An Empirical Study on Biodiversity Disclosure and Firm's Market Value in North America Based on Linear Regression Model

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Abstract. Biodiversity loss is a pressing global risk poised to significantly impact the corporate landscape over the next decade. As companies face escalating demands for transparency, non-financial disclosures, especially those concerning ESG factors, have garnered considerable attention. However, there is a notable deficiency in disclosures specifically highlighting biodiversity, an oversight this paper aims to address. Employing an empirical approach, this study scrutinizes the influence of biodiversity disclosure on corporate market value, focusing on a U.S. firm sample. This paper uncover a robust positive relationship between the level of biodiversity disclosure and a firm's market valuation. This correlation underscores the growing investor and stakeholder interest in corporate biodiversity initiatives. This analysis further reveals that the market value impact of biodiversity disclosure is not uniform. It varies with corporate size and industry characteristics, with small-sized and high-pollution firms experiencing a more substantial effect. This variability suggests that the market rewards smaller and more environmentally impactful companies for their transparency and commitment to biodiversity conservation. Drawing on Signaling Theory, Legitimacy Theory, and Stakeholder Theory, this study offers a comprehensive understanding of the motivations behind biodiversity disclosure and its tangible market impact. It highlights the strategic significance of integrating biodiversity considerations into corporate communications and underscores the need for further research into the nexus between ecological stewardship and financial success. The findings advocate for a proactive corporate approach to biodiversity, aligning with the growing market demand for environmental responsibility and sustainable business practices.

Keywords: Biodiversity Disclosure, Market Value, Signaling Theory, Legitimacy Theory.

1. Introduction

With the growing prominence of environmental protection issues, sustainable economic development has received widespread attention. According to the Global Risks Report 2022 published by the World Economic Forum, biodiversity loss has been ranked as one of the greatest global risks over the next 10 years. Biodiversity loss not only has direct ecological impacts, but also affects the social production environment and the stability of supply chains, posing significant business risks. Therefore, people put forward higher requirements for the sustainable development of enterprises.

According to Hassan et al., biodiversity conservation can be considered as a continuation of corporate social responsibility (CSR) [1]. The disclosure of this information is necessary, and Adler et al. pointed out that the lack of biodiversity disclosure will increase the risk of biodiversity loss and species extinction [2]. Gu et al. also hold CSR can affect the financialization of firm [3]. However, despite the overwhelming scientific evidence that human behavior can lead to a series of environmental problems, corporates' reporting still tends to explain firm's value from a financial perspective.

There are also a number of frameworks for biodiversity disclosure. The report "Is biodiversity a material risk for companies? An assessment of the exposure of FTSE sectors to biodiversity risk", published by F&C Asset Management in 2004, categorized the level of biodiversity risk in the industry into three groups - red, amber and green. Some companies have also adopted the GRI reporting framework with EN11 and EN12 as core biodiversity indicators and EN13, EN14 and EN15 as additional indicators. However, although GRI considers biodiversity from a performance indicator perspective, GRI indicators have been criticized for being too broad and too decontextualized.

While more attention has been paid to non-financial performance and disclosure, empirical studies on the relationship between biodiversity disclosure and corporate performance are few. This study establishes a comprehensive biodiversity disclosure indicator based on several indicators constructed by Giglio et al. to measure corporate biodiversity risk exposure [4]. A two-way fixed-effects model is used to analyze the impact of biodiversity disclosure on firms' Tobin Q, and the heterogeneity about firm size and industry nature.

2. Literature Review

As an extension of environmental performance, biodiversity disclosure relates to corporates' social responsibility and the quality of information disclosure. ESG nowadays is playing a significant role in evaluation of a corporate's potential of sustainable development and there have been many scholars conducting study in this domain. Some scholars explore the impact of ESG performance on firms' financial performance and the mechanism [5-7]. More specifically, some research pays attention to the carbon information [8]. The study around is lacking but Carvajal et al. have analyzed that board gender diversity may influence firm's environmental initiative and biodiversity disclosure [9]. In summary, the motivation of biodiversity disclosure and its impact on corporate financial performance can be analyzed from Signaling Theory, Legitimacy Theory and Stakeholder Theory.

2.1. Signaling Theory

According to Signaling Theory, full disclosure facilitates the realization of the value discovery function of the capital market. In an efficient market, all information is reflected in market prices in a timely and adequate manner [10]. For investors, their required return is often proportional to the expected level of risk. The disclosure of non-financial information can help investors to have a more comprehensive assessment of the company's operations, thus reducing uncertainty about the future, increasing confidence in the company's sustainable development, and lowering the required rate of return. Thus, full disclosure can be seen as a result of rational choice by high-quality firms. Since it is demanding for firms with poor performance to emulate the behavior of better performers, so better performers have an incentive to make full and standardized biodiversity disclosure to present their strengths. These positive signals lead investors, consumers, and other stakeholders to have good expectations and willing to pay a "green premium," which can improve the firm's stock price or cash flow.

2.2. Legitimacy Theory

According to the definition given by Suchman, corporate legitimacy refers to the general perception and assumption that the behavior of a business is considered desirable, appropriate, and suitable within a system of socially constructed norms, values, beliefs, and definitions [11]. It can be viewed as the evaluation of the enterprise by the public in society, an overall perception of the appropriateness and acceptability of the enterprise's behavior. Public's impression often comes from the proactive information disclosure, which means the enterprise can legitimize its activities by publishing CSR reports. Through adequate disclosure, an enterprise presents consistent values with the social system. The disclosure of environmental information is a key to legitimizing the environmental activities of enterprises, which demonstrates an enterprise's concern and commitment to public interest and helps to establish a good social image. At the same time, the corporate reputation brought by the disclosure, as an important intangible asset, will in turn bring higher corporate value and investment returns for the enterprise. For example, Elsayed found that the disclosure of biodiversity information has a positive impact on ROA [12].

2.3. Stakeholder Theory

Enterprises not only face pressure from shareholders on their financial performance, but are also subject to stakeholder pressure on environmental and social performance, as reflected in government

constraints, industry regulation and public monitoring. Stakeholder Theory suggests the main goal of enterprises is to create and maximize value for all stakeholders, which require firms to disclose relevant information in their reports for stakeholders' use. By disclosing biodiversity information, firms present their efforts and attempts, which is conducive to alleviating the external pressures and reducing the costs, thus leading to the improvement of financial performance.

3. Research Design

3.1. Data Sources

The data on biodiversity risk disclosure are derived from Giglio et al., who constructed and publicly released several measures of biodiversity risk exposure based on 10- k reports over the period 2001-2020 [4]. Firm-level data on North American public companies are obtained from the Compustat database, excluding financial firms and firms that have never had a biodiversity disclosure in 20 years (2001-2020), have a high number of missing values, have Debt-to-Asset ratio greater than 3. Finally obtain 2,915 observations, covering 11 industries. And it is an unbalanced panel because not all the companies issue these reports and disclosures for all the years considered.

3.2. Variable Selection

This study synthesizes the research of many scholars and selects Tobin's Q to measure firm's market value. Tobin's Q equals the market value divided by assets' replacement cost, which reflects investors' expectation of the corporate's profitability.

Several metrics for measuring firms' biodiversity risk exposure, including Count, Negative, and Regulation, were constructed and publicly released using Giglio et al. [4]. Count reflects the presence of firms' biodiversity risk disclosures; Negative is a sentiment analysis based on the BERT model, which categorizes the statements about biodiversity into Positive, Neutral and Negative, and calculates the difference between Negative minus Positive; Regulation reflects whether there is a rule-based description in disclosure. Factor analysis was used to synthesize the above three indicators reflecting corporate biodiversity disclosure from different perspectives into one factor to indicate the degree of corporate biodiversity disclosure. The KMO test and Barlett's test were conducted, and the results showed that the KMO measure was 0.605, which was greater than 0.6, and the chi- square value of Barlett's spherical test was 3858, with a p-value close to 0.000, which finally synthesized 1 factor of the degree of biodiversity disclosure.

Referring to previous studies, this paper considers the control variables in the following dimensions. Firm Size (Size), Risk Level (Leverage), Innovation (R&D), Liquidity (Cash), Profitability (ROA) [5].

3.3. Basic Regression

The regression model as follows:

$$Tobinq_{it} = \beta_0 + \beta_2 biodis_{it} + \beta_3 Size_{it} + \beta_4 Lev_{it} + \beta_5 ROA_{it} + \beta_6 Rdsale_{it} + \beta_7 Cash_{it} + \varepsilon it \quad (1)$$

Where β_0 is the constant term, and βit $(i = 1, 2, \ldots, n;\ t = 1, 2, \ldots, 20)$ are the regression coefficients of each variable, respectively; ε is the disturbance term.

In this paper, the coefficients of the equations are estimated using four ways: mixed linear model (1), random effects model (2), fixed effects model (3) and two-way fixed effects model controlling for time and industry (4), and the results of the regression of Tobinq under the four models are shown in Table 1. The Breusch-Pagan LM test is significant at the 1% level, and so the original hypothesis is rejected and the variable-intercept model is chosen. Further Hausman test showed that the original hypothesis was rejected at 1% level of significance, so it was more appropriate to choose fixed effects for the estimated parameters. Meanwhile, by comparing the within-group R^2, the results show that the goodness of fit of the two-way fixed model is generally higher than that of the other three approaches, and the F-test also rejects the original hypothesis that there is no time fixed effect at the 1% level. In

summary, this paper finally adopts the two-way fixed effects model to estimate the impact of biodiversity disclosure on firm value, which shows that the impact of biodiversity risk disclosure on firm performance is positive and significant.

Table 1. Regression results in different models

	(1) OLS	(2) RE	(3) FE	(4) 2-FE
Biodis	0.08661***	0.07295**	0.08661***	0.09549***
	(2.59)	(2.16)	(2.59)	(2.84)
Size	-0.12868***	-0.33234***	-0.12868***	-0.10680***
	(-8.94)	(-16.14)	(-8.94)	(-7.33)
Lev	0.60244***	1.11465***	0.60244***	0.82674***
	(5.26)	(8.34)	(5.26)	(6.92)
Rdsale	-0.03269	-0.00774	-0.03269	-0.06028**
	(-1.23)	(-0.33)	(-1.23)	(-2.24)
ROA	0.07407	0.44571***	0.07407	0.21971
	(0.49)	(3.37)	(0.49)	(1.45)
Cash	3.01452***	2.41694***	3.01452***	3.05345***
	(17.41)	(11.92)	(17.41)	(16.50)
_cons	1.89462***	2.98402***	1.89462***	1.63967***
	(16.38)	(17.57)	(16.38)	(13.65)
N	2915	2915	2915	2897
R2	0.166		0.166	0.214

t statistics in parentheses
* p < 0.1, ** p < 0.05, *** p < 0.01

3.4. Robust tests

To test the robustness, this paper use lagged explanatory variables and replacing the Tobinq with other variables describing financial performance or market value. From Table 2, (1) (2) (3) indicate that the regression results of one-period, two-period and three-period lag, all significantly positive. In addition, as shown in (4) (5), use stock return (Epfx) and total asset turnover (Sale/Asset) to replace the Tobinq and the results are significantly positive at 1% and 10% level, respectively. Therefore, those tests indicate that the findings of this study are highly robust.

Table 2. Robustness test

	(1) Lag 1	(2) Lag 2	(3) Lag 3	(4) Epfx	(5) S/A
Biodis	0.10566***	0.11092***	0.14408***	0.69291***	-0.04151*
	(2.79)	(2.69)	(3.36)	(3.69)	(-1.74)
Size	-0.04631***	-0.00268	0.04428**	0.11650	-0.03828***
	(-2.68)	(-0.14)	(2.15)	(1.43)	(-3.70)
Lev	0.28097**	0.18467	-0.02166	0.75766	0.64953***
	(1.99)	(1.19)	(-0.13)	(1.14)	(7.65)
Rdsale	-0.05019	-0.01465	-0.07659**	0.02102	-0.06515***
	(-1.55)	(-0.41)	(-2.02)	(0.14)	(-3.41)
ROA	0.29931	0.24832	0.11046	7.72720***	0.83683***
	(1.63)	(1.20)	(0.51)	(9.15)	(7.79)
Cash	2.68004***	2.25167***	2.13516***	2.79425***	-0.20095
	(12.69)	(9.65)	(8.82)	(2.70)	(-1.53)
_cons	1.64147***	1.46955***	1.26611***	-0.22830	0.88052***
	(11.70)	(9.27)	(7.51)	(-0.34)	(10.31)
N	2150	1718	1376	2897	2897
R2	0.187	0.177	0.169	0.058	0.175

t statistics in parentheses
* p < 0.1, ** p < 0.05, *** p < 0.01

3.5. Heterogeneity Analysis

Firms in different sizes and natures are subjected to different biodiversity constraints and the degree of importance attached to them, which could affect the market value. In accordance with the average size of the listed enterprises in each year, the sample firms were grouped into large- and small-scale groups and high- and low-pollution groups. As shown in Table 3 (1) (2), the coefficient of Biodis in small-scale firms is positive at the 1% significant level, indicating the more obvious corporate value enhancement is gained by smaller enterprises through disclosing biodiversity information. The reason may lie in the fact that it will be easier for small enterprises to enhance their corporate image through biodiversity disclosure, and stakeholders such as the public and the society tend to have a higher demand for the disclosure of information by large enterprises that their complete disclosure is deserved. As shown in table 3 (3) (4), Biodis is significantly positive at the 5% and 10% levels in high and low polluting firms, respectively. The coefficient of high polluting firms is larger and more significant, reflecting that biodiversity disclosure has a stronger effect on the value enhancement of high-risk firms. It may be due to the fact that high-polluting enterprises face greater pressure to reduce emissions and are also closely watched by the government, society and the public, so better disclosure is conducive to conveying positive signals of development, thus enhancing corporate image.

Table 3. Heterogeneity analysis

	(1) Small size	(2) Large size	(3) High polluted	(4) Low Polluted
Biodis	0.16216***	0.02579	0.09318**	0.08254*
	(2.96)	(0.77)	(2.28)	(1.76)
Size	-0.29921***	-0.02054	-0.11138***	-0.11995***
	(-7.79)	(-0.92)	(-6.10)	(-5.67)
Lev	1.01812***	-0.36452**	1.03169***	-0.37018*
	(5.70)	(-2.30)	(7.27)	(-1.96)
Rdsale	-0.06401*	0.27159***	-0.06855**	-4.20951*
	(-1.83)	(4.39)	(-2.33)	(-1.83)
ROA	0.28303	2.47266***	0.16483	0.52336**
	(1.40)	(8.21)	(0.90)	(2.31)
Cash	3.15382***	2.27467***	3.16692***	1.93043***
	(11.57)	(9.85)	(15.11)	(5.09)
_cons	2.35860***	1.71957***	1.49225***	2.62114***
	(10.60)	(8.92)	(10.22)	(13.52)
N	1443	1454	2274	623
R2	0.237	0.297	0.223	0.230

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4. Conclusion

Firstly, there is a significant positive correlation between biodiversity disclosure and corporate's market value with three possible reasons: according to the Signaling theory, the disclosure of biodiversity risk further alleviates the problem of information asymmetry, which increases investors' confidence in the sustainable development of the enterprise, thus increasing the liquidity of the stock and reflecting it in the capital market. According to the theory of organizational legitimacy, the disclosure of biodiversity by enterprises is conducive to reflecting their emphasis on social responsibility and their commitment to it, thus enhancing the legitimacy of their production and operation activities, and building a good image for them, and investors are willing to bear a part of the "green premium". As for the Stakeholder Theory, the disclosure of enterprises is subject to a

certain degree of public pressure. A true and adequate disclosure of biodiversity information is conducive to enterprises avoiding public opinion risks and reducing the cost of external regulation.

Secondly, the impact of biodiversity disclosure on corporate is greater in small-scale enterprises. First, large-scale enterprises are more rich and complete in information disclosure, biodiversity as a reflection of environmental performance, the disclosure of its contribution to the overall disclosure is not significant, and thus the impact on enterprise value is not significant; second, large enterprises are more powerful with greater ability to make full disclosure, so the public tends to have higher expectations for them, while small enterprises are subject to less pressure.

Thirdly, highly polluting enterprises' biodiversity disclosure has a greater impact on corporate performance. The production and operation activities of high-polluting enterprises often have a direct impact on biodiversity, and receive wider attention from the government and society, so people are more sensitive to the disclosure of high-polluting enterprises in the environmental protection level. In addition, because high-polluting enterprises need to pay a greater cost than the low-polluting enterprises to improve environmental performance, the disclosure can convey a stronger positive signal to the investor.

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