Assessing the efficiency of green investments based on portfolio approach

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Abstract. Green finance plays a critical role for achieving sustainable development goals. Scaling up green investments and increasing their efficiency requires addressing a number of methodological and practical problems. One of these is a problem of efficiency evaluation. The approach to assessing green investments efficiency proposed in the paper is based on the investment portfolio model. Its application makes it possible to assess green investments with regard for their principal impact on the investment portfolio quality rather than on the basis of actual results of environmental projects. The proposed methodology makes it possible to derive an acceptable rate of return on green investments for inclusion in the investment portfolio, as grounded on the identification of alternative ways to achieve environmental objectives. Using the example of forest cultivation, an algorithm is presented for estimating the guaranteed return proceeding from natural productivity, which can be used to evaluate the acceptable efficiency of investment in both forestry and alternative projects that aim at reduction of greenhouse gas concentration and development of sustainable power engineering. Even in case of low return, green investments can be financially attractive if they contribute to reducing the investment portfolio risks. The usefulness of the proposed approach depends on completeness of accounting the investment projects' environmental risk in overall market risk evaluation.

Keywords: Investment portfolio · Green finance · Sustainable development · Environmental risk.

1. Introduction

The transition to sustainable development requires a new model of production and consumption that would take into account the scarcity of natural resources and the need to maintain favourable environment (Spash, 2020). This means major restructuring of economy, including the development of efficient green sector. In this context, the role of green finance, in particular investments (Policy Framework for Investment, 2015; Sachs et al., 2019; Mishulina, 2019) necessary for the formation of a new environmentally oriented economic structure, increases significantly.

The literature review shows that the category of green investments is interpreted quite broadly. According to the G20 report (Inderst et al., 2022), the notion of green finance refers to investments that provide environmental benefits and contribute to realisation of sustainable development goals. In terms of a more applied aspect (Lindberg, 2014), green investments assume funding of public and private projects in the following areas: ecological goods and services, prevention and compensation of environmental damage, governmental programmes and public policy measures in the field of ecology,

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etc. A study by the Organisation for Economic Cooperation and Development (Green Finance Synthesis report, 2016) ranks green investments according to the nature of their involvement in achievement of ecological goals. To a large extent, direct participation is characteristic of investments in green jobs and green infrastructure. At the same time, investments in green securities or those in financial institutes dealing in green investment contribute to environmental goals indirectly, which can affect their efficiency.

The efficiency factor is one of the main obstacles to more active investment in the green sector of economy (Jacobs, 2013; Verenko and Kamenkov, 2018). The key problem is translating the environmental effect into the investor's cash flow. The better the environmental aspects are reflected in financial results, the more adequate is efficiency evaluation. The present research explores the possibility of applying the portfolio approach for improving the reliability of green investment efficiency assessment.

2. Materials and methods

Typically, evaluating the efficiency of green investments involves comparing them to conventional investment options. Under this approach, there is a high probability that the green alternative is less attractive in terms of returns. However, this assessment does not fully take into account the intended use of green investments. Green investments are not only a factor of economic growth, but also a means to prevent (mitigate) the environmental damage caused by it. By their nature, green investments act as a compensating component of the investment strategy of a country (region, company), which makes it appropriate to use the investment portfolio model to assess their efficiency. In this context, the main objective of the study is development of the approach that would adapt the portfolio analysis to evaluation of green investments.

Diversification is a key factor in forming an optimal investment portfolio, since it minimises the unsystematic risk while providing average market profitability (Markowitz, 2005). In this regard, the efficiency of green investments can be expressed through their impact on the portfolio quality. To evaluate the latter, it is customary to use the Sharpe ratio S_r (Berk and DeMarzo, 2017)

$$S_r = \frac{R_p - R_f}{\sigma_p}, \quad (1)$$

where R_p is the investment portfolio yield, R_f is the risk-free return taken at the level of profitability of risk-free government securities, σ_p is the measure of volatility of additional portfolio yield (R_p - R_f).

The risk-free rate of return is easily determined on the basis of publicly available information. Estimation of return on risky investments requires more sophisticated methods. One of the most popular methods is the capital assets pricing model (CAPM). It is based on the formula (Berk and DeMarzo, 2017)

$$R_i = R_f + \beta_i \times \left(R_m - R_f\right), \quad (2)$$

where R_i is the expected return on the *i-th* asset (investment portfolio), R_m is the average return in the investment market in broad terms (the yield on most representative stock exchange indices is often used as a proxy for this indicator, for instance, S&P 500); β_i is the beta of the *i-th* asset.

The key role in this model belongs to beta β_i which determines the measure of systemic risk inherent in the asset (investment portfolio) and is calculated as a covariance of volatility of the *i-th* asset and the market volatility as such. If $\beta_i = 1$, then the risk of investment and its yield is in line with the market average. The assets with $\beta_i > 1$ are relatively risky since they demonstrate above-the-market profit against the growth of economic activity and higher losses during economic downturns. If $\beta_i < 1$, then the sensitivity of investments to market fluctuations is below average, with the relevant risk.

Thus, the beta expresses the relationship between the returns and the level of systemic risk, while the Sharpe ratio S_r is a formal expression of the optimality criterion. Its use implies that high-yielding assets do not necessarily improve the quality of the investment portfolio if the increase in returns is accompanied by the increase in volatility. At the same time, the increase in coefficient is possible even in the situation of adding a low-return asset to the portfolio, if this is matched by low systemic risk which contributes to portfolio volatility reduction. This is especially true for the assets with $\beta_i < 0$. Given that their dynamics is opposite to the market trend, they are often added to the portfolio as a safety net.

In terms of this approach, green investments can be viewed as part of the portfolio; this may refer to any investment package of a country (company) that includes green project funding as its integral part. This makes it possible to assess their efficiency through their impact on the portfolio quality on the whole. It is therefore important to assess not only the yield, but also the risk level.

From the sustainability perspective, risk is not limited to market volatility. It should include assessment of environmental hazards and social uncertainty. However, the diversity of factors complicates the task of reducing risk to a single parameter which could be used in formulas 1 and 2. For instance, the concept of planetary boundaries, which is used to analyse global environmental risks, includes a minimum of 9 parameters (Steffen et al., 2015). Various ecological rankings and indices include many more parameters (Lopachuk, 2021). However, despite the difficulties in quantifying risk, the portfolio approach can be used to evaluate the acceptable profitability of green investments depending on their intended use.

A distinctive feature of green investments is their focus on maintaining the ecological balance disturbed by the degradation of natural ecosystems. Accordingly, the latter can be treated as a natural alternative to investments. In this case, the effect of green investments can be equated to gain from using the ecosystem, which is mathematically expressed as follows:

$$\sum_{t=0}^{N} \frac{E_t}{(1+R_m)^t} = \sum_{t=0}^{N} \frac{F_t}{(1+R_b)^t}, \quad (3)$$

where E_t is the effect of using green investments in year t; F_t is the guaranteed income yielded through the ecosystems' natural productivity in year t; R_b is the return on natural capital; N is the period under review.

Assuming that E_t and F_t remain constant over an indefinite period, formula 3 may be simplified

$$\frac{E}{R_m} = \frac{F}{R_b} \quad (4)$$

The parameter R_b is determined by natural productivity; therefore, it can be viewed as a guaranteed profit. In this respect, it is similar to the risk-free rate R_f in formulas 1 and 2, although not being fully equivalent, given the difference in financial and natural processes. It can be asserted that if $R_f < R_b$, then there exists an environmentally safe potential for economic growth, and vice versa. An environmentally optimal fiscal policy implies the equality $R_f = R_b$; in this case formula 4 is reduced to the expression

$$\frac{F+E_r}{R_b+R_r} = \frac{F}{R_b} \quad (5)$$

where E_r is the undefined part of the ecosystem's use effect conditioned by environmental risk; R_r is the risk margin (second part of formula 2).

Assuming that green investments completely eliminate the environmental risk, the right-hand side of the equation can be used for their evaluation. Accordingly, their affordable cost is calculated on the basis of the guaranteed income F from sustainable use of ecosystems.

3. Results

Applying the proposed approach assumes that the alternative to green investments are natural areas whose transformation has led to distortion of the ecological balance and raised the need for green investments as such. The most common type of natural territories in midlatitudes is forestry ecosystems. It is therefore appropriate to take them as a basis for demonstration of such approach.

The level of guaranteed income in sustainable forestry is determined by productivity of the ecosystem, and the relative indicator of risk-free yield (R_b) – by exploitable age. In particular, with a rotation period of 100 years and the average standing volume of 300 m^3 per hectare, the annual return in the form of wood increment is 3 m^3 or 1% (3/300 and 1/100 respectively). As a result, the biological processes, if the risk of natural disasters and price changes is neglected, guarantee the profitability of 1%. This rate of return is similar in nature to high-grade government bonds, and therefore can be considered as risk-free. Adding green investments with the above characteristics to the portfolio will improve its quality because, despite the low profitability (1%), the zero risk means the Sharpe ratio increment.

When using the proposed method, it is important to understand that green investment projects do not always involve exclusion of environmental risk altogether. If it is a question of its reduction, the problem of valuation remains relevant. In addition, risk-free yield based on guaranteed natural productivity may vary significantly depending on the type of ecosystem adopted as an alternative or direct investment target. With regard for this factor, the table below gives examples of assessing the acceptable return on different types of green investments.

Table 1. Acceptable return on selected types of green investments.

Green investments patterns	Key evaluation parameters		
	Natural alternative	Environmental risk level	Rate of return, %
Wetland restoration	-	none	1%
Forest cultivation	-	minimum	1-3%
Wind and solar energy	forest ecosystem	minimum	3%
Organic farming	-	minor	3-5%
Water efficiency improvement	aquatic ecosystem	minor	4-7%
Waste management	different types of ecosystems	depends on waste management process	broad range

The presented figures are approximate and need specification for every investment project. Nevertheless, they clearly demonstrate the logic of the approach. Higher financial benefit implies more intensive exploitation of ecosystems, contributing to greater imbalance between natural and economic processes and increased risk. In this context, a 2% return may be considered acceptable for sustainable forestry which is characterised by virtually zero environmental risk, whereas hazardous waste recycling supposes a higher return needed to compensate the increased risk.

4. Discussion

When applying the portfolio approach to assessment of green investments, they should be regarded as a kind of safety net that improves the portfolio quality by reducing risk, although the yield may fall. As practice shows, a significant part of green assets are characterised by a relatively low systemic risk (Akomea-Frimpong et al., 2021). This is confirmed by the data from (Yahoo Finance, 2022) which show that the shares of most companies operating in the sphere of renewable energy and water supply have a beta value less than one. A similar trend is observed for green bonds that are often traded at a premium compared to conventional bonds, while demonstrating less volatility (Bachelet et al., 2019).

At the same time, market risk does not fully account for environmental risk. The inclusion of factors that consider environmental risk in the denominator of formula 1 would significantly improve the attractiveness of green investments. The problems with valuation of environmental risk hinder its formalisation and limit the possibility of its consideration in financial markets. However, the role of green investments is significantly greater at the level of a country's or region's investment portfolio where decision-making largely involves strategic risk considerations. In particular, there is a tendency for green investments to increase in times of crises, when governments take particular efforts for structural adjustment (Zahan and Chuanmin, 2021; Dzeraviaha, 2020). This is confirmed by the content of economic support programmes implemented in a number of countries during the 2008-2009 recession and the pandemic-related global crisis of 2020; they include The European Green Deal (The European Green Deal, 2022) – the most ambitious programme of the European Union in terms of green funding – and other similar programmes.

5. Conclusion

Generally, green investments are aimed at achieving certain environmental objectives, which is often accompanied by fall of profits and financial attractiveness. Applying the portfolio approach allows their valuation to be structured with regard for their impact on the portfolio quality in broad terms. Given the green investments' ability to reduce the overall risk level, their attractiveness can increase significantly in the situation of insignificant yield.

This article presents an approach to estimating the minimum acceptable return on green investments. At the same time, the problem of formalisation of environmental risk which is far from being fully taken into account in market risk evaluation requires additional research. Its solution will make it possible to assess the efficiency of green investments more adequately and increase the attractiveness of such investments on the part of investors.

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