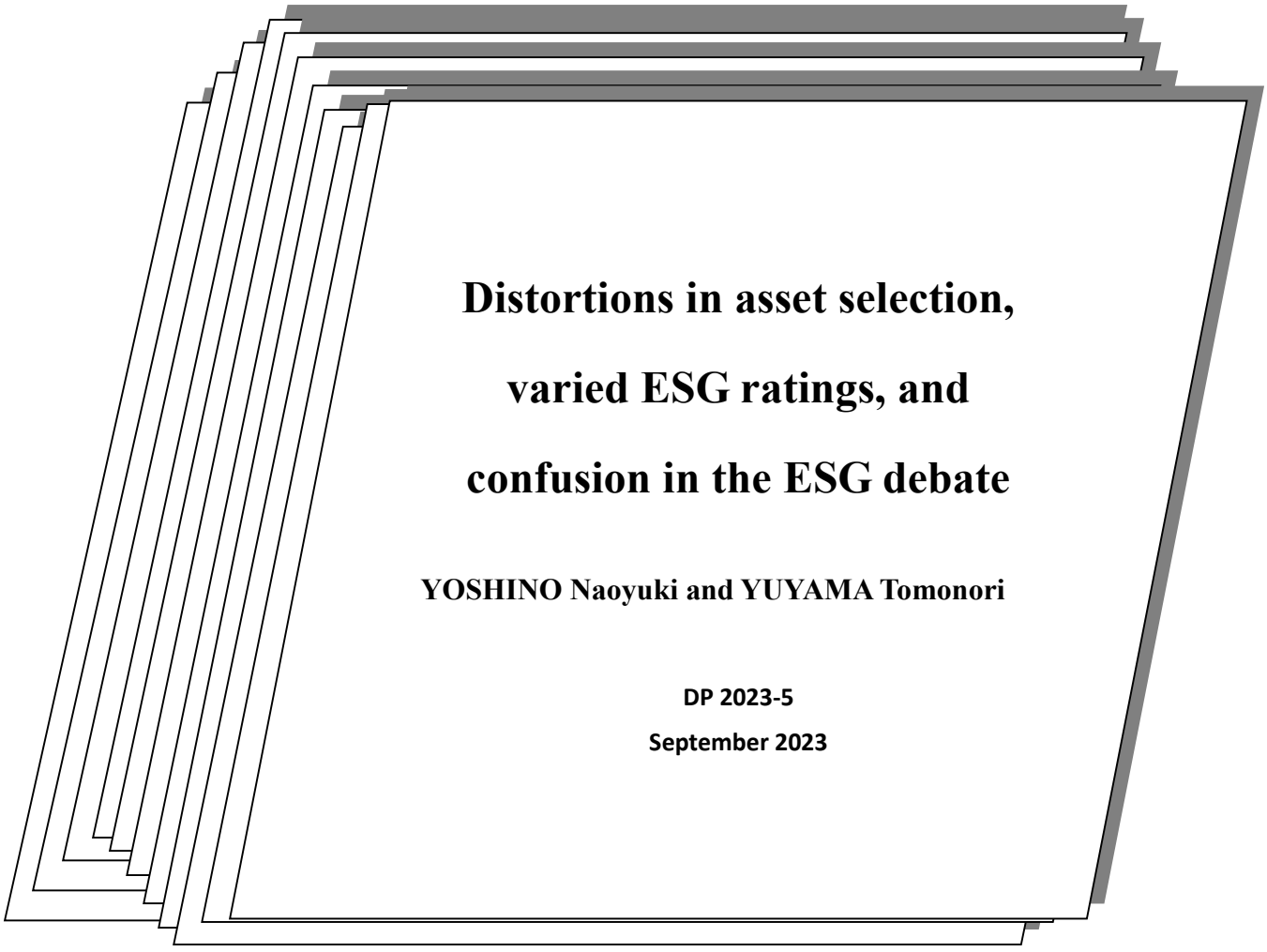

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Distortions in asset selection, varied ESG scores, and confusion in the ESG debate

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Abstract

ESG investments have become increasingly popular in recent years, and to support such investments, many rating agencies are providing ESG scores of firms. Meanwhile, the debate over ESG is very confusing and swinging, especially in the U.S., and there is a lot of discussion about how it should be done, including political thought. We discuss this issue from an investment-theoretical background. Through consideration of ESG factors, the ESG investment model may have moved from the traditional two-factor model of risk-return to a three-factor model adding an ESG component to it. This paper indicates the potential for distortion of asset allocation through the shift from traditional risk-return considerations to ESG score considerations. This is equally true for green bonds, resulting in the potential for asset allocation to be distorted by green bond criteria. Furthermore, we show that imposing a net carbon tax on greenhouse gas (GHG) emissions is a measure to correct this distortion in asset allocation and make asset allocation more risk-return based, in addressing global environmental issues.

Keywords: ESG (Environmental, Society and Governance); SDGs, Green investment; ESG score, Green credit rating; Net carbon tax.

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1. Introduction

In recent years, with the Sustainable Development Goals (SDGs) proposed by the United Nations and the Paris Agreement (2015), ESG (Environment, Social, and Governance) investment and the issuance of green bonds (ESG bonds) have been growing in Japan and internationally. Environmental improvements, especially reducing emission of CO2 and other toxic gases are key to achieving the 2050 net zero carbon target. However, the recent situation in the U.S. is somewhat different, and in fact, it has been pointed out that the outstanding amount of ESG investments in 2022 was actually half of that in 2020 (the previous survey).[1] Therefore, we first summarize the status of recent discussions on ESG in the U.S. In the U.S., while there is a view that ESG investments should be promoted to solve climate change issues, etc., with a clear and high level of awareness (also known as "woke capitalism"),[2] there is an anti-ESG view among conservative forces that the recent ESG movement is too radical. As such, the recent ESG debate is somewhat confused against a background of division in the U.S. society.

Next, we discuss the ESG investment debate from an investment-theoretical perspective, distancing ourselves from political considerations and protection of the energy industry. From the perspective of fiduciary duty, ESG investments include (1) the view that ESG factors should be allowed as long as they contribute to improving risk/return (Schanzenbach and Sitkoff 2020), (2) the view that considering ESG factors is in itself a fiduciary duty, as seen in Europe mainly (UNEP-FI and PRI 2019), and (3) the view that ESG investments should aim to resolve social and environmental issues (impact), as represented by the SDGs issues. All of these are intended not only to make decisions and make investments based on the traditional two factors of return and risk proposed by Markowitz (1952, 1991), but also to take into account ESG factors as a third factor in their investment decisions. Furthermore, a more detailed consideration of (2) can be divided into whether ESG factors should be considered as a third investment decision factor independent of risk/return or as a third factor insofar as it influences risk/return.

Several investment models that take ESG factors into account have been presented in existing studies. Yoshino *et al.* (2021a) note that, in addition to traditional investment decision factors based on risk and return (Markowitz 1952, 1991), ESG factors are added as independent determinants, which can distort risk-return-oriented asset allocation. Hong and Kacperczyk (2009) note that so-called toxic stocks ("sin" stocks), such as those of tobacco and alcohol companies, are considered stocks with low ESG scores, and tend to be undervalued by investors, which in turn increases their returns. On the other hand, many papers point out that stocks with superior ESG factors generate high excess returns

[1] US SIF (The Sustainable Investment Forum) (Dec 13, 2022) Blog. ""Trends Report" Documents Sustainable Investment Assets Of $8.4 Trillion." (https://www.ussif.org/blog_home.asp?display=194)
The survey is based on self-reporting, so the reliability of the data was somehow questionable. The sharp decline is reportedly due to the SEC regulations, in addition to the fact that ESG integration is no longer counted. (Suzuki 2022).

[2] "Woke" is an American slang term that appears to mean a high awareness of social issues such as social injustice, the environment, racism, and gender issues.

in many cases (Edmans 2011; Friede *et al.* 2015; Whelan *et al.* 2021, etc.). It is well known that Pedersen *et al*. (2021) and Pástor *et al*. (2021) noted concepts that bridge this perception gap. Pedersen *et al*. (2021) classifies investors into three categories (ESG-unaware, ESG-aware, and ESG-motivated) based on the extent to which they consider ESG factors and then note that returns vary depending on the extent to which each of these investors is accounted for in the market. For example, if ESG-motivated investors are the majority and use ESG information and also have preferences for high ESG scores, such investors would tolerate lower returns in exchange for ESG considerations. On the other hand, when there are many ESG-unaware investors who are unaware of ESG scores and simply seek to maximize their unconditional mean-variance utility, and when high ESG predicts high future profits, we show that high-ESG stocks deliver high expected returns. Pástor *et al*. (2021) also note that ESG preferences affect asset prices and thus stocks are priced by a two-factor asset pricing model, where the factors are the market portfolio and the ESG factor. However, it is difficult to incorporate such real-world agent behavior in reality into a model, and given that ESG investment is a new concept, there are many different approaches that can be taken.

This paper modifies the model of Yoshino *et al.* (2021a), in which ESG factors were taken as independent factors, and presents a model in which ESG factors affect risk and return. In addition, this paper focuses on environmental issues and explains about varied definitions of ESG by various ESG rating agencies which lead to distorted portfolio allocation. The reason for focusing on the environment is that we believe ESG investments are attracting the most attention because of the "E" factor in light of the net zero target and an increase in recent extreme weather events. The model assumes that investors pay attention to ESG scores hoping that ESG scores will affect the rate of return and the risks to the performance of the company, and compares traditional portfolio selection with this model that takes into account of environmental aspect. Furthermore, investors would like to show ESG investment as a showcase of their commitment into Environmental issues. We explain about various definitions of ESG (especially focusing on "environmental" issues) by different rating agencies and show distortion of portfolio allocation by investors as a result of varied definitions of ESGs. An example of two companies assessed by different rating agencies shows significantly different ESG scoring. The same argument applies to various regions of the world and the same conclusions that distort asset allocation can be drawn for green bonds, that is, varied standards. We conclude that introduction of net carbon tax is one of the ways to guide investors to optimal portfolio allocation; investors can simply watch "after net tax" rate of return and "after net tax" risks in their investments and no need to pay special attention to ESG factors.

This paper is organized as follows. Section 2 shows the status of recent discussions on ESG in the U.S. Section 3 presents the theoretical model and the problems associated with the assumptions of this model. Section 4 discusses the ways to avoid distorted portfolio allocation and achieve optimal allocation by introducing net carbon tax. Section 5 shows the numerical application of the theory and addressing methods. The last section provides conclusion.

2. Confusion in the ESG Debate in US

2.1 "Woke capitalism" and the Biden Administration's ESG Promotion Policy

We summarize the status of recent discussions on ESG in the U.S. In the U.S., while there is a view that ESG investments should be promoted to solve climate change issues and other challenges, with a clear and high level of awareness (also known as "woke capitalism"), there is an anti-ESG view among conservative forces that the recent ESG movement is too radical. Therefore, the recent ESG debate is somewhat confused against a background of division in U.S. society.[3]

Particularly in politics, this division seems to be symbolic. The current Democratic Biden administration has been promoting measures that would promote ESG investments under the policy that, at the federal level, climate change issues should be addressed by the government as a whole. For example, in March 2022, the Securities and Exchange Commission (SEC) announced a proposed climate-related disclosure rule for investors and posted it for public comment.[4] A particular point of discussion was the proposal to gradually require large companies to disclose GHG emissions for their entire supply chain (Scope 3) in addition to direct emissions (Scope 1) and indirect emissions from energy used by the company (Scope 2). However, this proposal has not yet been approved. Subsequently, in May 2022, the SEC also proposed amendments to its rules and reporting forms to promote consistent, comparable, and reliable information for investors when funds and advisors incorporate ESG factors.[5] These policies are highly controversial even at the federal level, and when SEC Chairman Gensler testified before Congress in April 2023, he was asked several tough questions by many members of Congress (mainly Republicans) about the rationale for the policy and what analysis it was based on. For about five hours, the members of the House Financial Services Committee bombarded Chairman Gensler with questions, with each member having five minutes to question him, he faced a tough grilling. However, Chairman Gensler remained unmoved, and answered that the SEC was not an environmental authority, but only requested disclosure under the securities laws, which is exactly what the SEC does.[6]

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[3] The trends in federal and congressional discussions on ESG in the U.S. are described in detail in Abe (2023) for reference, and should be referred to as appropriate.

[4] SEC Press Release (March 21, 2023), "SEC Proposes Rules to Enhance and Standardize Climate-Related Disclosures for Investors." (https://www.sec.gov/news/press-release/2022-46).

[5] SEC Press Release (May 25, 2022), "SEC Proposes to Enhance Disclosures by Certain Investment Advisers and Investment Companies About ESG Investment Practices." (https://www.sec.gov/news/press-release/2022-92)

[6] The April 17, 2023 House Hearing before the House Financial Services Committee entitled "Oversight of the Securities and Exchange Commission," can be viewed below. (https://financialservices.house.gov/calendar/eventsingle.aspx?EventID=408690)

2.2 President Biden's first veto over whether to consider ESG factors in pension plan management

Even more significant was the case of President Biden's veto in March 2023 for the first time since taking office.[7] This relates to a proposed amendment to the interpretation of the Employee Retirement Income Security Act (ERISA) operating rules, which have been amended each time the Obama, Trump, and Biden administrations have changed their interpretation of whether ESG factors should be explicitly considered when making investment decisions for the pension funds. And with regard to the regulatory change intended to clarify (i.e., eliminate consideration of ESG factors) investments that are "solely based on pecuniary factors" that took effect in January 2021, shortly before President Trump left office, President Biden announced the suspension of the regulation in March 2021, shortly after he took office.[8] In addition, President Biden's new regulatory proposal, which took effect in January 2023, clarifies that ESG factors may be considered as long as they contribute to risk/return improvement and do not violate fiduciary duty.[9] However, after the midterm elections, the Republican majority in the House of Representatives passed a resolution to suspend the enforcement of the rule, and the Democratic majority in the Senate also passed the resolution after two Democrats defected, leading to the first veto by the President to override the suspension resolution. The House subsequently failed to pass a two-thirds override of the veto, and the resolution was confirmed as repealed.

2.3 Movements for and against ESG at the state level

As is the characteristic of the U.S., ESG investment has generated a great deal of discussion not only at the federal level, but also at the state level. First, the new ERISA interpretive rule mentioned above is opposed by many states, especially Republican states (also known as "red" states), and some states (Texas, Kentucky, Oklahoma, Tennessee, etc.) have already enacted state laws prohibiting transactions with financial institutions that make divestments from companies dealing with fossil fuels, etc.[10] In March of this year, a joint statement was also released by the governors of 19 states opposing the Biden administration's ESG policies, arguing that the radical ESG movement puts the pensions of many hardworking Americans at risk, by not making investment decisions with the highest return as a priority.[11] The governor of Florida, Mr. DeSantis, a leading Republican governor, is also anti-ESG

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[7] White House Press Release (March 20, 2023), "Message to the House of Representatives — President's Veto of H.J. Res 30" (https://www.whitehouse.gov/briefing-room/presidential-actions/2023/03/20/message-to-the-house-of-representatives-presidents-veto-of-h-j-res-30/)

[8] U.S. Department of Labor (March 10, 2021), "U.S. Department of Labor Statement Regarding Enforcement of its Final Rules on ESG Investments and Proxy Voting by Employee Benefit Plans," (https://www.dol.gov/sites/dolgov/files/ebsa/laws-and-regulations/laws/erisa/statement-on-enforcement-of-final-rules-on-esg-investments-and-proxy-voting.pdf)

[9] U.S. Department of Labor (November 22, 2022), "Final Rule on Prudence and Loyalty in Selecting Plan Investments and Exercising Shareholder Rights," (https://www.dol.gov/sites/dolgov/files/EBSA/about-ebsa/our-activities/resource-center/fact-sheets/notice-of-proposed-rulemaking-on-prudence-and-loyalty-in-selecting-plan-investments-and-exercising-shareholder-rights.pdf)

[10] See Fukuyama (2022) for details.

[11] The joint statement can be viewed at: https://www.flgov.com/wp-content/uploads/2023/03/Joint-Governors-Policy-Statement-on-ESG-3.16.2023.pdf

and as he has announced his presidential candidacy, ESG could become an important theme in the presidential race.

On the other hand, some Democratic states (also known as "blue" states) are considering requiring ESG factors to be taken into account when managing state pension funds or considering divestment (California, New York, Illinois, Maine, etc.).

2.4 Financial implications of both approaches

In response to these moves, some argue that we should take these developments coolly, since neither move makes economic sense, increases costs, or has a negative fiscal impact, and that we should separate investment decisions from political moves and base them on fiduciary duty (Eccles and Lehrer 2023). For example, the measures to stop doing business with ESG-friendly financial institutions in a Republican state (red state), specifically Texas, are based on political reasons, banning to deal with them even if they offer superior price, quality, and performance, at a cost of at least $400 million a year and as much as $6 billion over the next 10 years (Garrett and Ivanov 2022). On the other hand, analyses conducted by CalPERS and CalSTRS, which are pension funds in California, one of the Democratic states (blue states), point out that in California for example, losses are amounting to billions of dollars as a result of the state's past policy on divestment (CalPERS 2021, CalSTRS 2023). It is also pointed out that divestment will simply increase the earnings of an already green company, and that no further green improvements can be expected.

3. Theoretical model of ESG investment and portfolio selection

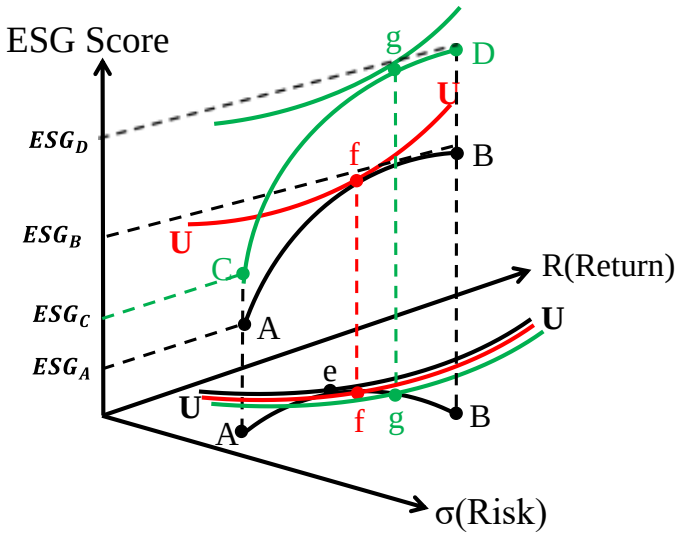
3.1 ESG factor as the third factor

Next, we examine the confusion in the ESG investment debate from an investment theoretical perspective, away from political considerations and protection of the energy industry. Seminal works by William Sharpe and Harry Markowitz led to modern portfolio analysis, which purely focused on risks and returns created by companies and did not consider environmental aspects (Markowitz 1952, 1991). However, environmental concern is strongly rising in these days as investors are paying attention to how companies deal with environmental issues. In other words, ESG investment is not only intended to make investment decisions based on the traditional two factors of return and risk, but also to take into account ESG factors as the third factor in investment behavior. More precisely, there is a difference between considering ESG factors as a third investment decision factor independent of risk/return, and considering them as a third factor insofar as they affect risk/return.

The model in this paper is a modification of Yoshino *et al*. (2021a), which considered ESG as an independent investment factor. A specific area of modification was the consideration of ESG as a factor affecting risk/return. In addition, the modified model assumes that ESG scores which are provided by ESG rating agencies are important components for investors as an independent factor. This means that the ESG investment model may have moved from the traditional two-factor model of

risk-return to a three-factor model that includes an ESG factor. At the same time, the ESG score will influence the rate of return and the risks of the companies to be invested. In other words, the paper's model differs from Yoshino *et al*. (2021a), which considered ESG as an independent investment factor, while the modified model assumes that ESG itself also affects risk/return.

First, let's consider how optimal asset allocation is affected when ESG factors are considered as a third investment decision factor independent of risk/return. Traditional investment theory (Capital Asset Pricing Model: CAPM) considers two factors, return (return on investment) and risk (variability of return), to determine an investor's optimal asset allocation.[12] In terms of Figure 1, the optimal asset allocation is achieved when point "e", the point of contact between the investor's utility curve U and the efficient frontier of risk-return (the set of points where the return is maximum for the same risk in the combination of return and risk for firms A and B that the investor can choose), is selected. However, if, for example, asset investment aims for carbon neutrality this would require asset allocation behavior that considers environmental factors (E-factor in ESG investment) as the third factor, such as whether the investment contributes to carbon reduction or not. Therefore, ESG factors independent from return and risk factors, which are shown on the vertical axis, will affect asset allocation (vertical axis). In this case, the ESG evaluation for firms A and B would be points ESG-A and ESG-B. If point "f" is selected as the point that maximizes utility in this context with respect to ESG, the selection point on the risk-return axis would also move from point "e" to point "f", which is the optimal investment allocation from risk-return-environment. But the issues do not end there.



(Source) Created by the authors

Figure 1: Relations between Risk, Return, and ESG

[12] The CAPM assumed in this paper is based on a simple model in which the market has no transaction costs, there are no restrictions on asset transactions, investors are free to borrow and invest their assets, there are no restrictions on the units of assets to be invested, the same assets are traded at the same price, individual investor behavior has no effect on market prices, and investment decisions are based on the assumption of a single period.

3.2 Varied assessment of ESG by rating agencies

The ESG score,[13] which is an index that evaluates the ESG factors of each company, is often used as a reference when making ESG investments, and is probably the issuing criteria when issuing green bonds. Investors rely on ESG rating agencies to make decision about how they allocate their portfolios based on agencies' evaluation of ESG. For example, when evaluating E (environmental) factors in ESG investments, investors themselves may lack knowledge, and it is assumed that in many cases, investments are made based on environmental evaluations by external ESG rating agencies, etc. However, some literatures cite that ESG scores for the same companies differ widely from one rating agency to another, and that they do not tend to converge (Chatterji *et al.* 2016; Berg *et al.* 2022). The reason for this is that the rating methodologies and criteria for ESG scores vary from one rating agency to another. Different agencies use their own criteria to evaluate a company's ESG efforts, assign a score based on the degree of disclosure, use a score based on whether or not the company has an ESG policy, or use a score based on actual ESG activities such as CO2 reduction by judging from performance, and so on.

Table 1 summarizes how ESG score (especially "E" score) are created by picking up 5 rating agencies. There are a number of factors that rating agencies look at to determine scores, for example, the degree of disclosure, commitment to environmental policy formulation and improvement, information disclosure, actual carbon emissions. What factors rating agencies consider important differ from one agency to another.

Table 1: Evaluation methods provided by major ESG rating agencies

ESG Score	Evaluation criteria overview
Bloomberg ESG Disclosure Scores	Environmental aspects are evaluated based on the degree of disclosure.
FTSE Russell's ESG Ratings	ESG risks are evaluated based on disclosure, commitment to policy formulation and improvement, etc. In terms of the environment, in addition to disclosure, they evaluate the existence of policies and commitments to improvement.
MSCI ESG Ratings	Evaluated based on 37 key ESG issues (ESG key issues). The environment side is also evaluated by setting a key issue.
Sustainalytics' ESG Risk Ratings	Based on ESG measures, information disclosure, and the level of problems. The same is true in terms of the environment.
Thomson Reuters ESG Scores	10 items: for the Environment factor, resource use, emissions, and innovation; for Society factor, employees, human rights, local communities, and product responsibility; and on Governance, management, shareholders, and CSR strategy. Regarding the environment, we evaluate it based on actual carbon emissions and whether or not there is a policy.

(Source) Created by the authors based on Yoshino and Yuyama (2021), Yuyama *ed.* (2020), and each rating agency's disclosure material.

[13] Although there may be various names for ESG score, such as ESG rating, ESG evaluation, ESG data, etc., this paper will use the term ESG score to unify them.

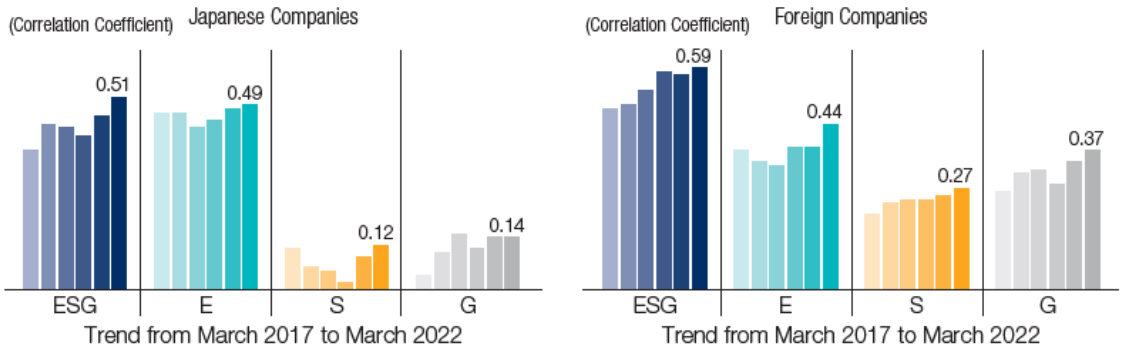
Furthermore, recently, even within the same ESG rating agency, multiple scores may be given for the same environmental area, further complicating the issue. For example, Bloomberg offers several scores related to the environmental area of ESG, including the ESG Disclosure Score, Bloomberg Score, and Carbon Intensity Score, each with a different score (see Table 2).

Table 2: Examples of multiple environment-related scores at the same agency (Case of Bloomberg)

ESG Score	Evaluation criteria overview
Bloomberg ESG Disclosure Score	Bloomberg's original score that converts the amount of corporate environmental, social, and governance data disclosure into a 100-point scale. Bloomberg identifies its own materiality items by referring to international data disclosure frameworks, and quantitatively scores the amount of disclosure for each of these items. Each data item is weighted according to the materiality of the data; for example, CO2 emissions are given more weight than other GHG disclosure items.
Bloomberg ESG Score	Measures a company's environmental and social performance on a 10-point scale using sector-specific indicators based on company disclosure data. Investors can use the scores to quickly assess performance related to key industry-specific issues relevant to financially important operations, such as climate change and health and safety, and to evaluate corporate activities relative to industry competitors.
Carbon Intensity Score	Each company is scored on a 10-point scale based on GHG emissions per revenue and EVIC.

(Source) Excerpt from Bloomberg material: "Available at Bloomberg ESG Score (Available in Bloomberg terminal)"

In this regard, the GPIF (2022) presents an interesting point. Figure 2 shows the correlation coefficients between the ESG scores of MSCI and FTSE between 2017 and 2022, which shows that the percentage of the same companies with different scores is still high. The correlation coefficients for ESG overall and "E" have improved to around 0.5, but for "G" and "S", the correlation coefficients are still low but improving and are no longer at the level of 0.1, which is very low.



(Source) Excerpt from GPIF (2022)

Figure 2: Trends in Correlation Coefficient of ESG Score Data from FTSE and MSCI

This difference in ESG scores by rating agencies also has a significant impact on resource allocation that takes ESG factors into account. We will explain this effect through Figure 1, again. One rating agency evaluates two companies as A-B and another rating agency evaluates two companies as C-D in Figure 1. The asset allocation of each investor results in different optimal point of "f" and "g" depending on which rating agency the investor consults with. In any case, it will move away from "e", the optimal allocation point obtained from the risk-return factor. In other words, it will lead to insufficient funds going to the investment destination determined from the risk-return factor, or to excess funds going to destinations that were not originally selected.

3.3 Green bonds case

Similar distortions in asset allocation can be seen in green bonds. According to the "Green Bond Principles: Voluntary Process Guidelines for Issuing Green Bonds" (June 2021) by the International Capital Market Association (ICMA), proceeds from the issuance of green bonds should fall into one of the following 10 project categories.

They are: (i) renewable energy, (ii) energy efficiency, (iii) pollution prevention and control, (iv) environmentally sustainable management of living natural resources and land use, (v) terrestrial and aquatic biodiversity, (vi) clean transportation, (vii) sustainable water and wastewater management, (viii) climate change adaptation, (ix) circular economy adapted products, production technologies and processes and/or certified eco-efficient products, and (x) green buildings. Green bonds can be issued if proceeds are used for any of the 10 categories.

However, even if projects meet one of the categories, the extent of environmental impacts can vary by projects. For example, there can be one energy-saving building with a 20% CO2 reduction, and another with 30% CO2 reduction, both of which can be built by issuing green bonds, but achieving different level of environmental sustainability. Investors buy green bonds because they contribute to positive environmental impact, but if the degree of impact differs significantly, there is a distortion in the allocation of funds.

3.4 Models of ESG factors affecting risk and return

Furthermore, the problem is not limited to the above. Above are cases where the ESG factor is independent of risk/return, but when the ESG factor itself affects risk/return, even if the ESG factor is taken into account, only two factors of risk/return are ultimately considered in the investment asset allocation. This is shown by the model as follows.

We set the utility function in equation (1), which includes all three elements discussed; the rate of return, risk, and ESG. Constraints that the new variable ESG is subject to are presented in equation (4).

$$\mathrm{U}\{R(\mathrm{ESG}),\ \sigma^2(\mathrm{ESG}),\ ESG\} = R(\mathrm{ESG}) - \beta\sigma^2(\mathrm{ESG}) + \gamma(ESG) \qquad (1)$$

$$\text{s.t. } R = \alpha R^A(\text{ESG}^A) + (1-\alpha)R^B(\text{ESG}^B) \tag{2}$$

$$\sigma^2 = \alpha^2(\sigma^A(\text{ESG}^A))^2 + (1-\alpha)^2(\sigma^B(\text{ESG}^B))^2 + 2\alpha(1-\alpha)\sigma^{AB}(\text{ESG}^A, \text{ESG}^B) \tag{3}$$

$$ESG = \alpha(ESG^A) + (1-\alpha)(ESG^B) \tag{4}$$

Substituting equations (2), (3), and (4) into equation (1), we obtain the optimal level of portfolio function, expressed in equation (5).

$$\begin{aligned} U\ \{R(\text{ESG}), \sigma^2(\text{ESG}), ESG\} &= \alpha R^A(\text{ESG}^A) + (1-\alpha)R^B(\text{ESG}^B) - \beta\{\alpha^2(\sigma^A(\text{ESG}^A))^2 + (1-\alpha)^2 \\ &(\sigma^B(\text{ESG}^B))^2 + 2\alpha(1-\alpha)\sigma^{AB}(\text{ESG}^A, \text{ESG}^B)\} + \gamma\{\alpha(ESG^A) + (1-\alpha) \\ &(ESG^B)\} \\ &= \alpha R^A(\text{ESG}^A) + R^B(\text{ESG}^B) - \alpha R^B(\text{ESG}^B) - \beta\{\alpha^2(\sigma^A(\text{ESG}^A))^2 + (1-2\alpha \\ &+ \alpha^2)(\sigma^B(\text{ESG}^B))^2 + 2\alpha\sigma^{AB}(\text{ESG}^A, \text{ESG}^B) - 2\alpha^2\sigma^{AB}(\text{ESG}^A, \\ &\text{ESG}^B)\} + \gamma(\alpha(ESG^A) + \gamma(ESG^B) - \gamma\alpha(ESG^B)) \end{aligned} \tag{5}$$

Obtaining the first-order conditions for the ratio between asset A (share = α) and asset B (share = 1-α), equation (5) can be shown as follows:

$$\begin{aligned} \partial U/\partial\alpha &= (R^A(\text{ESG}^A) - R^B(\text{ESG}^B)) - \beta\{2\alpha(\sigma^A(\text{ESG}^A))^2 - 2\sigma^B(\text{ESG}^B))^2 + \\ &2\alpha\sigma^B(\text{ESG}^B))^2 + 2\sigma^{AB}(\text{ESG}^A, \text{ESG}^B) - 4\alpha\sigma^{AB}(\text{ESG}^A, \text{ESG}^B)\} + \\ &\gamma(ESG^A) - \gamma(ESG^B) \\ &= R^A(\text{ESG}^A) - R^B(\text{ESG}^B) - 2\alpha\beta(\sigma^A(\text{ESG}^A))^2 + 2\beta(\sigma^B(\text{ESG}^B))^2 - \\ &2\alpha\beta(\sigma^B(\text{ESG}^B))^2 - 2\beta\sigma^{AB}(\text{ESG}^A, \text{ESG}^B) + 4\alpha\beta\sigma^{AB}(\text{ESG}^A, \text{ESG}^B) \\ &+ \gamma ESG^A - \gamma ESG^B \\ &= 0 \end{aligned} \tag{6}$$

Writing equation (6) for the α results in equation (7):

$$
\begin{aligned}
&R^A\,(\mathrm{ESG^A}) - R^B\,(\mathrm{ESG^B}) + 2\beta(\sigma^B(\mathrm{ESG^B}))^2 - 2\beta\sigma^{AB}(\mathrm{ESG^A}, \mathrm{ESG^B}) + \gamma ESG^A - \\
&\quad \gamma\, ESG^B \\
&= 2\alpha\beta(\sigma^A(\mathrm{ESG^A}))^2 + 2\alpha\beta(\sigma^B(\mathrm{ESG^B}))^2 - 4\alpha\beta\sigma^{AB}(\mathrm{ESG^A}, \mathrm{ESG^B}) \\
&= \alpha\{2\beta(\sigma^A(\mathrm{ESG^A}))^2 + 2\beta(\sigma^B(\mathrm{ESG^B}))^2 - 4\beta\sigma^{AB}(\mathrm{ESG^A}, \mathrm{ESG^B})\}
\end{aligned}
$$

$$
\begin{aligned}
\alpha &= 2\beta\{(R^A(\mathrm{ESG^A}) - R^B(\mathrm{ESG^B}) + 2\beta(\sigma^B(\mathrm{ESG^B})^2 - 2\beta\sigma^{AB}(\mathrm{ESG^A}, \mathrm{ESG^B}) + \\
&\quad \gamma(ESG^A - ESG^B)\} \,/\, \{(\sigma^A(\mathrm{ESG^A}))^2 + (\sigma^B(\mathrm{ESG^B})^2 - 2\sigma^{AB}(\mathrm{ESG^A}, \mathrm{ESG^B})\} \\
&= \{2\beta(R^A(\mathrm{ESG^A}) - 2\beta R^B(\mathrm{ESG^B}) + 4\beta^2(\sigma^B(\mathrm{ESG^B})^2 - 4\beta^2\sigma^{AB}(\mathrm{ESG^A}, \\
&\quad \mathrm{ESG^B}) + 2\beta\,\gamma(ESG^A - ESG^B)\} \,/\, \{(\sigma^A(\mathrm{ESG^A}))^2 + (\sigma^B(\mathrm{ESG^B})^2 - \\
&\quad 2\sigma^{AB}(\mathrm{ESG^A}, \mathrm{ESG^B})\}
\end{aligned}
\qquad (7)
$$

Equation (7) indicates the share of asset A in portfolio allocation. The last term in the numerator is an additional component that affects the allocation between asset A and asset B.

If ESG^A is larger than ESG^B, the portfolio allocation to asset A will become more significant, as shown in Figure 1. Point "e" in Figure 1 shows the optimal portfolio allocation based on the traditional portfolio investment. On the other hand, point "f" in Figure 1 shows the case where ESG is included in the utility function, where point "f" becomes the optimal portfolio allocation because the arc AB on the vertical side is taken into account.

However, there are two important assumptions that must be made for the above model to show appropriate asset allocation. First, the ESG rating agency must give an appropriate ESG assessment, which must also be suitable for use for investment decisions. Second, ESG factors are not independent factors but relevant as they affect risk and return.

In the current situation, we must point out that both of these assumptions are questionable. We would like to explain this issue below.

3.5 Do ESG factors affect risk/return?

3.5.1 Literature review on the relationship between ESG scores and risk-return

It is clear that the relationship between risk and return and ESG factors is not necessarily uniform. In this regard, there has been a great stock of research on the relationship between ESG factors and returns, as indicated by stock prices, and that between ESG and risk, as indicated by cost of capital or volatility. We review related literature here briefly.

To begin a brief summary of the literature review, we point out that there are various views on the relationship between ESG factors and risk/return, and it is not necessarily a conclusive finding. Yuyama *ed.* (2020) also points out that, in general, ESG investment performance has shown two

conflicting results, positive and negative (or uncorrelated), and it seems that we have not found a consistent view on how to interpret this. In addition, some literature pointed out that the reasons include differences in the regions and time periods covered, differences in the ESG scores used, definitions of performance (ROE, cost of capital, bond spreads, etc.), what constitutes a good ESG effort (ESG performance, ESG disclosure, etc.), differences in analytical methods, and statistical and technical factors such as whether or not to consider endogeneity issues (difficulty in identifying causality).

First, regarding the relationship between return and ESG factors, we could say that there are somewhat more studies that show a positive relationship between ESG factors and returns (that is, improvement in ESG factors have a positive effect on stock prices), but there are also some that show negative or neutral relationships, and the results are not uniform. It highly depends on the estimation method, period, and data, and it is still appropriate to consider that it cannot be said one way or the other. For example, Friede *et al*. (2015), a highly cited paper, reviews more than 2,200 existing studies on the relationship between ESG factors and Corporate Financial Performance (CFP), or corporate financial and investment performance, since 1970, and found that in roughly more than 90% of the studies, the relationship between ESG and Corporate Financial Performance (CFP) was non-negative (i.e., not a negative effect, but an uncorrelated or positive effect), and about 50-60% of these studies showed a positive effect. In a recent example, Whelan *et al.* (2021) show the results of an aggregation of more than 1000 studies since 2015. They divided the studies into those focused on corporate financial performance (e.g., operating metrics such as ROE or ROA or stock performance for a company or group of companies) and those focused on investment performance (from the perspective of an investor, generally measures of alpha or metrics such as the Sharpe ratio on a portfolio of stocks), to determine if there was a difference in the findings. According to the paper, they found a positive relationship between ESG and financial performance for 58% of the "corporate" studies focused on operational metrics such as ROE, ROA, or stock prices with 13% remaining neutral, 21% mixed results (the same study finding a positive, neutral and negative results) and only 8% showing a negative relationship. For investment studies typically focused on risk-adjusted attributes such as alpha or the Sharpe ratio on a portfolio of stocks, 59% showed similar or better performance relative to conventional investment approaches while only 14% found negative results.

Regarding the area and country, Auer and Schuhmacher (2016) show that, by region, there was little relationship between ESG factors and investment performance in the U.S. and Asia Pacific markets, and even negative effects were seen in Europe. One interesting study (Bansal *et al.* 2021) has shown that the relationship between ESG factors and returns varies and changes with time, such as favorable economic periods and recessionary periods. This study shows that the impact of ESG on returns varies from period to period.

Next, regarding the relationship between ESG factors and risk, which is indicated by cost of capital or volatility, etc., we find that many studies seem to indicate that ESG factors contribute to risk mitigation. Especially, the relationship between ESG factors and the cost of capital is generally

positive, which in turn has a positive effect on corporate value. However, it should be noted that a lower cost of capital on the corporate side means, conversely, a lower expected return from the investor's perspective, i.e., a potentially smaller return on investment. This is because the cost of capital also implies the expected return demanded by investors.

For a comprehensive survey, Cantino *et al*. (2017) review 31 papers, of which six are theoretical and 25 empirical. They note that the relationship between ESG factors and cost of capital is often viewed as positive for firm value, with lower cost of capital for firms with favorable ESG factors. However, they say that the relationship with the cost of debt, such as funding rates, is not clear. El Ghoul *et al*. (2011), a highly cited paper examining the impact on cost of capital, points out that firms with higher CSR scores have a relatively lower cost of capital and thus higher corporate value. In a recent study, Górka *et al*. (2022) also noted that the relationship between ESG factors and return volatility still depends on the business cycle (i.e., recessionary or expansionary periods). In addition, even when these results are taken into account, given the current situation with differences in the ESG scores used, the relationship to risk will naturally differ and a unified view will not be possible.

3.5.2 Empirical analysis of the relationship between ESG scores and risk/return

Table 3 shows the results of regression analysis with stock returns and volatility as explained variables, and ESG scores as explanatory variables, as well as control variables. The sample consists of companies included in Japan's Nikkei 225 as of December 30, 2021, and for which data are available. For the ESG score, we use the ESG score for 2021 (E, S, and G disclosure score and Percentile Score) provided by Bloomberg. The relationship between ESG score and return/risk is sometimes significant, sometimes not, and varies from score to score. For example, the coefficients for the same environmental score are significant for the Disclosure Score, while those for the Percentile Score are not significant at all.

Table 3: ESG scores and stock return/risk

	Dependent variable : Stock return 2021						
	ESG score						
	bld2021	ble2021	bls2021	blg2021	blep2021	blsp2021	blgp2021
ESG score	0.004*	0.003**	0.002	0.003	-0.000	-0.001	0.001
	(0.051)	(0.046)	(0.330)	(0.161)	(0.939)	(0.577)	(0.264)
Control variabls							
Total asset	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.796)	(0.932)	(0.831)	(0.758)	(0.700)	(0.718)	(0.795)
ROA	0.008	0.008	0.008	0.007	0.008	0.008	0.008
	(0.211)	(0.186)	(0.223)	(0.244)	(0.213)	(0.220)	(0.244)
Equity ratio	-0.003**	-0.003**	-0.003*	-0.002*	-0.003*	-0.003*	-0.003*
	(0.047)	(0.031)	(0.058)	(0.100)	(0.056)	(0.068)	(0.059)
Constant	0.028	0.138*	0.188**	-0.033	0.280***	0.298***	0.223***
	(0.821)	(0.079)	(0.020)	(0.871)	(0.007)	(0.000)	(0.007)
Observations	223	223	223	223	195	195	195

	Dependent variable : Stock volatility 2021						
	ESG score						
	bld2021	ble2021	bls2021	blg2021	blep2021	blsp2021	blgp2021
ESG score	-6.984*	-3.473	-4.302	-6.426	-3.192	-1.689	-2.223
	(0.074)	(0.115)	(0.269)	(0.124)	(0.102)	(0.361)	(0.252)
Control variabls							
Total asset	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.540)	(0.648)	(0.553)	(0.489)	(0.721)	(0.647)	(0.767)
ROA	32.320***	31.726***	32.584***	33.244***	31.574***	31.209***	32.519***
	(0.003)	(0.004)	(0.003)	(0.002)	(0.008)	(0.009)	(0.006)
Equity ratio	6.510**	6.861***	6.334**	5.668**	6.276**	7.118**	6.667**
	(0.011)	(0.008)	(0.013)	(0.028)	(0.032)	(0.016)	(0.023)
Constant	327.761	128.131	91.275	511.782	209.148	54.832	78.085
	(0.131)	(0.352)	(0.517)	(0.151)	(0.256)	(0.706)	(0.597)
Observations	223	223	223	223	195	195	195

(Note) The estimation equation is as follows. Data are annual data for 2021 only.

Stock or Volatility = α *ESG score + β *Control variables + Constant.

Normally, it would be desirable to set the stock price return and risk, which are the explained variables, one period later than the explanatory variables, but in this case, the same period was used because annual data was used and also because, through quarterly disclosure, it can be assumed that the financial information for the year is almost entirely reflected in the stock price for that year.

The definition of each ESG score is as follows

- bld2021: Bloomberg ESG disclosure score in 2021
- ble2021: Bloomberg Environment disclosure score in 2021
- bls2021: Bloomberg Social disclosure score in 2021
- blg2021: Bloomberg Governance disclosure score in 2021
- blep2021: Bloomberg Environment Percentile score in 2021
- blsp2021: Bloomberg Social Percentile score in 2021
- blgp2021: Bloomberg Governance Percentile score in 2021

***/**/* indicate that the coefficients are significant at the 1%, 5%, and 10% level, respectively.

Gray areas indicate cases where the ESG score is significant.

(Source) Bloomberg and author's calculation.

4. Eliminating Distortions in Asset Selection by Carbon Taxes

4.1 Net carbon taxes

In order to eliminate distortion in asset selection (that is, deviation from the optimal portfolio based on CAPM), we believe that there are two approaches to ESG focusing on E (environment). One is to impose tax on carbon emissions and wastes at the same rate worldwide. As shown in below, returns (R_A and R_B) are taxed according to each company's carbon emissions. Company A has a large amount of carbon emission, and so it pays higher tax than Company B, resulting in the return after tax to be $R_A < R_B$. Investors will invest more money in Company B.

Company A's return after carbon tax: $\underline{R_A} = R_A$ – (Net Carbon Tax TA)
Risks after Carbon Tax: $\underline{\sigma}_A$
Company B's return after carbon tax: $\underline{R_B} = R_B$ – (Net Carbon Tax TB)
Risk after Net Carbon Tax: $\underline{\sigma}_B$

$$\tilde{R}_t^A = R_t^A - T_t^A \tag{8}$$

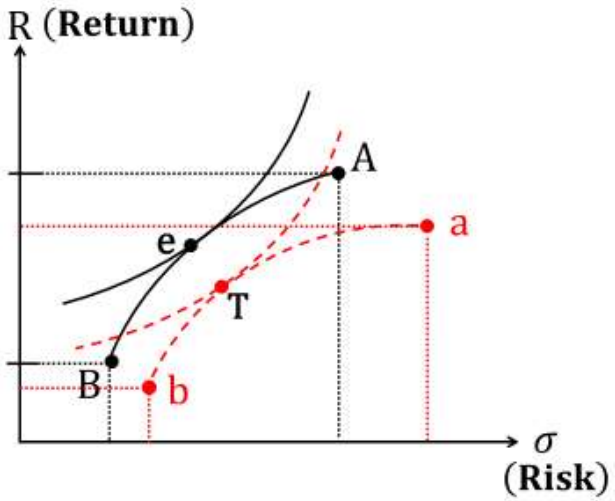
$$\tilde{R}_t^B = R_t^B - T_B \tag{9}$$

$$\tilde{R}_t = \tilde{\alpha}_t \tilde{R}_t^A + (1 - \tilde{\alpha}_t)\tilde{R}_t^B \tag{10}$$

$$\tilde{\sigma}_t^2 = \tilde{\alpha}_t^2(\tilde{\sigma}_t^A)^2 + (1 - \tilde{\alpha}_t)^2(\tilde{\sigma}_t^B)^2 + 2\tilde{\alpha}_t(1 - \tilde{\alpha}_t)\tilde{\sigma}_t^{AB} \tag{11}$$

Due to the varying amount of tax imposed depending on the size of carbon emissions, investors will continue to see companies' "return after net carbon tax ($\underline{R_A}$, $\underline{R_B}$)" and "risk after net carbon tax ($\underline{\sigma}_A$, $\underline{\sigma}_B$)," which are indicators available in the market, without caring for the environment factor. If investors look at "return after net carbon tax" and "risk after net carbon tax," we will be able to achieve optimal asset selection (point "T" in Figure 3). In other words, by applying the same rate of carbon tax worldwide, if carbon emissions such as CO2 are emitted more in the same industry, more net carbon taxes will be paid, and companies' after-net tax returns will be lower than other companies. As shown in Figure 3, the effective frontier of the asset selection shifts to a dashed line after imposition of net carbon tax. Therefore, investors can continue to make investment decisions simply based on two indicators of risk and return after net carbon tax, and theoretically the point "T" will be achieved that does not cause distortion of asset allocation (Figure 3). There are also issues such as whether the same carbon tax can be levied on developing countries that still rely heavily on coal. In theory, however, carbon taxes lead to investments that do not distort asset allocation in that investors can

determine investment allocations based on risk/return after carbon tax.[14] In practice, it will be possible to allow developing countries to levy net carbon tax at a lower rate at the beginning while targeting for the same tax rate globally.



(Source) Excerpt from Yoshino and Yuyama (2021) with some changes.

Figure 3: Eliminating distortion of asset selection due to carbon tax

Another way to eliminate distortion in asset allocation is to rigorously measure a company's green level and assign a green rating based on it. As mentioned above, the current problem was that, since green standards differ depending on the rating agencies, investment allocation was distorted by the judgment of what items were emphasized. Thus, when it comes to the environment, by imposing net carbon taxes at the same tax rate globally, or by calculating each company's green rating based on a global uniform standard, investors will be able to assess a company's risk/returns and take investment actions in accordance with a unified environmental rating standard (Figure 4). In recent years, it has become possible to estimate the status of carbon emission. As such, changing the weight of emissions used for calculating green rating is one way to promote efforts towards the goal set in Paris Agreement, depending on progress toward the 2050 goal (Mumtaz and Yoshino 2021).

[14] A rating system that quantifies CO2 emissions and wastes in detail, conducts green ratings based on globally uniform standards and thoroughly discloses the results to each company would enable distortion-free asset selection (Yoshino and Yuyama 2021). Correction of distortion in asset allocation can be achieved through carbon tax or unified green rating. In any case, it is necessary to determine the amount of CO2 and plastics and other wastes generated by production activities. Advances in satellite photographic technology have made it possible to measure a variety of emissions accurately.

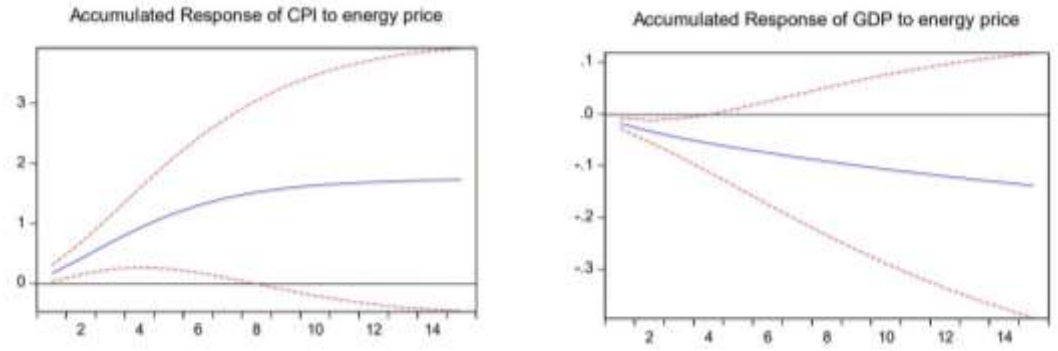
Credit Rating	Greenness(%)	CO_2	NOx	Plastic	N_2O etc
AAA	100 ～ 90	AAA	AAA	AAA	・・・・・
AA	90 ～ 80	A	AA	AAA	・・・・・
A	80 ～ 70	A+	A	BBB+	・・・・・
BBB	70 ～ 60	BBB	BB+	A-	・・・・・
BB	60 ～ 50	BB	BB-	BB+	・・・・・
B	50 ～ 40	B+	B	B-	・・・・・
CCC	40 ～ 30	CCC	B-	CCC	・・・・・
CC	30 ～ 20	CC	C	CCC	・・・・・
C	20 ～ 10	C	C	C	・・・・・

(Source) Yoshino and Yuyama (2021).

Figure 4: Need for uniform green rating

4.2 Macroeconomic impact of carbon taxes

The macroeconomic effects of carbon tax should also be considered. To estimate the macroeconomic effects of carbon tax, there is an empirical analysis of how a 5% tax on the price of oil would affect Japan's macroeconomy using a structural VAR (SVAR). The results of the analysis indicates that the long-term impact on price increases would be about 1.2% and the decline in GDP would be about 1.5%. (Figure 5. Yoshino *et al.* 2021b)



(Source) Excerpt from Yoshino *et al*. (2021b)

Figure 5: Macroeconomic effects of carbon tax (empirical analysis by SVAR) = impact on prices (CPI) and GDP

5. Numerical Application of the Theory

In this section, we demonstrate, by a simple numerical simulation, that the effect of ESG scores on expected returns and risks affects actual investment and asset allocation under our theoretical model in section 3 and 4.

Table 4 shows examples of different ESG scores for the same company; quite the opposite ratings from two ESG ratings agencies. ESG scores are based on the actual ESG score X and Y for Company A (service company) and Company B (pulp & paper company). ESG score X (ESG rating agency X's ESG score) evaluates Company B higher than Company A, while ESG score Y (ESG rating agency Y's ESG score) rates Company A higher than Company B. In fact, it has often been pointed out by GPIF (2022) that ESG scores of a company often differ between ESG rating agencies as shown in section 3.2.

In conventional investment model where investment decisions are determined only by risk/return and ESG is not considered, investment allocation ratio (α) to Company A is calculated according to equation (7) based on the expected returns (ER) and risk (Eσ) for the period. In a sample case, the ratio is 32% (0.32) for Company A, and allocating the remaining 68% to Company B achieves maximum utility.

Next, in the case of investment taking into account ESG, we look at an example using ESG scores X and Y. In the lower half of Table 4, the higher the ESG score is, the higher the expected return and the lower the expected value of the standard deviation (risk). The results are based on predictions from estimating equations that actually estimate the relationship between ESG scores and risk/return. In other words, if the ESG factor is a positive and significant coefficient on returns, a company with a higher ESG score will have higher returns. On the other hand, if the ESG factor is a negative and significant coefficient on risk (volatility), a company with a higher ESG score is less risky. The cases in Table 4 are based on the predictions of the estimation formula estimated for companies included in the Nikkei 225 in Japan in 2021 in Table 3.

The asset allocation taking ESG score into account is calculated according to equation (7), and the results show that investment allocation ratio to Company B (1-α) is higher for ESG investment (by ESG score X) than the conventional case (i.e., the case considering only risk and return and no ESG). The allocation ratio to Company B is 93% (0.93) and this contributes to maximizing utility. On the other hand, according to the ESG score Y (Company A's ESG score is higher), investment allocation to Company B is lower at 21% (0.21), which maximizes utility.

Finally, a sample case with carbon tax in Table 4 is an example calculating the ratio (α) assuming that carbon tax is imposed. Even as actual data, the GHG emissions employed in the sample were by far the largest for pulp and paper companies (Company B), about 30 times larger than for services companies. The expected return of pulp & paper company (Company B) with large carbon emissions is lower. Specifically, company B's expected return dropped from 6.0% to 2.8%, while that of Company A declined slightly to 5.4% from 5.5%. In this case, as shown in Table 4, investment

allocation to Company B that maximizes the utility is 67%, slightly down from 68% in the conventional investment case. Asset allocation differs depending on what ESG score is used.

Taking into account ESG factor, allocation to investment in a pulp & paper company (Company B) is higher in the example above with ESG score X. On the other hand, using ESG score Y, allocation is larger for the service company (Company A). The results of ESG scores affect expected returns and risks, and this in turn has a significant impact on investment allocation. In the current situation where ESG scores make varying assessments, it is important to note that ESG scores affect asset allocation when ESG investments are made based on the ESG scores. The question is whether ESG scores are appropriate and to what extent such a large variation in rating should be tolerated. And again, the question of whether ESG scores are actually a factor that influences risk and return also needs further analysis.

Table 4: Examples of differences in ESG score and carbon taxes impacting investment allocations

	No ESG score	ESG score X	ESG score Y	Carbon Tax case
	Without considering ESG	Company B's ESG score is high	Company A's ESG score is High	Carbon emission of company B is larger
ESG score for Company A	-	35	96	-
ESG score for Company B	-	77	12	-
Total GHG/Sales of Company A	-	-	-	35
Total GHG/Sales of Company B	-	-	-	1131
Company A's expected return E ($_{RA,}$)	0.055	0.044	0.062	0.054
Company B's expected return E ($_{RB,}$))	0.060	0.083	0.060	0.028
Company A's expected risk ($\sigma_{A,}$)	1.85	1.88	1.77	1.85
Company B's expected risk ($\sigma_{B,}$)	1.86	1.79	1.97	1.86
α estimates (Asset allocation to A)	0.32	0.07	0.79	0.33
(1-α) estimates (Asset allocation to B)	0.68	0.93	0.21	0.67

(Note) ESG scores show the actual rating results of Company A (services company) and Company B (Pulp & Paper) by ESG rating agencies. The value of the β and γ in equation (1) is calculated assuming 0.4 and 0.03 respectively.

The predicted return and risk values are estimates based on a return-risk model that includes ESG factors, estimated for a sample of Nikkei 225 constituent companies in 2021(see Table3). Asset allocation values are calculated based on Equation 7. The covariance of company A and B uses the covariance of the actual 2021 returns between these companies.

For the carbon tax, the load on asset A is assumed to be 0.1% of return and the load on asset B is a multiple of its gas emissions.

(Source) Based on Bloomberg data, and the authors' calculation.

6. Conclusion

SDGs, ESG, and green investment are important policy objectives that we have to achieve for sustainable environment and sustainable growth. At the same time, the debate over ESG is very confusing and swinging, especially in the U.S., and there is a lot of discussion about how it should be done, including political thought. This paper discusses this issue from an investment-theoretical background. Through consideration of ESG factors, it seems that the ESG investment model may have moved from the traditional two-factor model of risk-return to a three-factor model that adds an ESG component to it. Consequently, measuring companies' greenness or ESG level becomes important in investment decisions. However, each ESG rating agency has its own criteria for measuring ESG. Investors' portfolio allocations become distorted due to the lack of globally standardized criteria for such measurement. Investors evaluate a company's efforts toward ESG by its engagement. However, engagement cannot be quantitatively measured and is often a qualitative evaluation. It may likely be subjective evaluation rather than quantitatively measuring the amount of GHG emissions, which will lead to distorted allocation of portfolio investment discussed in this paper. To achieve clean energy and environment-related ESG, we recommend the adoption of international GHG taxation systems and the credit rating of companies' greenness based on GHG emissions to be used by investors. With the introduction of a net carbon tax, it would result in an asset allocation that is closer to the traditional risk-return based two-factor model, while still taking environmental concerns into account.

Finally, although adopting an international taxation system for GHG emissions is desirable, it might be difficult for developing countries to do so at once. Therefore, we recommend starting such a system in regions where economic cooperation and economic integration exist, like the European Union or the Association of Southeast Asian Nations. Another policy proposal is to make a global green credit rating of companies based on their emissions of not only CO2 but also pollutants such as NOx, plastics, etc., which will drive investors further toward optimal portfolio allocation for sustainable economic development.

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