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THE BLUENESS INDEX, INVESTMENT CHOICE, AND PORTFOLIO ALLOCATION

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Abstract

Recently, the concept of “blue finance”’ was introduced to the world. Blue finance envisages that ocean firms issue financial instruments to obtain funds and take necessary measures to make the ocean environment blue. To measure the blueness of a firm, we estimate the blueness index using GHG emissions as a percentage of sales. This study proposes a theoretical model to estimate the portfolio's utility function by incorporating the blueness factor. The result suggests a positive relationship between the blueness proxy and optimal investment allocation. In the absence of blueness, their returns would be taxed; thus, the participation of investment in blue bonds decreases. Last, we examine the factors that cause stock returns and document a positive association between the blueness of a firm and stock returns. This evidence indicates that firms that are relatively ‘bluer’ may be more perceptive of the public’s preference for sustainable investments, thereby leading them to outperform.

Keywords: ocean emissions, blueness index, bonds, portfolio allocation, emission tax

JEL Classification: G11, G12, H21

Contents

1. INTRODUCTION

The ocean absorbs immense heat due to increased greenhouse gas (GHG) concentrations in the atmosphere, mainly from fossil fuel consumption. Vanderklift et al. (2019) claimed that, due to the degradation of blue carbon ecosystems, which include mangroves, seagrass, and tidal marshes, 0.15 to 1.02 billion tons of carbon seeps into the atmosphere each year, which is one to six times the levels of CO_2 that the deforestation of the Amazon releases. Increases in the release of carbon emissions into the atmosphere cause the temperature to rise, which leads to coral bleaching and causes a loss of breeding grounds for marine fish and mammals. The Paris Agreement on climate change envisages limiting the global average temperature rise to well below 2 °C, which will avoid the massive, irreparable effects of ocean warming on marine ecosystems and services. The ocean emissions include CO_2, SO_2, and NO_x. About 2% of SO_x emissions originate from the ocean across coastal regions, while atmospheric NO_x contributes 25% of the total emissions. The proportion of CO_2, SO_2, and NO_x in ocean emissions varies across regions, and ocean emissions assessment is too uncertain (Ciais et al. 2013).

Financial markets and institutions play a critical role in providing financing for ocean firms and achieving sustainability. Both public and private sectors can contribute to achieving sustainability by providing blue financing to create a stable blue economy. The Sustainable Blue Economy Finance Principles are elastic in terms of their application throughout the whole ocean economy, identifying the necessary modalities to assess the different proposals and their implementation. The purpose of sustainable investment is to confirm that ocean-related investment contributes long-term value without hurting marine ecosystems and reduces carbon emissions. The “blue finance” concept aims to obtain funds by issuing blue bonds, blue IPOs, blue credit, or blue investments. The literature has not provided a specific definition of blue finance; however, researchers have defined it from their perspectives. Gulseven (2020) argued that blue finance’s goal is to promote the execution of projects and achieve the sustainable development goals (SDGs) relating to marine resources. To achieve the objective of ocean sustainability, SDG 14 safeguards the interest of marine resources. A firm’s ocean emissions can decrease when it takes the necessary measures to make the ocean blue. It is therefore essential to measure the blueness of ocean firms.

According to Tirumala and Tiwari (2020), there have been many investments in blue finance, ranging from investments in fisheries and aquaculture to investments in coastal and marine tourism, the water supply, environmental protection, shipbuilding, ecosystem conservation, chemicals and pharmaceuticals, ports and shipping, offshore oil and gas, and energy. The issuance of the first two blue bonds occurred in 2016 and 2019; these were the Seychelles Blue Bond and the Nordic–Baltic Blue Bond, which raised USD15 million and USD213 million. The purpose of blue bonds is to develop sustainable fisheries and water resource management and protection (Tirumala and Tiwari 2020). More recently, investments in blue finance have received more attention, and there are projections for an estimated USD5.22 billion in pursuit of projects that focus on developing sustainable fisheries and protecting them from waste: RARE’s Meloy Fund, Encourage Capital, Althelia’s Sustainable Ocean Fund (SOF), and Circulate Capital (Tirumala and Tiwari 2020). Further, Tirumala and Tiwari (2020) stated that the development of blue finance is in its infancy and looked to green finance initiatives as a reference point to begin to think about the future growth of the market for blue bonds; since 2007, green financing channels have raised over USD521.

This study has several objectives. First, we estimate the blueness index, which determines how blue a firm is. To examine the blueness of a firm, we use the ocean emissions as a percentage of sales. A higher value of the blueness index for an ocean firm means that it produces lower emissions. Second, we propose a theoretical model that measures the portfolio utility function, covering the return, risk, and blueness index. We assume that investors participate in blue bonds and that they base their preferences on the blueness of firms. Third, this study proposes that governments might impose taxes for ocean emissions in the absence of blueness factors, reducing bonds' returns. We test this hypothesis empirically and report that, when firms face taxes on emissions, the returns of non-blue firms are lower. Fourth, we identify the factors that affect stock returns and find a positive relationship between firms' blueness and their returns. This study finds that relatively "bluer" firms may be more socially conscious, leading to outperformance.

The structure of the rest of this study is as follows. Section 2 explains the relationship between ocean emissions, financing, and the blue economy. Section 3 provides a brief overview of blue finance. Section 4 proposes a theoretical model of investors' utility function, including the blueness index and emission taxation, and examines the factors that cause stock returns. Section 5 describes the data and sample. Section 6 discusses the empirical results, and Section 7 concludes the study.

2. OCEAN EMISSIONS, FINANCING, AND THE BLUE ECONOMY

The blue economy has the potential to enable inclusive economic growth, generate employment opportunities, and attain sustainable development goals. The ocean provides an essential source of proteins for the global economy. Spalding (2016) suggested that half of the world's inhabitants live within 100 kilometers of the coast and indicated that estimates place the global ocean economic activity between USD3 and USD6 trillion. Hilborn and Costello (2018) suggested that capture fishery is the most important or significant human activity in the economy, playing a central role in the blue economy and blue growth. The general conclusion that Hilborn and Costello (2018) communicated is that the fishing yield is likely to increase and that blue growth is possible if fisheries engage in reforms focusing on enhancing efficiency. Ocean emissions affect the ecosystem, challenge goals associated with sustainable development, and affect people living on the world's coasts (Steffen 2012).

Eikeset et al. (2018) indicated that the idea of blue growth (by way of "sustainable development") stemmed from multiple academic meetings: (a) the first on "sustainable development" at a 1972 United Nations conference that took place in Stockholm; (b) the second at a 1992 United Nations conference focused on the "economic dimension" of "sustainable development" in Rio; and (c) the third at a 2002 United Nations conference focused on the "social dimensions" of "sustainable development" in Johannesburg; finally, at a fourth meeting held in Rio, the idea of "blue growth" emerged to "secure or restore the potential of the oceans, lagoons, and inland waters by introducing responsible and sustainable approaches to reconcile economic growth and food security with the conservation of aquatic re-sources" (Eikeset et al. 2018, 178). According to Niiranen et al. (2018, 321), the EU sees "blue growth" as a framework for sustainable economic growth in our oceans and seas and along our coasts, whereas the United Nations (UN) Food and Agriculture Organization (FAO) views blue growth as an "opportunity to promote sustainable socioeconomic management of capture fisheries and aquaculture." Niiranen et al. (2018, 321)

described blue growth as focusing on "using the oceans to create maximal income to society in a way that is ecologically, socially, and economically sustainable, i.e., preserving the functioning of all ecosystem services accrued from the oceans." Goddard (2015) argued that the blue economy refers to a sustainable ocean economy in which countries explore marine resources by balancing ocean systems' capacity and resilience. In another study, Smith-Godfrey (2016) contended that the blue economy aims to manage blue resources while considering societal development without affecting the ocean systems. Most countries have emphasized restrictions on ocean pollution, which are an essential component of the Paris Agreement and the Aichi targets (part of the Convention on Biological Diversity). In summary, people consider "blue investment" as the pursuit of growth in an ecological, social, and economically sustainable manner (Bennett 2018) in relation to marine resources.

It is possible to connect the blue economy's components in terms of sustainability, human well-being, social equity, and multilateralism for international cooperation. The European Union has taken various initiatives to harness marine resources' economic prospects for sustainable development and devise a proper utilization mechanism. The blue economy currently integrates traditional marine-based sectors, such as fishing, maritime transport, and tourism, and new marine activities, like aquaculture, biotechnology, offshore renewable energy, and bio-prospecting. In an attempt to develop win-win-win strategies for aligning the concerns of coastal communities, the environment, and investors, Barbesgaard (2018) highlighted four primary concerns: (a) the tragedy of the commons and "green grabbing"; (b) blue growth as a counter to the destruction of marine and coastal ecosystems; (c) incentivizing "sustainable fisheries"; and (d) blue carbon initiatives. Overcoming these concerns and balancing the priorities associated with dealing with each of these issues require targeted efforts. Barbesgaard (2018) commented on creating a speculative frontier for financers and described how blue initiatives can appeal to investors. Today, the primary sources that countries use to finance ocean activities are based on the commitments covering the official development assistance and public budgets (Wabnitz and Blasiak 2019), which are woefully inadequate. Other funding sources that have recently emerged include philanthropic grants (Guggisberg 2019), but a private solution to the problem of sustainability is preferable.

According to the World Ocean Initiative (2020), nine out of ten institutional investors have shown their intent to support the sustainable ocean economy. This survey evaluated the investors' likelihood of financing the blue economy, enabling the utilization of ocean reserves to achieve economic growth and better livelihoods and to safeguard and reinstate the marine environment. Almost 81% of investors viewed blue finance as an attractive feature when investing. The respondents gave similar values to the environmental and social benefits as they obtain financial returns. Roughly 75% of thematic investors attempted to invest in assets that will add value to their investments and ensure ocean sustainability. The respondents further claimed that a clear definition of blue finance to achieve a sustainable blue economy does not exist. Additionally, they argued that there is a lack of investment-grade projects in the blue economy. They proposed the introduction of innovative financial products covering a mix of finance and public–private partnerships to gauge and mitigate risk investments in the blue economy.

We can create a link between ocean emissions, financing, and the blue economy to explain their relationships. Like environmental pollution, ocean emissions create various problems for the ecosystem, which adversely affect the health of the ocean environment. An essential component of financing ocean firms is to create opportunities to invest in blue projects through incentives. As a comparison, we can

refer to green finance, whereby firms have different options to raise funds and make the environment green. In line with this proposal, ocean firms may issue blue bonds, blue IPOs, blue loans, and blue investment to gather funds that contribute to firms' development and minimize the risk of ocean emissions, thereby achieving a blue economy. This study examines the blueness factor of firms and investigates how it helps to increase investment participation in blue bonds.

3. BLUE FINANCE: AN OVERVIEW

Blue finance is a recently introduced concept that covers (a) blue bonds, (b) blue IPOs, and (c) blue investment. The purpose of blue finance is to encourage the implementation of projects and attain the SDG that envisages the preservation and sustainable employment of the oceans, seas, and marine resources for sustainable development (Gulseven 2020). In the literature, no clear-cut definition of a "blue bond" or "blue project" is available. It is a financing instrument to gather funds for fulfilling the sustainable development goals associated with life underwater by strengthening blue natural capital (Blue Natural Capital Financing Facility (BNCFF) 2019). The good governance of the ocean and coastal habitats creates long-term value in marine and coastal ecosystems, mitigates GHG emissions, and enhances livelihoods that rely on the ocean and resources in an erratic climate. According to the World Bank, a "blue bond is a debt instrument issued by governments, development banks, or others to raise funds from investors to finance marine and ocean-based projects that have positive environmental, economic, and climate benefits."

The financing principles of the sustainable blue economy developed in 2018 based on transparency to promote green and social bond markets to consider the environmental, social, and governance (ESG) framework in identifying projects that increase the local community's livelihoods. The BNCFF (2019) referred to a blue bond "as a green/environmental, social or sustainable blue bond project." This represents undertaking a project by issuing blue bonds to achieve the blueness of the ocean, seas, and marine resources. The financing of blue bonds emphasizes coastal ecosystems in alignment with the green bond principles to achieve environmentally sustainable management of living natural resources, terrestrial and aquatic biodiversity conservation, sustainable water and waste management, and climate change adaptation (International Capital Market Association 2018).

Initially, the Republic of Seychelles introduced the first blue bonds in October 2018 by raising proceeds of USD15 million for a tenure of 10 years. It utilized the funds to extend the marine secured zones, increase the governance of significant fisheries, and ensure that the blue economy's progress persists. The World Bank, the Global Environment Facility, and the International Bank for Reconstruction and Development have assisted with a finance package of USD20 million, loans of USD5 million, and a grant of USD5 million, respectively, for financing blue bonds to preserve the marine ecosystem and enhance the possibilities for the value chain of the seafood industry. Furthermore, the International Bank for Reconstruction and Development (IBRD) extended a guarantee of EUR5 million and the Global Environmental Facility (GEF) provided credit of USD5 million as a non-grant instrument. These credit enhancement mechanisms aimed to mitigate risk on behalf of investors, thereby enhancing credit ratings and reducing interest rates to a level that is between 2% and 3%.

To safeguard and restore the Baltic Sea, the Nordic Investment Bank raised funds by issuing blue bonds in January 2019. It issued the blue bonds for 5 years and attracted an amount of USD213 million with a coupon rate of 0.375%, which faced oversubscription by more than two times. It utilized the proceeds to finance projects relating to water pollution prevention, wastewater treatment, and water-related climate change adaptation. In short, we can argue that blue bonds aim to achieve social and sustainable goals to support the blue economy. Table 1 summarizes the details of blue bonds.

Table 1: Terms of Blue Bonds

Bond	Purpose	Size	Duration	Investors	Financing Terms
Seychelles Blue Bond	Transition support to sustainable fisheries	USD15 million	10 years	World Bank; Private Placement: Calvert Impact Capital; Nuveen; and Prudential Capital Market	The loan from the GEF decreased the interest rate for the government from 6.5% to 2.8%
Nordic–Baltic Blue Bond	Water resource management and protection	USD213 million	5 years		0.375% coupon

Source: Tirumala and Tiwari (2020).

Over the last decade, there has been a tremendous increase in green bonds. Initially, government organizations issued green bonds to make the environment green and achieve sustainable development in their economies. Subsequently, corporate firms issued green bonds to raise funds, assuming that they will contribute to the green environment. Following a similar pattern, we argue that blue bonds will be a vital financing instrument through which firms can improve the ocean's quality by obtaining funds (similar to Tirumala and Tiwari 2020). To examine firms' blueness, this study develops a blueness index that classifies firms based on the amount of emissions that they produce; as the blueness of a firm increases, its emissions decrease, which leads to more sustainable development. However, as the firm's blueness decreases, its emissions increase, indicating that it needs funds to invest in blue technology and mitigate the risk of creating emissions.

4. THEORETICAL MODEL

4.1 The Investor's Utility Function

To develop the relationship between risk and return, Markowitz (1952) initially proposed the investor's utility function associated with a portfolio. He argued that the proportion of investment is based on the risk and return relationship. Further, he suggested different efficient frontiers at which investors can maximize their returns. Investors participate in treasury securities, stocks, bonds, mutual funds, hedge funds, real estate, and so on to optimize each respective portfolio's allocation.

We express the traditional portfolio utility function (Bell 1995) as:

$$U(R_t, \sigma_t^2) = R_t - \beta\sigma_t^2 \quad (1)$$

where R_t represents the rate of returns that a firm obtains by investing in blue bonds, σ_t^2 shows the risks associated with the blue bonds, and β indicates the sensitivity of risk. We can write the portfolio return (R_t) as:

$$R_t = \alpha_t R_t^A + (1 - \alpha_t) R_t^B \quad (2)$$

where α shows the proportion of investment in blue bond *A* and $(1 - \alpha)$ denotes the percentage of investment in blue bond *B*. R_t^A and R_t^B estimate the rate of returns in blue bonds *A* and *B*, respectively. We calculate the aggregate risk of a portfolio as:

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

Equation (3) indicates the α percentage sensitivity of blue bond *A*, and $(1 - \alpha)$ shows the percentage sensitivity of blue bond *B*. σ_t^A and σ_t^B represent the variance of blue bonds *A* and *B*, respectively. σ_t^{AB} represents the covariance between bond *A* and bond *B*. We can write the variance and covariance as:

$$\sigma_t^A = E\left(R_t^A - \overline{R}_t^A\right)^2$$

$$\sigma_t^B = E\left(R_t^B - \overline{R}_t^B\right)^2$$

$$\sigma_t^{AB} = E\left(R_t^A - \overline{R}_t^A\right)\left(R_t^B - \overline{R}_t^B\right)$$

4.2 A Model Incorporating the Blueness Factor into the Investor's Utility Function

The change in industrial innovation and business patterns worldwide has adversely affected the overall environment. Over the last two decades, there has been a substantial surge in GHG emissions, which has created severe problems for aquatics and human beings' survival. To overcome the environmental issues, every firm must adopt the measures necessary to circumvent ocean emissions. In line with this argument, investors are interested in investing in firms that reduce ocean emissions.

This study investigates how investors can estimate the emissions that ocean firms produce. We assume that investors allocate a certain proportion of their investments to blue bonds and that, as such, they have determined the optimal allocation among these investments. As investors are concerned about firms' blueness, they prefer to invest in firms that reduce ocean emissions. In light of blue bonds, the portfolio utility function is based on the risk, the rate of return, and the blueness factor. We employ the bonds that a firm issues as a determinant of its blueness in terms of obtaining funds. We can express the utility function in this regard as:

$$U(R_t, \sigma_t^2, Blue_t) = R_t - \beta\sigma_t^2 + \gamma(\mathrm{Blue}_t) \quad (4)$$

$$\text{s.t.}\, R_t = \alpha_t R_t^A + (1-\alpha_t) R_t^B \tag{5}$$

$$\sigma_t^2 = \alpha_t^2 (\sigma_t^A)^2 + (1-\alpha_t)^2 (\sigma_t^B)^2 + 2\alpha_t (1-\alpha_t)\sigma_t^{AB} \tag{6}$$

where R_t indicates the return of the portfolio, σ_t^2 shows the riskiness of the bonds, and $Blue_t$ refers to the blueness of the bonds. β represents the sensitivity of risk, and γ suggests the weight of blueness related to bonds. This study examines the level of the blueness of bonds, which we can write as:

$$Blue_t = \alpha Blue_t^A + (1-\alpha) Blue_t^B \tag{7}$$

where α and $(1-\alpha)$ indicate the proportion of the blueness factor associated with bonds *A* and *B*, respectively. $Blue_t^A$ and $Blue_t^B$ show the blueness of bonds *A* and *B*, respectively.

In this study, we propose to estimate the blueness index, which is equal to the sum of ocean emissions scaled by the firm's net sales. This measure indicates the percentage of ocean emissions that the net sales produce. To capture the effect of ocean emissions, we use the emissions of CO_2, SO_2, and NO_x. A lower percentage of ocean emissions to sales represents lower emissions that a firm produces. We compute the blueness of the bond as:

$$Blue_t^A = \frac{-a_1(CO_2) - a_2(SO_2) - a_3(NO_x)}{Y_t^A} \tag{8}$$

$$Blue_t^B = \frac{-b_1(CO_2) - b_2(SO_2) - b_3(NO_x)}{Y_t^B} \tag{9}$$

where CO_2, SO_2, and NO_x refer to the ocean emissions that a firm produces. The coefficients (a_1, a_2, a_3) and (b_1, b_2, b_3) differ from one firm to another. Y_t^A and Y_t^B show the net sales of firms *A* and *B*.

Substituting Equations (5), (6), and (7) into Equation (4), we obtain the optimal level of portfolio function as:

$$\begin{aligned} U = {} & \alpha_t R_t^A + (1-\alpha_t) R_t^B - \beta\{\alpha_t^2 (\sigma_t^A)^2 + (1-\alpha_t)^2 (\sigma_t^B)^2 + 2\alpha_t (1-\alpha_t)\sigma_t^{AB}\} \\ & + \gamma\{\alpha Blue_t^A + (1-\alpha) Blue_t^B\} \end{aligned} \tag{10}$$

Obtaining the first-order conditions in terms of the ratio between bond *A* and bond *B* (α_t), we can express Equation (11) as:

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

By rearranging Equation (11), we obtain:

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

Equation (12) reveals the proportion of investment in bond *A* (Yoshino, Taghizadeh-Hesary, and Otuka 2020). If firms do not account for the necessary measures to reduce the ocean emissions, then the share of bond *A* will be $\alpha_t = \frac{\frac{1}{2\beta}(R_t^A - R_t^B) - (\sigma_t^B)^2 - \sigma_t^{AB}}{(\sigma_t^A)^2 - (\sigma_t^B)^2 - 2\sigma_t^{AB}}$. $Blue_t^A - Blue_t^B$ distinguishes between the allocation of bond *A* and the allocation of bond *B*. If $Blue_t^A > Blue_t^B$, then the portfolio allocation of bond *A* will be larger. However, the firm's blueness index varies, and investors choose to allocate their portfolio based on the firm's consideration of blueness measures.

4.3 Emission Taxation and Portfolio Allocation

This section argues that tax incentives exist for firms that behave in a socially responsible manner. In the presence of non-compliance, the government may impose emission (CO_2, SO_2, and NO_x) taxation, which emphasizes that firms need to invest in blue projects. Applying ocean emission taxation decreases the rate of returns on assets A and B.

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

$$T_A = t_1\left(CO_{2_t}^A\right) + t_2\left(SO_{2_t}^A\right) + t_3\left(NO_{x_t}^A\right) \quad (14)$$

$$T_B = t_1\left(CO_{2_t}^B\right) + t_2\left(SO_{2_t}^B\right) + t_3\left(NO_{x_t}^B\right) \quad (15)$$

By adjusting the ocean emissions, we obtain the new utility function (Equation 13) covering the after-tax rate of return and after-tax risk. The tax rates are the same for firms A and B (Equations 14 and 15). We can obtain an after-tax rate of return (Equations 16 and 17) as follows:

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

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

Utilizing Equations (16) and (17), we can determine the optimal allocation of assets between A and B. We compute the optimal rate of return and risk as:

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

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

By applying the first-order condition of the utility function, we find the optimal allocation of the portfolio as follows:

$$\tilde{\alpha}_t = \frac{\frac{1}{2\beta}\left(\tilde{R}_t^A - \tilde{R}_t^B\right) - (\tilde{\sigma}_t^B)^2 - \tilde{\sigma}_t^{AB}}{(\tilde{\sigma}_t^A)^2 - (\tilde{\sigma}_t^B)^2 - 2\tilde{\sigma}_t^{AB}} \tag{20}$$

Equation (20) shows the proportion of investment after considering the ocean emission taxation in Equation (12). After imposing international emission taxation, we assume that the optimal allocation of portfolio shifts downward. This implies that investment in blue bonds decreases if a firm does not account for the blueness factors and a regulator imposes emission taxation.

4.4 Drivers of Stock Returns Including the Blueness Index

To determine how the blueness of a firm might affect its performance, we develop the following empirical model:

$$SPR_{it} = \alpha_{it} + \beta_1 ROB_{it} + \beta_2 IB_{it} + \beta_3 Blueness_{it} + \beta_4 Risk_{it} + \varepsilon_{it} \tag{21}$$

where SPR_{it} refers to the stock returns of ocean firms, ROB_{it} denotes the rate of return on bonds, IB_{it} stands for the number of issuance bonds, $Blueness_{it}$ shows the blueness index of the firm, and $Risk_{it}$ is the credit rating of the bonds ranging from AA to BBB.

5. DATA AND SAMPLE

To test our hypothesis by developing an investment portfolio, we select seafood and shipping firms as proxies for blue firms. We obtain the data relating to the monthly prices of bonds from finance.yahoo between December 2018 and December 2019. Information about ocean emissions is difficult to obtain as different researchers have indicated only tentative percentages. However, we utilize the forecasted data of the global maritime emission inventory in 2019.[1] This study determines the proportion of investment with and without the blueness index for developing the optimal portfolio. We propose that a firm's blueness leads to increased participation of bonds as it takes steps to make the environment blue. To examine the effect of the blueness index on

[1] https://www3.epa.gov/ttn/chief/conference/ei18/session1/neef.pdf. According to the analysis, the emissions of CO_2, SO_2, and NO_x were 12, 17, and 26 million tons, respectively, in 2019.

the stock return, we select 31 Norwegian firms operating in the seafood and shipping sectors from 2017 to 2019.

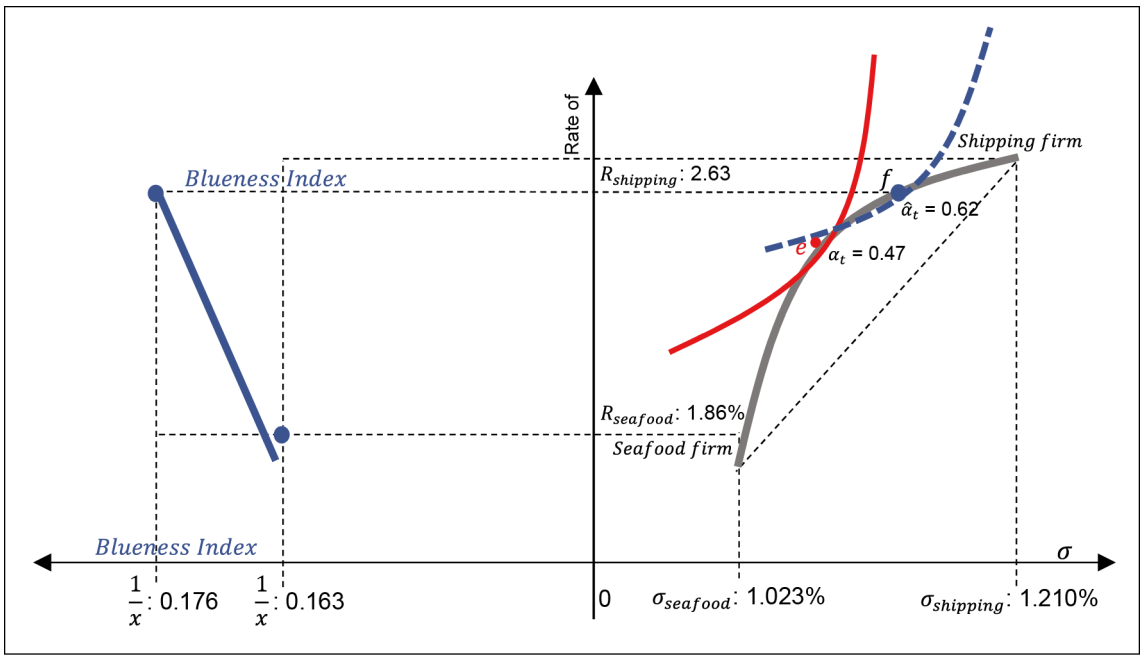
6. RESULTS

6.1 The Investor's Utility Function and the Blueness Index

When participating in ocean firms, investors are concerned about firms' preferences for making the environment blue. The blueness factor could help by taking advantage of the tax benefits associated with blue investment, and they may receive a "halo" effect as people consider them to be responsible stewards. Hence, we assume that bluer firms attract more investment. To test this proposition and develop an investment portfolio, we select two Norwegian seafood and shipping firms. We obtain the monthly average bond returns from December 2018 to December 2019 and find that investors earn 1.86% from the seafood firm and 2.13% from the shipping firm on average. The variance of $\sigma_{seafood}$ and $\sigma_{shipping}$ is 1.023% and 1.210%, respectively. The covariance between the seafood and the shipping firm is -0.0225.

We measure the blueness factor using the notation $Blue_t = \frac{-a_1(CO_2)-a_2(SO_x)-a_3(N_2O)}{Y_t}$, where a_1, a_2, and a_3 are the weights of emissions. Y_t refers to the net sales of the firm. The negative sign refers to emissions resulting from sales. A higher value refers to a lower level of blueness of the firm. For a clear understanding, we use the blueness index as 1/x, which refers to a higher level of blueness creating lower emissions. The ocean emissions that the firms produce vary due to the size and nature of their ocean business. The firms do not report emission-related data; therefore, we employ the forecasted data of ocean emissions, which show that they produced 12 million tons of CO_2 emissions, 17 million tons of SO_2, and 26 million tons of NO_x in 2019.

Figure 1: Portfolio Allocation Considering the Blueness Index



Source: Authors.

In the absence of the blueness factor, we measure the utility function and the proportion of investment as $\alpha_t = \frac{\frac{1}{2\beta}\left(R_t^A - R_t^B\right) - \left(\sigma_t^B\right)^2 - \sigma_t^{AB}}{\left(\sigma_t^A\right)^2 - \left(\sigma_t^B\right)^2 - 2\sigma_t^{AB}}$. Figure (1) displays the relationship between the risk, the return, and the blueness index. On one side of the x-axis, we plot the riskiness of bonds; on the other side, we draw the blueness index. The y-axis represents the return on bonds. We find that the value of α_t equals 0.47, which shows that investors purchase a 47% share in the seafood firm, as the red line on the utility function without the blueness index indicates. Next, we estimate the utility function by incorporating the blueness of the firms, $\hat{\alpha}_t = \frac{\frac{1}{2\beta}\left(R_t^A - R_t^B\right) - \left(\sigma_t^B\right)^2 - \sigma_t^{AB} + \frac{\gamma}{2\beta}\left(Blue_t^A - Blue_t^B\right)}{\left(\sigma_t^A\right)^2 - \left(\sigma_t^B\right)^2 - 2\sigma_t^{AB}}$, and find that participation in investment increases the share in the seafood firm to 62%. This implies that blueness is a vital predictor when deciding to invest in a portfolio because $\hat{\alpha} > \alpha$. This finding suggests that investors allocate their funds by considering the rate of return, the riskiness of bonds, and the firm's blueness. As a result, the utility function shifts upward from point "e" to point "f." When we compare the utility functions of the seafood and the shipping firm and report that investors are willing to take on more risk, they prefer to invest in bluer firms.

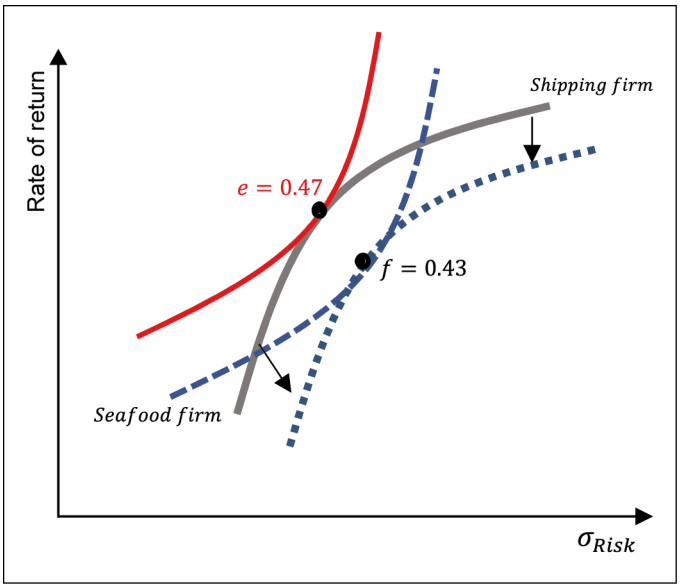
It is important to note that, when the value of β increases, the participation in the respective bond decreases due to the rise in risk factors. In comparison, the value of γ shows the investors' preference for bluer bonds. A higher value of γ increases the participation of investors in the respective bond.

In short, we can argue that "blueness" is an important indicator to attract investment on the one hand and to make the ocean blue on the other. Over the past few years, there has been a tremendous surge in the issuance of green bonds to make the environment green. Following a similar pattern, ocean firms may issue bonds wherein investors prefer to participate in the respective firms that are taking the necessary measures to make the ocean blue.

6.2 The Investor's Utility Function and Emission Taxation

In the absence of the blueness index, the participation of investment in the seafood firm is 47%. We assume that an ocean firm produces different emissions that distort the ocean environment. However, firms that generate ocean emissions may incur international emission taxation. Here, we assume that countries impose a 2% tax on emissions, which reduces the returns of the seafood and shipping firms. The imposition of the tax reduces the net earnings of the seafood and shipping firms. Likewise, the variance of their returns and covariance changes and the seafood firm's investment decreases to 43%. This evidence suggests that firms must comply with the set of rules that the regulators frame; otherwise, they may face emission tax, which will affect their returns and their participation in investment.

Figure 2: Emission Taxation and the Utility Function



Source: Authors.

6.3 Examining the Drivers of Stock Returns Including the Blueness Index

To conduct the empirical analysis, we consider 31 Norwegian firms operating in the seafood and shipping industries during the period from 2017 and 2019. We gather the relevant data from the firms' annual reports and the Oslo Stock Exchange. We hypothesize that the stock return influences the bonds' return, the issuance number of bonds, the blueness index, and the bonds' risk rating. Due to the lack of availability of data on blue bonds, we use the data on bond issuance and return on bonds. Table 2 presents the descriptive statistics of the variables that we use in this study.

Table 2: Descriptive Statistics

Variable		Mean	Std Dev.	Min.	Max.
SPR	Share price returns (%)	5.03	0.15	–29.84	74.90
ROB	Return on bonds (%)	0.52	0.84	0	4.70
IB	Issuance of bonds (million NOR)	2,028.41	4,575.38	10.81	29,128.00
Blueness	Emissions as a percentage of sales (1/x)	12.28	17.99	–6.23	75.18
Risk	Credit ratings of the bonds (AA, A, and BBB)	–	–	–	–

Source: Authors.

Table 3 presents the empirical results. This study employs the feasible generalized least square (FGLS) estimator to remove the problem of serial correlation and heteroskedasticity. We can report that the coefficient of the return of bonds is positive and significantly affects the stock returns. This evidence suggests that a firm's required return is higher, which makes its beta or systemic risk higher, and we expect that, as a firm takes on more risk, it becomes inherently riskier. This study identifies a negative relationship between the number of issuances of bonds and the stock returns.

We express the blueness index as the ocean emissions produced as a percentage of the firm's sales. A higher value of the blueness index of a firm refers to lower emissions produced. In this study, our variable of interest is the blueness index, which positively influences the stock returns. This evidence elaborates that firms pursue blue strategies to maximize their share prices. In other words, environment-friendlier firms satisfy the criteria to make the ocean blue and their probability of earning stock returns is higher. Lastly, the risk variable shows the credit rating of bonds, which does not have a statistical relationship with the stock returns. We can interpret this as indicating that the risk level associated with a firm's bond issuance may not have a significant impact because we base the proxy for risk on investment-grade bonds.

Table 3: Results of the Panel FGLS Estimator

Variable	Model 1	Model 2	Model 3
ROB	0.286***	0.290***	0.294***
	(3.59)	(3.21)	(3.27)
IB	–0.441**	–0.377**	–0.441**
	(–2.14)	(–2.10)	(–2.14)
Blueness	0.184*	0.171*	0.176*
	(1.86)	(1.81)	(1.82)
Risk (AA)		–0.200	
		(–0.18)	
Risk (BBB)			0.126
			(1.34)
Constant	–1.703	–0.525	–0.286
	(–0.74)	(–0.14)	(–0.10)
Wald Chi_2	28.98***	26.31***	27.41***

Notes: This table presents the drivers that cause stock returns using the FGLS estimator. ROB = return on bonds, IB = issuance of bonds in million NOR, blueness = a measure of the blueness index, which we compute as the percentage of emissions to sales, and risk = a credit rating of the bonds.

Source: Authors.

7. CONCLUSION

Over the last few years, there has been a tremendous increase in ocean emissions, which pollute the ocean and threaten ocean species' lives. To achieve the blue ocean objective, "blue finance" has recently emerged, wherein a firm can issue blue instruments, for example bonds, IPOs, and credit, to raise funds for investing in blue technology to achieve sustainability goals.

This study is an attempt to measure the level of blueness of firms. To estimate the blueness index, we use ocean emissions as a percentage of sales. The results show that a higher value of the blueness index leads to lower emissions. In this study, we develop a theoretical model to estimate a portfolio's utility function by introducing the blueness factor. We assume that investors participate in blue bonds and that their preference for investing in "bluer" firms is stronger. It is possible to argue that less blue firms become riskier due to non-compliance with the necessary measures for the blue ocean.

Further, we report that, if firms account for the blueness measures, their investment in blue bonds is higher. To achieve the objective of blueness, firms must make the ocean blue. For non-compliance with the blueness factors, governments should impose ocean emission taxation, which will affect the bond returns; thus, the participation in blue bonds decreases. Finally, we determine the drivers that cause stock returns and find

that firms' blueness positively influences their stock returns, which indicates that firms that are relatively "bluer" may be socially responsible, leading to their outperformance.

This study is useful for policymakers, firms, investors, and regulators to account for firms' blueness. In the absence of blue parameters, firms may face emission taxation, which eventually reduces their returns. We propose that financing regulators should develop different financing frameworks for providing funds so that firms can benefit and invest in blue technology, thereby achieving the blue ocean's blueness parameters. Future research could test the proposed theoretical model on a large dataset of ocean firms and compare their returns, riskiness, and blueness index.

REFERENCES

Barbesgaard, M. 2018. “Blue Growth: Savior or Ocean Grabbing?” *Journal of Peasant Studies* 45 (1): 130–49.

Bell, D. E. 1995. “Risk, Return, and Utility.” *Management Science* 41 (1): 23–30.

Bennett, N. 2018. “Navigating a Just and Inclusive Path towards Sustainable Oceans.” *Marine Policy* 97: 139–46.

Blue Natural Capital Financing Facility (BNCFF). 2019. *Blue Bonds: Financing Resilience of Coastal Ecosystem*, prepared by Nathalie Roth, 4Climate, Torsten Thiele, Global Ocean Trust, and Moritz von Unger, Silverstrum. Luxembourg.

Ciais, P. and Sabine C. 2013. “Carbon and Other Biogeochemical Cycles.” In *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by T. F. Stocker et al., 465–570. Cambridge, UK: Cambridge University Press.

Eikeset, A., A. Mazzarella, B. Baviosdottir, D. Klinger, S. Levin, E. Rovenskaya, and N. Stenseth. 2018. “What is Blue Growth? The Semantics of ‘Sustainable Development’ of Marine Environments.” *Marine Policy* 87: 177–9.

Goddard, C. 2015. *The Blue Economy: Growth, Opportunity and a Sustainable Ocean Economy*. Economist Intelligent Unit, London.

Guggisberg, S. 2019. “Funding Coastal and Marine Fisheries Projects under the Climate Change Regime.” *Marine Policy* 107.

Gulseven, O. 2020. “Measuring Achievements towards SDG 14, Life below Water, in the United Arab Emirates.” *Marine Policy* 117, 103972.

Hilborn, R., and C. Costello. 2018. “The Potential for Blue Growth in Marine Fish Yield, Profit and Abundance of Fish in the Ocean.” *Marine Policy* 87: 350–5.

International Capital Market Association. 2018. “Green Bonds Principles—Voluntary Process Guidelines for Issuing Green Bonds.” https://www.icmagroup.org/assets/documents/ Regulatory/Green-Bonds/Green-Bonds-Principles-June-2018-270520.pdf.

Markowitz, H. 1952. “Portfolio Selection.” *Journal of Finance* 7: 77–91.

Niiranen, S., A. Ritcher, T. Blenckner, L. Stige, A. Valman, and A. Eikeset. 2018. “Global Connectivity and Cross-Scale Interactions Create Uncertainty for Blue Growth of Arctic Fisheries.” *Marine Policy* 87: 321–30.

Smith-Godfrey, S. 2016. “Defining the Blue Economy. Maritime Affairs.” *Journal of the National Maritime Foundation of India* 12 (1): 58–64.

Spalding, M. 2016. “The New Blue Economy: The Future of Sustainability.” *Journal of Ocean and Coastal Economics* 2 (2): 1–21.

Steffen, J. 2012. *IUCN Oceania Office, Green to Blue Economy*. s.l.: IUCN. http://cmsdata. iucn.org/downloads/iucn_green_to_blue_economy.pdf.

Tirumala, R. D., and P. Tiwari. 2020. “Innovating Financing Mechanism for Blue Economy Projects.” *Marine Policy* 104194, forthcoming.

Vanderklift, M., R. Marcos-Martinez, J. Butler, M. Coleman, A. Lawrence, H. Prislan, A. Steven, and S. Thomas. 2019. “Constraints and Opportunities for Market-Based Finance for the Restoration and Protection of Blue Carbon Ecosystems.” *Marine Policy* 107. https://doi.org/10.1016/j.marpol.2019.02.001.

Wabnitz, C., and R. Blasiak. 2019. “The Rapidly Changing World of Ocean Finance.” *Marine Policy* 107.

World Ocean Initiative. 2020. “Will Blue Finance Fulfill its Potential?” Accessed 27 June 2020. https://www.woi.economist.com/will-blue-finance-fulfil-its-potential/.

Yoshino, N., F. Taghizadeh-Hesary, and M. Otuka. 2020. *Optimal Portfolio Selection for Investment in ESG Goal, Facing Issues in ESG Investment*, edited by N. Nemoto, 95–107. ADBI book series: Environmental, Social, and Governance Investment—Opportunities and Risks for Asia, Japan. Asian Development Bank Institute, Japan.