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INVESTMENT RISK MANAGEMENT SPECIFICS IN ESG INVESTING: CEE STOCK MARKETS EXAMINING

One of the most dynamic trends in the development of the modern market of financial investments is ESG investing. Investing which is based on the inclusion of Environmental, Social and Governance criteria into consideration. In this case, there is an actual problem of analysis mapping ESG criteria with investment risk management. This article considers specific features of inclusion ESG assessments into investment risk management. For this purpose, the S&P Global system of ESG scores was used. The assessments of market risk for both direct and portfolio investments were considered. The dichotomy between the approaches of diversification and prioritization based on ESG criteria had been identified. The article offers expansion of portfolio risk management within the framework of a three-criteria optimization model (risk, return, and ESG score based criteria). The article justifies the investment decision on the basis of construction of an effective set of pair "risk – ESG score" which provides an analogue of the classical frontier line in modern portfolio theory. The implementation of this approach was carried out to the companies included into stock index baskets of three Central and Eastern European (CEE) stock markets: Poland, Czech Republic and Hungary.

Keywords: ESG investing, risk management, stock market, portfolio choice, investment decision.

JEL classification: G11

Introduction and research problem. ESG criteria (Environmental, Social and Governance) incorporation into investment decision-making processes is a strong mainstream of financial markets in recent years. Today it is possible to say that ESG investing is an upending activity at the stock markets and often corresponds to the notion of "sustainable" investments. Thus, more than 25 % of all global assets under management (AUM) are now being invested with a comprehensive ESG factors analysis. Bloomberg estimates that this type of assets are poised to reach $41 trillion by the end of 2022 (Kishan, 2022). The dynamic which is presented in this Bloomberg's research indicates that ESG investing encompasses all developed stock markets: North America, Europe and Japan. ESG investing also penetrates successfully into emerging markets.

Investments with ESG criteria are popular in almost all segments of the modern investment market: the stock market, the bond market, the market of mutual funds, and ETFs. It is interesting that ESG criteria also apply to analysis of alternative investments (Salerno, 2021).

In accordance with its naming, ESG investing is based on three pillars: Environmental, Social, and Governance factors.

The "Environmental" factor concerns a company's environmental performance. This considers a wide range of directions. Namely, biodiversity, climate change mitigation, greenhouse gas emissions, energy efficiency, unconventional forms of electricity generation, waste management and others.

The "Social" factors are considered through the focus on diversity, equity, and inclusion (so called conception DE&I). Diversity at the company is supposed presence and development differences that may include race, gender, age, religion, sexual orientation, ethnicity, nationality and other. The equity factor is promoting justice, impartiality, and fairness within the procedures and processes in a company. Inclusion is the degree of real (not formal "for reporting") implementation of diversity and equity factors in ongoing company activity.

The "Governance" factors correspond to the quality of rules and procedures of corporate governing. Relationships between shareholders and executives, relationships with stakeholders, existence of a meaningful strategic sustainability plan (involves, by the way, "E" and "S" components development). An inalienable part of "G" is a clearly defined position on the issues of political contributions, lobbying, bribery, and corruption.

Interest in ESG investment is driven first of all by accepting fundamental values which are formulated in the 2030 Agenda for Sustainable Development adopted by all United Nations Member States in 2015 (European Commission, 2015). Another aspect of interest concerns sustainable long-term investments. Implementation of these interests does not exclude consideration of investment risks and estimation of expected profitability. To some extent, it is even the opposite. The question grows: how to combine the goals of sustainable investing with desired risk-return correspondence and adopted investment risk management to this? The research presented in this article was carried out in this direction.

It should be noted that ESG investing covers both direct and portfolio investment. One of the key issues is assessments of the ESG level in the company, which is considered as the object of investment. In fact, such assessments would present a complex and multidimensional task. With direct investment (especially majority holdings) it can be carried out by the investor independently. However, with portfolio investment this is not rational and, in fact, it is impossible (ESG estimations of 100 companies whose shares are included into the portfolio, direct way is not real). Therefore, a number of global agencies have developed ESG scoring systems. Such scoring in numerical form reflects the level of ESG criteria implementation into company activities. It is a numerical approach that allows one to effectively include the ESG level in the modelling of the portfolio structure.

Our approach is based on expansion of the classical two-criteria (risk-expected return) optimization problem. Expansion focuses on the adding criterion of maximising the portfolio's ESG score. In this case, several specifics have been raised. The most important of these is the contradiction between the classical diversification and the prioritization of investment decisions in financial instruments with high ESG score companies. This creates specific risk management features. The proposed solution is based on the construction of an analogue of an effective frontier in the space "risk – ESG score".

Our research was carried out in this direction based on the analysis of large companies in Central and Eastern Europe (CEE) stock markets. This is interesting because such companies only start to receive ESG assessments.

Literature review. The attention of investment market theorists and practitioners to ESG investing has increased significantly in the last 10 years, which is reflected in the rapid growth of the number of publications dedicated to this direction. This is exhibited in the wide overview (Gao, Meng, Gu, Liu, & Farrukh, 2021). Article presents bibliometric ordering of publications focused on ESG frameworks. Authors statistically ground the exponential growth in scientific publications at the period of the last 30 years.

Of course, starting points of ESG consideration trace back to mid-century, when investors began to focus on excluding some investment products that conflicted with certain social, or personal moral, or ethical values and beliefs. And the key point was the UN's adoption of 17 goals in this direction, presented in (European Commission, 2015).

The essence of ESG criteria and their raising and deep understanding were elaborated in the paper (Bergman, Deckelbaum, & Karp, 2020). This publication encompasses an explanation of ESG factors as critical issues for companies at such frameworks.

The broad variety of ESG investing aspects set out in the article by Boffo and Patalan (2020). This paper includes deep analysis of qualitative and quantitative presentation ESG factors at their inter-relationships with investment management. Authors elaborate the attitude and interests of different market participants at the frameworks of ESG financial ecosystem.

Of course, one of the crucial elements of ESG investing is to answer the question: how to get an understanding of the ESG level at the company which is considered to be an object for investment? We use approach based on ESG scores and in the context it should be pointed out information resource (ESG The Report, 2020). This informational resource provides review of ESG scoring assessments and explanations for companies and individuals looking for ESG investing.

The basic points of our research focuses on risk and return considerations and their consideration is crucial for proposed investment risk management. Investment risk measuring is structured in different approaches in (Kaminskyi, Motoryn, & Pysanets, 2019). The integrated approach for risk assessment was considered in (Kaminskyi, Butylo, & Nehrey, 2021). Taking into account that such an indicator as K-ratio was applied in our research and in this aspect it should be indicated in the paper (Kestner, 2003), where K-ratio was considered.

Portfolio approach in ESG context was considered in (Hill, 2020). The author considers basic elements of portfolio theory. It includes considering risk-return correspondence, the nature of diversification, efficient frontier, CAPM and other. ESG efficient frontier was considered in (Pedersen, Fitzgibbons, & Pomorski, 2021). Authors

propose a theory in which each stock's ESG score plays two roles: (1) providing information about firm fundamentals, and (2) affecting investor preferences.

It should be noted that similar questions were considered in (Giese, Lee, Melas, Nagy, & Nishikawa, 2019). Authors had analyzed stock returns in relation to ESG scores.

From a more general point of view, the analysis of the relationship between ESG scoring and profitability and risk is presented in (Giese, Nagy, & Lee, 2020). In this paper, the analysis of profitability is considered as a whole from the index ESG, and its components E, S, and G separately. This approach allows a deeper understanding which factors determine profitability more than others.

The results of our research are interesting to consider through cross-analysis with (Zehir & Aybas, 2020) where authors considered similar issues but on other markets.

Research goal and questions. The basic goal is to form a grounded approach to portfolio investment decisions which take into account three components: risks, profitability, and ESG scores. The initial research question concerns analysis of relationship between ESG scores and risk-return correspondence. Another crucial question encompasses the dichotomy between diversification effect and ESG investing focus.

Data. *Data sources.* Time horizon for analysis was 2017–2022 years. The first data source was information resources of stock indices. It was considered indexes of CEE stock markets (Bulgaria, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Romania, Slovenia, Slovakia). Companies included into the index baskets were selected for research.

The second data source was ESG assessments for selected companies. It analyzed various ESG score providers. Namely, scoring data of such providers as S&P Global, MSCI, Sustainalytics and Gartner were analyzed. There were two criteria for scoring selection procedure: completeness of scoring coverage for the specified period and information component of scoring report. The ESG scoring system S&P Global was chosen.

Assessments of risks and returns values were calculated on the basis of information resource Investing.com. Given the fact that quotes are presented in different currencies, we used the returns also presented on this resource. The time interval for analysis was a week.

Data cleaning. The data for the research were analyzed by ESG score availability. Only three indices include companies with ESG scores of S&P Global providers. They are PX (Czech Republic), BUX (Hungary), and WIG20 (Poland). This is a reflection of the fact that the ESG score valuation processes, to a certain extent, are only beginning in CEE stock markets. The ESG scoring system S&P Global was launched in 2013.

Analysis of the data regarding the information provided by Investing.com showed that some of the companies under consideration were new to the corresponding market and information was not complete to research.

As a result, 21 companies had all necessary information and they were involved into research.

Methodology. The initial methodological aspect of the investigation was the grounding of a certain relationship between the company's ESG and risk level and profitability. This aspect arises from the nature of ESG factors. Indeed, these factors focus on sustainable development and should reduce risk in the long run and ensure stable returns. Thus, the first question raised in the study was the analysis of the existence of assumed relationships. One of the components of this is the choice and reasoning of a certain indicator (risk, profitability, or their ratio).

During the analysis we studied a number of dependencies, but the focus was on the dependence between K-ratio and ESG score. Why was K-ratio selected? Because from our point of view K-ratio corresponds to consistency of returns over time. Our methodological assumption that K-ratio mathematical expression of consistency interrelates with "sustainability". Really, the basis for consideration of K-ratio is value-added index (VAI). If we fixed some time interval (week, month, quarter or year) we will receive raw of (random) variables for n periods (with chosen length of time interval):

$$r_{0,1}, r_{1,2}, \ldots, r_{n-1,n},$$

where $r_{i,i+1}$ denotes return from period i to $i + 1$.

Value-added index is defined as:

$$VAI = 1000(1 + r_{0,1})(1 + r_{1,2}) \ldots (1 + r_{n-1,n}).$$

By definition (Kestner, 2003) K-ratio will be:

$$K - ratio = \frac{Slope\, of\ linear\ regression\ for\ VAI}{Standard\ error\ of\ slope}.$$

Summarizing this methodological point we study dependency K-ratio from ESG score. The results are below.

Second methodological aspect raised from modern portfolio theory. The starting point is the assumption that investors want to minimize risk and at the same time maximize expected return.hese criteria are "don't go in the same direction". Typically, higher return is accompanied by higher

risk. The portfolio risk management is based on constructing "efficient frontier" and considering "Markowitz efficient portfolios" (Hill, 2020). Our approach is to add to the optimization problem criteria of maximization portfolio ESG score:

$$\begin{cases} \sigma_p^2 \to min \\ ER_p \to max \\ ESGscore_p \to max \end{cases}$$

After that to apply efficient frontier techniques for investment risk management set out.

The consideration of dependences between three indicators at the frameworks of 3 criteria optimization model is third our methodological aspect.

Main findings. The first step in the research was to calculate the indicators of risk, expected return, K-ratio. These calculations are given in Table 1. The Table 1 involves ESG scores on the base of two periods: 2019 and 2021 years. Also, the relative increase of scoring values is presented. This shows that the processes of introducing ESG criteria into the activities of CEE companies are very active and scores demonstrate average 62 % increasing in scoring over two years.

The indicators in Table 1 illustrate the pattern from the first methodological aspect. Specifically, it was suggested that K-ratio in the next period depends on the current ESG score values. For this purpose we considered ESG scores for 2019, and K-ratio values were calculated for the period from 31.05.2020 to 22.05.2022. The shift in dates from 01.01.2020 to 31.05.2020 is due to the desire to eliminate the huge volatility caused by the announcement of COVID-19 pandemic at the beginning of March 2020.

The main result of considered data is a nonlinear (logarithmic) relationship between K-ratio and ESG score (pictured at Fig. 1). Points in this picture are adequate companies. This supports the assumption that a higher ESG score creates a more consistent level.

Our correlation analysis shows that the relationship with ESG score is most pronounced with K-ratio (0,65). So, the correlation between the risk level (index σ) and ESG score is estimated as -0,35. Correlation between expected returns and ESG score estimated as 0,22.

The portfolio analysis of three-criteria optimization problems (indicated above) can be

Table 1. **Basic indicators**

Index	Company	ESG score 2019	ESG = 2021-2019	% of changes	ER	Risk	K-ratio
BUX	MOL Group	70	-1	-1 %	0,001	0,026	0,023
PX	ČEZ	36	20	56 %	0,001	0,019	0,058
PX	KOMERČNÍ BANKA	34	18	53 %	0,000	0,020	0,029
PX	ERSTE GROUP BANK	52	-3	-6 %	0,001	0,031	0,024
BUX	OTP Bank	34	6	18 %	0,004	0,029	0,015
PX	VIG	27	9	33 %	0,001	0,025	0,019
WIG20	Bank Polska Kasa Opieki SA (PEO)	20	14	70 %	-0,001	0,030	0,028
WIG20	Santander Bank Polska	29	5	17 %	0,000	0,033	0,024
WIG20	PKO Bank Polski	26	6	23 %	0,002	0,031	0,030
WIG20	OrangePL	22	8	36 %	0,000	0,036	0,017
WIG20	CCC SA	16	11	69 %	-0,002	0,049	0,009
WIG20	KGHM Polska Miedź SA (KGH)	15	10	67 %	0,001	0,043	0,020
WIG20	Cyfrowy Polsat SA	8	16	200 %	0,001	0,028	0,014
WIG20	MBANK	24	0	0 %	0,002	0,039	0,019
WIG20	Polskie Górnictwo Naftowe i Gazownictwo SA (PGN)	19	4	21 %	-0,001	0,034	0,037
WIG20	LPP SA	17	6	35 %	0,004	0,039	0,031
WIG20	Grupa Lotos	21	1	5 %	0,006	0,047	0,003
BUX	Gedeon Richter	16	4	25 %	0,001	0,029	0,021
WIG20	PGE SA	13	7	54 %	-0,001	0,043	0,031
WIG20	CD PROJEKT	3	15	500 %	0,012	0,054	-0,037
WIG20	ASSECO POL	11	4	36 %	0,002	0,033	0,031

considered in several two-dimensional planes. To analyze the linkage between portfolio risk and ESG score we have constructed a dependency curve between ESG score and portfolio risk (Fig. 2). In fact, it is analogous to the classical efficient frontier where included ESG scores of portfolio. Portfolio corresponded to the points of efficient frontier raised from minimization of risk under fixed level of ESG scores.

Constructed curve AOB demonstrates non-linear dependency between portfolio risk and ESG score. Point O corresponds to a portfolio with minimum risk. In this context it is logical to use the OB part of this curve for investment risk management. Really, this part of the efficient frontier provides a marginal rate between increment ESG portfolio score and portfolio risk. The crucial fact that higher ESG portfolio score leads in one direction with higher

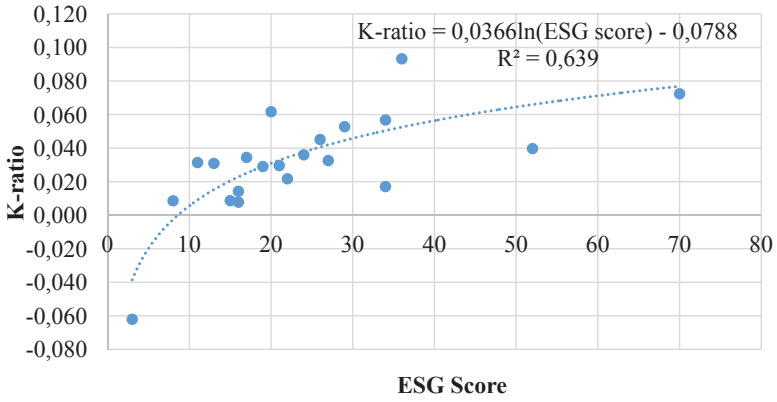

Fig. 1. Dependency between K-ratio and ESG score

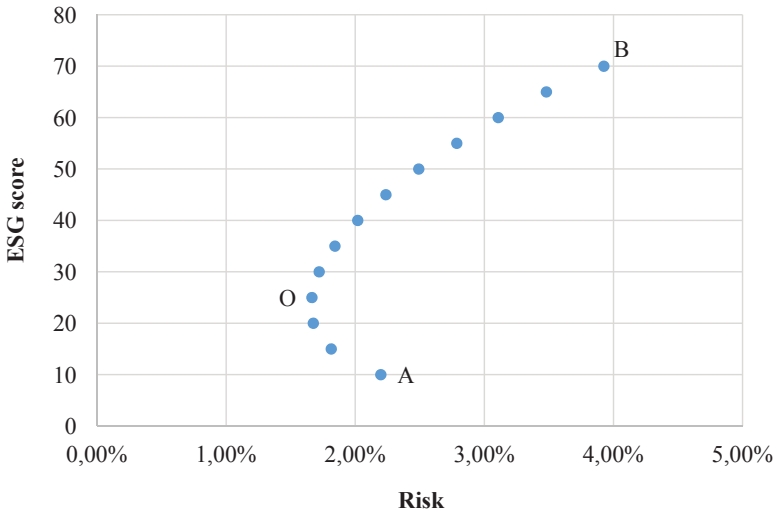

Fig. 2. Efficient frontier "Risk – ESG score"

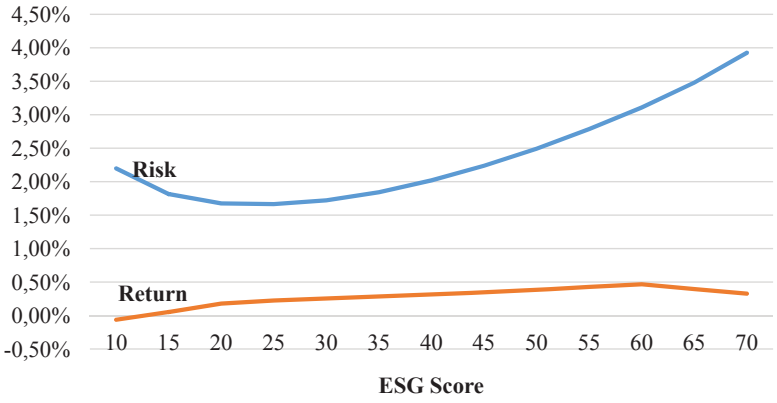

Fig. 3. Dependency between risk, return and ESG scores of portfolios

risk. The explanation raised from the decreasing number of companies in portfolio when we "raising the bar" of portfolio ESG score. This leads to a decreasing diversification effect and increasing risk.

Continuation of this analysis includes consideration of dependencies with profitability. Dependency data are given in graphic form on Fig. 3.

Fig. 3 demonstrates nonlinear interdependence as couple of "risk – ESG score" as couple of "expected return – ESG score". Founded dependencies set out frameworks of risk management.

Conclusions. Investing with ESG factors generates a number of specific features of risk management. They should be taken into account in both direct and portfolio investment. The first feature is the presence of certain relationships between the implementation of ESG factors and the level of risk and profitability. At the same time, there was no clear verified correlation with the classical indicators of risk and profitability in the portfolio theory in our study. Although the risk shows a small level of negative correlation. However, we used K-ratio as a consistency of investments indicator and it demonstrated a non-linear dependence with ESG scores. In our view, K-ratio largely reflects the numerical expression of the nature of ESG and can be used as a measure of implementing ESG in portfolio context.

An important effect of investment risk management in ESG investing is the dichotomy between diversification and prioritization of investment in companies with high ESG scores. We have confirmed this effect on the studied data. In order to adapt the investment risk of management to this effect it is proposed to build an efficient frontier of couple "Risk – ESG score". This approach gives an understanding of the marginal rate of substitution risk by ESG effect. It allows us to transform the problem into a numerical form.

The conceptual approach of management risk in this case may be the use of indicator "Minimum Acceptable ESG Level". I.e. determining the minimum acceptable ESG portfolio score and following risk minimization. However, it is necessary to keep in mind that a high level of ESG portfolio score will not necessarily correspond to a portfolio in which all components will be high ESG score. This is explained by the linearity of the scoring function.

Another strategy might be to apply the indicator "Minimum Acceptable ESG Level" not to the portfolio, but to specific companies. At the same time, the effects of diversification may be reduced and more risky. The comparison of this strategy with the strategy presented in this article is the subject of further research.

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ХАРАКТЕРИСТИЧНІ ОСОБЛИВОСТІ ІНВЕСТИЦІЙНОГО РИЗИК-МЕНЕДЖМЕНТУ В ESG-ІНВЕСТУВАННІ: ДОСЛІДЖЕННЯ ФОНДОВИХ РИНКІВ ЦЕНТРАЛЬНОЇ ТА СХІДНОЇ ЄВРОПИ

Одним із найдинамічніших трендів розвитку сучасного ринку фінансових інвестицій є ESG-інвестування, тобто інвестування, яке ґрунтується на залученні до розгляду екологічних, соціальних та управлінських критеріїв. Частка цього виду інвестування на світових ринках уже перевищує 30 % інвестиційних активів, що перебувають в управлінні. Тож актуальною стає проблема аналізу зіставлення ESG-критеріїв з інвестиційним ризик-менеджментом. Ця проблема є предметом дослідження, проведеного із застосуванням до портфельного інвестування на ринках Центральної та Східної Європи. З цією метою в роботі було використано скоринги ESG, що розраховуються за методологією системи S&P Global.

Оцінювання ринкового ризику було здійснено як для прямих, так і для портфельних інвестицій. Для прямих інвестицій було проведено дослідження між значеннями ESG-скорингу та низкою показників ризику та дохідності. Ідентифіковано взаємозв'язок між значеннями скорингу та показником K-ratio. Цей взаємозв'язок змодельований логарифмічною залежністю.

У межах проведеного дослідження було ідентифіковано дихотомію між підходами диверсифікації та пріоритизації ESG-критеріїв при інвестуванні. Запропоновано розширення портфельного ризик-менеджменту в межах трикритеріальної оптимізаційної моделі (мінімізації ризику, максимізації очікуваної дохідності та максимізації ESG-скорингу портфеля). У статті обґрунтовано інвестиційне рішення, що базується на побудові ефективної множини у площині «ризик – ESG-скоринг». Це є певним аналогом ефективної множини «ризик – дохідність» у сучасній портфельній теорії.

Вибудований у дослідженні підхід ризик-менеджменту було застосовано для створення інвестиційного портфеля з компаній, включених у кошики трьох фондових індексів ринків Центральної та Східної Європи, а саме: PX (Чехія), WIG20 (Польща), BUX (Угорщина).

Ключові слова: ESG-інвестиції, ризик-менеджмент, фондовий ринок, вибір портфеля, інвестиційне рішення.

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