comprehensive analysis of environmental, social, and governance factors (ESG) becomes a necessity for companies that have a goal to attract socially responsible investors. According to American analytics and advisory company Gallup, 48% of U.S. investors say they are very or somewhat interested in purchasing sustainable investing funds, and roughly 40% require information on company's corporate governance policies and advocated social values before buying its shares [1]. Sustainable investments with ESG criteria are becoming popular in almost all segments of the investment market: the stock market, the bond market, the market of mutual funds, and ETFs. Different analytic and rating companies, such as MSCI, Sustain Analytics, ISS, Moody's, S&P, develop ESG scores models to assist investors in their choice of sustainable investments. As a result, the model to evaluate ESG impact on investor's decision is needed to be developed. Considering that ESG factors are often more researched in developed countries, analysis of their impact for Central and Eastern European countries' markets may be beneficial for understanding their relevance for diversification and risk assessment in these particular conditions.

Relevance of the topic. ESG investing remains a topic of interest for over a decade, which can be derived from the increasing amount of publications connected with this issue. For instance, ESG factors consideration and problems connected with ESG frameworks are deeply presented in studies of Hill, Aguilera, Fifka, Eccles, and Serafeim. ESG investing most common concepts and practices as well as approach to quantitative and qualitive analysis of the factors are discovered by Kell, Boffo, and Patalano. The relationship between profitability and ESG factors are discussed by Giese, Nagy, and Lee, Friede, Busch, and Bassen, Dunn, Fitzgibbons, and Pomorski, Bansal, Wu, and Yaron, Hendrikse and Demers. In Ukrainian scientific field, the work of Kaminskyi and Nehrey

discusses clustering approach to stocks based on ESG scorings, showing the practical approach to the qualitative measurement of factors' impacts. As the number of publications devoted to ESG investing is exponentially increasing, active permanent analysis of the obtained results is required.

Research purpose and objectives. The purpose of this research lies in evaluation of Environmental, Social, and Governance factors' impact on the investors' portfolio risk and return in Central and Eastern European markets as well as developing of ESG-modified portfolio approach.

Main objectives of the research:

- development of conceptual understanding regarding the features of ESG-investing and its origination;
- determining of the main approaches to ESG scoring systems and their differences and similarities;
- analysis of ESG-investing trends evident from Warsaw, Prague, and Budapest Stock Exchanges;
- extension of classical Markowitz optimization problem by including ESG factor;
- building of modified portfolio approach to develop ESG-leveraged investment portfolio for CEE markets;
- analysis of correspondence between market risk, return, and ESG scores.

Research object and subject. Object of the research is investment portfolios that are computed from CEE markets' investments. Subject of the research is the impact of ESG-factors' consideration in portfolio valuation in term of risk, return and diversification.

Research methods. Comparative and statistical analyses are used to identify Environmental, Social and Governance scoring methods and quantitative valuation.

Analysis of portfolio performance under the influence of ESG factors was carried out by constructing an ESG-modified Markowitz portfolio model, ESG-modified Sharpe ratio, and Capital Asset Pricing Model for evaluation of expected returns.

Data used in the research reference global analytical and rating agencies as Standard&Poor's Global, MSCI, Sustainalytics, and Refintiv. Other useful sources are ESG reports of the companies researched in the paper, financial data accelerators as Marketwatch, Yahoo Finance and Statista as well as publications of researchers in ESG-field.

Scientific novelty. This research attempts to expand the known theoretical approach to "E", "S", and "G" factors quantitative and qualitative valuation and scoring by determining main advantages and disadvantages of the existing methods and creating a complex alternative approach. The classical portfolio optimization problem is also modified in the research to account for ESG impact in CEE markets, extending the current scientific field.

Application of research results. From practical point of view, developed ESG-portfolio approach can be considered to evaluate the possible risks and returns of the portfolios that consist of sustainable investments in the relevant market. This topic is recommended to be further developed by extending the pool of researched countries and Stock Exchanges as well as considering ESG-factors' relevance in mergers and acquisitions.

Structure overview. Paper consists of introduction, 3 chapters, conclusions, references, and appendices. First chapter discusses the origination of ESG investing and different sustainable investment styles, describes the main components of "ESG" such as environmental, social, and governance factors, and provides an overview of issues connected with ESG investing. The second chapter focuses on the standardization of ESG reporting and evaluates different ESG-scoring methods; similarities and differences in the

approaches of the global ratings are considered and correlation analysis between scoring systems' inputs, risk, and return is compiled. The third chapter presents a modified classical Markowitz portfolio optimization problem as well as introduces the ESG-modified Sharpe ratio and ESG standardized score. Using data from 2021-2022 for WIG-20, BUX, and PX stocks, six CEE-focused ESG-modified portfolios are developed based on various ESG ratings. Optimized portfolio results are evaluated based on the main hypotheses regarding portfolio's diversification, volatility, and return.

CHAPTER 1

Theoretical and methodological basis of ESG investing

1.1 Origination of ESG Investing

Environmental, social, and governance (ESG) investing has become an increasingly popular approach to investment in recent years, with a growing number of investors recognizing the importance of sustainability issues in investment decision-making. At the same time, the idea of including ESG factors at least partially emerged more than half a century ago. It can be dated to the 1960s and 1970s when the modern form of Socially Responsible Investing (SRI) was developed, as investors began to use their financial leverage to promote social and environmental change. The development of SRI was largely driven by advocacy groups and individual investors who sought to address social and environmental issues through their investments. Examples of this movement include communities protesting Western companies that continued to operate in the South African market ignoring ongoing apartheid or individual investors who refused to engage with so-called “sin stocks” – shares of the companies that were involved in tobacco, alcohol, and gambling industries [2-3].

The 1980s and 1990s saw the growth of SRI mutual funds and the emergence of shareholder activism, which allowed investors to exert pressure on companies to improve their social and environmental performance. As the concept of SRI evolved, investors began to recognize the importance of environmental, social, and governance (ESG) factors in investment decision-making.

The term "ESG" was first coined in the 2005 report "Who Cares Wins" by the United Nations Environment Programme (UNEP) and the asset management firm Mercer. The report argued that ESG factors were material to investment performance and recommended that investors integrate these factors into their investment decision-making processes [4]. Since then, ESG investing has gained momentum, with a growing number of investors incorporating ESG factors into their investment strategies.

In 2006, United Nations developed the United Nations Principles for Responsible Investment (UNPRI) [5]. They included six main principles that guided investors in their approach to responsible investing that can be summarized as:

a) incorporating ESG factors into investment analysis and decision-making;
b) actively promoting ESG issues within the investment industry;
c) seeking disclosure on ESG issues from the entities in which investors invest;
d) working to ensure that ESG issues are properly accounted for by the entities in which investors invest;
e) promoting acceptance and implementation of the principles within the investment industry;
f) reporting on progress in implementing the principles.

The development of the UNPRI has had a significant impact on ESG investing. The principles have helped to mainstream ESG investing by providing a framework for investors to integrate ESG considerations into their investment processes. The principles have also helped to increase awareness of the importance of ESG factors among investors, regulators, and the wider public.

The United Nations' Sustainable Development Goals (SDGs) have also played a role in the development of ESG investing. The SDGs, adopted in 2015, provide a framework for sustainable development and include 17 goals and 169 targets. The SDGs have been embraced by the investment community as a way to align investment strategies

with sustainable development objectives [6]. In 2016, the Principles for Responsible Investment (PRI) launched a tool for investors to align their investment strategies with the SDGs [7].

Another important factor in ESG investing evolution can be attributed in part to the increasing availability of data related to environmental, social, and governance factors. According to Kell [8], the launch of the Global Reporting Initiative (GRI) in the ninetieth of the 20th century has influenced corporate disclosure on ESG issues, making more than 80% of the world's largest corporations use GRI standards. It is supported by the development of industry-specific reporting that allows investors to investigate companies' ESG compliance more accurately [9]. This data has helped investors recognize that ESG factors can have a material impact on financial performance, making ESG investing more appealing. Additionally, improvements in data availability have allowed investors to more accurately measure the ESG performance of companies and assess their risk profiles.

The origination of ESG investing paved the way for a range of socially responsible investment styles, including traditional SRI, mission investing, and impact investing, each with its own unique approach to achieving social or environmental goals while seeking financial returns. One of the earliest forms of SRI was exclusionary screening, in which investors excluded certain companies or industries from their portfolios based on ethical or moral considerations. More recently, the focus has shifted towards positive screening, in which investors seek out companies that have a positive impact on society and the environment. Mission investing is another form of SRI that involves investing in companies or organizations that align with the investor's social or environmental goals. Unlike traditional investment strategies, mission investing prioritizes the achievement of a social or environmental impact over financial returns. Impact investing is a more targeted form of mission investing that focuses on investing in projects or companies with the specific goal of achieving a measurable social or environmental impact. Impact

investors seek to achieve a financial return while also creating positive social or environmental outcomes [2].

Each style has its own unique approach to achieving these goals, with different methods for selecting investments and evaluating performance. The relationship between financial and ESG-related returns in different investment styles is presented below (figure 1.1).

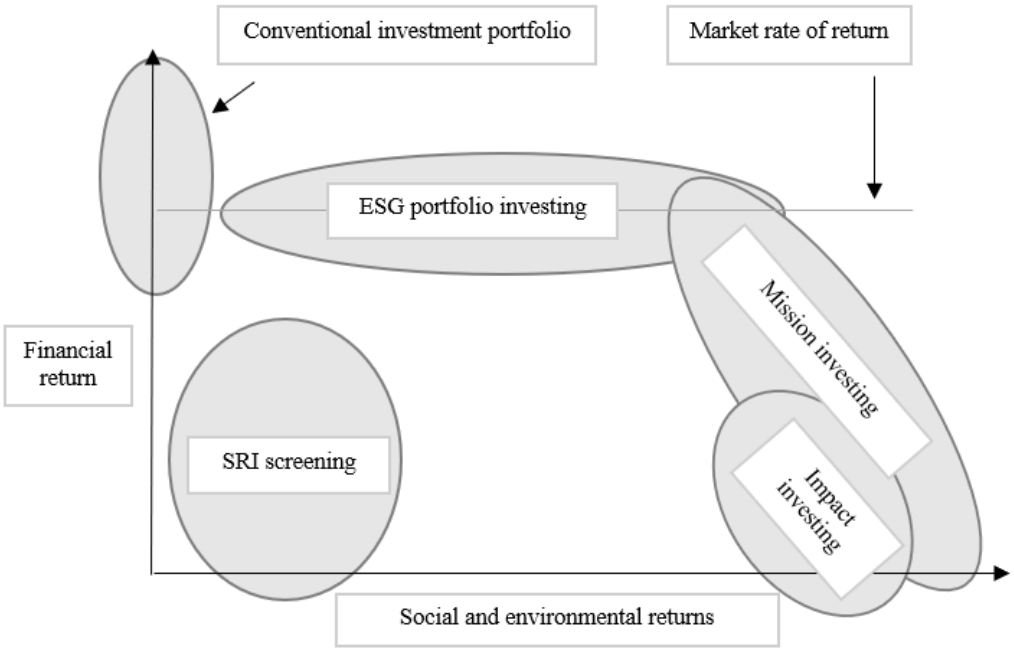

Figure 1.1. Correlation between financial returns and social and environmental impacts for different styles of investment

Source: Hill [2]

Overall, ESG investing represents an evolution of SRI that reflects investors' changing priorities and expectations, as well as the growing recognition of the importance of sustainability issues in the global economy. The emergence of ESG investing and the

incorporation of the SDGs into investment strategies represent an important step towards more sustainable investment practices.

1.2 Essence of factors “E”, “S”, and “G” in modern investing

As discussed previously, early socially responsible investing was focused on excluding certain companies, while modern ESG investing focuses on distinguishing efforts made by the market participants to include ESG factors into companies’ long-term strategies, contributing to achieving environmental and social impacts. Striving for sustainability, investors are able to evaluate potential investments from several different perspectives. Areas of potential improvements/impacts can vary depending on the company’s industry, specialization, interest, geographical presence, and other factors. However, typically ESG evaluation focuses on three key categories [3]:

- The "Environmental (E)" component of ESG covers various environmental factors, including energy efficiency, greenhouse gas emissions, deforestation, climate change, waste management, and water usage.
- The "Social (S)" component encompasses social factors such as labor standards, board and workplace diversity, human rights, privacy, and health and safety, among others.
- The "Governance (G)" component addresses corporate governance issues, including board composition, executive compensation, political contributions, and bribery and corruption, in relation to the "E" and "S" categories.

Environmental factor, described by Lee, Cin, and Lee [10], is "the extent to which a firm manages its environmental impacts and engages in environmentally responsible activities." The authors argue that environmental responsibility can be beneficial for firms in terms of reducing costs, improving operational efficiency, and enhancing reputation.

Environmental practices that can contribute to environmental responsibility include energy efficiency measures, waste reduction and recycling, pollution control, and the use of renewable energy sources. Firms can engage in more proactive environmental practices, such as investing in clean technologies or developing environmentally-friendly products and services.

A number of studies have found a positive correlation between environmental responsibility and firm performance [11-12]. The results conclude that firms with better environmental performance tend to have lower operating costs, higher returns on assets, and better stock performance. At the same time, some firms may face higher costs in implementing environmentally responsible practices, which could affect their financial performance in the short term.

Social factor is closely related to the companies' Corporate Social Responsibility (CSR) practices. Shortly, it can be described as company's obligations and impacts on the society in which it operates. Social responsibility includes a range of activities such as ensuring fair labor practices, promoting diversity and inclusion, and contributing to the development of local communities.

According to research by Aguilera and et. [13], at the individual level, employee values and beliefs play an important role in shaping CSR outcomes. Specifically, they argue that employees who hold strong social values are more likely to engage in socially responsible behavior, which in turn can positively impact the organization's CSR outcomes. Employees who feel a sense of ownership and engagement in the organization's CSR initiatives are more likely to actively participate and contribute to their success.

At the organizational level, a strong commitment to CSR from top leadership can create a culture that values and prioritizes social responsibility, which eventually will attract and retain employees who share these values and contribute to the organization's overall success.

At the societal level, the authors highlight the potential for CSR to contribute to broader social change. By prioritizing social responsibility, organizations can create positive externalities for the communities in which they operate. For example, companies that prioritize fair labor practices can contribute to the development of a broader movement for worker rights.

From the point of investor's return, these positive societal changes in the long-term lead to better firm performance as well. A study by Eccles and Serafeim [14] found that companies with strong social performance tend to have higher profitability and stock returns compared to companies with weaker social performance. Additionally, research by Edmans [15] found that firms that invest in employee satisfaction and well-being tend to have higher financial returns over the long term.

Governance factor refers to the processes, policies, and regulations that govern a firm's management and decision-making activities. Becht, Bolton, and Roell describe the importance of the board of directors in corporate governance, as the board is responsible for monitoring the firm's performance and ensuring that management's actions are in the best interest of the shareholders [16]. According to Aboud and Yang [17], corporate governance is a critical component of corporate social responsibility, as it provides the framework for ethical decision-making and accountability.

Corporate governance is usually implemented through a set of policies and procedures that define the roles and responsibilities of the board of directors, management, and shareholders. Effective corporate governance requires transparency, accountability, and stakeholder engagement. This may include regular reporting of financial and non-financial performance metrics, the appointment of independent directors, and the establishment of mechanisms for shareholder participation in decision-making [18].

The impact of corporate governance on financial performance is complex and varies depending on the context. Hussain et al. conducted a study that analyzed the triple

bottom line (economic, social, and environmental) performance of firms and found a positive relationship between corporate governance and sustainability performance [19].

As stated previously, companies that are concerned with environmental and societal issues and implement their management into corporate strategies tend to reach higher returns in the long run. In this relation, the success of ESG-related activities is moderated by institutional ownership, with the positive impact of ESG performance being stronger for firms with higher levels of institutional ownership [20].

Overall, each of the described factors takes an important role in the evaluation of a company's sustainability. Often "E", "S", and "G" are not investigated separately, but evaluated in the complex as they tend to influence each other. Risks connected with mismanagement of these factors are interrelated. For instance, ignoring issues connected with pollution in a certain area where the company operates may lead to a place being uninhabitable. This will influence local communities, as they may want to migrate to a better environment, which may impact workforce availability on one hand and local market demand on the other hand. Therefore, it becomes crucial for both firm's management and investors to consider all the factors during the company's sustainability assessment, as it can pose significant risks to its financial performance.

1.3 Alternative view on implementing ESG factors in portfolio investment objectives

Implementation of ESG factors into portfolio investment objectives is becoming a high priority for corporations and institutional investors. BlackRock, world's largest asset management company with over 15 trillion USD AUM (assets under management) in 5 years' time, integrates sustainability considerations across their investment strategies and offers a range of ESG-focused funds. BlackRock has emphasized the importance of ESG

factors in investment decision-making and actively engages with companies on ESG issues [21]. For instance, in 2020, BlackRock joined Climate Action 100+, an investor-led initiative to engage with companies on climate-related risks and opportunities. In 2021-2022, BlackRock voted against directors at companies that were not making sufficient progress on climate-related disclosures and risk management. They also supported shareholder proposals related to climate change, diversity, and other ESG matters and advocated for improved ESG disclosure and reporting by companies to enhance transparency and enable more informed investment analysis [22-23].

HSBC sustainable financing and investing survey 2021 has found that out of 2000 surveyed issuers 59 percent have a general ESG policy in place, emphasizing that big firms are more likely to have such a policy - 85 percent of large investors (over 25 billion USD in assets) have implemented a company-wide approach, versus 34 percent of smaller institutions (less than 1 billion USD) [24].

At the same time, the expansion of the ways the company may define and approach ESG-related issues, lack of uniformity in ESG scoring systems which leads to their subjectivity, and, as a result, the difficulty of quantifying and comparing ESG performance raise concerns and cause a range of criticism.

According to Pollman [25], the compilation of ESG funds may be confusing and misleading for some investors, as the companies included may focus on one of the factors, while underperforming in others (e.g. solving environmental issues, but have issues with racial and sexual discrimination). Since “ESG” is a universal term that covers wide-ranging issues, adding ESG-related investments to a portfolio may not meet the needs of investors with specific topics of concern.

Another issue is related to the novelty of the ESG evaluation as a concept. The absence of a unified approach leads to a situation when companies can apply different metrics and standards for the assessment of their performance, choose the information

they want to disclose, and change these parameters from year to year. As a result, ESG data over a period of time may be incomparable and inconsistent.

It also can be argued that numerous rating agencies evaluate the management of ESG-related risks rather than companies' impact on developing new solutions to bring positive social and environmental outcomes [26]. In this way, companies like Pepsi and Coca Cola may receive high rankings due to strong corporate governance and reduction of greenhouse emissions, while actually being the manufacturers of addictive high-sugar drinks that contribute to diabetes and obesity.

Looking at the issue solely from a financial point of view, a number of research argue that considering only ESG-driven stocks for investment does not lead to better portfolio performance. Based on aggregated evidence from more than 2000 empirical studies, Friede, Busch, and Bassen differentiate between portfolio and nonportfolio studies [27]. It is stated that only 15.5% of portfolio studies show positive ESG relation to corporate financial performance, while 11% are identified as negative, 73.5% - as neutral or mixed. Researchers discuss 3 possible reasons for such results:

- various overlapping market and nonmarket factors within a portfolio can obscure existing ESG alpha, thereby affecting the correlation levels;
- many ESG funds consist of a mix of negative and positive ESG-screened funds, which can lead to distortion and cancellation of any remaining effects;
- studies on portfolios, particularly mutual funds, incorporate management fees and other costs like performance fees and trading costs. In contrast, firm-specific studies typically do not consider such fees and costs.

At the same time, Zehir and Aybar's research on portfolio performance in Europe and Turkey indicates there is no relationship between sustainable investing and portfolio performance [28]. The result is derived from CAPM regression evaluation and the Fama-French three-factor model employed as a performance measurement benchmark, showing

nearly zero abnormal return and even underperformance in 2 out of 8 portfolio studies conducted. The authors mention that the ESG evaluation is conducted solely based on Refinitiv data and propose to extend the research by comparing results using different ESG data sources.

Grahovak and Ovuk's empirical study supports the findings of the previously mentioned research, demonstrating no statistical significance and no abnormal returns for the ESG portfolios for European stocks, assessed using a best-in-class or worst-in-class approach [29]. Performance evaluation models such as CAPM, Fama-French, and Carhart were employed to analyze the effects of ESG ratings on portfolio performance over the period from 2010 to 2021. Moreover, the results potentially suggest negative alpha values for the high-low portfolio, although statistical significance was not established. This implies that investors employing a long-short portfolio strategy may experience lower returns compared to the market and potentially incur costs associated with such an investment strategy.

One of the limitations of the studies is that the ESG score method is usually identified based on one available scoring system and approach, not accounting for differences that the scoring system can bare and add value to investors by focusing on specific metrics and risks. In this paper, we are willing to address this issue by considering different scoring systems and accounting for their impact on optimal portfolio compilation.

Overall, as a relatively recent concept, ESG investing has its issues; from year to year, joint work of academia, regulators, and investors aims to voice these concerns and provide solutions that will enable to make industry accountable for its actions and actually bring value to the environment and society. Our paper attempts to analyze the optimal ESG portfolio in Central and Eastern Europe markets considering these issues to some extent by acknowledging that approach to ESG reporting and application of different ESG

scoring systems may present conflicting results, which can shed light on the market evaluation of different ESG approaches.

Conclusions to Chapter 1

ESG investing has mostly developed in the recent half of the century, starting its way from Socially Responsible Investing concept that was launched by advocacy groups bringing attention to unfair business practices and harm caused by "sin stocks". This led to emergence of shareholder activism and the realization of investors' power to influence companies' behavior by their investing decisions. In 2005, UNEP's report "Who cares win" coined the term "ESG", paving the way for modern ESG-related practices to become a part of entities' business strategies.

In the chapter, we focus on the advances that were made by developing United Nations Principles for Responsible Investment, officially defining main principles of responsible investing like including ESG factors into investment analysis, advocating for non-financial activities' disclosure, and reporting, as well as United Nations Sustainable Development Goals that provided a framework for addressing sustainable development goals and targets. We further analyze how the ESG investing rise was influenced by the increase in data availability with the launch of global reporting standards like GRI and SASB.

Different socially responsible investment styles are then discussed to provide a wider view of how traditional socially responsible investing, mission investing, and impact investing can relate to specific investors' interests. We differentiate between exclusionary and positive screening that either exclude or seek out investments based on certain ethical and moral considerations; mission investing and impact investing are defined at styles that prioritize social ad environmental impacts over financial returns.

The approach to the classification of ESG components – Environmental, Social, and Governance – is further developed based on the factors that are mostly covered in each group. Based on the analyzed research, we conclude that environmental practices such as energy efficiency measures, waste and pollution control, and investing in clean technologies in the long run can lead to lower operating costs and higher returns on assets, commitment to social responsibility attracts and retain employees bringing value to the communities where the company operates, and strengthening of governance factor benefits company's transparency, shareholders' interests and better sustainability performance. At the same time, we underline the interrelation between all three components, as ignoring issues in one of the areas can expose the company to the risks connected with other components.

Finally, the paper emphasizes the criticism connected with ESG investing, categorizing the main issues that need to be addressed. We uncover the problematic nature of using the universal "ESG" term for investment evaluation, as it leads to confusion and unclarity for mission and impact investors. The chapter also discusses how the lack of standardization in ESG rating methodologies undermines ESG data reliability and comparability, while ESG scoring systems often focus on mitigating risks rather than evaluating innovative approaches to bring positive social and environmental impacts.

The results of numerous pieces of research studying portfolio performance in relation to ESG factors are mentioned to further develop an understanding of expectations that can be set for ESG investors. Different methodologies like CAPM regression evaluation, the Fama-French three-factor model, and best-in-class or worst-in-class assessment are applied to analyze portfolio financial performance, showing limited evidence for the positive correlation between dedication to ESG issues and stock returns. We then consider possible reasons that may contribute to such results and declare our approach to further CEE market optimal ESG portfolio development addressing the issue of limited ESG scoring application.

CHAPTER 2

ESG-level assessment in investing processes

2.1 ESG disclosures as part of company's reporting

Considering the rise in investors' interest in the ESG performance of the firms they are eager to invest in, finding information that would provide full disclosure on the related activities has become a necessity in the company's evaluation process. In this regard, the reporting on ESG activities has become a valuable part of the company's analysis.

According to Fifka [30], the history of social and environmental reporting can be divided into three phases. The first phase began in the 1970s and was marked by the emergence of social accounting and social auditing. During this phase, companies started to publish standalone social and environmental reports, but there was no standardization in terms of reporting frameworks. In the 1980s, social and environmental reporting became more formalized, and the focus shifted to sustainability reporting. The Global Reporting Initiative (GRI) was established in 1997 to provide a framework for sustainability reporting.

The second phase began in the 2000s and was marked by an increase in the number of companies publishing sustainability reports. In this phase, the GRI established itself as the leading standard-setter for sustainability reporting. The GRI framework was adopted by many companies and became the de facto standard for sustainability reporting.

The third phase began in the 2010s and is characterized by an increased focus on integrated reporting. Integrated reporting seeks to provide a more comprehensive view of a company's financial, social, and environmental performance. The International Integrated Reporting Council (IIRC) was established in 2010 to develop a framework for integrated reporting. Over 2500 businesses in more than 70 countries have adopted integrated reporting, 43.1% of which are attributed to Asia Pacific region, 25.1% - to continental Europe, 23.1% - to Middle East and Africa, and the rest to North and Latin America [31].

Recent research has shown that there is a lot of work in progress dedicated to standardization in sustainability reporting across companies and industries. However, there are still challenges in terms of the comparability and reliability of sustainability reporting. As companies continue to evolve their reporting practices, it will be important to continue to develop and refine reporting standards to ensure that sustainability reporting remains meaningful and informative for stakeholders.

Since the focus of this research takes place in the Central and Eastern European markets, evaluation of ESG reporting specifically for companies operating in these markets can provide additional understanding of popular reporting practices. Firms that were chosen for analysis are constituents of Warsaw Stock Exchange Index – WIG-20, Prague Stock Exchange Index – PX, and Budapest Stock Exchange Index – BUX, amounting to 46 companies in total. Based on the publicly available data, 44 of the companies predominantly use The Global Reporting Initiative (GRI) Standard and only 2 companies report in the Sustainability Accounting Standards Board (SASB) standard. The main differences between these frameworks are formulated in the table below (table 2.1).

In general, these frameworks are complementary, since their simultaneous application may be beneficial for a company to assess its ESG standing and identify risks both on the high-level scope and in more nuanced industry-related areas.

Table 2.1. Characteristics of GRI and SASB reporting standards

Factor \ Standard	*Global Reporting Initiative (GRI)*	*Sustainability Accounting Standards Board (SASB)*
Materiality	Focuses on all sustainability issues that are important to stakeholders	Focuses on a set of financially material sustainability issues that are most relevant to a company's industry
Standardization	Allows companies to choose which sustainability indicators to report on based on their own priorities and context	Provides standardized metrics for each industry that are based on financially material sustainability issues.
Target audience	Designed for a wide range of stakeholders, including investors, NGOs, governments, and the general public	Designed for investors who want to use sustainability information to make investment decisions
Reporting scope	Covers a broad range of sustainability topics, including environmental, social, and governance issues	Focuses on industry-specific sustainability issues that may have a material financial impact
Reporting process	Extensive and time-consuming, requiring companies to engage with stakeholders	More streamlined and standardized

Source: based on [32]

European Union also makes important steps to move away from voluntary disclosure of non-financial information to standardized and mandatory reporting, at least for the companies of public interest, such as listed companies, banks, insurers, and others. In 2014, Non-Financial Reporting Directive 2014/95/EU was adopted and introduced to European market participants, indicating an obligation to disclose key performance indicators connected with environmental matters, social and employee standards, respect

for human rights, and anti-corruption policies [33]. In 2023, The Corporate Sustainability Reporting directive 2022/2464/EU (CSRD) entered into force, modernizing the rules of social and environmental disclosure and extending the reporting requirements on almost 50 000 companies in total [34]. CSRD is one more step to harmonized and standardized sustainability reporting practices.

Prochniak and Ploska's article [35] provides insight into the readiness of Central and Eastern Europe market participants to adopt these new EU regulations. Analysis of WIG-20 companies has concluded that only three out of 20 companies applied all practices related to Best Practices for WSE-listed companies and GRI; 7 companies do not apply at least 6 listed practices. Issues that are mostly not reported or not aligned with Best practices include integration of ESG into the company's strategy, adjusting business models to sustainable matters, ESG-related risk management, and efficient internal auditing. Therefore, there is still much work to be done on the way to full transparency of market participants regarding sustainability disclosures.

In recent years, providing publicly available data about ESG and CSR standpoint on the firms' website as part of the "for investor" reporting package has become a standard practice, which has allowed to develop a broader understanding of strategy and policies that are applied in different companies. However, even with the standardized approach to ESG reporting, it is often perceived as of qualitative rather than quantitative nature. While different firms may formulate their sustainability goals to be related to specific topics or actions and help investors gain a perspective on the overall company's concern, fair and versatile comparative analysis of firms' environmental, social, and governance performance remains a main investor's challenge. This issue is one of the underlying factors that contributed to ESG-scoring systems development.

2.2 Comparative analysis of ESG scoring systems

Creation and formulation of ESG scoring systems were a direct result of investors' need to assess companies and incorporate ESG factors into their investment decisions. Although more and more companies claim to use widespread reporting frameworks like GRI and SASB as a core, there is still an issue connected with a high level of variability of how companies choose to present their ESG performance, the metrics they use, and the evaluation of their ESG risks. It becomes essential for investors to find a unified tool that would allow them to compare companies' performance without spending an enormous amount of time and resources researching and analyzing individual reporting packages of each potential company to invest in. ESG scoring systems enabled the comparability of information based on a common language and set of principles for measuring and reporting on ESG issues.

ESG scoring systems are usually connected with rating agencies that develop their specific methodology, including a variety of quantitative and qualitative metrics. This research focuses on the evaluation provided by Sustainalytics, S&P Global, MSCI, and Refinitiv, however, other rating agencies such as Bloomberg, FTSE Russell, ISS, CDP, Moody's should be recognized as their work largely contributes to ESG data transparency and availability.

Sustainalytics is a subsidiary of Morningstar, one of the largest stock market data providers in the world. It provides ESG ratings on 20,000 companies and 172 countries, measuring the environmental, social, and corporate governance performance of companies on a global scale [36]. Sustainalytics methodology focuses on ESG risk management, compiling its rating based on quantitative score and a risk category. Material ESG issues are the center of the calculation, while separate "E"/"S"/"G" cluster scores are developed to provide additional information to the overall rating [37]. Sustainalytics

approach is useful to the investor that seeks information on the company's exposure to ESG risks and wants to minimize volatility of their ESG-portfolio.

S&P Global provides ESG scores for over 11,500 companies. The scores are calculated based on company answers to S&P's ESG questionnaire of over 450 questions and/or publicly available data [36]. S&P Global approach is focusing on both ESG risks and opportunities, determining a profile of an entity in regard to the macro sector, regional analysis, and an entity's business mix [38]. An important part of the assessment is evaluating the forward-looking effects of material ESG events on the company's financial health and performance. The main building blocks of an entity's ESG profile can be described in the following way:

- Environmental Profile: greenhouse gas emissions, waste and pollution, water use, and land use;
- Social Profile: workforce and diversity, safety management, customer engagement, and communities;
- Governance Profile: structure and oversight, code and values, transparency and reporting, and financial and operational risks.

Therefore, an investor that is interested in the industry-specific evaluation of the company in comparison to its peers and the company's approach to both risks and opportunities in the long-term strategy can choose to rely on S&P Global ESG rating.

MSCI ESG Ratings are produced by MSCI ESG Research, which is considered one of the largest rating agencies. These ratings cover 14,000 equity and fixed-income issuers and are widely recognized as among the top providers of ESG scores and ratings in the industry [36].

MSCI ESG Rating Pillars focus on 10 main themes that are divided into key issues investigated in the market (table 2.2).

Table 2.2. MSCI ESG Ratings Pillars and Key issues

Pillar	***Theme***	***Key Issues***
Environmental	Climate Change	- carbon emissions - product carbon footrpint - financing environmental impact - climate change vulnerability
	Natural Capital	- water stress - biodiversity and land use - raw material sourcing
	Pollution and Waste	- toxic emissions and waste - packaging material and waste - electronic waste
	Environmental Opportunities	- Clean Tech - Green Building - Renewable energy
Social	Human Capital (HC)	- labor management - health and safety - HC development - supply chain labor standards
	Product Liability	- product safety and quality - chemical safety - consumer financial protection - privacy and data security - responsible investment
	Stakeholder Opposition	- controversial sourcing - community relations
	Social Opportunities	- access to finance - health care - opportunities in nutrition and health
Governance	Corporate Governance	- ownership and control - Board - Pay - Accounting
	Corporate Behavior	- business ethics - tax transparency

Source: MSCI methodology described in [39]

MSCI ESG Rating assesses companies' resilience to long-term and financially relevant ESG risks by addressing three main issues:

- Level of entity's commitment to the management of key ESG risks and opportunities and its organizational capacity to do it to the full extent;
- Evident steps and projects initiated by the company to improve its performance;
- Successful cases of managing specific risks and opportunities.

This multidimensional and structured approach covers a wide range of topics, defining ESG opportunities as a separate issue of ESG assessment, which can be beneficial for investors who seek companies that are not only mitigating risks but specifically providing solutions and bringing innovation into environmental and social development.

Refinitiv provides an extensive ESG database that covers more than 630 different ESG metrics and tracks over 85% of the global market cap. Refinitiv has been collecting ESG data since 2002 and offers ESG coverage for over 12,000 global companies across 76 countries [40]. The scoring methodology considers 10 categories across ESG factors, applying industry-specific weights for environmental factors (resource use, emissions, and innovation) and social factors (workforce, human rights, community, product responsibility) while leaving category weights the same for all industries in governance factor evaluation (management, shareholders, and corporate social responsibility) [41]. Refinitiv also provides an evaluation of the ESG controversy score. An extensive data library and score assessment of each factor's category enable investors to achieve more comparability between companies when focusing on a specific ESG-related issue.

Depending on the investor's preferences and needs, one ESG scoring system may be more suitable than another one. Based on the scoring systems' focus, methodology, and approaches, a comparative analysis of various ESG ratings has been developed (Table 2.3).

Table 2.3. Comparative analysis of ESG scoring systems

Measure\System	***MSCI***	***S&P Global***	***Sustainalytics***	***Refinitiv***
Data coverage	> 14,000 issuers globally	> 11,500 companies globally	> 20,000 companies globally	> 12, 000 companies across 76 countries
Transparency in the research process	More transparent	Less transparent	More transparent	Less transparent
Methodology: main focus	Environmental, Social, and Governance Pillars	Environmental, Social, and Governance Profiles	Corporate Governance, material ESG issues (MEIs), and idiosyncratic ESG issues	Ten categories under Environmental, Social, and Governance factors
Methodology: controversies	Included in ESG assessment	No explicit inclusion	Included in ESG assessment	Included in ESG assessment
Number of available qualitative scores	1	4	1	14
Ranking	Relative to industry peers using a relative scoring system	Relative to its peers, assigns percentile rankings	Based on industry-specific ESG risk factors	Provides both percentile and quartile rankings
Score scale	CCC (0, Laggard) - AAA (10, Leader)	1-100 (1 as worst, 100 as best)	0-50 (0 as the lowest level of unmanaged risk, 50 as the highest level of unmanaged risk)	1-100 (1 as worst, 100 as best)

Source: compiled by the author based on [36-42]

Researchers have attempted to analyze whether different ESG scoring systems provide similar results and how their application can be used in assessing the financial performance of the companies (table 2.4). Findings show that there is no consistent result across the application of different ESG scoring systems, and even among results provided by research based on the same ESG Rating.

Table 2.4. Findings on the relation between ESG scores and financial outcomes

Research	***ESG Scoring System***	***Findings***
Dunn, Fitzgibbons, and Pomorski [43]	MSCI ESG Rating	Companies with lowest ratings have up to 15% more volatility and 3% higher betas than highly rated stocks
Bansal, Wu, and Yaron [44]	MSCI ESG Rating	Highly rated companies perform better in good economic environment, but worse during recession
Hendrikse, Joos, and Lev [45]	MSCI ESG Rating, Refinitiv	No evidence that companies with higher ESG scores mitigated risks better during COVID-19
Lopez-de-Silanes, McCahery, and Pudschedl [46]	Bloomberg ESG scores, Sustainalytics ESG Ratings	The quantity of the ESG data disclosed by the company correlated with its quality; ESG is correlated with decreased risk, but no statistically significant relationship between Sustainalytics ESG rankings and financial performance
Zehir and Aybar [28]	Refinitiv	No statistically significant relationship between sustainable investing and portfolio performance in European and Turkish market
Kaminskyi and Nehrei [48, 49]	S&P Global	High-level ESG portfolios demonstrated less risk and higher return in stable environment, but fell in profitability and became more volatile after pandemic

Source: compiled by the author based on [28, 43-49]

A basic hypothesis would be to expect that different scoring systems would still evaluate companies in a similar range of scores. However, considering the peculiarities of each rating compilation and evaluation, investors should consider different ratings specifically to their needs.

Implementation and exploration of ESG scoring in CEE markets is an important part of our research, as it contributes to the attraction of foreign investors. ESG scoring enhances transparency and accountability; therefore, by evaluating companies' ESG performance, investors gain insights into factors that may impact long-term financial performance and reputation. This transparency fosters trust between investors and companies, as it ensures that companies are held accountable for their environmental and social impact. Moreover, the implementation of ESG scoring in the CEE markets can create a competitive advantage. As sustainable investing gains prominence globally, companies and markets that demonstrate strong ESG performance are more likely to attract capital from investors who prioritize sustainability goals. By integrating ESG considerations into their business strategies, CEE companies can differentiate themselves and tap into a growing pool of ESG-focused investors. At the same time, it is important to consider specific features of risk management that are connected with ESG-scoring-based investing, analyzing the dichotomy between diversification and prioritization of investment in companies with high ESG scores [50].

For Ukraine specifically, exploring the implementation of ESG scoring in the CEE context offers valuable experience. Ukraine can learn from successful ESG integration strategies employed by other CEE countries, understand the specific challenges and opportunities in the region, and adapt these learnings to its own unique circumstances. By proactively embracing ESG practices and demonstrating a commitment to sustainability, Ukraine can position itself as an attractive investment destination for socially responsible investors in the future, fostering economic growth, attracting foreign capital, and contributing to the country's sustainable development goals.

Correlation between ESG scorings across Poland, Czech Republic, and Hungary stock markets was compiled using the latest available data (as of 2021-2022), provided by Sustainalytics, S&P Global, MSCI, and Refinitiv (table 2.5). From 46 companies, Sustainalytics scores were available for 93% or 43 companies, S&P Global – for 57% or 26 companies, MSCI – for 46% or 21 companies, and Refinitiv – for 65% or 30 companies. The biggest coverage provided by rating agencies is attributable to companies traded on Warsaw Stock Exchange, while companies that are presented in Budapest Stock Exchange index are the least covered.

Data used for computing expected returns and volatility of the stocks is based on datasets of daily returns between January 1st, 2021 and February 28th, 2022. This period is chosen based on several factors:

- this time range can be considered a period of relative "calmness" of the market between COVID shock and global recession, partially influenced by russia's invasion of Ukraine;
- the related ESG-data provided by rating agencies is mostly focused on 2021 financial years' results, as 2022 annual reporting is not yet available for all the companies at the moment of the research.

Table 2.5. Correlation between ESG scores, risk, and returns based on CEE stocks

Rating agency	***Score type***	***Expected return***	***Risk***
Sustainalytics	ESG risk rating	-0.09	-0.08
S&P Global	Integral ESG score	0.08	**-0.41**
	E-score	-0.32	**-0.54**
	S - score	0.16	-0.28
	G - score	0.13	-0.38
MSCI	ESG Score	-0.03	-0.32

Table 2.5 continued

Rating agency	*Score type*	*Expected return*	*Risk*
Refinitiv	Integral ESG Score	**0.41**	-0.29
	E-score	**0.67**	**0.40**
	E: Emissions	0.29	0.05
	E: Resource Use	**0.44**	0.14
	E: Innovation	**0.65**	**0.46**
	S-score	**0.45**	-0.15
	S: Human Rights	0.32	0.16
	S: Product Responsibility	0.11	-0.23
	S: Workforce	**0.50**	0.22
	S: Community	0.27	-0.28
	G-score	0.01	**-0.47**
	G: Management	-0.01	**-0.51**
	G: Shareholders	-0.09	-0.17
	G: CSR Strategy	0.33	0.22

Source: computed by the author based on stock performance and ESG scores data

Correlation analysis suggests that the expected return of the stocks is best described by Refinitiv scoring and is mostly impacted by the Environmental score (almost 70%, strong correlation), in particular by the Innovation parameter (65% correlation). The social score has a moderate correlation with expected returns (45%), mostly impacted by the Workforce score (50% correlation). Other ratings show a weak correlation between ESG factors and stock returns.

At the same time, the relation between stocks' risk and ESG score is moderate and provides the following patterns:

- S&P Global ESG scores are in reversed correlation to stocks' risks, mostly influenced by Environmental Profile score (54% correlation), contributing to the idea that mitigating environmental risks may lower stock's volatility;

- Refinitiv scores suggest that G-score, in particular, high management quality can minimize stock risks (51% correlation);
- Refinitiv E-score, especially Innovation, can trigger stocks' volatility (40% and 46% correlation accordingly).

Such results are explainable, as they are supported by the findings of related studies – for instance, investing in environmental innovation may attract investors, but costs related to R&D activities supporting such strategy can influence the financial results of the company in the short term, impacting its volatility.

The conflicting findings of the correlation analysis between different scoring systems further add to the idea that absence of the uniformity and standardization of rating agencies' methodology may significantly influence the results of the research. Furthermore, providing a more detailed split of the underlying ESG score (assessing each "E", "S", "G" factor separately) makes the correlation more informative and stronger.

All in all, ESG scoring systems can provide a wide range of analytical data that can be useful to investors in terms of ESG risk assessment, specific industry-related issues and opportunities, companies' long-term strategy, and other related topics. The following chapter discusses how ESG score valuation can be applied in the modern portfolio optimization model.

Conclusions to Chapter 2

ESG investing has gained momentum largely due to the development of ESG reporting practices, increasing data transparency, and quantitative assessment of ESG scoring agencies. This has enabled scholars to research ESG investing through the application of statistical and econometric approaches and regulators to further develop

requirements for the company's non-financial disclosures, benefitting society and meeting investors' needs.

Chapter 2 discusses three phases of social and environmental reporting development, emphasizing the importance of social auditing, the adoption of global reporting frameworks, and the introduction of integrated reporting. We further analyze the most popular standards used by Warsaw, Budapest, and Prague Stock Exchange constituents – Global Reporting Initiative and Sustainability Accounting Standards Board, underlining differences in their approaches to materiality, standardization, target audience, reporting scope, and reporting process. It is argued that the application of the recently enforced European Union Corporate Sustainability Reporting directive is an important step for the harmonization and standardization of sustainability reporting practices for listed companies, but it may cause complications for market participants who still fail to fully commit to the cause.

Chapter 2 then continues to discover the main ESG scoring systems used for the evaluation of companies' ESG risks and opportunities management. The focus is on 4 largest ESG data providers including Sustainalytics, S&P Global, MSCI ESG Ratings, and Refinitiv. Based on the agencies' methodologies and areas of concern, we evaluate their informativity in the following way: Sustainalytics provides the highest coverage of companies globally, providing more transparency in the research process and focusing on material and idiosyncratic ESG issues, assessing the unmanaged risk – best for industry-specific research on risk mitigation; S&P Global has the least company coverage but provides a wider quantitative assessment of "E", "S", and "G" profiles using sector, regional, and entity-specific analysis as well as peer-to-peer percentile rankings – best for multifactorial evaluation of ESG risks and opportunities management related to companies in a specific region and industry; MSCI Ratings have the most transparent methodology approach and focus on 33 key issues across 3 ESG Pillars, but are limited to a letter score scale as a final rating – best for regulations standardization and stand-alone

company's assessment; finally, Refinitiv scoring covers 630 ESG metrics resulting in 14 final quantitative evaluations of ESG factors that account for industry-specific weights in "E" and "S" factors, equally assessing Governance factor across industries – best for benchmarking and academic research, especially while analyzing specific ESG factor.

Furthermore, the importance of the implementation of ESG scoring in the CEE markets is discussed, considering its contribution to investor attraction as the result of higher transparency and accountability as well as an opportunity to appeal to investors who prioritize sustainable investments. For Ukraine, exploring the results of ESG scoring in the CEE context offers valuable experience to position itself as an attractive investment destination in the future, contributing to economic growth and sustainable development goals.

The paper analyzes scoring data availability for Poland, Czech Republic, and Hungary's stock markets participants, resulting in Sustainalytics and Refinitiv databases being the most sufficient for the research. We then compile a correlation analysis between ESG scores, risks, and returns on CEE stocks, underlining the strongest correlation between return and Refinitiv E- and S-scores as well as between risk and S&P Global E-score and Refinitiv G-score. These results allow us to address the evident patterns and formulate hypotheses regarding ESG-modified portfolio performance in the further chapters based on different scoring systems applied.

CHAPTER 3

Three-criteria portfolio optimization model: ESG-score, risk, and return

3.1 Extension of classical Markowitz optimization problem including ESG factor

Over the past few decades, traditional financial theories and investment strategies have faced mounting criticism for their failure to account for environmental, social, and governance (ESG) factors. In recent years, there has been a growing interest in incorporating ESG considerations into investment decision-making processes, reflecting a broader shift towards sustainable investing. One way to achieve this is by extending the classical Markowitz optimization problem [51], which is widely used to construct efficient portfolios based on expected returns and risks. By including ESG factors, this approach aims to provide investors with a more holistic and socially responsible framework for portfolio construction.

The traditional Markowitz model, also known as the mean-variance model, is a widely used investment theory that aims to optimize a portfolio's return by minimizing its risk. Developed by Harry Markowitz in 1952, the model assumes that investors are rational and risk-averse and that the expected returns and risks of different assets are known with certainty. The model assumes that investors can construct an efficient portfolio by combining assets in such a way that the portfolio offers the highest possible return for a given level of risk. The model calculates the expected return of the portfolio as the weighted average of the expected returns of its constituent assets, and the portfolio's

risk is measured by its variance or standard deviation. This can be described by the following formula:

$$R_p = I_{RF} + (R_M - I_{RF})* \sigma_p/ \sigma_M,$$

where

- R_p = expected portfolio return;
- R_M = market portfolio return;
- I_{RF} = risk free interest rate;
- σ_M = market's standard deviation;
- σ_p = standard deviation of portfolio.

At the same time, this model has several limitations:

- expected returns and risks of assets are not always known with certainty, as they are influenced by information asymmetry and various endogenous shocks;
- asset returns do not always form a normal distribution;
- model is sensitive to input assumptions, particularly the estimation of expected returns and the covariance matrix since even small changes in these inputs can significantly impact the optimal portfolio allocation;
- the model does not account for transaction costs, taxes, and other constraints that may impact the practical implementation of the portfolio;
- the model does not consider non-financial factors such as ESG considerations, which can impact the risk and return of an investment.

In this research, we will focus mostly on the last limitation, extending the model by including ESG-related evaluations as the third criterion in the Markowitz model.

First introduced by William F. Sharpe in 1966 [52], the Sharpe ratio has become a part of modern portfolio theory, measuring risk-adjusted return that considers the return earned by an investment relative to the risk taken. While the Markowitz optimization

model can be used to calculate the efficient frontier of portfolios that maximize returns for a given level of risk, the Sharpe ratio can be used to identify the point on the efficient frontier that represents the highest risk-adjusted return, which is also known as the tangency portfolio.

However, in this study, we want to account for investors whose main focus is high ESG return (environmental and societal impact) rather than expected financial return. Therefore, we create an "ESG-modified Sharpe ratio" that evaluates risk-adjusted ESG return. While the original Sharpe ratio focuses on the relation between the portfolio's excess financial return and volatility, we prioritize the compilation of the portfolio with the highest ESG score and lowest risk. Therefore, our optimization problem is modified to maximize the portfolio's overall ESG score rather than return.

3.2 Portfolio optimization in Central and Eastern Europe markets

Applying the classical portfolio optimization model, we first create a standard portfolio that will consist of 18 companies' stocks from the WIG, PX, and BUX indices. The companies are chosen based on the availability of ESG scores, as a classical portfolio will provide us with a basis for comparison while evaluating the ESG-modified model. While we aim to compile an optimal ESG-modified model, we still need an understanding of how its returns may differ from a classical risk-return optimal portfolio.

Using historical stocks' daily return data from January 1st, 2021 till February 28th, 2022, we are able to compute covariance metrics that are later used for defining portfolio volatility (Appendix B). Evaluation of expected returns is then derived with the help of the Capital Asset Pricing Model.

The benchmark used for compiling Beta values for each stock is New Europe Blue Chip Index (NTX). This is a free-float market-cap-weighted price index made up of the

top blue chip stocks (ranked by free-float adjusted market capitalization) traded on stock exchanges in Central, Eastern, and South-Eastern Europe and Austria [53]. This benchmark seems to be the most appropriate for the evaluation of CEE stocks as it is more relevant for the market conditions in which the interest of research takes place.

Risk-free rates for stocks are chosen as 10-year government bonds yield in Poland, the Czech Republic, and Hungary [54] and applied to each stock based on the traded market accordingly. These inputs allow us to calculate each stock's expected return and volatility, solving for optimal portfolio allocations by maximizing the Sharpe ratio while balancing risk and return (table 3.1).

Table 3.1. CEE Optimal Portfolio

Ticker	***Weight***	***Expected Return***	***Volatility***	***Ticker***	***Weight***	***Expected Return***	***Volatility***
PEO.WA	0.0%	11.1%	40.4%	PKO.WA	0.0%	11.0%	39.2%
CDR.WA	0.8%	8.1%	59.9%	PZU.WA	3.7%	9.3%	29.3%
CPS.WA	13.3%	6.9%	26.5%	CEZ.PR	18.5%	6.5%	20.1%
DNP.WA	7.3%	7.1%	34.5%	ERBAG.PR	8.3%	9.5%	29.7%
KGH.WA	1.8%	10.4%	46.9%	KOMB.PR	0.3%	8.6%	25.6%
LPP.WA	0.0%	10.8%	56.2%	MONET.PR	17.3%	5.4%	20.7%
MBK.WA	0.0%	10.7%	53.1%	RICHT.BD	20.6%	8.6%	24.8%
PKN.WA	1.6%	10.1%	35.8%	MOL.BD	6.6%	9.0%	27.6%
PGE.WA	0.0%	8.9%	48.3%	OTP.BD	0.0%	9.7%	37.6%
Portfolio expected return			**7.5%**				
Portfolio volatility			**12.7%**				
Sharpe ratio			**59.1%**				

Source: calculated by the author

Based on the created model, the maximized Sharpe ratio that is achievable for the Central and Eastern Europe (CEE) portfolio is 59%, with a 7.5% of expected return and 12.7% of volatility. Considering the wide range of individual stocks' volatility, portfolio creation and diversification truly lead to minimizing investor risks. Overall, 12 out of 18 individual stocks are used for portfolio allocation. The concentration matrix of such a portfolio can be described as follows:

- more than 20% of the portfolio are allocated in 1 security out of 18;
- almost 40% of the portfolio are allocated in 2 securities out of 18;
- 60% of the portfolio are allocated in 4 securities out of 18;
- 80% of the portfolio are allocated in 6 securities out of 18;
- the rest of the portfolio is distributed between 6 other securities.

Adding new assets to a portfolio is connected with adding additional degrees of freedom, making efficient frontier a multi-dimensional solution.

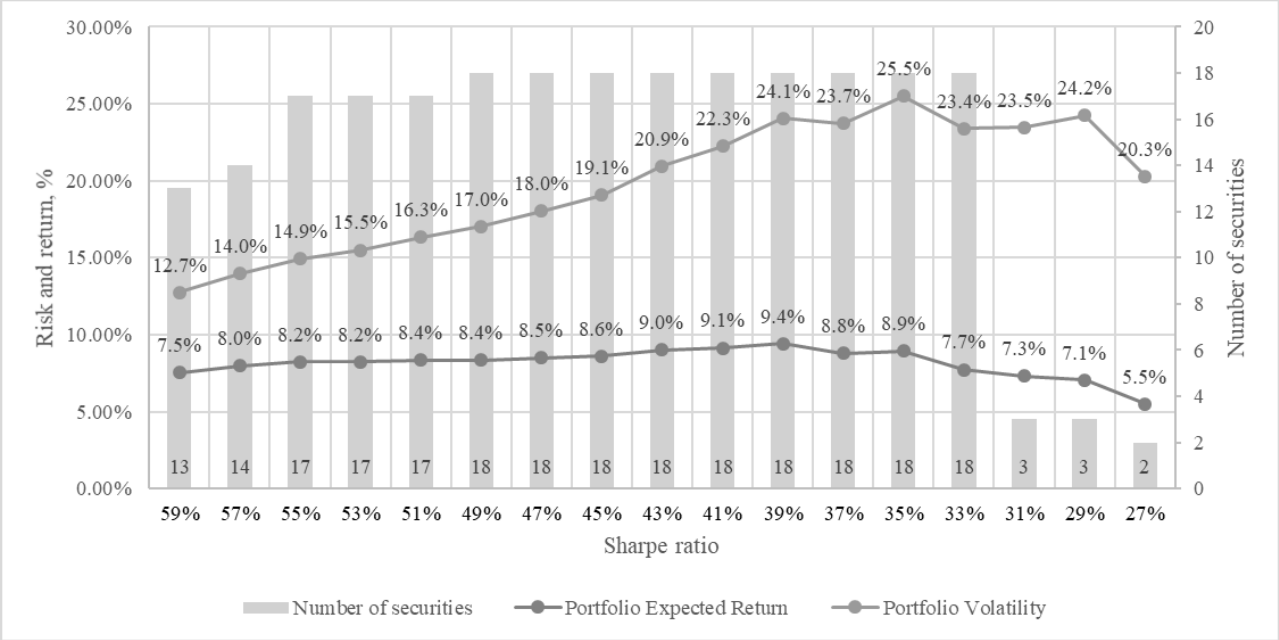

Figure 3.1. Risk and return combinations at various Sharpe ratio levels

Source: calculated by the author

Therefore, for visualization, we have presented different combinations of risk and return and number of securities involved in the portfolio derived by lowering Sharpe ratio starting from its optimal level (figure 3.1). It is evident that the CEE market is high risk-low return, as with the increasing risk of the investments they do not compensate for it with significantly higher returns. At the same time, diversification strategy and maximizing the number of securities in the portfolio contribute to both portfolio risk and return. At the Sharpe ratio at the level of 31-33%, a drop in portfolio securities' number from 18 to 3 occurs, contributing to even higher volatility and lower returns.

With gained understanding of risk and return relations in the CEE market, the next step of our research involves integrating ESG-score in the portfolio optimization model to evaluate ESG return and risk relationship.

3.3 Application of modified portfolio model to ESG investing in CEE

Based on the research discussed in this paper as well as evidence from correlation analysis, we formulate the following hypothesis regarding portfolio optimization results:

- optimizing for an ESG-return factor negatively influence the diversification of the portfolio as more weights are allocated to stocks with higher ESG ratings;
- volatility of an optimal ESG-adjusted portfolio is lower than the volatility of the classical risk-return portfolio, as ESG factors contribute to the company's long-term performance;
- ESG-modified portfolio using Refinitiv scores as a basis tends to have higher returns, while an ESG-modified portfolio based on S&P Global Environmental scores results in lower volatility.

To integrate ESG scores into the portfolio optimization model, it is necessary to make a standardized ESG return factor. In order to make the "ESG return" of the portfolio's variations comparable, we adjust the ESG return of the model based on the scoring scale of each rating system (table 3.2).

Table 3.2. Approach to standardization of ESG scores

ESG scoring system	*Applied formula*
Sustainalytics	$ESG_{st.f.} = (50 - ESG_{f.})/50*100\%$
MSCI	$ESG_{st.f.} = ESG_{f.}/10*100\%$
S&P Global	$ESG_{st.f.} = ESG_{f.}/100*100\%$
Refinitiv	$ESG_{st.f.} = ESG_{f.}/100*100\%$

Source: developed by the author based on scoring scales

As MSCI scores are originally provided in letter rating (AAA as leader, CCC as laggard), we further transfer the letter scores to their average final industry-adjusted number score (table 3.3).

Table 3.3. MSCI scores as applied in the model

Letter Rating	***Leader/Laggard***	***Final Industry-Adjusted Company score***	***Average Score applied***
AAA	Leader	8.571 – 10.0	9.286
AA	Leader	7.143 – 8.571	7.857
A	Average	5.714 – 7.143	6.429
BBB	Average	4.286 – 5.714	5.000
BB	Average	2.857 – 4.286	3.572
B	Laggard	1.429 – 2.857	2.143
CCC	Laggard	0.0 – 1.429	0.715

Source: average score applied based on [39]

Six ESG-modified optimal portfolios were calculated using integral ESG scores provided by S&P Global, MSCI, Sustainalytics, and Refinitiv, as well as two separate scores that have shown the highest correlation with return and risk: Refinitiv E: Innovation score and S&P Global E-score accordingly. ESG-modified Sharpe ratio derived as the relationship between standardized ESG return and portfolio volatility was maximized in order to compute an optimal stock allocation (table 3.4).

Table 3.4. Parameters of ESG-modified optimized portfolios

Portfolio parameter	*ESG score base*					
	Sustainalytics	*MSCI*	*S&P Global*	*Refinitiv*	*Refinitiv E: Innovation*	*S&P Global E-score*
# of securities	10	8	7	8	7	5
ESG-return	20.0	7.4	51.0	65.4	62.5	51.8
Standardized ESG-return, %	60.0	**74.4**	51.0	65.4	62.5	51.8
Expected return, %	7.2	7.2	7.3	7.3	**7.8**	7.1
Volatility, %	12.9	13.2	14.2	**12.6**	14.8	13.1
Sharpe ratio, %	56	55	51	**58**	53	54
ESG-modified Sharpe ratio, %	464	**566**	360	519	422	396

Source: calculated by the author

As demonstrated in the model results, application of 4 out of 6 selected ESG scores into the portfolio optimization model leads to a standardized ESG return of over 60%. In this way, investors can combine different approaches or use a particular rating system based on their individual interests, and still receive a balanced ESG-focused portfolio.

The highest ESG-modified Sharpe ratio is achieved by applying an MSCI-based scorecard, combining average portfolio volatility and high ESG return. At the same time, since the translation of letter ratings required usage of average number scores rather than

actual ones, it may have contributed to a somewhat under- or overestimated ESG evaluation of the stocks in the same letter group.

Evaluation of standard portfolio metrics of volatility and Sharpe ratio concludes that Refinitiv score-based portfolio provides the lowest financial risk to the investor. At the same time, investors that are focused on innovations in the environmental field are rewarded with the highest financial return. Optimizing the portfolio using Refinitiv data is supported by correlation analysis that found the strongest link between Refinitiv scores, return, and risk.

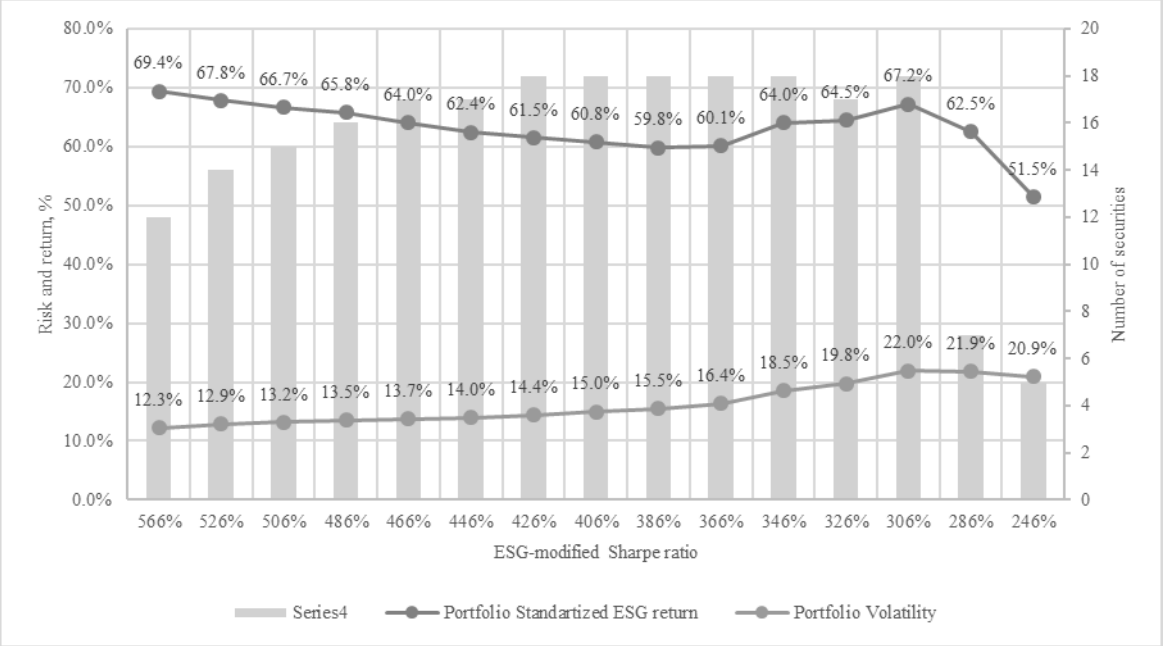

Figure 3.2. Risk and ESG-return combinations at various ESG-modified Sharpe ratio levels based on MSCI scoring

Source: calculated by the author

In comparison to the standard risk-return model, ESG-modified portfolios achieve a slightly lower return (7.2% vs. 7.5% in tab.3.1) and higher volatility (on average 13.5%

vs. 12.7% in tab.3.1). However, considering that ESG-modified portfolio focuses on making an impact rather than achieving profits, these results are adequate for an investor to consider this type of investment in CEE markets.

Solving for different combinations of portfolio weights to derive the ESG-modified portfolio at different levels of ESG-modified Sharpe ratio provides an interesting overview on the correlation between portfolio ESG return, volatility, and diversification.

MSCI-based portfolios compilation (fig. 3.2) shows that in general lower ESG-modified Sharpe ratio is defined by low diversification (246% - 5 securities, 286% - 7 securities), while high diversification (over 15 securities) will mostly lead to a decrease in portfolio volatility and an increase in portfolio's ESG return, maximizing ESG-modified Sharpe ratio up to the point of 450-460%. However, at the cut-off point of ESG return of 65%, the diversification of the portfolio deteriorates lowering the number of the securities included in the optimal portfolio.

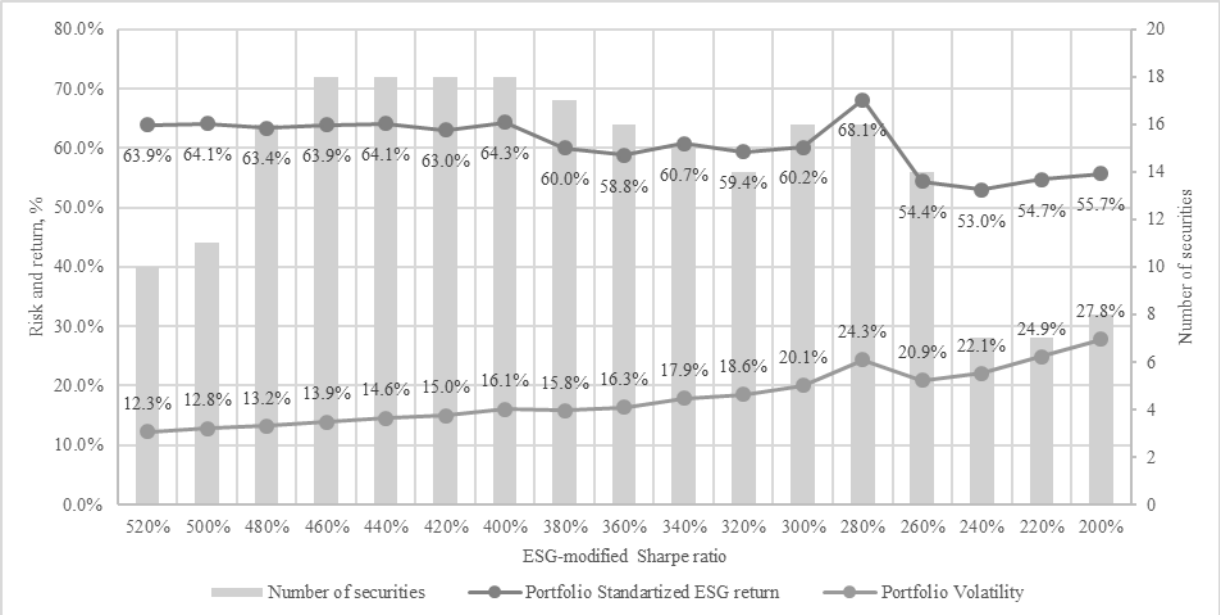

Figure 3.3. Risk and ESG-return combinations at various ESG-modified Sharpe ratio levels based on Refinitiv scoring

Source: calculated by the author

Similar results are retrieved from a compilation of portfolios using Refiniv scoring as a base for ESG-modified Sharpe ratio (fig. 3.3). Low diversification (under 8 securities with at least 1% of weight) is associated with higher volatility and lower ESG returns. However, at the cut-off point of 63.5% return and 13.5% risk in order to maximize the ESG-modified Sharpe ratio, the model requires lowering our portfolio compilation from 17 to 10 securities.

Based on the model results, the first hypothesis was accurate as optimizing ESG-modified portfolio leads to lower diversification (8 companies out of 18). Moreover, the concentration of funds allocated in one stock deteriorates from 80% allocated in 6 securities in the standard model to 80% allocated in 3 securities in the ESG-modified model. Most "ESG-acceptable" funds based on all six models include CEZ as, Moneta Money Bank, and Cyfrowy Polsat SA.

The second hypothesis was rejected based on the research results. Reasons for higher ESG-focused portfolio volatility may lie within lower ESG standards implementation rate among the companies in CEE markets, which leads to a smaller amount of companies that are able to satisfy ESG criteria, resulting in lower risk diversification. It is also worth mentioning that data availability for BUX and PX constituents in regard to different ESG scoring is quite limited, which influences the whole portfolio compilation being dominated by companies presented in WIG-20. Therefore, volatility may be impacted by specific country risks and needs further research.

The third hypothesis was partially accurate, as the Refinitiv-based portfolio has shown the best results both in terms of returns and volatility. On the other hand, the S&P Global Environmental score in the portfolio evaluation demonstrated average volatility in comparison to other portfolios.

Overall, the research results demonstrate that the application of different ESG scores into the portfolio optimization model is a beneficial practice that leads to a balanced

ESG-focused portfolio, allowing investors to investigate ESG-related areas of interest and apply a scoring method that is most suitable for their individual goals. Particular components of E, S, and G pillars can influence financial returns and risks more than others, so in future studies, it is suggested to focus on applying specific industry-related or country-related scores in the portfolio optimization model. Although the study indicates that ESG-modified portfolios in CEE markets tend to have lower risk diversification and higher portfolio volatility, it is important to note that with rising interest in ESG-investing initiatives, the situation may be drastically changing every year, suggesting a necessity to continue the research in further, including new markets and instruments.

Conclusions to Chapter 3

Based on the theoretical background of ESG investing, numerous literature review, and comparative analysis of ESG scoring systems carried out in chapters 1 and 2, we are able to apply the formulated knowledge to developing the three-criteria portfolio optimization model for the CEE market.

Our approach uses the traditional Markowitz mean-variance model that focuses on minimizing the portfolio volatility and maximizing the portfolio approach. We address the limitation of the model connected with ignoring non-financial factors in portfolio evaluation by proposing an ESG-modified optimization model, where we maximize an ESG-modified Sharpe ratio – a measure of risk-adjusted ESG return.

Data used for the model compilation includes daily returns of WIG-20, BUX, and PX stocks over the period of January 2021 – February 2022. The choice of this specific timeline is justified by aiming to evaluate the portfolio's performance during a "non-crisis" period after COVID-19 as well as applying the latest available ESG scoring. ESG quantitative scores used in the research contain assessments from Sustainalytics, MSCI,

S&P Global, and Refinitiv, allowing us to create various portfolio compilations and evaluate their performance. Stocks' betas are compiled using New Europe Blue Chip Index as a benchmark and risk-free rate is calculated based on 10-year government bonds yield in Poland, the Czech Republic, and Hungary.

We compute a traditional risk-return optimized portfolio model as a basis of comparison for an ESG-adjusted optimized portfolio. In addition, Chapter 3 formulates main hypotheses for our ESG portfolio evaluation that can be described as follow:

- increasing the portfolio's ESG return factor results in lower diversification of the portfolio;
- optimal ESG-modified portfolio is less exposed to the risks and shows less volatility in comparison to a classical risk-return portfolio;
- Refinitiv E: Innovation-based ESG portfolio shows higher financial returns than the portfolio compiled based on other scores, while the portfolio optimized for the S&P Global Environmental score bares less volatility.

We then create six ESG-modified portfolios using 4 ESG total scores and 2 factor-specific ESG scores that have shown the strongest correlation with risk and return in Chapter 2. For ESG-modified Sharpe ratio comparability, we standardize all ESG scores to the same scale.

Model results demonstrate that CEE-based ESG-modified portfolio can be optimized to achieve standardized ESG return of over 60% by the measure of Sustainalytics, MSCI, Refinitiv, and Refinitiv E: Innovation scores. Using an MSCI-based scorecard achieves the highest ESG-adjusted Sharpe ratio of 5.66. However, using average number scores for letter ratings may lead to over or underestimating ESG evaluation within the same letter group. Refinitiv score-based portfolios provide the lowest financial risk, while environmental-focused investors using Refinitiv Innovation

score can gain the highest financial return. Correlation analysis supports optimizing portfolios with Refinitiv data.

ESG-adjusted portfolios have slightly lower returns and higher volatility compared to the standard model, but are suitable for impact-focused investors in CEE markets. Diverse MSCI-based portfolios yield higher ESG-adjusted Sharpe ratios, lowering portfolio volatility and increases ESG return up to 450-460%. Similar trends are seen in portfolios using Refinitiv scoring, with low diversification leading to higher volatility and lower ESG returns. At the same time, sensitivity analysis of portfolio compilation to the set of ESG-modified Sharpe ratios demonstrates that there is a cut-off point, at which the portfolio's number of securities must decrease in order to achieve better risk-ESG-return correlation.

As a result, the research findings support the first hypothesis which states that optimizing a portfolio for ESG return causes higher security concentration and lower portfolio optimization. We reject the second hypothesis referring to the lower volatility of ESG-modified portfolios, formulating several reasons that can influence the research results: lower implementation rate of ESG standardized reporting and sustainability practices among CEE market participants leads to a limited amount of securities that can satisfy investor's needs as well as application of ESG scores that are mostly compiled based on peer-to-peer and industry-specific analysis may somewhat distort the results when we make a combined portfolio without an industry focus. The third hypothesis was proved to be partially accurate in regard to Refinitiv-based portfolio parameters.

In further studies, it is recommended to explore a bigger scope of securities like bonds and derivatives to understand whether the financial instrument nature may affect ESG-modified portfolio results. It can be beneficial to extend the scope of studies to industry-specific portfolios to further discover the correlation between ESG scoring methodologies and their impact on portfolio evaluation. Finally, including other available ESG scoring data in the analysis can help regulators and scholars to establish the

advantages and disadvantages of applying certain methodologies and their ability to explain and influence not only the investment's financial performance but also environmental and social impact.

CONCLUSION

ESG investing, which involves evaluating environmental, social, and governance factors in investment decisions, has gained popularity in recent years. Analytic and rating companies have developed ESG score models to assist investors in choosing sustainable investments. However, the impact of ESG factors in Central and Eastern European (CEE) markets remains unclear. This research aims to evaluate the impact of ESG factors on investor portfolio risk and return in CEE markets by applying various ESG scoring systems as well as develop a practical approach for ESG-modified portfolio assessment.

In Chapter 1, the study developed an understanding of the origination of environmental, social, and governance (ESG) investing, discovering its path starting from SRI movement in the 1960s and 1970s, the growth of SRI mutual funds, and the emergence of shareholder activism in the 1980s and 1990s till the United Nations Environment Programme (UNEP) report "Who Cares Wins", which coined the concept of ESG investing. The availability of data related to ESG factors was identified as an important factor in ESG investing growing popularity and related research. The study highlighted that different types of socially responsible investment styles, such as exclusionary screening, positive screening, mission investing, and impact investing, have emerged with different approaches to achieving social or environmental goals while seeking financial returns. The main components of "E", "S", and "G" factors were discussed, highlighting the interconnectedness of all ESG factors with the growing importance of corporate management in implementing environmental and societal changes.

In Chapter 2, it was discovered how introducing standardized reporting into companies' annual reporting has impacted investors' awareness of ESG issues. Analysis of GRI and SASB standards provided a broader understanding of various reporting

frameworks and their complementary effect on each other, while underlining the importance of the European Union Corporate Sustainability Reporting Directive enforcement for standardization and transparency of publicly-traded companies in Central and Eastern Europe markets. Additionally, the study focused on the ESG scoring systems developed by Sustainalytics, MSCI, ISS, Refinitiv, S&P Global, and other rating agencies, defining their core differences that can influence investors' decisions. Correlation analysis of various ESG scores, risk, and return has concluded that Refinitiv ESG scoring and S&P Global rates are the most influential in terms of investment performance.

In Chapter 3, a classical Markowitz portfolio optimization model was extended to cover for ESG-factors, formulating standardized ESG scores and ESG-modified Sharpe ratio. One classical portfolio model and six ESG-modified portfolio models consisting of Warsaw, Prague, and Budapest Stock Exchanges securities were calculated to discover the impact of ESG modification applied in the CEE markets. The results have shown that ESG-focused portfolios, created solely in the CEE market, tend to have a lower return rate, higher volatility, and lower diversification, allowing us to confirm two out of three proposed hypotheses. Portfolios that focus on specific ESG-related metrics like environmental innovation can provide additional returns against the classical optimized model.

Further research recommends examining a broader range of securities, such as bonds and derivatives, to understand whether the nature of financial instruments can influence the outcome of ESG-modified portfolios. To further explore the relationship between ESG valuation methodologies and their impact on portfolio valuation, it may be beneficial to extend the scope of the study to industry-specific portfolios. Finally, incorporating other available ESG assessment data into the analysis will help regulators and academics understand the strengths and weaknesses of using a particular methodology as well as gain a deeper understanding of the environmental and social impacts of an investment.

With the growing amount of exogenous shocks that the market has experienced in the last recent years, aiming for investment that may benefit our environment and society, in the long run, is the best way to ensure one's future. Financial speculations, bubbles, and crises contribute to investors' desire to choose substance over short-term gain, increasing the ESG influence on all the areas of our lives. While slightly underperforming compared to classical risk-return portfolios, CEE ESG-modified portfolio analysis still shows that this investment style has its benefits and should be researched more deeply, encouraging greater data availability, transparency, and the development of sustainable strategies among the market participants.

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Appendix A

ESG scores evaluation by Sustainalytics, S&P Global, MSCI, and Refinitiv

Ticker	Risk	Expected return	SustainAnalytics	S&P Global				MSCI	Refinitiv				
			ESG risk rating	Integral ESG score	E-score	S - score	G - score	ESG Score	Integral ESG Score	E-score	E: Emissions	E: Resource Use	E: Innovation
PEO.WA	40.4%	11.1%	26.5	43		10	42	5.00	73	81	66	56	91
CDR.WA	59.9%	8.1%	14.5	29		14	35	6.43	38	61	80	59	52
CPS.WA	26.5%	6.9%	19	26		41	23	2.14	58	44	32	42	61
DNP.WA	34.5%	7.1%	26.1	14		10	13	3.57	37	26	24	46	0
KGH.WA	46.9%	10.4%	32.9	28		30	26	5.00	57	65	80	53	50
LPP.WA	56.2%	10.8%	14	34		44	31	5.00	62	89	93	85	87
MBK.WA	53.1%	10.7%	14.4	30		26	28	6.43	80	87	59	75	97
PKN.WA	35.8%	10.1%	26.9	37		31	47	5.00	58	57	78	60	29
PGE.WA	48.3%	8.9%	45.3	21		20	26	2.14	47	55	62	46	55
PKO.WA	39.2%	11.0%	23.5	32		26	35	6.43	64	59	68	61	56
PZU.WA	29.3%	9.3%	18.6	38		33	37	5.00	77	64	80	63	60
CEZ.PR	20.1%	7.3%	29.5	59		64	57	7.86	72	79	90	85	58
ERBAG.PR	29.7%	9.5%	14.5	39		28	40	6.43	77	80	59	91	82
KOMB.PR	25.6%	8.8%	22.4	54		40	55	7.86	71	48	98	85	26
MONET.PR	20.7%	6.5%	16.5	38		41	32	7.86	53	28	59	6	26
RICHT.BD	24.8%	7.1%	30.4	21		38	16	6.43	68	54	79	47	0
MOL.BD	27.6%	8.3%	26	61		55	65	7.86	67	69	92	80	29
OTP.BD	37.6%	10.3%	17.4	43		30	45	6.43	76	79	77	68	82

Ticker	Risk	Expected return	Refinitiv (continued)								
			S-score	S: Human Rights	S: Product Responsibility	S: Workforce	S: Community	G-score	G: Management	G: Shareholders	G: CSR Strategy
PEO.WA	40.4%	11.1%	79	59	76	88	82	62	55	76	76
CDR.WA	59.9%	8.1%	36	0	36	82	30	34	27	31	72
CPS.WA	26.5%	6.9%	63	54	93	57	33	59	69	41	35
DNP.WA	34.5%	7.1%	49	55	10	83	59	26	15	69	13
KGH.WA	46.9%	10.4%	64	56	96	60	71	35	17	94	35
LPP.WA	56.2%	10.8%	71	93	90	94	23	39	24	57	85
MBK.WA	53.1%	10.7%	74	71	31	86	90	86	92	62	94
PKN.WA	35.8%	10.1%	46	16	68	71	54	79	97	15	87
PGE.WA	48.3%	8.9%	44	59	20	46	42	38	36	29	62
PKO.WA	39.2%	11.0%	76	78	31	94	78	48	62	13	35
PZU.WA	29.3%	9.3%	79	43	88	86	85	78	94	43	52
CEZ.PR	20.1%	7.3%	64	53	97	54	69	70	72	61	75
ERBAG.PR	29.7%	9.5%	77	59	76	92	68	76	82	75	50
KOMB.PR	25.6%	8.8%	68	39	31	83	94	85	83	83	94
MONET.PR	20.7%	6.5%	34	0	31	58	26	89	94	94	56
RICHT.BD	24.8%	7.1%	75	50	88	77	96	69	75	67	42
MOL.BD	27.6%	8.3%	81	69	95	87	81	39	42	8	75
OTP.BD	37.6%	10.3%	70	0	97	89	77	82	92	67	58

Source: rating agencies' data libraries, Yahoo finance

Appendix B

Covariance matrix for CEE stocks for January 2021 – February 2022 data

Covariance Matrix (Σ) (Jan 1st, 2021 till Feb, 28th 2022)

	PEO.WA	CDR.WA	CPS.WA	DNP.WA	KGH.WA	LPP.WA	MBK.WA	PKN.WA	PGE.WA	PKO.WA	PZU.WA	CEZ.PR	ERBAG.PR	KOMB.PR	MONET.PR	RICHT.BD	MOL.BD	OTP.BD
PEO.WA	0.00054	0.00008	0.00008	0.00006	0.00025	0.00025	0.00043	0.00027	0.00027	0.00044	0.00027	0.00008	0.00020	0.00019	0.00004	0.00008	0.00016	0.00027
CDR.WA	0.00008	0.00119	0.00006	0.00005	0.00008	0.00003	0.00011	0.00009	0.00009	0.00007	0.00007	0.00003	0.00004	0.00005	0.00004	0.00004	0.00009	0.00004
CPS.WA	0.00008	0.00006	0.00023	0.00006	0.00006	0.00013	0.00005	0.00005	0.00009	0.00006	0.00008	0.00001	0.00001	0.00003	0.00001	0.00001	0.00004	0.00004
DNP.WA	0.00006	0.00005	0.00006	0.00039	0.00005	0.00014	0.00007	0.00005	0.00006	0.00006	0.00005	0.00003	0.00003	0.00004	0.00000	0.00002	0.00002	0.00005
KGH.WA	0.00025	0.00008	0.00006	0.00005	0.00073	0.00023	0.00024	0.00029	0.00026	0.00023	0.00018	0.00004	0.00010	0.00010	0.00003	0.00003	0.00013	0.00013
LPP.WA	0.00025	0.00003	0.00013	0.00014	0.00023	0.00105	0.00017	0.00017	0.00017	0.00029	0.00019	0.00008	0.00016	0.00017	0.00004	0.00008	0.00011	0.00024
MBK.WA	0.00043	0.00011	0.00005	0.00007	0.00024	0.00017	0.00093	0.00027	0.00027	0.00042	0.00024	0.00004	0.00017	0.00016	0.00005	0.00009	0.00016	0.00021
PKN.WA	0.00027	0.00009	0.00005	0.00005	0.00029	0.00017	0.00027	0.00043	0.00026	0.00026	0.00017	0.00006	0.00016	0.00014	0.00001	0.00004	0.00015	0.00016
PGE.WA	0.00027	0.00009	0.00009	0.00006	0.00026	0.00017	0.00027	0.00026	0.00077	0.00024	0.00014	0.00007	0.00005	0.00011	0.00002	0.00001	0.00013	0.00011
PKO.WA	0.00044	0.00007	0.00006	0.00006	0.00023	0.00029	0.00042	0.00026	0.00024	0.00051	0.00025	0.00007	0.00019	0.00018	0.00004	0.00008	0.00016	0.00024
PZU.WA	0.00027	0.00007	0.00008	0.00005	0.00018	0.00019	0.00024	0.00017	0.00014	0.00025	0.00028	0.00004	0.00013	0.00011	0.00002	0.00005	0.00010	0.00017
CEZ.PR	0.00008	0.00003	0.00001	0.00003	0.00004	0.00008	0.00004	0.00006	0.00007	0.00007	0.00004	0.00013	0.00005	0.00007	0.00002	0.00002	0.00005	0.00005
ERBAG.PR	0.00020	0.00004	0.00001	0.00003	0.00010	0.00016	0.00017	0.00016	0.00005	0.00019	0.00013	0.00005	0.00029	0.00015	0.00002	0.00004	0.00009	0.00018
KOMB.PR	0.00019	0.00005	0.00003	0.00004	0.00010	0.00017	0.00016	0.00014	0.00011	0.00018	0.00011	0.00007	0.00015	0.00022	0.00005	0.00003	0.00010	0.00015
MONET.PR	0.00004	0.00004	0.00001	0.00000	0.00003	0.00004	0.00005	0.00001	0.00002	0.00004	0.00002	0.00002	0.00002	0.00005	0.00014	0.00003	0.00002	0.00002
RICHT.BD	0.00008	0.00004	0.00001	0.00002	0.00003	0.00008	0.00009	0.00004	0.00001	0.00008	0.00005	0.00002	0.00004	0.00003	0.00003	0.00020	0.00006	0.00008
MOL.BD	0.00016	0.00009	0.00004	0.00002	0.00013	0.00011	0.00016	0.00015	0.00013	0.00016	0.00010	0.00005	0.00009	0.00010	0.00002	0.00006	0.00025	0.00011
OTP.BD	0.00027	0.00004	0.00004	0.00005	0.00013	0.00024	0.00021	0.00016	0.00011	0.00024	0.00017	0.00005	0.00018	0.00015	0.00002	0.00008	0.00011	0.00047

Source: calculated based on stocks' daily returns - Yahoo finance