Impact of the Poseidon Principles on debt financing transactions

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Abstract

This study examines the impact of the Poseidon Principles, a green finance initiative by lending institutions in the maritime shipping industry, on debt financing transactions. Using a dataset of 1,470 debt financing transactions from 564 maritime companies between 1998 and 2024, the research employs both quantitative and qualitative analysis. The quantitative analysis reveals a statistically significant reduction in the amount and duration of debt financings post-Poseidon Principles, although interest and coupon rates have increased. Moreover, our results indicate that the amount and duration of debt financings between ESG-linked and non- ESG -linked debt financings are the same. However, interest and coupon rates for ESG-linked debt financings is reduced compared to non-ESG-linked debt financings. Qualitatively, the content analysis highlights a growing trend toward integrating sustainability elements into financing structures, with an increasing emphasis on ESG-linked instruments, such as sustainability-linked loans. Nonetheless, traditional financing methods continue to dominate, particularly in non-ESG transactions, which are predominantly tied to asset-heavy, industry-specific projects. Furthermore, the quantitative analysis, reveals that despite the rise in ESG-linked financings, their adoption remains limited. These findings indicate a gradual transition in the maritime industry towards sustainability, with ESG-linked debt structures becoming more prominent, while their real-world impact on main financing terms remains constrained. Our results also highlight a divergence between the increasing visibility of sustainable finance and its actual adoption by the shipping companies. Lastly, our findings highlight the complexities of integrating sustainability into capital intensive industries, such as shipping.

Keywords: Green finance, ESG, sustainability-linked financing, decarbonization, maritime shipping industry.

1. Introduction

As firms increasingly embrace Environmental, Social, and Governance (ESG) practices, their financial strategies are becoming more intertwined with sustainability goals, with creditors paying more attention to ESG performance as an indicator of long-term viability (Zhang et al., 2024). This shift has been especially prominent in industries like maritime shipping, which due to its importance for global trade faces substantial environmental pressures and regulatory requirements. The International Maritime Organization (IMO) has set ambitious targets to reduce carbon dioxide (CO2) emissions from shipping, further driving the need for green finance in the industry (Wang et al., 2023).

The shipping industry, which accounts for about 90 percent of global trade, is particularly susceptible to the challenges posed by environmental degradation and climate change (Wang et al., 2023). The introduction of environmental goals, such as the IMO 2050 target, which aims to cut emissions by half by 2050, has necessitated significant investment in new technologies such as alternative marine power solutions (Pangalos, 2023). These high-capital investments highlight the growing role of green finance in supporting the maritime shipping industry's transition to more sustainable operations (Xu and Gao, 2022). The financial sector has increasingly been recognized as a crucial driver in the transition toward sustainability and climate neutrality, particularly as it plays a central role in mobilizing private capital necessary to meet the climate goals set out by the Paris Agreement and the UN Sustainable Development Goals (SDGs) (Maltais and Nykvist, 2020). Debt financing, a key mechanism linking firms to capital markets, has become particularly important in the context of corporate sustainability (Zhang et al., 2024). Despite the expanding scope of green finance, particularly with the rise of green bonds, challenges such as greenwashing, where companies misrepresent the environmental benefits of their investments, remain a concern in ensuring the credibility and effectiveness of these financial structures (Gigante and Manglaviti, 2022).

Zhou and Yuen (2023) state that sustainable shipping has grown into a significant area of research since the early 21st century. While green finance is increasingly acknowledged as essential for this transition, the specific mechanisms of how it influences funding decisions within the maritime industry, particularly regarding debt financing, remain underexplored in academic research (Morchio et al., 2024). Furthermore, while ESG factors are now integral to many corporate financing decisions, the precise impact of these factors on debt financing, particularly in capital-intensive industries like shipping, is still not well understood (Gigante and Manglaviti, 2022; Zhao and Zhang, 2024). As a result, there exists a critical gap in the literature regarding the role of green finance, particularly green bonds with ESG factors, in shaping the debt financing strategies of shipping companies, an industry under increasing pressure to meet sustainability goals while managing substantial capital expenditures (Morchio et al., 2024).

This paper seeks to address this gap by exploring the influence of the Poseidon Principles on debt financing transactions in the maritime industry. Specifically, it will examine how the adoption of these green finance and sustainability-linked financial debt structures affects the main terms of the debt financing transaction for maritime shipping companies.

2. Literature review

2.1. Types of green finance structures

Green finance has become an essential part of the global financial landscape, focused on supporting the transition toward a more sustainable economy by directing capital toward projects that address environmental challenges (Morchio et al., 2024). This has led to the development of a range of financial structures, including green bonds, green loans, sustainability-linked loans, and sustainability-linked bonds, each designed to promote environmental sustainability in different ways. These debt structures focus more on the “E” factor of ESG, driving the trend of sustainable corporate finance (Auzepy et al., 2023).

Green bonds are perhaps the most widely recognized of these structures, designed to finance projects with environmental benefits such as renewable energy, energy efficiency, or pollution reduction. The first green bond was issued by the World Bank in 2008, and since then, the market for green bonds has grown substantially, reaching USD 167 billion by 2018 (Maltais and Nykvist, 2020). Unlike conventional bonds, green bonds include a "use of proceeds" clause that requires the funds raised to be directed toward environmentally sustainable projects, helping issuers signal their commitment to sustainability. However, a key distinction of green bonds is that investors typically have recourse to the issuer’s overall balance sheet. In particular, when investors buy green bonds, their repayment and returns are backed by the issuer's overall financial stability (i.e., the issuer's balance sheet), not just the performance or success of the specific environmentally friendly projects funded by the bond (Maltais and Nykvist, 2020). Therefore, investors are also protected by the general financial health and creditworthiness of the bond issuer. This characteristic often makes green bonds less risky for investors compared to project-specific financing. In other words, that means that they are not directly exposed to the financial risks of the specific projects being financed (Maltais and Nykvist, 2020). Moreover, green bonds often trade at a slight yield discount compared to traditional bonds, a phenomenon known as the "greenium" (Maltais and Nykvist, 2020), driven by the high demand for sustainable investment opportunities, though some studies have found that in real-world settings, the greenium may be negligible (Lau et al., 2022).

Green loans are financial products similar to traditional loans but are specifically intended to fund environmentally sustainable projects. These loans are typically used to finance initiatives such as renewable energy installations or green buildings, with the funds required to meet specific environmental criteria (Morchio et al., 2024). Unlike green bonds, which are also used to support

environmentally beneficial projects, green loans often involve more direct engagement with the projects they finance. They are typically tied to specific environmental performance outcomes, such as meeting energy efficiency targets or reducing carbon emissions, which ensures that the projects fulfill their green objectives (Morchio et al., 2024).

Sustainability-linked loans are another innovative financial instrument within the green finance ecosystem. Unlike green loans, which require that the proceeds be allocated exclusively to specific green projects, sustainability-linked loans are tied to the borrower's overall sustainability performance. The terms of these loans, such as interest rates, can vary depending on how successfully the borrower meets predefined ESG targets (Auzepy et al., 2023). In other words, borrowers can work on improving their sustainability practices across their entire business or organization (for example, reducing carbon emissions or improving workplace diversity), and the terms of the loan (such as the interest rate) will be adjusted based on how well they meet their ESG targets. Unlike other financing options that require funds to be spent on specific green projects, sustainability-linked loans offer more flexibility by focusing on the overall sustainability goals of the borrower, not on individual projects. This flexibility makes sustainability-linked loans an attractive option for borrowers aiming to improve their ESG performance without needing to commit funds to specific projects (Auzepy et al., 2023).

Together, these debt structures contribute to the growth of green finance, a market that facilitates investments in projects with positive environmental impacts. The rapid expansion of green bonds and other green financial structures reflects growing investor demand for sustainable investments, while also highlighting challenges such as the risk of greenwashing and the lack of unified standards (Gigante and Manglaviti, 2022). Green finance, through its diverse structures, thus plays a crucial role in advancing global sustainability goals, helping businesses, governments, and financial institutions align their activities with long-term environmental priorities (Ye and Tian, 2024).

2.2. Environmental prioritization in shipping finance

In the maritime shipping industry, financing strategies are heavily influenced by environmental considerations, with limited emphasis on social (S) and governance (G) factors. Shipping companies typically adopt a mix of debt and equity financing to address the financial demands amid environmental regulations and sustainability goals (Pangalos, 2023). This includes raising funds through public equity markets, issuing bonds, securing bank loans, and leveraging assets as collateral (Pangalos, 2023).

The focus on environmental (E) factor in the maritime shipping industry is driven by mounting pressure to comply with international environmental standards such as the IMO's decarbonization targets and regional policies promoting green technologies. These standards require significant investment in cleaner technologies and fuels, including LNG-powered ships, scrubbers, and energy-efficient designs (Pangalos, 2023). As a result, the financial ecosystem surrounding maritime shipping

is disproportionately aligned with environmental performance while often neglecting the broader implications of social responsibility and corporate governance practices.

In this context, the Poseidon Principles were introduced on June 18, 2019, as an initiative led by global maritime shipping banks, including Citi, Societe Generale, and DNB. This effort was developed in partnership with prominent stakeholders in the maritime industry, such as A.P. Møller Mærsk, Cargill, Euronav, Gram Car Carriers, Lloyd's Register, and Watson Farley & Williams. In June 2018, a series of three workshops were conducted in Singapore, London, and New York City, bringing together 45 senior ship financiers along with a select group of ship owners and industry experts (Rebelo, 2020). The purpose of these workshops was to identify practical strategies for incorporating climate risk into financial decision-making within the maritime shipping industry. Participants shared a common vision of success, envisioning a coalition of dedicated institutions that would adopt a set of principles aimed at integrating climate considerations into lending practices, in line with the climate-related objectives set by the IMO.

Prioritization on sustainability is reflected in the composition of green financial structures within the maritime shipping industry. Maritime shipping companies primarily issue green loans and bonds tied to vessel-related energy upgrades, demonstrating a narrow interpretation of sustainability that overlooks critical S and G dimensions (Pangalos, 2023). For example, social aspects such as crew welfare, labor conditions, and community engagement rarely feature in the metrics tied to financing terms. Similarly, governance concerns, such as transparency in emissions reporting (Tsatsaronis et al., 2024) or anti-corruption practices, often remain underexplored in funding frameworks, such as Poseidon Principles.

2.3. Empirical studies in green financing

The existing literature on green financing in the maritime shipping industry and the financial sector explores a range of approaches, including green bonds, sustainability-linked loans, and impact of ESG performance on corporate financing decisions. While these studies provide valuable insights, no research, to the best of our knowledge, directly examines the impact of the Poseidon Principles, an initiative that sets a framework for sustainable ship financing, on debt financing transactions within the maritime shipping industry. In particular, Maltais and Nykvist (2020) explore the role of green bonds in driving sustainability within financial markets, particularly through the lens of ESG integration. Their empirical study, based on interviews, investigates how green bonds help redirect capital toward sustainable projects, such as renewable energy and green infrastructure. They find that the green bond market's rapid expansion has notably influenced market participants' engagement with sustainability. However, their study does not delve into maritime shipping specifically but offers insights into the financial tools that could be relevant for maritime shipping firms in the context of broader sustainability goals.

Auzepy et al. (2023) provide an empirical study of sustainability-linked loans, which incorporate ESG criteria into debt financing. Their analysis, using a sample of loans issued between 2017 and 2022, reveals that sustainability-linked loans only partially incentivize sustainability through key performance indicators (KPIs). Their findings suggest limited success in driving real improvements in ESG performance among borrowers, and stock market reactions show little enthusiasm for sustainability-linked loans, especially in the European Union. The study highlights concerns about the effectiveness of ESG-linked debt products, such as green bonds and sustainability-linked loans, in producing actual sustainability outcomes.

Zhang et al. (2024) examine the influence of ESG-related competitive disadvantages on the cost of debt financing among Chinese firms. They find that companies facing ESG-related disadvantages tend to face higher debt financing costs, particularly in industries with local environmental concerns. Similarly, Peng and Xie (2024) show that ESG greenwashing can increase debt financing costs, underscoring the importance of genuine ESG efforts. Zhao and Zhang (2024) explore how ESG performance affects capital structure decisions in Chinese firms, finding that firms with better ESG scores enjoy lower debt financing costs and higher access to debt capital. Additionally, Asimakopoulos et al. (2023), in their empirical study focusing on the relationship between ESG ratings and corporate financial decisions, suggest that ESG-rated firms experience lower costs for both bank loans and bonds, reflecting the financial benefits of being ESG-rated. Similarly, Kong (2023) argues that strong ESG performance in family-owned businesses can result in lower financing costs. The above-mentioned studies do not specifically focus on the maritime shipping industry, leaving a research gap in understanding how these factors may apply to maritime finance.

Morchio et al. (2024) analyze the adoption of green financial products in bulk shipping, focusing on the preferred financing methods and the scale of resources raised by international firms. The study highlights the role of green finance in supporting the maritime shipping industry's sustainability efforts but does not explicitly investigate the Poseidon Principles. Similarly, Xu and Gao (2022) examine how green finance influences the marine economy, with a focus on energy conservation and environmental protection in coastal areas, but their study does not directly address debt financing or the Poseidon Principles.

The studies reviewed here demonstrate a growing body of literature on the intersection of ESG, green finance, and corporate debt financing. They provide evidence that ESG factors can influence the cost of debt and the availability of financing, particularly through structures like green bonds and sustainability-linked loans. However, there is a significant gap in the literature regarding the specific impact of the Poseidon Principles on debt financing transactions in the maritime shipping industry. Existing research on green finance in the shipping industry highlights key insights but leaves a gap in understanding how specific financial tools, like the Poseidon Principles, impact debt financing

decisions. The Poseidon Principles, which specifically target the decarbonization of shipping, have not been empirically studied in relation to debt structuring and financing costs.

Given that the Poseidon Principles aim to align ship financing with the IMO's decarbonization goals, there is a clear need for empirical research to explore how these principles influence debt financing decisions, the effectiveness of sustainability-linked loans in the maritime shipping industry, and their potential to drive real improvements in ESG performance among shipping firms. This study aims to address the gap by investigating the impact of the Poseidon Principles on debt financing decisions in the industry.

3. Methods

3.1. Sample

The sample of our study includes 1,470 debt financing transactions of 564 maritime shipping companies, from January 1, 1998, until August 31, 2024. Out of total 1,470 debt financing transactions, 90.8 percent do not have any ESG element, whereas the remaining 9.2 percent are ESG-link debt financings (see Table 1).

Table 1. Descriptives of debt financing transactions per year

		ESG		Total
		No	Yes	
Year	1998	3	0	3
	2000	2	0	2
	2001	1	0	1
	2003	5	0	5
	2004	2	0	2
	2005	18	0	18
	2006	8	0	8
	2007	14	0	14
	2008	17	0	17
	2009	24	0	24
	2010	56	1	57
	2011	70	0	70
	2012	87	0	87
	2013	70	0	70
	2014	102	0	102
	2015	41	0	41
	2016	94	0	94
	2017	104	0	104
	2018	104	5	109
	2019	91	10	101
	2020	92	14	106
	2021	85	37	122
	2022	72	22	94
	2023	110	28	138
	2024	63	18	81
Total		1335	135	1470

The debt financing transactions consists of term loan facilities, revolving loan facilities, lease financing using the sale and leaseback bareboat structure, corporate bonds and Japanese operating leases with call option (JOLCOs). The various types of debt financing transactions are reported in Table 2.

Table 2. Descriptives of debt financing transactions per type

			ESG		
			No	Yes	Total
Type	Term Loan	Count	667	73	740
		% within Type	90.1%	9.9%	100.0%
		% within ESG	50.0%	54.1%	50.4%
	Revolving Loan	Count	18	6	24
		% within Type	75.0%	25.0%	100.0%
		% within ESG	1.4%	4.4%	1.6%
	Lease	Count	183	6	189
		% within Type	96.8%	3.2%	100.0%
		% within ESG	13.7%	4.4%	12.9%
	Bond	Count	464	49	513
		% within Type	90.4%	9.6%	100.0%
		% within ESG	34.8%	36.3%	34.9%
	JOLCO	Count	1	1	2
		% within Type	50.0%	50.0%	100.0%
		% within ESG	0.1%	0.7%	0.1%
Total		Count	1333	135	1468
		% within Type	90.8%	9.2%	100.0%
		% within ESG	100.0%	100.0%	100.0%

The 564 maritime shipping companies in our sample operate in various shipping sectors, such as dry bulk, wet tanker, containership, gas tanker, offshore, diversified, and cruise (see Table 3).

Table 3. Descriptives of debt financing transactions per sector

			ESG		
			No	Yes	Total
Sector	Dry	Count	148	14	162
		% within Sector	91.4%	8.6%	100.0%
		% within ESG	11.1%	10.4%	11.0%
	Tanker	Count	225	23	248
		% within Sector	90.7%	9.3%	100.0%
		% within ESG	16.9%	17.0%	16.9%
	Container	Count	75	34	109
		% within Sector	68.8%	31.2%	100.0%
		% within ESG	5.6%	25.2%	7.4%
	Gas	Count	83	5	88
		% within Sector	94.3%	5.7%	100.0%
		% within ESG	6.2%	3.7%	6.0%
	Offshore	Count	645	17	662
		% within Sector	97.4%	2.6%	100.0%
		% within ESG	48.3%	12.6%	45.0%
	Diversified	Count	62	25	87
		% within Sector	71.3%	28.7%	100.0%
		% within ESG	4.6%	18.5%	5.9%
	Cruise	Count	32	2	34
		% within Sector	94.1%	5.9%	100.0%
		% within ESG	2.4%	1.5%	2.3%
	Other	Count	65	15	80
		% within Sector	81.3%	18.8%	100.0%
		% within ESG	4.9%	11.1%	5.4%
Total		Count	1335	135	1470
		% within Sector	90.8%	9.2%	100.0%
		% within ESG	100.0%	100.0%	100.0%

3.2. Data

The data of our study were extracted from Marine Money's Deal Database (MMDD). MMDD contains most equity and debt capital transactions of companies operating in the maritime shipping industry (MMDD, 2024). The data extracted include the name of the company, the debt financing transaction date, whether each debt financing transaction is ESG-linked or not, the shipping sector of the company that performed each debt financing transaction, the debt financing transaction amount in USD currency, the duration of each debt financing transaction, the interest rate or coupon rate of each debt financing transaction, whether pricing of each debt financing transaction is based on benchmarking rate, such as LIBOR, SOFR, NIBOR, EURIBOR, and whether the debt financing transaction is secured (i.e., mortgage-backed) or unsecured.

From the debt financing transaction date, a new dummy variable was created to account for the launch of the Poseidon Principles. The variables of our study appear in Table 4.

Table 4. Variables

Panel A: Description of variables

Code	Categorical Variable	Calculation
SECTOR	Shipping sector of each company	Grouped in 8 categories; 1: Dry 2: Tanker 3: Container 4: Gas 5: Offshore 6: Diversified 7: Cruise 8: Other
TYPE	Type of debt financing transaction	Grouped in 5 categories; 1: Term Loan 2: Revolving Loan 3: Lease 4: Bond 5: JOLCO
YEAR	Year of debt financing transaction	From debt financing transaction date
ESG	ESG-linked debt financing transaction	Dummy variable; 0: No 1: Yes
PP	Lauch of the Poseidon Principles	Dummy variable; 0: Before 1: After

Code	Continuous Variable	Calculation
AMOUNT	Amount of debt financing transaction in USD million	as provided by MMDD
DURATION	Duration in years of debt financing transaction	as provided by MMDD
RATE	Interest/Coupon rate of debt financing transaction	as provided by MMDD

Panel B: Descriptives statistics of continuous variables

	N	Min.	Max.	Mean	Std. Dev.	Skewness		Kurtosis	
						Stat.	Std. Error	Stat.	Std. Error
AMOUNT	1,427	1.25	8,500.00	320.64	523.14	6.42	0.06	68.87	0.13
DURATION	855	0.25	60.00	6.11	4.19	4.90	0.08	42.22	0.17
RATE	589	0.07	13.50	4.85	2.87	0.57	0.10	-0.44	0.20

Panel C: Descriptives statistics of continuous variables before/after launch of the Poseidon Principles (PP)

		N	Mean	Std. Dev.	Std. Error Mean
AMOUNT	No	854.00	364.49	584.66	20.01
	Yes	573.00	255.29	406.66	16.99
DURATION	No	498.00	6.53	4.90	0.22
	Yes	357.00	5.52	2.82	0.15
RATE	No	347.00	4.81	2.69	0.14
	Yes	242.00	4.92	3.12	0.20

Panel D: Descriptives statistics of continuous variables for ESG & Non-ESG linked debt financing transaction (ESG)

		N	Mean	Std. Dev.	Std. Error Mean
AMOUNT	No	1,293.00	322.37	521.20	14.49
	Yes	134.00	303.97	543.27	46.93
DURATION	No	756.00	6.10	4.35	0.16
	Yes	99.00	6.19	2.69	0.27
RATE	No	537.00	4.95	2.88	0.12
	Yes	52.00	3.82	2.59	0.36

4. Analysis

4.1. Baseline analysis

To test whether the launch of the Poseidon Principles has an impact on amount, duration, and pricing of debt financing transactions, we run the non-parametric Independent-samples Mann-Whitney U (M-W) test. In particular, M-W test is used to analyze whether the means of AMOUNT, DURATION, and RATE differ between the two periods, i.e., before and after launch of the Poseidon Principles on June

18, 2019. The M-W test was selected instead of the parametric Independent-samples T test because the normality assumption is violated for the variables under investigation (see Panel B of Table 4). The results of the M-W test appear in Table 5.

The null hypothesis of the M-W test is that the distribution of each variable is the same between the two periods (dummy variable of PP). The M-W test suggests that for all variables, except for RATE, there are significant differences in the distribution before and after launch of the Poseidon Principles. Thus, the results of the M-W test in conjunction with the descriptives statistics in Panel C of Table 4 indicate that the amount and the duration of debt financing transactions were reduced after launch of the Poseidon Principles. In contrast, the launch of the Poseidon Principles did not have any impact on interest or coupon rate of debt financing transactions.

Table 5. Results of M-W test

	PP		ESG	
Variable	**Sig.[a]**	**Decision**	**Sig.[a]**	**Decision**
AMOUNT	0.000	Reject the null hypothesis	0.446	Retain the null hypothesis
DURATION	0.000	Reject the null hypothesis	0.104	Retain the null hypothesis
RATE	0.815	Retain the null hypothesis	0.006	Reject the null hypothesis

Note: a. The significance level is 0.05

To test whether ESG-linked and non-ESG-linked debt financing transactions have any impact on the characteristics of debt financing transactions, such as amount, duration, and pricing, we rerun the M-W test for AMOUNT, DURATION, and RATE variables grouped by the ESG variable. The results of the second M-W test also appear in Table 5. The M-W test suggests that for AMOUNT and DURATION there are no significant differences in the distribution of ESG-linked and non-ESG-linked debt financings. Thus, the amount and the duration of debt financing transactions is unchanged for ESG-linked and non-ESG-linked debt financings. Moreover, our findings point out that for RATE variable there is significant difference in the distribution of ESG-linked and non-ESG-linked debt financings. The results of the second M-W test in conjunction with the descriptives statistics in Panel D of Table 4 indicate that the interest rate or the coupon rate of debt financing transactions is lower of ESG-linked debt financing compared to non-ESG-linked debt financings.

4.2. Robustness analysis

For robustness purposes, we supplemented our analysis with the non-parametric Independent-samples Kolmogorov-Smirnov (K-S) test. The null hypothesis of the K-S test is that the distribution of each

variable is the same across between the two periods (dummy variable of PP). K-S test is focused on comparing the entire distributions, while M-W test compares the central tendency, i.e., medians, and rank distribution. Thus, K-S test is more sensitive to differences in shape and spread of distributions, whereas M-W test is more focused on the differences in central tendencies. The results of the K-S test appear in Table 6.

Table 6. Results of K-S test

	PP		ESG	
Variable	**Sig.[a]**	**Decision**	**Sig.[a]**	**Decision**
AMOUNT	0.000	Reject the null hypothesis	0.488	Retain the null hypothesis
DURATION	0.008	Reject the null hypothesis	0.681	Retain the null hypothesis
RATE	0.022	Reject the null hypothesis	0.014	Reject the null hypothesis

Note: a. The significance level is 0.05

The K-S test indicates that for all variables there are significant differences before and after launch of the Poseidon Principles. The results of the robustness analysis using the K-S test confirm the findings of M-W test, as well as indicate that on top of amount and duration of debt financing transactions, the launch of the Poseidon Principles have also impacted interest rates and coupon rates of debt financing transactions. Thus, the results of the K-S test in conjunction with the descriptives statistics in Panel C of Table 4 indicate that the amount and interest rates or coupon rates of debt financing transactions were increased after launch of the Poseidon Principles.

We rerun the K-S test to examine whether the distribution of each variable is the same between ESG-linked debt financings and non-ESG-linked debt financings. The results of the second K-S test also appear in Table 6. The K-S test indicates that for only RATE variable there is significant difference between ESG-linked and non-ESG-linked debt financing transactions. Thus, the results of the robustness test concur with the initial finding of our baseline analysis that the interest rate or the coupon rate of debt financing transactions is lower for ESG-linked debt financing compared to non-ESG-linked debt financings.

Lastly, we conducted crosstabulation analysis with chi-square test to explore whether there is a relationship between the launch of the Poseidon Principles (PP variable) and ESG-linked debt financings (ESG variable). The Pearson chi-square statistic is statistically significant, $\chi 2$ (df = 1) = 178.95, p = 0.000, indicating that there is a statistically significant relationship between the launch of the Poseidon Principles and ESG-linked debt financings. Therefore, the interpretation of the cell

frequencies in the contingency table is warranted. The results of the crosstabulation can be found in Table 7.

Table 7. Cross tabulation PP and ESG

			ESG		
			No	Yes	Total
PP	No	Count	878	9	887
		% within PP	99.0%	1.0%	100.0%
		% within ESG	65.8%	6.7%	60.3%
	Yes	Count	457	126	583
		% within PP	78.4%	21.6%	100.0%
		% within ESG	34.2%	93.3%	39.7%
Total		Count	1,335	135	1,470
		% within PP	90.8%	9.2%	100.0%
		% within ESG	100.0%	100.0%	100.0%

As can be seen from the results of the contingency table, before the launch of the Poseidon Principles, as expected, the vast majority of debt financing transactions (99 percent) were non ESG-linked. After the launch of the Poseidon Principles the ESG-linked debt financing transactions increased from 1 percent to 21.6 percent. Therefore, despite the buzzwords of sustainability and decarbonization in maritime shipping industry, the impact of Poseidon Principles on debt financing transactions is quite weak, since 78.4 percent of debt financing transactions do not have any ESG angle. This aligns with Auzepy et al. (2023), who highlight that despite their increasing availability, the ESG financing structures have not been widely adopted by organizations or debt capital providers, which might reflect challenges such as awareness, accessibility, or alignment with corporate priorities. This statement means that while financial structures tied to ESG goals, such as green bonds, green loan, and sustainability-linked loans, are becoming more visible in financial markets, their actual usage remains limited.

4.3. Content analysis

Our quantitative analysis was supplemented with qualitative analysis by employing content analysis. The content analysis, conducted using Python 3.13.0 in a Jupyter Notebook, aimed to identify commonly emerged topics from the 1,470 debt financing transactions per PP and per ESG. First, we used the Pandas library to load and handle the dataset, which included the columns, description of debt financing transaction and PP (Gerakoudi et al., 2024). The data were first filtered by the PP

column, separating the dataset into two categories, pre-Poseidon Principles (PP = 0) and post-Poseidon Principles (PP = 1). This separation allowed for a distinct content analysis before and after the adoption of these principles. Additionally, we run content analysis for ESG-linked (ESG = 1) and non-ESG-linked (ESG = 0) debt financing transactions. Text preprocessing was performed using regular expressions to tokenize and clean the data. A custom list of stop words was defined to eliminate common, non-informative words such as "the", "and", and "is", which are frequently encountered in narratives and texts but do not contribute to the analysis. The text was converted to lowercase, and punctuation was removed to standardize the data for further processing. The cleaned text data was processed into a document-term matrix using the gensim library. This matrix was then used to build a Latent Dirichlet Allocation (LDA) model, which is a popular topic modeling technique that allows the identification of latent topics within a set of documents (Gerakoudi et al., 2024). The LDA model was initially configured to extract three topics for each of the four sub-samples (pre-PP and post-PP; ESG and non ESG). Finally, we observed that the three, two, or four topics extracted from the model were highly overlapping. As a result, we decided to use just two topics for the model. For both content analyses (for PP and ESG), we utilized the most salient terms from the two topics to ensure a clear and concise representation of the underlying themes.

After preprocessing the data, it was prepared for use with algorithms to identify key topics from the corpus. The LDA model was used to classify the text in Python's Jupyter Notebook environment (Gerakoudi et al., 2024). LDA, a popular unsupervised machine learning technique, clusters words into topics based on probability distributions. Two topics were identified for each by analyzing perplexity and coherence scores, with the model performing similarly for 3 and 4 topics. Visualization using pyLDAvis highlighted the relationships between topics and their relevance (Gerakoudi et al., 2024).

The analysis reveals a shift in maritime shipping debt financings toward sustainability from the introduction of Poseidon Principles and emergence of ESG debt financings (see Figures 1-4). Specifically, the examination of the two content analyses yielded the following findings:

Pre-Poseidon Principles versus Post-Poseidon Principles (see Figures 1-2).

- Pre-Poseidon Principles (PP=0) most salient terms include *notes, corporate, senior, vessels, sale, facility, bond, purchase*.
- Post-Poseidon Principles (PP=1) most salient terms include *bonds, sale, built, corporate, leaseback, issues, purchase, loan*.

Referring firstly to the Pre-Poseidon Principles, keywords like *notes, senior, bond* reflect a traditional focus on fixed-income financial debt structures. These terms may indicate that pre-Poseidon financing emphasized structured debt and creditworthiness (Pangalos, 2023). In addition, the mention of *facility* maybe suggests reliance on established credit structures for vessel financing. By comparison, the Post-Poseidon Principles dataset exhibits the continuation of *bonds* and addition of *loan,* which may signify a sustained use of debt instruments but with potential diversification in their application. Moreover, the *leaseback* keyword introduces a focus on innovative financial mechanisms, such as sale-and-leaseback arrangements, probably indicating an adaptation to align with new environmental or operational frameworks (Auzepy et al., 2023).

Apart from that, regarding the Pre-Poseidon Principles dataset, keywords like *vessels* and *sale* highlight transactions centered around physical maritime assets. This possibly suggests a quite straightforward approach to financing tied to tangible assets. Additionally, the keyword *purchase* probably indicates an active focus on acquisition, likely of vessels or related infrastructure. Alternatively, the Post-Poseidon Principles dataset shows the addition of *built,* which might suggest an increased emphasis on new vessel construction, possibly with an eye toward environmentally compliant designs (Pangalos, 2023). This approach emphasizes financing structures that align with Poseidon Principles (Morchio et al., 2024), along with the broader rise of green bonds and loans targeting environmental sustainability (Maltais & Nykvist, 2020).

Concerning again the Pre-Poseidon Principles dataset, the keyword *corporate* maybe reflects a traditional focus on large-scale organizational finance, perhaps centered on profitability and operational stability (Pangalos, 2023), while keyword *senior* possibly implies that before the Poseidon Principles, the maritime industry relied heavily on conventional financial structures like senior debt and secured loan structures that emphasized creditor security, with vessels often serving as collateral to secure repayment obligations (Pangalos, 2023). In parallel to that, the Post-Poseidon Principles dataset shows continued emphasis on *corporate,* which could reflect a focus on organizational-level financing. However, the addition of *issues* maybe suggests a shift toward addressing broader challenges, such as sustainability and regulatory compliance. The emergence of *issues* alongside *corporate* financing possibly underscores a dual focus on organizational priorities and global challenges, such as sustainability and decarbonization. This trend reflects the maritime industry's integration of ESG factors into strategic decision-making, a theme consistent with broader financial markets (Zhao & Zhang, 2024). Finally, the shift from *facility* to *loan* and the introduction of *leaseback* could highlight an evolution in financial instruments to address emerging maritime financing needs.

Figure 1. Pre-PP (PP=0) Most Salient Terms

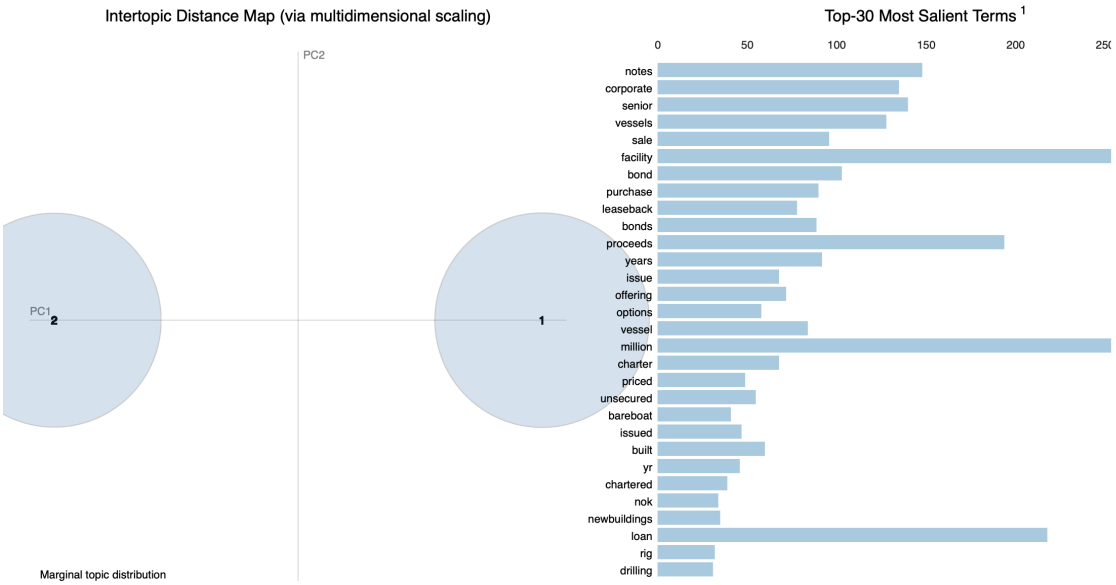
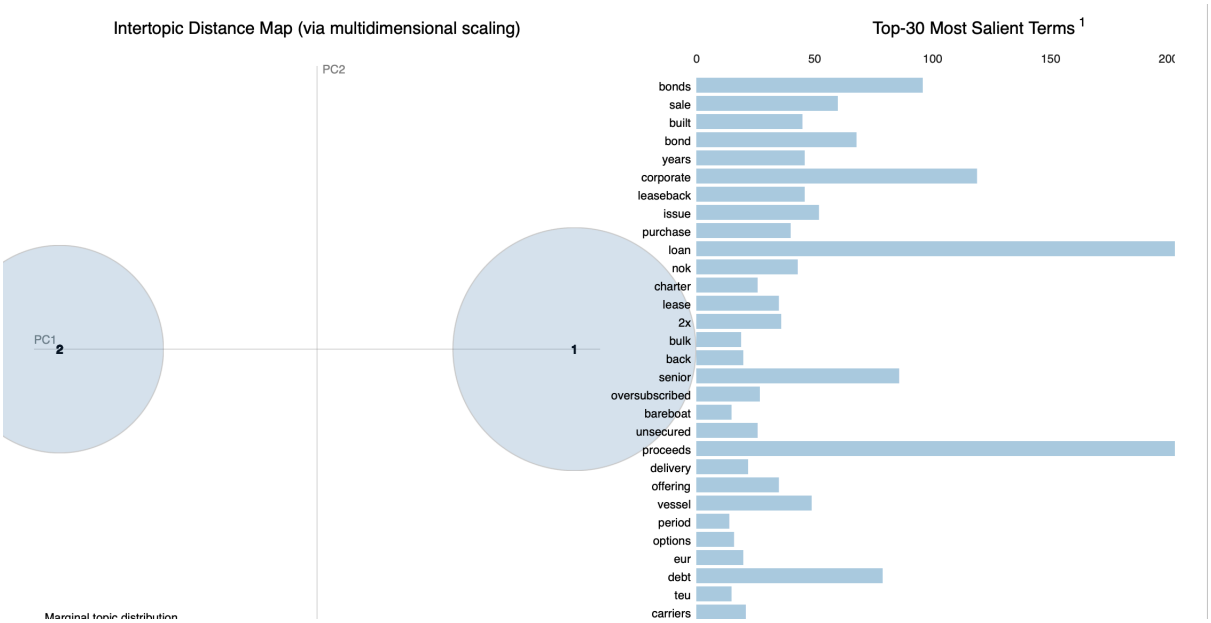


Figure 2. Post-PP (PP=1) Most Salient Terms



Non-ESG versus ESG Debt Financings (see Figures 3-4).

- For non-ESG, most salient terms include *vessel, FPSO , project, credit, LIBOR, revolving, interest*.
- For ESG, most salient terms include *green, corporate, purposes, general, linked*.

Referring to Non-ESG (ESG=0), the presence of keywords such as *vessel* and *FPSO* (Floating Production Storage and Offloading) perhaps suggests a strong linkage to maritime, oil, and gas industries. This could indicate that these debt financings are predominantly associated with asset-heavy and industry-specific projects (Pangalos, 2023). Additionally, the presence of keywords *project* and *credit* possibly suggest a focus on financing structured initiatives, often tied to tangible deliverables or milestones (Rebelo, 2020). As far as ESG (ESG=1) is concerned, keywords like *green* and *linked* maybe emphasize environmental considerations and sustainable goals. These terms could align with the broader agenda of promoting projects or corporations that demonstrate a commitment to ESG principles (Auzepy et al., 2023). In addition, the presence of *corporate, general,* and *purposes* potentially suggests that the use of debt proceeds is for general corporate purposes.

Next, as far as the financial structure and terms are concerned, Non-ESG include keywords like *LIBOR* and *interest,* which could point to traditional financial metrics and benchmarks that are central to determining loan terms. Moreover, the keyword *revolving* possibly indicates flexible credit structures, often used for working capital in traditional industries (Sufi, 2009). Referring to ESG, the absence of financial jargon such as *LIBOR* or *interest* perhaps suggests that ESG loans may prioritize non-financial metrics like sustainability impact over traditional financial structures (Gigante and Manglaviti, 2022) and use of proceeds for general corporate purposes instead of vessel acquisitions.

Following that, in the Non-ESG, the dominance of keywords related to specific industries (*vessel*, *FPSO*) and structured financing (*project*, *credit*) might indicate a focus on traditional economic activities with clear deliverables. At the same time, ESG show emphasis on *green*, *general*, and *linked* reflects alignment with broader, less industry-specific goals, potentially to support corporate transformation toward sustainability (Auzepy et al., 2023).

Finally, the technical nature of *Non-ESG* keywords (*LIBOR, revolving*) possibly implies an audience with specialized financial knowledge; whereas *ESG* keywords are more accessible and general, likely catering to a broader audience, including stakeholders focused on environmental and social impact.

Figure 3. Non-ESG (ESG=0) Most Salient Terms

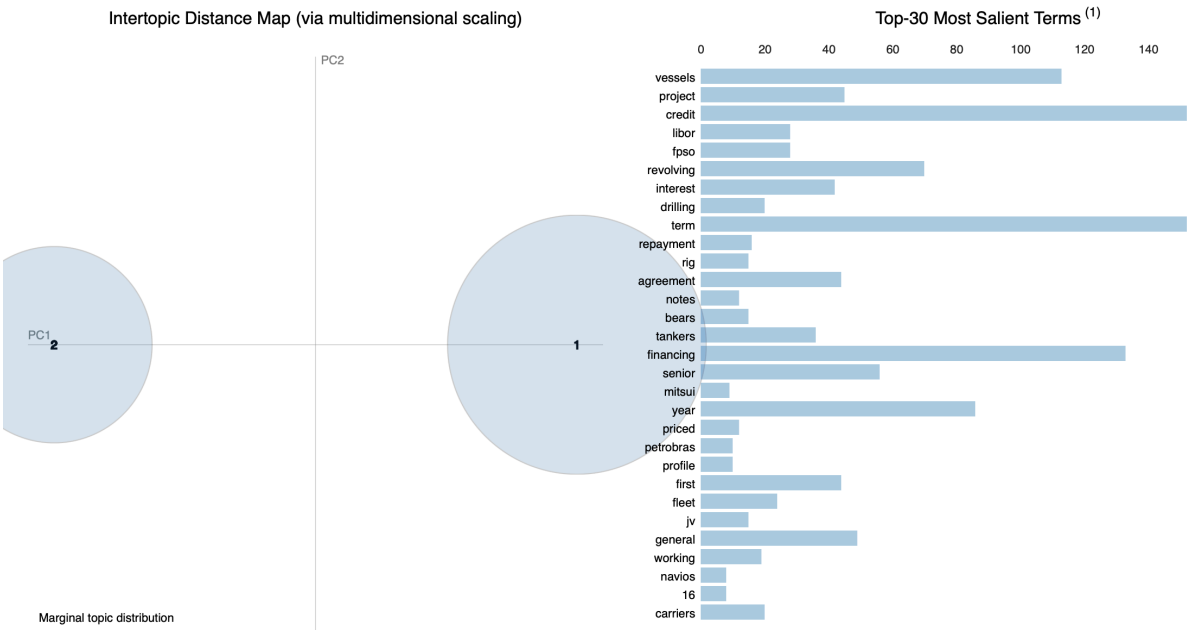
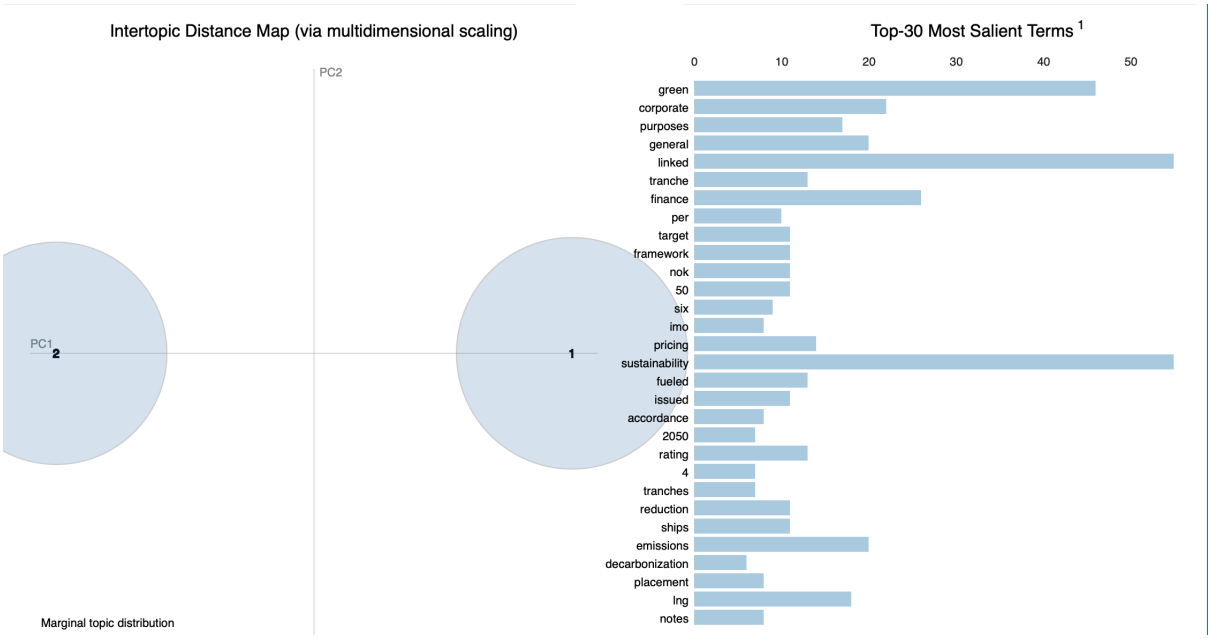


Figure 4. ESG (ESG=1) Most Salient Terms



5. Discussion

Our quantitative analysis provides mixed results regarding the impact of the Poseidon Principles on debt financing transactions. Specifically, the M-W test of our quantitative analysis suggests that the amount of debt transactions is reduced, and the duration of debt transactions is shorten following the launch of the Poseidon Principles, but there is no statistically significant difference in the interest or coupon rates of these transactions. Our results contradict Morchio et al. (2024) findings, which highlight that both green financial products and shipping investments often involve longer-term commitments due to the nature of the industry and the time needed to see financial returns. Furthermore, our results do not align with Zhou and Yuen (2023), who report a positive correlation between corporate social responsibility engagement and financial leverage. However, the K-S test of our quantitative analysis indicates that the interest rates and the coupon rates were increased after the introduction of the Poseidon Principles. This finding contradicts with Alves and Meneses (2024) who highlight that as a company's ESG score improves (i.e., the company is seen as more sustainable and responsible), it is likely to pay a lower interest rate on its debt.

When comparing ESG-linked to non-ESG-linked debt financing transactions, the M-W test of our quantitative analysis indicates no statistically significant differences in the amount or duration of debt financing transactions. Our results suggest that these terms remain largely unaffected by the inclusion of ESG criteria, aligning with Maltais and Nykvist's (2020) findings that the main terms of green bonds, such as amount and duration, often remain unchanged while the proceeds are directed toward specific green projects. This also aligns with the findings of Auzepy et al. (2023), who suggest that this type of financing primarily focuses on channeling funds into green initiatives rather than driving substantial structural changes in financing arrangements. As a result, it's not surprising that the debt amounts or durations remain relatively unaffected by the shift towards green financing. However, the M-W test for the cost of debt (interest or coupon rate) shows a significant difference between non-ESG-linked and ESG-linked debt financing transactions, with the latter having lower rates. This result, which is confirmed by the K-S test of our quantitative analysis, is in accordance with Alves and Meneses (2024) who highlight that as a company's ESG score improves (i.e., the company is seen as more sustainable and responsible), it is likely to pay a lower interest rate on its debt. Additionally, Maltais and Nykvist (2020), who conducted an empirical study on the green bond market, found that, similar to our results, green bonds generally offer lower interest rates than conventional bonds, but issuers did not expect these rates to decrease further. However, this finding contradicts Siddiqa (2024) who argue that ESG-linked debt financings do not substantially alter the underlying structure of debt financing transactions. Moreover, Gigante and Manglaviti (2022) found no statistically significant evidence of a clear, direct relationship between the ESG score average and the cost of debt for European non-financial corporates.

Despite the growth in ESG-linked transactions, the results also indicate that their adoption remains limited. Before the Poseidon Principles, only 1 percent of debt financing transactions were ESG-linked, whereas after the launch, this increased to 21.6 percent. This shift reflects a move toward more sustainable financing, though the broader adoption remains low, with 78.4 percent of debt transactions still not incorporating any ESG criteria. This aligns with Auzepy et al.'s (2023) study, which highlights that despite the increasing availability of ESG-linked financial structures, their uptake remains limited due to barriers such as awareness, accessibility, and alignment with corporate priorities.

Our content analysis suggests a shift toward sustainability in maritime financing, particularly after the introduction of the Poseidon Principles. This shift appears to be associated with an increasing reliance on ESG-aligned financial instruments, such as sustainability-linked loans, which may reflect broader global trends toward green finance (Morchio et al., 2024). However, traditional financing structures continue to play a significant role, particularly in the pre-Poseidon Principlesperiod, where funding was closely tied to specific industries and projects (Pangalos, 2023). These findings highlight the shift in financing practices influenced by the Poseidon Principles.

Additionally, our analysis demonstrates that ESG loans show a shift in priorities, emphasizing environmental and social outcomes over traditional financial metrics. These instruments align with corporate sustainability objectives, showcasing the increasing integration of ESG principles into maritime financing practices (Auzepy et al., 2023). In contrast, non-ESG loans maintain a focus on traditional financial metrics and structured financing mechanisms, reflecting the coexistence of these two approaches in the current landscape (Gigante & Manglaviti, 2022).

The findings also reveal differences in financial structures over time. The pre-Poseidon Principles period was dominated by established financing methods centered on fixed-income debt structures and tangible asset transactions (Pangalos, 2023). In contrast, the post-Poseidon Principles era reflects a gradual shift toward innovative financial structures, such as sale-and-leaseback arrangements, and an increased focus on environmentally compliant vessel construction (Auzepy et al., 2023; Pangalos, 2023). This evolution suggests the influence of global sustainability initiatives on maritime financing practices.

Our analysis further suggests that while ESG-aligned financing instruments are gaining importance, they have not yet fundamentally altered the core terms of debt transactions in the sector (Maltais & Nykvist, 2020; Auzepy et al., 2023). Rather, these instruments serve as complementary tools, coexisting with traditional financing methods. This gradual shift reflects the incremental adoption of sustainability-focused financial structures and highlights the role of regulatory frameworks and market demand in shaping the maritime industry's approach to financing, with a growing emphasis on transparency, innovation, and environmental responsibility (Zhao & Zhang, 2024).

6. Conclusions

Despite the growing buzz around sustainability and decarbonization in the maritime shipping industry, to the best of our knowledge there is no study regarding the impact of the Poseidon Principles on debt financing transactions. The purpose of our empirical study is to fill this gap. Our analysis reveals that following the introduction of the Poseidon Principles, the main terms of debt financing transactions have deteriorated for maritime shipping companies. Specifically, post June 2019, maritime shipping companies have received lower debt amounts, with shorter debt durations, at a higher cost of debt.

Moreover, our empirical findings indicate that there are no statistically significant differences between ESG-linked and non-ESG-linked debt financing transactions regarding their amount and duration. Our findings concur with Maltais and Nykvist (2020), who argue that while ESG-linked debt structures, such as green bonds, direct funds to specific sustainable projects they often do not alter the fundamental terms of the debt, such as debt amounts or durations. Greenwashing proposition may be pertinent in this context. Gigante and Manglaviti (2022) argue that companies are using ESG-linked debt structures more as a signaling tool to display commitment to sustainability rather than as a way to improve their debt financing terms. Consistent with these concerns, borrower's ESG scores have been shown to deteriorate following the issuance of low-transparency sustainability-linked loans highlighting potential misuse of these instruments (Kim et al., 2022). Furthermore, stock markets demonstrate vigilance against greenwashing, reacting positively only to high-transparency sustainability-linked loans announcements, reinforcing the need for robust transparency to validate sustainability claims. In a similar context, Amiraslani et al. (2022) demonstrate that firms with high social capital can enhance their value through ESG-linked debt financing, further underlining the importance of genuine and transparent ESG commitments in strengthening financial performance. Auzepy et al. (2023), is also in alignment with our findings, point out that ESG-linked debt financing is often more focused on directing funds toward green initiatives without necessarily driving deeper structural changes in financing arrangements, such as altering the amounts or durations of the debt. This perspective aligns with our findings, where we observe no substantial changes in debt amounts or durations despite the increased use of ESG-linked financing tools. The findings from Bofinger et al. (2022) can further support this notion. They suggest that a firm's ESG profile significantly impacts its valuation, as an improvement in corporate social responsibility practices leads to a higher ratio of actual to true firm value. This is relevant because even if some fundamental terms of the debt (such as amount and duration) do not change, the improved ESG profile resulting from ESG-linked debt could positively influence a firm's valuation. In this context, the adoption of ESG-linked debt may not be driven by a desire to alter the structure of the debt itself but rather by the signal of sustainability it sends to the market, leading to higher firm valuation. However, we provide empirical indication that the cost of ESG-linked debt financing transactions is lower compared to the non-ESG-linked debt

financing transactions. Therefore, our study enriches the recent and scant body of research with respect to the impact of ESG structures on the main terms of debt financing transactions.

While ESG-linked debt financings have increased from 1 percent to 21.6 percent after the introduction of the Poseidon Principals, they still represent the minority of debt financing transactions. Most debt financing transactions (78.4 percent) after the introduction of the Poseidon Principals lack any ESG element, supporting the view that the adoption of such debt structures is still quite limited. Our finding can be understood within the broader context of the limited adoption of ESG-linked debt financings, such as green bonds and sustainability-linked loans (Auzepy et al., 2023). Despite their growing presence, ESG-linked debt structures still face barriers to widespread adoption (Auzepy et al., 2023). Companies may be hesitant to fully embrace these debt structures due to the potential costs or complexities involved in restructuring financing terms (Siddiqa, 2024). Additionally, ESG-linked debt structures could still be viewed more as a way to signal environmental or social responsibility to stakeholders, rather than a genuine tool for effecting lasting change in corporate financing practices (Tsatsaronis et al., 2022).

Our analysis integrates findings from both quantitative and qualitative analyses to provide a comprehensive understanding of debt financing trends in maritime shipping post-Poseidon Principles. Quantitatively, we find that the main terms of debt financing transactions for maritime shipping companies have deteriorated since the introduction of the Poseidon Principles, with lower debt amounts, shorter durations, and higher costs observed post-June 2019. Additionally, there are no statistically significant differences between ESG-linked and non-ESG-linked debt financing transactions concerning debt amounts or durations. Qualitatively, our content analysis reveals a trend toward incorporating sustainability elements in financing structures, with an increased emphasis on ESG-linked debt instruments, such as sustainability-linked loans. However, traditional financing methods remain dominant, particularly in non-ESG transactions, which are closely tied to asset-heavy and industry-specific projects.

In conclusion, the parallel insights from our quantitative and qualitative analyses emphasize both the progress and challenges of ESG-linked financing in maritime industries. While these debt financing structures have gained traction and offer some cost benefits, their adoption remains limited, and their impact on debt structures appears marginal. These findings underscore the need for greater transparency and robust frameworks to enhance the credibility and effectiveness of ESG-linked financial instruments in driving meaningful change (Kim et al., 2022; Zhao & Zhang, 2024).

This study offers valuable contributions to the academic literature on the intersection of ESG considerations and corporate finance, particularly in the context of the maritime shipping industry. While ESG-linked debt financing instruments have garnered significant attention, there remains a lack of detailed research on the actual impact of these instruments, specifically in relation to the Poseidon

Principles. Our findings indicate that, despite the growing emphasis on sustainability, the introduction of the Poseidon Principles has not led to substantial changes in the fundamental terms of debt financing (Maltais and Nykvist, 2020). Moreover, the findings that companies might use ESG-linked debt more as a signaling tool rather than as a means to alter their financing structure present an interesting insight on greenwashing and its potential impacts on market behavior. Scholars might be interested in how the financial markets and debt capital providers perceive these instruments and whether they contribute to a more transparent and sustainable corporate environment (Auzepy et al., 2023; Tsatsaronis et al., 2022).

For managers, particularly in the maritime shipping industry, this study provides several key takeaways about the role of ESG-linked debt in corporate finance strategies. Despite the increasing prevalence of ESG-linked debt structures, such as green bonds or sustainability-linked loans, our results suggest that these instruments do not significantly affect the fundamental terms of debt, including the amounts or durations of financing. While the lower cost of debt associated with ESG-linked transactions may be attractive, managers should be mindful that the use of these structures may not lead to substantial changes in their overall financing strategy (Gigante & Manglaviti, 2022). One important consideration for managers is the role of signaling. Our findings suggest that ESG-linked debt may be more about sending a signal to stakeholders about a company's commitment to sustainability rather than achieving deep structural changes in financing terms. This has important implications for how companies should position themselves when adopting ESG-linked debt. Managers may need to communicate clearly to investors and other stakeholders whether their adoption of ESG-linked debt is part of a broader sustainability strategy or primarily aimed at enhancing corporate reputation (Gigante & Manglaviti, 2022).

Additionally, while transparency in ESG reporting is rewarded by lenders with lower costs of debt (Raimo et al., 2021), managers should be aware of the growing importance of robust ESG disclosures. Companies with clearer and more transparent ESG reporting practices may benefit from more favorable financing terms, even if the primary terms of their debt are not fundamentally altered. This suggests that investing in high-quality ESG reporting and disclosures can lead to improved access to capital at lower costs (Auzepy et al., 2023). Furthermore, managers should also be aware of the limited adoption of ESG-linked debt, with such transactions still representing a minority of overall debt financing post-Poseidon Principles. This presents both a challenge and an opportunity: while ESG-linked debt is growing, it is still not widely adopted, meaning that companies considering these financing structures should be proactive in understanding the barriers to adoption. Moreover, managers should carefully assess whether the use of ESG-linked debt aligns with their company's long-term strategic goals and sustainability objectives or if it is being used primarily as a tool to signal corporate responsibility (Siddiqa, 2024; Auzepy et al., 2023).

Future research should be directed towards addressing critical gaps in literature. Although green finance is gaining importance, existing studies primarily focus on the effects of green labels on bond yields, overlooking their broader impact on financing decisions (Maltais and Nykvist, 2020). The unique challenges faced by the marine industry, such as the absence of tailored green financial products, also remain insufficiently explored (Xu and Gao, 2022). Furthermore, there is limited understanding of how ESG factors influence debt financing in industries like maritime shipping, particularly regarding the availability of debt (Gigante and Manglaviti, 2022; Zhao and Zhang, 2024; Devalle, 2017). Future research should focus on addressing the barriers hindering the wider adoption of ESG-linked financial structures, such as awareness, accessibility, and alignment with corporate goals (Auzepy et al., 2023; Tsatsaronis et al., 2022). A deeper exploration of their impact on debt terms and broader industry practices will be essential to understanding their true potential in driving sustainability in the maritime sector (Morchio et al., 2024).

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