ECO-FINANCIAL PORTFOLIO USING OPTIMAL ENVIRONMENTAL BUILT-IN RATIO FOR HEDGING FINANCIAL AND ENVIRONMENTAL RISKS

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Abstract Reducing their environmental load has recently become a key concern to firms. Many financial products that invest in companies with a strong environmental consciousness, such as the Nikko Eco-fund, have been released. Ever since, several studies on the relationship between the environment and finance have been conducted. The preceding studies state that investment that considers the environmental aspects of a company shows excellent financial performance. Therefore, it is important to consider the environmental aspect of a company in the investment process. However, there is no preceding study that quantitatively states how much of the environmental aspect of a company should be considered when making an investment. Regarding the eco-fund, choosing an ecological fund based on an interview or questionnaire is a qualitative process, as an ecological fund does not reflect a firm’s environmental performance, nor does it reduce environmental risk.

The purpose of this study is to construct a new investment model that quantitatively shows how much to consider the environmental aspects of a company in the investment process. This study constructs an environmentally oriented portfolio using emissions data on environmental load material and sales of company, applying eco-performance and economic screening. In addition, this study constructs a financially oriented portfolio using financial data, applying financial screening. Next, this study constructs an eco-financial portfolio by combining the abovementioned two portfolios at the rate of the environmental built-in ratio $\alpha [0,1]$. This study compares and evaluates the financial performance of each eco-financial portfolio with a different value of $\alpha$. In each $\alpha$, $\alpha$ of the portfolio showing the best performance is defined as $\alpha^*$ (the optimal environmental built-in ratio, $\alpha^*$). Finally, depending on the value of $\alpha^*$, we discuss how much
to consider environmental aspects in the investment process.

Keywords—Environmental risks, Portfolio, Eco-Funds, Economic screening, Eco-performance screening, Efficient frontier, CSR, Environmental built-in ratio α

I. INTRODUCTION

Growth potential and profitability are the conventional measures used in corporate valuation and image. Due to recent scandals and corporate crimes as well as the spread of socially responsible investment (SRI), especially in Europe, corporate social responsibility (CSR) is gaining increasing attention as a corporate valuation factor[1].

As a form of corporate self-regulation integrated into a business model, CSR policy functions as a self-regulatory mechanism whereby a business monitors and ensures its active compliance with the spirit of the law, ethical standards, and international norms. In some models, a firm’s CSR implementation goes beyond compliance and engages in “actions that appear to further some social good, beyond the interests of the firm and that which is required by law.” Thus, CSR aims to embrace corporate responsibility and foster positive impacts on the environment and stakeholders, including consumers, employees, investors, and communities.

Environmental concerns have been particularly prominent, and more companies are focusing on “environmental management,” through which business is conducted in harmony with the global environment to foster sustainable development. In this process, reducing the environmental load is an important task [2].

Recently, many financial products that invest in companies with a strong environmental consciousness, such as the Nikko Eco-fund, have been released[3]. The Nikko Eco-fund is an open-ended investment trust fund, which has pursued capital gains specifically investing in stocks of 1) companies whose environmental activities are superior and that are expected to keep growing, and 2) companies that conduct businesses related to environmental issues and are expected to keep growing. However, choosing an ecological fund based on an interview or questionnaire is a qualitative process. The disclosure of such information can cause conflicts of interests with corporate managers, particularly when it can affect their remuneration. Schaltegger and Burritt[4] argue that external stakeholders must provide corporate managers with incentives to disclose this type of information in a transparent fashion.

As a matter of fact, a conventional ecological fund does not necessary reflect a firm’s environmental performance, nor does it reduce environmental risk. An investment cannot be said to reduce environmental risk unless firms’ environmental performance can be quantitatively evaluated using information on the emissions data concerning the environmental load material. Many studies exist about the relationship between the natural environment and investment[5-9].

Derwall et.al[10] state that “[Based on the sample period and eco-efficiency data provided by innovest, the results suggest that stocks that perform relatively well along environmental dimensions collectively produce superior portfolio returns. The average return on the two constructed portfolios was found to be large (in terms of the estimated difference in alpha generation per annum) and significant on a risk, style, and industry-adjusted basis. The statistical significance was reasonably robust to variations in methodology. Overall, the results suggested that the benefits of considering environmental criteria in the investment process can be substantial.”]
Van et al. [11] state that “although the alpha results were not found to be statically significant, the effect of the sustainable rating was found to have a positive impact on alpha over the sample period. The unadjusted results illustrated the high sensitivity of the sustainable portfolios with large cap and growth biases. After adjusting for these effects, the authors conclude that there is potential to benefit from potential outperformance of sustainable investment.”

Forrest et al. state [12] that “Goldman Sachs’ ESG research aims to integrate ESG factors into industrial analysis and valuation per sector, and to identify investment opportunities related to alternative energy, water and other emerging ESG issues. This report updates an initial one dealing with links between long-term drivers of valuation and performance in the energy industry. It brings together the ESG framework analysis—with enhanced clarity in definitions and updated for 2005 data—with their latest industrial analysis (“Global energy: 125 projects to change the world,” Feb 2006). In addition, it incorporates quantitative valuation techniques developed by Goldman Sachs’ Tactical Research Group in their “Director’s Cut” reports. The winners based on the ESG frameworks have outperformed their peers by an average of 5% (Feb 2004 to Aug 2005) and 6% (Aug 2005 to Oct 2006).”

These preceding studies mostly state that investment that considers the environmental aspect of a company shows excellent financial performance. Therefore, it is important to consider the environmental aspect of a company in the investment process. In addition, we should consider the environmental aspect in the investment process. However, there is no preceding study that quantitatively states how much to consider the environmental aspect of company when making an investment.

This study constructs an environmentally oriented portfolio using emissions data on environmental load material and sales of company, applying eco-performance and economic screening. In addition, this study constructs a financially oriented portfolio using financial data, applying financial screening. Next, this study constructs an eco-financial portfolio by combining the abovementioned two portfolios at the rate of the environmental built-in ratio $\alpha[0,1]$. This study compares and evaluates the financial performance of each eco-financial portfolio with a different value of $\alpha$. In each $\alpha$, $\alpha$ of the portfolio showing the best performance is defined as $\alpha^*$ (the optimal environmental built-in ratio). Depending on the value of $\alpha^*$, we discuss how much to consider the environmental aspect in the investment process.

The purpose of this study is to construct a new investment model that quantitatively shows how much to consider the environmental aspect of a company in the investment process.

**II METHOD**

This study uses two screening methods [3] in the portfolio construction process. Then, this study constructs an eco-financial portfolio by combining environmentally and financially oriented portfolios.
Two screening methods are used for the environmentally oriented portfolio of this study: eco-performance and economic screening. Decisions about investment brands and ratios are then taken on the basis of the efficient frontier. Using both eco-performance and economic screening allows us to overcome two issues affecting eco-funds: opaque screening in brand selection and the exclusive use of qualitative data.

### A. Eco-performance Screening

First, we consider the total environmental load emissions and sales of each brand to calculate its total per-sales environmental load emissions. Then, we calculate their annual change rate. Finally, investment brands are screened according to their average change rates. We select companies with change rates lower than 100% or showing a decreasing trend (i.e., companies that can increase their environmental efficiency).

We consider the fact that larger companies produce more emissions in order to screen firms fairly.

**Fig. 2 Scatter plot of sales and environmental load emissions in the transportation equipment industry**

Eco performance is calculated in the following manner:

- $f$: Brand name;
- $t$: Year;
- $G_f$: Total environmental load emissions of brand $f$;
- $S_f$: Sales of brand $f$;
- $P_f$: Per-sales total environmental load emissions of brand $f$;
- $Q_f$: Average emission change rate of brand $f$;
- $G_{f,t}$: Total environmental load emissions of brand $f$ in year $t$;
- $S_{f,t}$: Sales of stock $f$ in year $t$;
- $Q_{f,t}$: Change rate of the total per-sales environmental load emissions of brand $f$ from year ($t-1$) to year $t$;
- $S_f$: Average change rate of brand $f$;
- $P_{f,t}$: Total per-sales environmental load emissions of brand $f$ in year $t$:

$$P_{f,t} = G_{f,t}/S_{f,t}. \quad (1)$$

$$Q_{f,t} \text{ (%): Per-sales change rate of the total environmental load emissions of brand } f \text{ year from } (t-1) \text{ to year } t:$$

$$Q_{f,t} = (P_{f,t}/P_{f,t-1}) \times 100. \quad (2)$$

$S_f$: Average change rate of brand $f$

$$S_f = \text{AVERAGE}(Q_{f,2009} + \cdot \cdot + Q_{f,2013}) \quad (3)$$

### B. Economic Screening

Economic screening evaluates the profitability of each brand by using return on equity (ROE) as an indicator. In general, companies with an ROE at or above 10% are considered blue chip companies. Therefore, we select companies with an ROE at or above 10% for this screening.

**Fig. 3 Investment brand coverage using the two screening methods**
C. Suggestion of Environmentally Oriented Portfolio

One of the premises of an environmentally oriented portfolio is that the environmental loads of a market vary according to such factors as the economy and legal regulations. In Japan, environmental loads will likely continue to decrease over the long term because the country has ratified agreements on global environmental load reduction, such as the Kyoto Protocol and the Cancun Agreement (adopted by the 16th Conference of the Parties in 2010). As Japan is gradually being subjected to policies to reduce environmental loads, companies that fail to comply with these policy requirements will be weeded out. Therefore, such companies represent a risk for investors.

In this study, we calculate the environmental efficient frontier for n investment stocks selected by the above two screening methods. We select the best point on the environmental efficient frontier, and decide investment brands and investment ratios. The best point means that there are 5 to 10 investment brands and the investment ratios are not biased.

D. Suggestion of Financially Oriented Portfolio

A financially oriented portfolio is constructed by evaluation of a company’s financial aspect only. As a construction method, we first select the investment brand group by financial screening. In the same way as for the environmentally oriented portfolio, we calculate the efficient frontier for n investment stocks selected by the abovementioned financial screening.

We select the best point on the efficient frontier, and decide the investment brands and investment ratios. The best point means that there are 5 to 10 investment brands and the investment ratios are not biased.

E. Financial Screening

This study conducts only one screening in the process of developing a financially oriented portfolio. Therefore, this study selects about 50 brands only for this financial screening. Since the portfolio base period is from 2008 to 2013, this financial screening selects the top 50 from the ROE ranking of 2008. In other words, investment targets of the financially oriented portfolio are the top 50 of the ROE ranking.

F. Construction Method of Eco–financial Portfolio $F_α$

Eco–financial portfolio is combined by the above two portfolios (environmentally and financially oriented portfolios) at the rate of Environmental built-in ratio $α[0,1]$.

Construction model of eco–financial portfolio is shown in the following manner:

$$F_α = α × F_1 ⊕ (1 − α) × F_2$$

$F_1$: Environmentally oriented portfolio

$F_2$: Financially oriented portfolio

$F_α$: Eco–financial portfolio

$α$: Environmental built-in ratio $α[0,1]$

$⊕$: Definition by adding matrixes vertically

$$F_1 = \begin{pmatrix} a & ax \\ b & bx \\ c & cx \end{pmatrix} \in R^n × R^2$$

$a,b,c \cdots \cdot \cdot \cdot$ : investment brands

$ax,bx,cx$: investment rates

$$F_2 = \begin{pmatrix} A & Ax \\ B & Bx \\ C & Cx \end{pmatrix} \in R^m × R^2$$

$A,B,C \cdots \cdot \cdot \cdot$ : investment brands

$Ax,Bx,Cx$: investment rates

$F_α = \begin{pmatrix} a & α × ax \\ b & α × bx \\ c & α × cx \\ \vdots & \vdots \end{pmatrix}$

$A & (1 − α) × Ax \\ B & (1 − α) × Bx \\ C & (1 − α) × Cx \\ \vdots & \vdots \end{pmatrix} \in R^{m+m} × R^2$ (7)
G. Construction Method of Optimal Environmental Built-in Ratio $\alpha^*$

This study compares and evaluates the financial performance of each eco–financial portfolio with different value of $\alpha$. In each $\alpha$, $\alpha$ of the portfolio showing the best performance is defined as the optimal environmental built-in ratio $\alpha^*$. In this study, the portfolio evaluation period is from January 2014 to November 2016.

The calculation model of the optimal environmental built-in ratio $\alpha^*$ is

$$\alpha^* = \min_{\alpha \geq 0} \{ R_t(F_\alpha) \}$$

$\alpha^*$: Optimal environmental built-in ratio  
$R$: Standard deviation of portfolio stock price movements (risks)  
$t$: Evaluation year  
$R(F)$: Standard deviation of F portfolio stock price movements (risks)

III. DISCUSSION

The proposed method was used with data on greenhouse gas emissions and sales amount collected from the CSR and securities reports [14] covering the period 2008–2013.

Eco-performance screening was carried out first, leading to the selection of 357 target investment brands, chosen from about 1,200 candidates. Then, screening for economic performance was performed on those 357 brands; 42 brands were selected as investment targets.

We determined the investment brands and investment ratios using the efficient frontier. We then built an environmental efficient portfolio.

<table>
<thead>
<tr>
<th>Brand name</th>
<th>Investment ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daiwa House</td>
<td>0.151341201</td>
</tr>
<tr>
<td>Morinaga scika</td>
<td>8.83042E-06</td>
</tr>
<tr>
<td>Tsumura</td>
<td>7.61E-06</td>
</tr>
<tr>
<td>Sumitomo gomu</td>
<td>0.005094447</td>
</tr>
<tr>
<td>Komatsu</td>
<td>0.601278689</td>
</tr>
<tr>
<td>Sankogosei</td>
<td>0.242269229</td>
</tr>
</tbody>
</table>

There are six investment brands, and each investment ratio is the best balanced among environmental efficient frontiers. The investment ratios are suitable for an environmentally oriented portfolio.

Next, we determined the investment brands and investment ratios of financially oriented portfolio using the efficient frontier. We, then, built a financial efficient portfolio.

![Image](https://example.com/image1.png)

![Image](https://example.com/image2.png)
TABLE 2 Investment brands and ratios of financially oriented portfolio

<table>
<thead>
<tr>
<th>Brand name</th>
<th>Investment ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>RIZAP group</td>
<td>0.172711866</td>
</tr>
<tr>
<td>CommSeed</td>
<td>0.192634414</td>
</tr>
<tr>
<td>FreeBit</td>
<td>0.015154835</td>
</tr>
<tr>
<td>Yumeshin</td>
<td>0.021149051</td>
</tr>
<tr>
<td>MonotaRO</td>
<td>0.598349833</td>
</tr>
</tbody>
</table>

We constructed two kinds of portfolio (environmentally and financially oriented) by efficient frontier. We combined these two portfolios with different values of $\alpha$ and built eco–financial portfolios with different values of $\alpha$.

Since the evaluation period is from January 2014 to November 2016, we calculated the optimal environmental built-in ratio $\alpha^*$ in the evaluation period.

This study compared and evaluated the financial performance of each eco–financial portfolio with different values of $\alpha$.

This study selects the environmental built-in ratio $\alpha^*$, the point at which standard deviation is at a minimum. This is because the entire market always grows over the long term, as described by modern portfolio theory, and it is possible to obtain profit with high probability if we can minimize the risks. Therefore, the environmental built-in ratio $\alpha^*$ is 0.8, and the minimum risk portfolio contains 80% of the environmentally oriented portfolio and 20% of the financially oriented portfolio.

VI. CONCLUSION

By incorporating the environmentally oriented portfolio using environmental performance evaluation into the financial oriented portfolio, we can reduce the risk of the entire portfolio. When the environmental investment incorporation ratio $\alpha$ is 0.8, the risk is extremely reduced. Therefore, we can conclude that risk can be reduced significantly by considering not only the financial aspects of a company but also the environmental aspects of the company at a certain ratio. In this study, the optimal environmental built-in ratio $\alpha^*$ was found to be 0.8. However, there is a possibility that this $\alpha^*$ will change significantly if using different data and a different portfolio construction method.

One reason the risk is reduced is stock price fluctuation of environmental and financial brands contradict a little for the entire market. Furthermore, environmental brands show calmer movement than do financial brands. There is an investment strategy in which only environmental brands are owned. However, the results of this study show that adding financial brands to the mix can increase returns and simultaneously reduce risk. We selected environmentally good brands by screening the total environmental load emissions. Furthermore, we hedged both the environmental and financial risk by an
efficient frontier. Finally, we could quantitatively express how much to evaluate the environmental aspects of a company.

REFERENCES