A Note on Multifactor Asset Pricing Models for ESG Investing*

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1. Introduction

ESG investing is "the consideration of environmental, social and governance factors alongside financial factors in the investment decision-making process." (MSCI, 2018)

According to MSCI (2018), "the practice of ESG investing began in the 1960s as socially responsible investing (SRI), with investors excluding stocks or entire industries from their portfolios based on business activities such as tobacco production or involvement in the South African apartheid regime." Since then, ESG investing has been gaining a great interest worldwide ever since Kofi Annan, the seventh Secretary-General of the United Nations, initiated the Principles for Responsible Investment (PRI) in 2006. The reason why ESG investing has been rapidly and intensively implemented globally is that "the PRI works with its international network of signatories to put the six Principles for Responsible Investment into practice." (PRI, 2021) We have more than 4000 PRI signatories from over 60 counties the AUM (assets under management) of which amount to 120 trillion US dollars. Also in Japan, since the Government Pension Investment Fund (GPIF), the world's largest public pension fund joined the PRI on September 28, 2015, ESG investing has been one of the most important issues in the Japanese asset management industry (GPIF, 2020). Accordingly, the Japan's Stewardship Code was introduced in 2014, the Governance Code in 2015, the Fiduciary Duty in 2017 and the Fair Disclosure Rule in 2018. As the institutional investors are supposed to comply with such PRI-related codes, duties and rules, ESG investing is rapidly becoming important in the Japanese investment chain. The foreword of the PRI principles states the signatories' commitment as follows:

"As institutional investors, we have a duty to act in the best long-term interests of our beneficiaries. In this fiduciary role, we believe that environmental, social, and corporate governance (ESG) issues can

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affect the performance of investment portfolios. We also recognise that applying these Principles may better align investors with broader objectives of society." (PRI, 2021)

Along these lines, empirical analyses have been leading theoretical ones in the ESG investing literature. Recently, however, several theoretical analyses of ESG investing can be found in Pedersen et al. (2021) and Pastor et al. (2021). In this regard, we develop a multifactor asset pricing model which incorporates non-financial ESG attributes as well as financial cash flows. This model provides a foundation of the empirical design for understanding the risk-return profiles of ESG investing including Bolton and Kacperczyk (2021) who showed evidence for carbon risk premium in the US stock market.

The rest of this paper is organized as follows: Section 2 reviews a ESG Consumption-CAPM and develops ESG Multifactor Asset Pricing Models. Section 3 concludes.

2. Model

We assume an economy in which N assets are traded in discrete time $t = 0,1,\cdots$ and consider a representative agent who invests in asset $i\ (= 1,\cdots,N)$. At any point in discrete time t, asset i is traded at price $P_{i,t}$. The agent invests in a portfolio that comprises N assets. At any point in discrete time t, the agent has an initial endowment. She then earns income Y_t and consumes non-durable goods C_t. She invests in a portfolio θ_t that comprises N assets by imposing self-financing. At time $t+1$, she receives dividends $D_{t+1} = \left(D_{1,t+1}\cdots D_{N,t+1}\right)'$ to close her investment position by selling the portfolio at price $P_{t+1} = \left(P_{1,t+1}\cdots P_{N,t+1}\right)'$.

Investing in unit amount of asset i at time t allows the agent to consume $\mathbf{B}_{t+1} = \left(b_{ik,t+1}\right)_{i=1,\cdots,N;k=1,\cdots,K} = \left(\boldsymbol{b}_{i,t+1}\right)_{i=1,\cdots,N}$ amount of ESG attribute $k\ (= 1,\cdots,K)$ at time $t+1$.

The representative agent will receive the expected utility from the consumption of non-durable goods, C_t, as well as that of ESG attributes, $\mathbf{B}_t$, along a discrete-time horizon from the preset to the future.

She is to maximize the expected utility subject to the consumption dynamics of non-durable goods as well as those of ESG attributes. In conjunction with market clearings at any point in discrete time $t\ (= 0,1,\cdots)$, the first-order necessary condition (FOC) gives an equilibrium asset price of EGS investing as Theorem 1.

Theorem 1 (ESG Asset Pricing: Ishijima and Maeda, 2018)

At any point in discrete time, an equilibrium asset price of ESG investing is given endogenously in perfect competition.

$$\boldsymbol{P}_t = E_t\left[(\boldsymbol{D}_{t+1} + \boldsymbol{P}_{t+1})\cdot M^C_{t:t+1}\right] + E_t[\delta\cdot\mathbf{B}_{t+1}\cdot\boldsymbol{M}^Z_{t:t+1}] \tag{1}$$

where we define the intertemporal marginal rate of substitution (IMRS): $M^C_{t:t+1} \coloneqq \delta \cdot \left(\frac{\partial u(C_{t+1}, \boldsymbol{Z}_{t+1})}{\partial C_{t+1}} \Big/ \frac{\partial u(C_t, \boldsymbol{Z}_t)}{\partial C_t}\right)$. In addition, we define the intertemporal marginal rate of substitution between consumption of ESG attributes and non-durable goods which we will call "ESG-IMRS:" $\boldsymbol{M}^{\boldsymbol{Z}}_{t:t+1} \coloneqq \frac{\partial u(C_{t+1}, \boldsymbol{Z}_{t+1})}{\partial \boldsymbol{Z}_{t+1}} \Big/ \frac{\partial u(C_t, \boldsymbol{Z}_t)}{\partial C_t}$.

We assume that there exists a risk-free asset which generates the deterministic gross return of $x^f_{t:t+1}$ from time t to time $t+1$. The risk-free asset is assumed not to provide ESG attributes.

Theorem 2 (ESG Consumption-CAPM: Ishijima and Maeda, 2018)

The risk premium of ESG investing is the sum of two covariances – i.e., CF and ESG covariances.

$$E_t\left[W_{i,t:t+1}\right] - x^f_{t:t+1} = -x^f_{t:t+1} \cdot Cov_t\left(X_{i,t:t+1}, M^C_{t:t+1}\right) + -x^f_{t:t+1} \cdot Cov_t\left(Y_{i,t:t+1}, M^C_{t:t+1}\right) \qquad (2)$$

where we define CF Return $X_{i,t:t+1} \coloneqq D_{i,t+1} + P_{i,t+1}/P_{i,t}$, ESG Yield $Y^Z_{i,t:t+1} \coloneqq \boldsymbol{b}_{i,t+1}\boldsymbol{M}^{\boldsymbol{Z}}_{t+1:t+1}/P_{i,t}$, and Double Return $W_{i,t:t+1} \coloneqq X_{i,t:t+1} + Y^Z_{i,t:t+1}$, respectively. □

On the basis of ESG Consumption-CAPM of Theorem 2 which was developed by Ishijima and Maeda (2018), the risk premium of ESG investing is the sum of CF and ESG covariances. By developing a multifactor model for each of two covariances, the risk premium of ESG investing has a multifactor representation.

Theorem 3 (ESG Multifactor Asset Pricing Model: Ishijima and Maeda, 2022)

The risk premium of ESG investing has a combination of two multifactor models: One is the traditional expected beta model and the other "hedonic risk-premium model."

Expected Beta Model (CF Risk Premium): The CF covariance is the weighted sum of the risk premium of common factors $\boldsymbol{F}$, where the weight is the estimated coefficient for the CF Return regression on common factors.

Hedonic Risk-Premium Model (ESG Risk Premium): The ESG covariance is the weighted sum of the risk premium of ESG attributes $\boldsymbol{M}^{\boldsymbol{Z}}$.

3. Conclusion

We developed ESG Multifactor Asset Pricing Models that allow us to conduct sophisticated empirical analyses of ESG investing. In our future work, we are planning to apply our models in order to conduct empirical analyses to show double bottom line in Japanese capital markets.

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