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Covid-19 and Optimal Portfolio Selection for Investment in Sustainable Development Goals

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ABSTRACT

The Covid-19 pandemic and global economic recession has shrunk global energy demand and collapsed fossil fuel prices. Therefore, renewable energy projects are losing their competitiveness. This endangers the achievement of several Sustainable Development Goals (SDGs) and the Paris Agreement on Climate Change. Various consulting companies define the SDGs differently. Institutional investors hire consulting companies and allocate their investment based on the consultants' suggestions. This paper theoretically shows that the current allocation of investors by considering SDG based on various consulting companies will lead to distortion in the investment portfolio. The desired portfolio allocation can be achieved by taxing pollution and waste such as CO_2, NO_x, and plastics, globally with the same tax rate. Global taxation on pollution will lead to the desired portfolio allocation of assets.

1. Introduction

In today's global society, where people aspire to achieve SDGs targeted for 2030, the goals interconnect with each other, and the main agenda is to "leave no one behind." SDGs provide a shared blueprint for peace and prosperity for people and the planet now and in the future.

Several SDGs are directly and indirectly related to clean and renewable energy, and the positive impacts that it would have on health, well-being, and quality of life (Taghizadeh-Hesary and Yoshino, 2020). This means that the UN global agenda clarified the importance of the development of green energy and reducing pollution (CO_2 or NO_x); however, data show that, based on the current mechanism, it is not possible to achieve these goals. If the current trajectory of global fossil-fuel use continues, the planet's temperature is likely to rise by 4–6°C above the pre-industrial level. Such an increase would be catastrophic for food production, human health, and biodiversity. In many parts of the world, it would threaten communities' survival (Sachs et al. 2019). Governments have already agreed to keep global warming below 2°C, but have yet to take decisive action to create low-carbon energy systems. Greenhouse gas (GHG) emissions mainly cause climate change, and global warming is now indisputable. The increases in GHG levels merit government intervention guided by the SDGs and the Paris Climate Agreement. The most disappointing aspect of the contemporary global green economy is the low rate of investment. (Sachs, 2019). Currently, in the wake of the Coronavirus (Covid-19) pandemic that has put most economies in a tailspin, investors are concerned more about the rate of return and risk of investment. They care less about the environment and SDG indicators. However, the business downturns have collapsed fossil fuel prices; hence, renewable energy projects

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are losing their competitiveness. Therefore, in the era post Covid-19, governments need to support green and renewable energy projects to keep the pace of investment for achieving the SDGs and the Paris Agreement on climate change.

Institutional investors are the largest suppliers of capital to listed companies, managing almost $100 trillion assets in Organisation for Economic Co-operation and Development (OECD) countries alone. Institutional investors are ideally positioned to steer corporate capital allocation towards more sustainable uses owing to their size and their role as a conduit between the climate savers and the capital markets. However, institutional investors' asset allocation to direct infrastructure investment remains small, less than 1% for OECD pension funds, and the "green" investment components remain even more limited (Yoshino, Taghizadeh-Hesary and Nakahigashi, 2019). However, institutional investors use the services of different consulting firms, which define the criteria of SDGs. Thus, the SDG component is an additional factor that investors must consider. Investors for setting their portfolio allocation study three factors risk, rate of return, and SDG. In the past, they only considered the risk and rate of return. As the criteria of SDG by each consulting firm are different, the measurement is also different, which distorts the investments.

A review of the academic literature shows that various studies have highlighted the importance of green finance and green investments in the deployment of renewable energy projects for GHG emission reduction (Strand, 2016; Paramati et al., 2017; Kutan et al., 2018; Taghizadeh-Hesary and Yoshino, 2019; Taghizadeh-Hesary and Yoshino 2020; Sun et al. 2020). However, we could not find any study that developed a model for calculating the optimal portfolio allocation for investment in SDGs, and from this aspect, this study is novel.

The main objective of this paper is to show that the best policy will be taxing GHGs and wastes such as CO_2, NO_x, or plastics (depending on the SDG target) globally, forcing investors to focus on "rate of return" and "risk" after-tax. The next section presents the criteria for measuring the SDGs in 3 major consulting firms, the third section presents the theoretical model for the optimal portfolio selection for investment in SDGs, and the fourth section presents the concluding remarks and policy recommendations.

2. Criteria for SDGs by Different Consulting Firms

Different consulting companies provide different criteria for measuring the SDGs, resulting in investors with portfolio allocation for SDGs. In this section, we consider the criteria that three major consulting firms follow to measure the SDGs based on different indicators.

Klynveld Peat Marwick Goerdeler (KPMG) is a multinational professional service (financial audit, tax, and advisory) network, and one of the Big Four accounting organizations with headquarters in Amstelveen, Netherlands. KPMG sets the SDG Industry Matrix to attract greater private sector actions into each relevant SDG. The SDG Industry Matrix has been jointly managed by the United Nations Global Compact and KPMG. Four main groups of indicators were considered to measure the consistency of each SDG: *demographics* (population prediction in specific countries or regions), *income growth, technology* (renewable energy sources, knowledge sharing cultures, among others), and *collaborations* (between governments, companies, international organizations, and academia, among others). The higher the levels of these four indicators, the more actively SDG investments can be made. (KPMG & UN Global Compact, 2016).

Nomura Research Institute, Ltd. (NRI) is the largest Japanese management consulting and economic research firm. According to NRI, the consistency and contribution level to SDGs should be quantitatively defined. NRI sets four key performance indicators in investigating business activities: *innovation, business opportunity, impact, and cost* (NRI, 2019).

Pricewaterhouse Coopers International Limited (PwC) is a multinational professional services network headquartered in London. PwC ranks as the second-largest professional services (financial audit, tax, and advisory) firm in the world and is considered one of the Big Four accounting firms. PwC has developed indicators that consider the business level for achieving global goals, including SDGs. The indicators include *leadership* (business and financial strategies), *employee engagement* (awareness and bottom-up initiatives), *reporting* (risk assessment and management), and *collaborations* (among suppliers, consumers, government, NGOs, and others) (PwC, 2016).

Table 1 summarizes this section by showing different criteria that three major consulting firms are following for measuring the SDGs:

Table 1
Criteria of 3 major consulting firms for measuring the SDGs based on different indicators

Consulting firm	Criteria for measuring the SDGs
KPMG	*demographics* (the population prediction in specific country or region), *income growth, technology* (renewable energy sources, knowledge sharing cultures, among others), and *collaborations* (between governments, companies, international organizations, academia among others)
NRI	*innovation, business opportunity, impact, and cost*
PwC	*leadership* (business and financial strategies), *employee engagement* (awareness and bottom-up initiatives), *reporting* (risk assessment and management), and *collaborations* (among suppliers, consumers, government, NGO and more)

Source: Compiled by the authors based on KPMG & UN Global Compact (2016); NRI (2019) and (PwC, 2016).

3. Theoretical Model of SDG Investment and Portfolio Selection

3.1. Model by incorporating the SDG indicator in the investors' utility function

In this subsection, we modify the conventional portfolio utility function by incorporating the SDG indicator. First, equation (1) represents the traditional portfolio utility function, which includes risk and rate of return.

$$U(R_t,\ \sigma_t^2) = R_t - \beta\sigma_t^2 \tag{1}$$

Second, we can consider the SDG investments in the new portfolio utility function in the following equations:
Rate of Return:

$$R_t = \alpha_t R_t^A + (1-\alpha_t)R_t^B,\ \text{whereA} = \text{Company(orasset)A},\ \text{B} = \text{Company(or asset) B} \tag{2}$$

Risks:

$$\sigma_t^2 = \alpha_t^2\left(\sigma_t^A\right)^2 + (1-\alpha_t)^2\left(\sigma_t^B\right)^2 + 2\alpha_t(1-\alpha_t)\sigma_t^{AB} \tag{3}$$

SDGs:

$$SDG_t^A = a_t^1\left(CO_2^A t\right) + a_t^2\left(NO_X^A t\right) \tag{4}$$

$$SDG_t^B = b_t^1\left(CO_2^B t\right) + b_t^2\left(NO_X^B t\right), \tag{5}$$

where 1 is the CO_2, and 2 is the NO_x exposed by companies A and B. In equations (4) and (5), the coefficients of (a_t^1, a_t^2) and (b_t^1, b_t^2) are different from one consulting company to another.

The level of total SDGs is described as

$$SDG_t = \ \alpha_t\left(SDG_t^A\right) + (1-\alpha_t)\left(SDG_t^B\right) \tag{6}$$

Next, we set the utility function in equation (7), which includes all the three elements discussed; the rate of return, risk. The new variable SDGs subject to the constraints are presented in equation (8):

$$\text{U}\left(R_t,\ \sigma_t^2,\ SDG_t\right) = R_t - \beta\sigma_t^2 + \gamma(SDG_t) \tag{7}$$

$$\text{s.t. } R_t = \alpha_t R_t^A + (1-\alpha_t)R_t^B \tag{8}$$

$$\sigma_t^2 = \alpha_t^2\left(\sigma_t^A\right)^2 + (1-\alpha_t)^2\left(\sigma_t^B\right)^2 \tag{9}$$

Substituting equations (6), (8), and (9) into equation (7), we obtain the optimal level of portfolio function, expressed in equation (10).

$$U = \alpha_t R_t^A + (1-\alpha_t)R_t^B - \beta\{\alpha_t^2\left(\sigma_t^A\right)^2 + (1-\alpha_t)^2\left(\sigma_t^B\right)^2 + 2\alpha_t(1-\alpha_t)\sigma_t^{AB}\Big\} +\ \gamma\left\{\alpha_t\left(SDG_t^A\right) + (1-\alpha_t)\left(SDG_t^B\right)\right\} \tag{10}$$

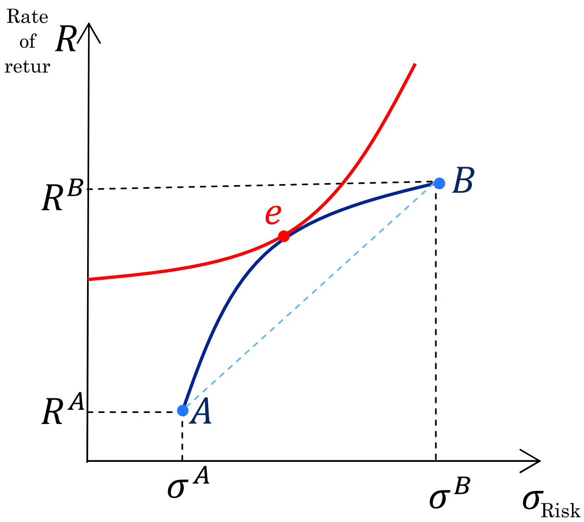

Figure 1. Traditional portfolio investment selection Source: Authors' depiction.

Obtaining the first-order conditions for the ratio between asset A and asset B (α_t), equation (11) can be shown as follows:

$$\frac{\partial U}{\partial \alpha_t} = \left(R_t^A - R_t^B\right) - \beta\left\{2\alpha_t\left(\sigma_t^A\right)^2 + 2(1-\alpha_t)\left(\sigma_t^B\right)^2\right\} + (2-4\alpha_t)\sigma_t^{AB} + \gamma\left(SDG_t^A - SDG_t^B\right) = 0 \quad (11)$$

Writing equation (11) for the $\alpha_t$results in equation (12):

$$\alpha_t = \frac{\frac{1}{2\beta}\left(R_t^A - R_t^B\right) - \left(\sigma_t^B\right)^2 - \sigma_t^{AB} + \frac{\gamma}{2\beta}\left(SDG_t^A - SDG_t^B\right)}{\left(\sigma_t^A\right)^2 - \left(\sigma_t^B\right)^2 - 2\sigma_t^{AB}} \quad (12)$$

Equation (12) indicates the share of the allocation to asset A. The last term in the numerator is an additional component that affects the allocation between asset A and asset B. If SDG_t^A is larger than SDG_t^B, the portfolio allocation to asset A will become more significant, as shown in Figure 2. In Figure 1, shows the traditional portfolio investment, determined by the rate of return and risks. Point "e" is the optimal portfolio allocation. Figure 2 shows the case where SDG is included in the utility function, where point "*f*" becomes the optimal portfolio allocation because asset A shows a higher SDG score compared to asset B.

However, the measure of SDG differs from one consulting company to another. Investors select a consulting company to allocate their portfolio based on the definition of the SDG of that company. The asset allocation of each investor results in distorted portfolio allocation based on the different weights of (a_t^1, a_t^2) and (b_t^1, b_t^2) as in equations (4) and (5). Thus, each investor will choose a different portfolio based on the consulting company they chose.

3.2. GHG taxation and optimal portfolio allocation for investment in SDGs

A standard global GHG taxation (taxing CO_2 and NO_x) will give us a new rate of return on assets A and B, presented in this sub-section. Tax rates can be adjusted based on the progress of pollution reduction. If the pollution reduction is slow compared to the target, the global tax rate can be adjusted by the same rate.

$$U\left(\widetilde{R}_t, \widetilde{\sigma}_t^2\right) = \widetilde{R}_t - \beta\widetilde{\sigma}_t^2 \quad (13)$$

$$T_t^A = \frac{t_1\left(CO_2^A t\right) + t_2\left(NO_X^A t\right)}{Y_t^A} \quad (14)$$

$$T_t^B = \frac{t_1\left(CO_2^B t\right) + t_2\left(NO_X^B t\right)}{Y_t^B} \quad (15)$$

Equation (13) shows the new utility function of investors based on the "after-tax rate of return" and "after-tax risk." In equations (14) and (15), T_t^A and T_t^B denote the GHG tax rate charged to companies A and B, respectively. Y_t^A and Y_t^B are the total outputs of companies A and B, respectively. t_1 and t_2 show the tax rate on CO_2 and NO_x, which have the same rates globally. The tax rate on CO_2 is the same for companies A and B, and the tax rate of NO_x is the same for companies A and B. These rates need to be the same globally to avoid distortion of the investments between different countries.

$$\widetilde{R}_t^A = R_t^A - T_t^A \quad (16)$$

$$\widetilde{R}_t^B = R_t^B - T_B \quad (17)$$

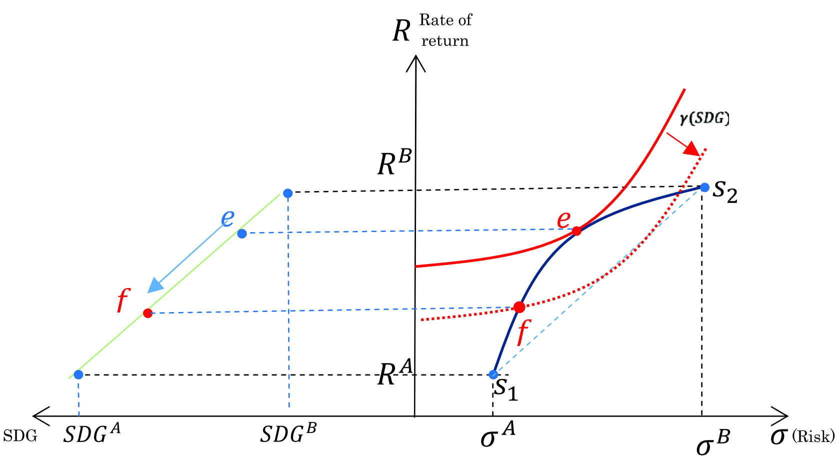

Figure 2. Portfolio allocation when SDG is taken into account *(in the second quadrant)* Source: Authors' depiction.

Equations (16) and (17) show the "after-tax rate of return" of company A and company B. The optimal allocation of assets is computed between company A and B as in equations (18) and (19) that show the optimal rate of return and risk, respectively:

$$\widetilde{R}_t = \widetilde{\alpha}_t \widetilde{R}_t^A + \left(1 - \widetilde{\alpha}_t\right) \widetilde{R}_t^B \tag{18}$$

$$\widetilde{\sigma}_t^2 = \widetilde{\alpha}_t^2 \left(\widetilde{\sigma}_t^A\right)^2 + \left(1 - \widetilde{\alpha}_t\right)^2 \left(\widetilde{\sigma}_t^B\right)^2 + 2\widetilde{\alpha}_t \left(1 - \widetilde{\alpha}_t\right) \widetilde{\sigma}_t^{AB} \tag{19}$$

Next, to find the optimal portfolio allocation ratio between asset A and asset B, we obtain the first-order condition of the utility function for $\widetilde{\alpha}$:

$$\frac{\partial U}{\partial \widetilde{\alpha}_t} = \left(\widetilde{R}_t^A - \widetilde{R}_t^B\right) - \beta \left\{ 2\widetilde{\alpha}_t \left(\widetilde{\sigma}_t^A\right)^2 + 2\left(1 - \widetilde{\alpha}_t\right)\left(\widetilde{\sigma}_t^B\right)^2 \right\} + \left(2 - 4\widetilde{\alpha}_t\right) \widetilde{\sigma}_t^{AB} = 0 \tag{20}$$

Finally, we obtain the optimal level of portfolio allocation as in equation (21):

$$\widetilde{\alpha}_t = \frac{\frac{1}{2\beta}\left(\widetilde{R}_t^A - \widetilde{R}_t^B\right) - \left(\widetilde{\sigma}_t^B\right)^2 - \widetilde{\sigma}_t^{AB}}{\left(\widetilde{\sigma}_t^A\right)^2 - \left(\widetilde{\sigma}_t^B\right)^2 - 2\widetilde{\sigma}_t^{AB}} \tag{21}$$

Evidently, as in equation (21), investors do not need to consider SDG as an additional item, as shown in equation (12). Instead, investors maximize their utility based only on the rate of return and the risk after tax. The optimal portfolio allocation is as shown in equation (21). The $\widetilde{\alpha}_t$ indicates the optimal portfolio as shown in Figure 3 by point *f*. *f* is the optimal point after the adoption of the international GHG taxation scheme.

4. Conclusion and Implications

The 2030 Agenda for Sustainable Development is faced with various global issues, especially the Covid-19 pandemic and the associated economic downturn. However, globally, the rate of investment in SDGs is low that endangers the aspirations for 2030. The global recession has forced investors to consider the rate of return and the risk of investment only, and investors are less interested in environmental factors or SDG indicators as their incomes have tightened drastically. This implies that the achievements of the SDGs in the post Covid-19 era will require more government support. Hence, it is essential to look for the optimal portfolio allocation by institutional investors to promote investments towards SDGs.

This paper argues that each consulting company has its criteria for the measurement of SDG. Institutional investors set their investment portfolio in SDGs based on the criteria set by the consulting firm, which distorts the portfolio allocation because there are no global standardized criteria for SDG measurement.

Based on the theoretical models provided in this paper, we investigated the optimal portfolio investment scheme by considering the SDGs. Here we recommend policy changes to achieve clean energy and environmental-related SDGs. The best way is to adopt international GHG (CO_2, NO_x) and plastic taxation systems. This forces investors to focus on the rate of return and risk (after-tax) and risk (after-tax). This international taxation system will ultimately lead to optimal asset allocation and achieve sustainable growth.

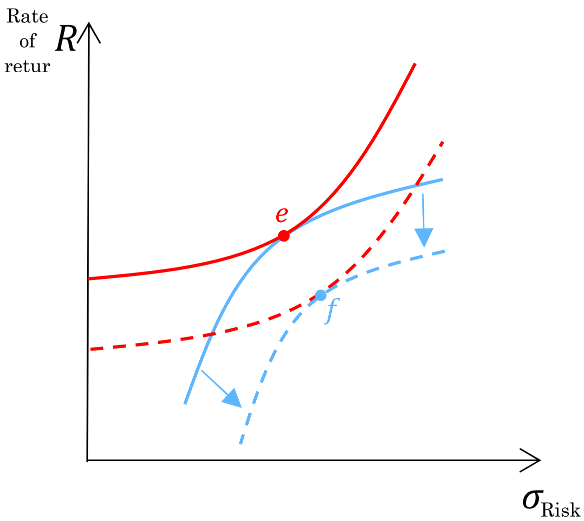

Figure 3. International GHG taxation scheme Source: Authors' depiction.

Importantly, imposing an emission tax on polluting companies and injecting the collected tax into green projects will increase their rate of return; hence, private investors will increase their willingness to invest in environmentally friendly assets. Finally, although adopting the international taxation system on GHG and plastic might be desirable, it takes time to adopt this scheme. It is recommended to start adopting such a system in regions where economic cooperation and economic integration exist, like the European Union (EU) or the Association of Southeast Asian Nations (ASEAN).

This research was a theoretical study with practical policy recommendations. For future studies, it is recommended to use data from the real world for empirically testing the model developed in this study.

Declaration of Interest Statements

none

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CRediT authorship contribution statement

Naoyuki Yoshino: Conceptualization, Methodology, Formal analysis. **Farhad Taghizadeh-Hesary:** Formal analysis, Investigation, Supervision, Validation, Writing - review & editing. **Miyu Otsuka:** Project administration, Visualization, Writing - original draft.

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