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Early movers in sustainability

How can early adoption of the Taskforce on Nature-related Financial Disclosures increase financial returns for asset managers?

Master thesis in Management and Economics of Innovation

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DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
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Abstract

As environmental risks are at the forefront of financial markets, nature-related disclosures have gained momentum. This thesis investigates how early adoption of the Taskforce on Nature-related Financial Disclosures (TNFD) influences returns for asset managers. By applying a Difference-in-Differences methodology to matched samples of early and late adopters within East Capital's portfolio, the study assesses short-term financial impacts using rolling average returns and rolling Sharpe ratios. Early adopters perform poorly in the short run. These results are contextualized using signaling theory, the Efficient Market Hypothesis, behavioral finance, and the early-mover advantage literature. The findings suggest that the effectiveness of voluntary ESG signals, such as the adoption of TNFD, is shaped by credibility, investor attention, and market maturity. The thesis contributes to understanding when and how sustainability disclosures translate into competitive financial outcomes, offering implications for asset managers navigating ESG integration and strategic positioning.

Keywords: TNFD, Early Mover Advantages, Efficient Market Hypothesis, Difference-in-Differences

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August Björkler & Gustav Stenhammar, Gothenburg, May 2025

List of Acronyms

A selected list of acronyms that are used throughout the thesis and listed in alphabetical order:

CSRD	Corporate Sustainability Reporting Directive
DID	Difference-in-Differences
EMH	Efficient Market Hypothesis
ESG	Environmental, Social and, Governance
NFRD	Non-Financial Reporting Directive
TCFD	Taskforce on Climate-related Financial Disclosure
TNFD	Taskforce on Nature-related Financial Disclosure

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1

Introduction

This chapter introduces the growing relevance of environmental, social, and governance (ESG) factors in the finance industry, highlighting how investor demand and regulatory developments have driven increased sustainability reporting. It discusses the evolution of regulatory frameworks such as the NFRD and CSRD of the EU, as well as voluntary standards such as TCFD and a more in-depth discussion of the more recent TNFD. Despite growing adoption, ESG and nature-related disclosures still pose challenges, including data inconsistency, voluntary adoption, and unclear links to financial performance.

The chapter identifies a key research gap: limited knowledge on how early adoption of nature-related disclosures, particularly TNFD, impacts financial outcomes. It frames the study's aim, which is to explore whether early TNFD adoption improves returns for asset managers, using East Capital's portfolio holdings as a basis for analysis. The chapter concludes with a statement of the research questions and acknowledges limitations related to sample size and novelty of the TNFD data.

1.1 Background

ESG factors have evolved within the finance industry from a niche concern to a mainstream criterion. There is an increase of interest from asset managers' side to balance the financial returns with ESG-related considerations, which leads to an increased demand for funds aligned with sustainability goals (Hasnaoui, 2025). Asset management firms looking to invest in ESG related alternatives face several distinct disclosure-data sets, rating methodologies and ranking systems which complicates the comparison from an ESG view. In addition, the regulations between the US, UK and EU are differentiating from each other, which further increases the difficulty for investors to compare companies (Paul et al., 2024). The number of companies that report on sustainability has steadily increased, both for the top 100 companies in 58 countries (N100) and for the 250 largest companies in the world (G250). Between

the years 1993 to 2022 there has been an increase from 12% to 79% for the N100 and from 35% to 96% for the G250 between the years 1999 to 2022 (KPMG, 2022).

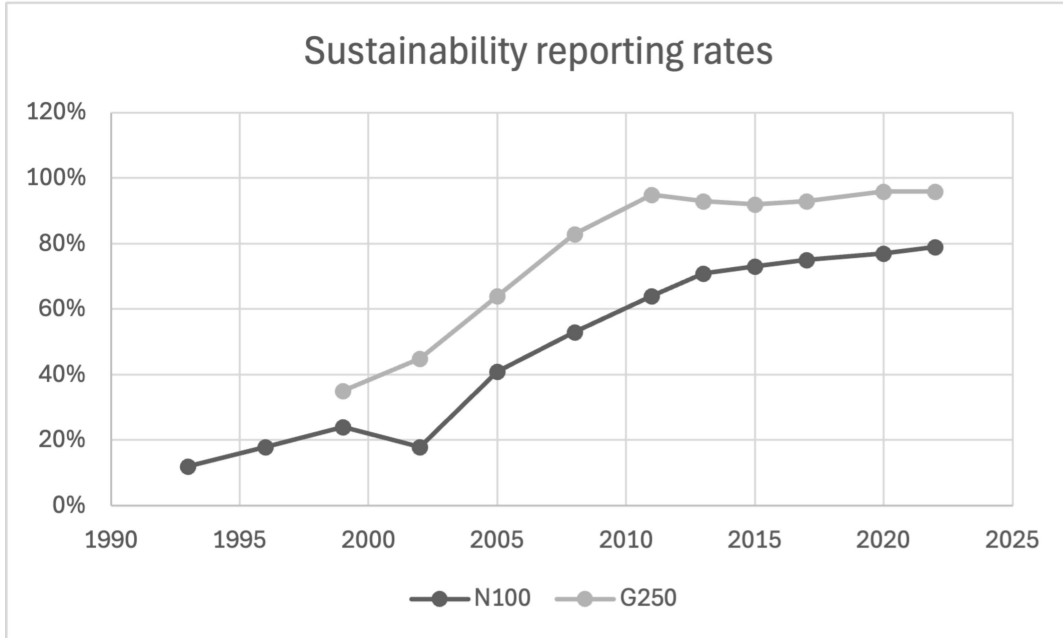


Figure 1.1: Number of companies reporting on sustainability according to KPMG (2022)

In relation to the increased demand from investors, regulators such as the European Commission started to set stricter regulations regarding non-financial reporting. The mandatory framework Non-Financial Reporting Directive (NFRD) was implemented by the European Commission 2014 which at the time was a major step towards greater business transparency and accountability on environmental and social issues. On the other hand, a particular problem with the NFRD was that it left much room for interpretation. This led to the information being disclosed in the way considered most useful, since there was no standard disclosure framework (European Parliament, 2021). In 2021, the European Commission highlighted the flaws in the NFRD due to its limited reliability and comparability. A more robust and affordable framework was then established to prevent greenwashing and double counting. This led to the Corporate Sustainability Reporting Directive (CSRD) which will oblige around 50 000 companies in January 2024 to report sustainability development compared to the previous 11 000 (European Union, 2022).

The Taskforce on Climate Related Financial Disclosure (TCFD) was introduced in 2017, which set out 11 recommended disclosures designed to promote decision-useful,

forward-looking information on the material’s financial impact on climate-related risks. TCFD was integrated by the European guidelines for reporting climate-related information in 2019 which provided guidance on releasing information that is consistent both for NFRD and TCFD. It is voluntary in the EU but mandatory in countries such as Japan, New Zealand, and the UK. The framework was designed to be adaptable for both the non-financial sector and the financial sector, which includes banks, asset management, asset owners, and issuers. The disclosures were built on four thematic areas which represent the core elements of how organizations operate: strategy, risk management, governance and metrics, and targets (CDSB, 2021). Based on the same thematic areas as the TCFD, another framework was introduced in 2022 but as a beta-version, the Taskforce on Nature-Related Financial Disclosures (TNFD). It focuses on nature’s assets and the services it provides, and its mission is to provide decision makers within business and capital markets with better quality reporting through corporate reporting on nature. In the beginning of 2024, over 320 companies from 45 different countries had committed to be early adopters of the framework and thereby started to report nature related disclosures based on the TNFD recommendations (TNFD, 2024).

Not only have regulators increased their awareness and actions regarding ESG factors, but also asset management firms. Asset management is “the practice of increasing total wealth over time by acquiring, maintaining and trading investments that have the potential to grow in value”. The world’s top asset management companies serve companies, individuals, foundations, and governments around the borders. Their investments decisions and shareholder votes have a great influence on corporations around the world (Paul et al., 2024). ESG funds which take environmental, social and governance factors into account in their investment strategies have been prominent in aligning financial goals with sustainability objectives. But the results have been twofold; there exist many studies highlighting how ESG affects the performance of listed companies. Some studies suggest that the incorporation of ESG improves fund performance and some studies claim that it is a constraint since it may lead managers to exclude stocks with high potential (Wong & Li, 2024).

Although the European Commission has integrated TCFD recommendations, the framework itself is voluntary to follow and disclose within the EU. The framework is mandatory in other specific areas such as New Zealand, Japan and UK. One reason why companies adopt mandatory frameworks is the investors’ demand for comprehensive and cohesive disclosure, which has increased faster than what the

regulators are making mandatory. This gap that previously existed for climate-related disclosure is now existing for nature-related disclosure. Asset managers thus fill this gap by adopting voluntary frameworks to tackle the government delay (Paul et al., 2024). The TNFD is one example of a voluntary framework to attract asset managers (TNFD, 2023). As mentioned above, it is still unclear whether the disclosure related to ESG increases the profitability of funds since the research done on the subject has produced mixed results (Wong & Li, 2024). One reason why asset management firms tend to voluntarily follow these recommendations is that it is expected that TNFD will be supported globally and disclosure obligations will be implemented in national disclosure regimes as TCDF has been (Widdup & Julier, 2024).

1.2 Problem description, aim and research questions

The studies on what ESG-focused portfolios achieve in financial aspects are still divided, whether the portfolios receive a positive or negative outcome in the sense of stock value (Wong & Li, 2024). Moreover, there has been limited information on biodiversity from organizations, and previous studies may not have included nature-related disclosure as an ESG factor. In other words, the impact of nature-related disclosure on financial success for companies is still questionable. Why some asset managers voluntarily adopt these frameworks without clear financial evidence can be explained by several factors. Firstly, it signals to investors that they can provide greater transparency and accountability in response to increasing pressure to protect biodiversity. Secondly, it increases the overall ESG reputation which can be viewed as an intangible resource that should be positively valued by investors. Finally, it showcases the firm's ability to comply with emerging reporting architecture and future regulations that TNFD recommendations are expected to become (Widdup & Julier, 2024).

Despite the positive factors, there are downsides for companies adopting the framework. Primarily, it makes nature-related risks more obvious for investors and analysts to assess, which potentially can hurt the reputation depending on their biodiversity impact. Furthermore, the signal that will be sent depends on credibility, and negative reactions can occur if the information disclosed is lacking accuracy and does not reveal the true impacts of the company. Lastly, to follow the TNFD the

company needs to devote significant resources since this type of reporting is complex (Widdup & Julier, 2024).

Investment decisions are increasingly based on three elements: return, risk, and sustainability. Historically there have been more focus on the first two mentioned, but sustainability's importance has grown increasingly in recent years. This has forced asset managers to develop new approaches to strategically allocate assets that integrate ESG factors into the optimization process (Abate et al., 2024).

This study will help identify how the disclosure of biodiversity-related factors affects the returns for asset managers, which have been subject to limited research. This study will attempt to fill this research gap and make it more clear on the complicated relation between stock value and reporting on TNFD. The aim of this study is to examine whether early adoption of the TNFD framework leads to better financial performance compared to later adoption. Furthermore, this study aims to understand the main explanations and the factors that could be used to understand the results. Consequently, the study aims to answer the following questions:

1. How has early adoption of the TNFD influenced financial returns compared to late adoption?
2. How can the financial effects of early adoption of the TNFD be understood through established economical theory?

1.3 Limitations

This study will use data from companies within East Capital's portfolio, which limits the number of companies. On the other hand, East Capital's portfolio has a global presence which helps to make the data more diverse. This study uses companies in the East Capital portfolio that have committed to the TNFD and are classified as early adopters by the TNFD. Another limitation is the finite data on TNFD because it has only been out on the market since 2021. The lack of a granular time stamp on when each company started to commit is also viewed as a limitation.

1.4 Thesis outline

The study will begin with a literature review which goes into more depth of the TNFD and non-financial framework. In addition, an overview of research on ESG, first mover advantages and Difference-in-Differences method. Afterwards, a theoretical framework that includes four different theories that will later be used to explain the results. The four theories are signaling theory, efficient market hypothesis, behavioral finance and early-mover advantages. Signaling theory was included to understand how voluntary TNFD disclosure may act as a signal of transparency and long-term commitment. It was used to analyze why such signals might fail if they lack credibility, clarity, or alignment with investor expectations. The Efficient Market Hypothesis (EMH) was chosen to assess whether markets efficiently incorporate new sustainability information into stock prices. Behavioral finance was included to account for cognitive biases and interpretive delays that can prevent investors from accurately assessing complex ESG disclosures. This theory helps explain why even well-intentioned sustainability signals may be overlooked or misinterpreted. Finally, first-mover advantage theory was selected to frame the strategic risks and opportunities of early adoption. It was used to explore whether early adopters incur short-term costs while positioning themselves for long-term gains in a maturing regulatory environment.

After the theoretical framework is established, the method will be presented. This study employs a Difference-in-Differences (DiD) methodology to estimate the financial effects of early adoption of TNFD.

Following the method, the results and discussion are presented. These two chapters answer both research questions and the aim of the study. The result focuses more on the second research question, which is more empirical based, by giving a hands-on answer on how the financial results are affected by an early and late adoption of the TNFD. The discussion is more related to the first research questions due to it explaining the results based on the theories presented.

Lastly, the conclusion will tie up the study by highlighting the results and some of the main explanations to how the results can be interpreted.

2

Framework and literature overview

This chapter includes literature closely related to the topic of the study and aims to contribute information that facilitates the understanding of the reader. Firstly, by providing a summary of research related to TNFD. Secondly, by going through other ESG-related frameworks. Lastly, an overview of existing research covering ESG and non-ESG related First-Mover Advantages, ESG and financial performance, and studies on Difference-in-differences is offered to the reader for an opportunity to dive deeper into the related literature.

2.1 The Taskforce on Nature-Related Financial Disclosures

TNFD is an international initiative that was established to support organizations in integrating nature-related risks into their strategic and financial decision-making processes. The framework provides tools that can be used to identify, manage, and report dependencies and impacts of businesses and financial institutions on natural ecosystems. Very central to the purpose of TNFD is the recognition that economic and financial systems are significantly interconnected with nature and that the maintenance of healthy ecosystems is critical for long-term financial and operational resilience (Taskforce on Nature-related Financial Disclosures, 2023).

The emergence of TNFD stems from the fact that biodiversity and ecosystems are deteriorating at a very fast rate. Many essential ecosystem services, such as water security, pollination, and soil health, are under severe pressure and are experiencing significant damage from businesses and economies. The TNFD (2023) highlights that the global economy is now exceeding safe limits for six out of the nine planetary boundaries, which poses systemic risks that are not fully accounted for in financial

markets. Although there is a growing recognition in society of these challenges, nearly 70 percent of the companies that report environmental data do not evaluate their impact on biodiversity in a comprehensive manner (TNFD, 2023).

Building on the well-established Taskforce on Climate-Related Financial Disclosures (TCFD), which has been described previously, the TNFD adopts a similar structure by focusing on the same four pillars; governance, strategy, risk management, and metrics. However, TNFD expands the focus of TCFD on climate-related issues to include nature-related risks, such as loss of biodiversity, water security, and deforestation. Although climate and nature are, of course, interconnected, nature-related risks are more diverse and localized, which requires even more tailored approaches and actions with regard to assessments and management. Hence, the TNFD is very important in addressing environmental sustainability within financial and operational decision making (TNFD, 2023).

One of the key differences between the TNFD and TCFD frameworks lies in the inclusion of three additional disclosures, which are specific to nature-related risks. The first is about engagement, which requires organizations to disclose their interactions with stakeholders, including local communities and indigenous people, to manage dependencies and impacts on ecosystems. This emphasizes the social dimensions of nature-related risks (TNFD, 2024). The second disclosure addresses sensitive locations, where businesses must identify and report areas with significant biodiversity interactions, which can be for examination of local nature issues such as water stress and deforestation. The third disclosure is about value chains, which highlights the need to assess both upstream and downstream dependencies and impacts. This highlights the interrelation of ecosystems across supply chains (TNFD, 2024).

What further distinguishes TNFD from TCFD is its alignment with global biodiversity goals, such as the Kunming-Montreal Global Biodiversity Framework (GBF), adopted by 196 governments in 2022. In particular, the TNFD supports the GBF Target 15, which calls on businesses to monitor and disclose their nature-related dependencies and risks by 2030. This alignment ensures that TNFD's recommendations serve corporate and international biodiversity objectives (TNFD, 2024).

In summary, TNFD maintains the focus of TCFD on the four pillars of governance, strategy, risk management, and metrics, but places additional emphasis on

engagement, sensitive locations, and value chains. It shifts the focus from climate to nature-related factors. This makes it a more comprehensive framework for addressing complex risks related to nature. By bridging financial decision making with ecological considerations, the TNFD aims to provide a robust framework for integrating biodiversity matters into corporate strategy and decision-making.

2.2 Frameworks of non-financial disclosures

Non-financial disclosure frameworks can be divided into two separate groups, mandatory (required by law) and voluntary (optional for companies). At first, non-financial disclosures started out as voluntary and were not reported on as much as today. The first major framework was the Global Report Initiative (GRI), which was released in 1997 and provided basic guidelines on how to develop sustainable development reports for enterprises using their own indicators of environmental performance (Dousolin & Mougnot, 2023). Another voluntary framework was released in the year 2000 and was named the Carbon Disclosure Project (CDP). CDP sent questionnaires based on disclosure and then classified them based on four aspects: awareness, disclosure, management, and leadership skills (Huang et al., 2025). In the same year, the UN Global Compact was released that included principles on human rights, labor standards, environment, and anticorruption. Companies annually report on their activities and their progress, and as in the previous frameworks, this is also voluntarily (Gonzalez-Perez & Leonard, 2015).

In 2003 the AA1000 Accountability Principles Standard was released and was built on four principles which makes the company more sustainable when adopted. Inclusivity, materiality, responsiveness, and impact all play a major role in this framework, helping the organization to be more transparent and credible (Farooq et al., 2021). Furthermore, ISO 26000 was released in 2010 and one primary goal was to create a standardized and global framework that at the time did not exist. Other objectives were to improve their social responsibilities and increase the social responsibility credibility (Moratis & Cochius, 2011). The Sustainability Accounting Standard Board (SASB) was created in 2011 by Bloomberg, Rockefeller Foundation and Deloitte, among others. The framework was aimed for investors by developing accounting standards for sustainability. The work was driven by two issues: the growing economic importance of intangible assets and the significance of the market's demand for transparency and comparability (Parfitt, 2024). In 2017 the TCFD

was released to the public and is structured on four pillars: governance, strategy, risk management and metric & targets as mentioned earlier. The pillars are divided into eleven recommendations (TCFD, 2025).

The European Commission published the Non-Financial Reporting Directive (NFRD) in 2014 which was a major step since it was the first framework required to follow under specific circumstances such as the company exceeding 500 employees (European Parliament, 2021). A few years later (2021) the Corporate Sustainability Reporting Directive (CSRD) was released as an improved version of the NFRD which made it more difficult to get away with greenwashing amongst other aspects. These two mandatory frameworks are only regulated in the EU.

2.3 Overview of existing research

Table 2.1 summarizes previous research on the advantages of being a first mover, both from the ESG and non-ESG perspectives. The table provides information on how early adoption strategies influence ESG integration, financial results, and firm competitiveness. Several studies show that early movers tend to benefit from improved ESG commitment, reputational gains, and long-term strategic advantages. However, the advantages are not always clear, as many findings emphasize the importance of context, such as industry conditions, regulatory clarity, and market maturity. This comparative overview helps identify the key factors that influence whether early adoption leads to sustainable value creation. The table serves as a foundation for the reader by illustrating where early movers succeed or struggle, and by highlighting gaps in the literature.

Table 2.1: Summary of previous studies on first-mover advantages: ESG and non-ESG related

Title	Author(s)	Method	Results	Conclusions
Active First Movers vs. Late Free-Riders?	Bauckloh et al. (2023)	DiD and event study on ESG commitment of early vs. late UN PRI signatories.	Early adopters improved ESG integration; late adopters showed weaker implementation.	First movers show stronger ESG commitment; highlights need for regulation to prevent greenwashing.

First-Mover Advantages in Weak Appropriability	López & Roberts (2002)	Historical analysis of financial services and regression analysis.	First movers gained early dominance; advantages eroded as competitors entered.	First-mover advantages diminish over time; timing and regulations are critical.
Winning the Race to Net Zero	World Economic Forum (2022)	Case studies comparing early vs. late movers in sustainability.	Early movers had better growth, cost savings, and access to capital.	Proactive sustainability provides long-term advantages and competitive gains.
First-Mover Advantages	Lieberman & Montgomery (1988)	Theoretical review of first-mover advantages across industries.	First movers benefit from leadership but face risks like market uncertainty.	Advantages depend on industry conditions; late movers can also thrive.
The Half-Truth of First-Mover Advantage	Suarez & Lanzolla (2005)	Framework for assessing first-mover success in different contexts.	Advantages strongest in stable markets; rapid change increases risks.	Success depends on market and technological evolution.
Do Early Birds Get the Returns?	Carow et al. (2004)	Event study analyzing early vs. late movers in acquisitions.	Early movers see higher returns if strategically positioned.	Success depends on industry, financing, and strategic alignment.
First Mover Advantages in Transitional Economies	Luo & Peng (2007)	Analysis of foreign direct investment in China.	First movers gained early advantages but faced higher risks initially.	Long-term success depends on local conditions and firm strategies.
First-Mover Advantages in Green Innovation	Przychodzen et al. (2019)	Panel regression on green innovation impacts (1999–2016).	Initial financial drawbacks; long-term market value gains.	Green innovation benefits require balancing sustainability and financial goals.

2. Framework and literature overview

When Does It Pay to Be Green?	Su et al. (2024)	Panel data analysis on environmental practices across industries.	Early adoption of benefits depend on competition and resources.	Strategic timing of adoption is crucial for success.
TCFD Disclosures: Singapore Perspective	Loh & Yock (2021)	Study on early adopters of TCFD disclosure practices.	Governance disclosure is strong; strategy disclosure is weak.	Regulation and investor clarity needed for consistent practices.
Stock market reaction: nature-related financial disclosure	Jerome & Poretti (2025)	Event study: voluntary adoption of nature-related financial disclosures.	Statistically significant negative abnormal return around the disclosure date.	Markets may perceive early TNFD-style disclosures as costly or non-credible signals.

Table 2.2 gives an overview of studies that look at how ESG practices relate to financial performance. These studies use a range of methods, from statistical models to interviews, which shows how hard it is to pin down ESG’s financial impact. While some findings suggest ESG can help long-term performance, the results are mixed overall. Just reporting ESG efforts isn’t enough, what seems to matter more is how well ESG goals are built into a company’s core strategy. This summary highlights how complex and uncertain the link between ESG and financial outcomes really is.

Table 2.2: Summary of studies on ESG and financial performance

Title	Author(s)	Method	Results	Conclusions
ESG and Financial Performance	Whelan et al. (2021)	Meta-analysis of 1,000+ studies (2015–2020).	58% of corporate studies and 59% of investment studies show positive ESG-financial outcomes.	ESG engagement yields better long-term results; disclosure alone is insufficient.

Impact of ESG on Financial Performance	Chen et al. (2023)	Panel regression using stakeholder and signal transmission theory.	ESG improves financial performance, strongest in large firms and high-risk industries.	Careful ESG strategy balancing is critical to avoid diminishing returns.
ESG Integration: Myths and Realities	Kotsantonis et al. (2016)	Industry trends and empirical research review.	Material ESG factors enhance financial outcomes, generic strategies do not.	Distinguish material vs. immaterial ESG; align ESG with corporate strategy.
Sustainability Risks in Asset Management	Hübel & Scholz (2020)	Augmented Fama-French model to analyze ESG risks.	High ESG stocks are riskier but can mitigate downside; no clear ESG risk premium.	Strategic ESG risk management helps avoid downside exposure.
CSR Perception and Financial Performance	Sciarelli et al. (2019)	Experimental study on CSR disclosure in asset management.	Higher CSR disclosure correlates with financial performance.	Align CSR messaging with ethical financial products to maximize benefits.
ESG Integration in Investment Processes	van Duuren et al. (2016)	Survey of managers in Europe and US.	ESG aids risk management; European managers are more ESG-optimistic than US peers.	ESG is key for red-flagging risks but less impactful for active decisions.
The ESG Integration Paradox	Cappucci (2018)	Qualitative analysis of ESG integration barriers.	Full ESG integration improves long-term performance; partial adoption increases costs.	Comprehensive ESG integration is necessary to avoid counterproductive outcomes.

The literature review was designed to progressively guide the methodological development of this thesis. It began with a broad overview of empirical studies that address the re-

relationship between ESG factors and financial performance. The goal was to understand the general landscape, including common research findings, methodological strategies, and frequently used variables. Table 2.2 summarizes these high-level studies. Many of them indicate a positive link between the implementation of ESG reporting and firm performance, but emphasize that context, implementation strategy, and data transparency are key to producing meaningful results.

After the broader review of ESG and financial performance, a more focused review was carried out, concentrating on studies that compared outcomes between two groups. In going through these articles, it became clear that many of these studies used a so-called Difference-in-Differences (DiD) approach. This method was often applied in settings involving regulatory changes, new disclosure requirements, or similar external events, contexts that are comparable to the introduction of frameworks like TNFD. DiD is well suited to such situations, as it helps control for time trends and unobserved differences between groups when assessing the impact of a specific change.

Table 2.3 presents a focused selection of ESG studies that applied DiD or related panel-based causal methods. These studies served as direct methodological inspiration for this thesis. They informed not only the choice of methodology, but also variable construction (e.g., using ROA, sales growth, leverage as control variables among others) and the structure of robustness checks, including fixed effects and clustered standard errors.

Table 2.3: Summary of studies on Difference-in-Differences

Title	Author(s)	Method	Dependent Variable	Main Conclusion
Public ownership and ESG policies	Coluccia et al. (2024)	DiD, WLS, TFP (ACF method).	TFP.	Public ownership boosts productivity, especially for non-ESG firms.
Propensity Score Matching and ESG Influence	Neethu et al. (2023)	PSM + DiD.	ROA, Tobin's Q, ESG, Leverage.	Mergers hurt ESG performance; no strong financial performance gain.

Continued on next page

Table 2.3 – continued from previous page

Title	Author(s)	Method	Dependent Variable	Main Conclusion
ESG Risk Premium and Mutual Fund Sustainability	Dunbar et al. (2023)	DiD + Fama-French 3-factor model.	Mutual fund excess returns.	ESG mutual funds outperform post-ESG repurposing.
ESG Ratings and Corporate Green Innovation	Wang & Chu (2024)	Multi-period DiD, staggered DiD, SDID, event study.	Green patent applications.	ESG boosts green innovation, especially source-based innovation.
ESG Rating and Green Total Factor Productivity	Zhu & Zhu (2025)	Staggered DiD + mediation analysis.	Green Total Factor Productivity.	ESG ratings improve green productivity and help small/polluting firms.
Say-on-Pay Laws and ESG Performance	Pawliczek et al. (2021).	Staggered DiD with fixed effects.	ESG Scores (composite/env/soc).	SOP laws drive ESG contracting and improve ESG scores.
ESG Index Listing and Financial Distress	Singh (2024)	DiD + panel data regression.	Financial distress (Altman Z).	ESG index listing reduces financial distress.
AI Implementation and ESG Performance	Tao et al. (2025)	Staggered DiD + PSM + placebo tests.	ESG Score (Sino-Securities).	AI improves ESG performance, especially with good governance.
ESG Ratings and Digital Innovation	Wang (2025)	SDID, staggered DiD, PSM, event study.	Digital innovation (patents).	ESG drives digital innovation; over-focusing may lead to diminishing returns.

3

Theoretical framework

This chapter outlines the theoretical foundations used to interpret the financial effects of early TNFD adoption. The aim is to provide a conceptual lens through which the results of the study can be better understood. Theories such as signaling theory, the efficient market hypothesis, behavioral finance, and early mover advantages are introduced to explain how voluntary disclosures like the TNFD may influence investor perception, information asymmetry, and asset pricing. These frameworks help explore why early adoption can, or may not, lead to higher returns and under what conditions such signals are likely to be credible, effective, or misinterpreted. Together, these theories guide the analysis of both empirical findings and their broader implications.

3.1 Signaling theory

Signal theory is based on two pillars, decision-making and communication. It describes scenarios in which signalers send observable signals that carry credible information about unobservable qualities. When decision makers have incomplete information, signals can help them make more grounded decisions. In order to examine the power of the signals, the cost plays a role. Higher-quality signalers have the resources and expertise to afford to send out the signals, meanwhile, lower-quality signalers might not be able to (Connelly et al., 2025). Signal theory is built on five essential components: the signaler, the signal, the receiver, receiver feedback and the signaling environment. Typically the signalers send positive signals to the receivers but there are times when insiders unintentionally send negative information to the outsiders. Whether the information is intentionally/unintentionally or positive/negative, it has the potential to remove information asymmetry by providing more information to the stakeholders. Depending on the signals interpretation, the receivers may send feedback to the signalers to facilitate more efficient signaling in the future. The signaling environment has the opportunity to affect the transmission and perception of signals and feedback (Friske et al., 2023).

Signals can also be characterized as signals of intent, camouflage, and need. Intent signals express future action, possibly dependent on the receiver's response. For example, an intent signal could be when a firm quickly implements a response to a rival's com-

petitive action in order to appear tough and mark that the firm will not roll over easily. Camouflage signals, on the other hand, are signals that disguise a liability. They are designed to divert attention away from a vulnerability towards some other characteristics. An example could be a company that is expanding internationally that participates in strategic alliances to deal with the problem of foreignness. Lastly, need signals communicate requirements to the receiver. This could be the case for a company with multiple divisions and subsidiaries, where each is responsible for signaling its need for resources, and the headquarters are deciding which are signaling the greatest need (Connelly et al., 2011).

The usefulness of a signal depends on the way in which the signal corresponds to the sought-after quality of the signaler, in addition to the extent to which the signalers attempt to deceive. Both are required, and together they form the credibility (reliability) of the signal. Some scholars use the term credibility to describe to what degree the signaler is honest and correlates with the signaler quality. The more honest the signalers are, the more likely the signal itself would be interpreted as more honest and reliable. However, if a signaler sends different signals, the way receivers interpret those signals could change (Connelly et al., 2011). Another factor that affects the interpretation of the signal is the amount of noise in the signaling environment. Noise can be referred to as extraneous or misleading information that can obscure or distort the intended message of the signal. Intuitively one would expect that with an increasing amount of noise an increasing amount of resources would be forced to be put on the signal in order to differentiate from the noise. If the noise gets too large, the signalers may be less inclined to separate because the noise makes the signaling too expensive and less informative (de Haan et al., 2011).

3.1.1 Signaling in the form of voluntary sustainability

The act of voluntary sustainability reporting is becoming more and more common. Sustainability reporting may help organizations better understand how their activities affect different stakeholder groups and it has the opportunity to strengthen corporate accountability. In addition, it might be used as a marketing tool to describe corporate activities to combat climate change and achieve a more sustainable future (Friske et al., 2023).

The view received is that investors value the stakeholder management practices embodied in sustainability reports. The financial performance will suffer in the long run if management cannot satisfy the major stakeholders. Using sustainability reports, management engages and informs the stakeholders with discussions about the company's ESG projects and future opportunities. Investors who believe in the long term benefit of stakeholder management would view sustainability reporting as a logical application as good stakeholder engagement. Correspondingly, such investors would believe reporting is a sound

investment which might positively affect firm value. Another reason to use sustainability reporting is to accomplish organizational legitimacy. The adoption of frameworks can claim legitimacy by meeting social norms and expectations about ESG transparency. This boosts the corporate image and reputation. The implementation of a sustainability framework signals to possible investors that the firm is “a legitimate corporate citizen with sustainability plans for the future”. Lastly, voluntary nonfinancial disclosures have positive spillover effects on the financial disclosures. There is a connection in the sense of transparency between sustainability reports and financial reporting which should reduce information asymmetry. The increased transparency helps the investors to identify risks that otherwise might not be evident in financial statements and letters to shareholders. To conclude, the firm value should increase when investors value high transparency, proactive stakeholder management and organizational legitimacy which consequently increases with adoption of sustainability frameworks (Friske et al., 2023).

Despite the many reasons why sustainability reporting may be interpreted as positive signals, literature also provides contradictory evidence that it may impact the market value negatively. The implementation of sustainability reporting requires a considerable amount of the company’s resources. Both financial and human resources have to be committed on an ongoing basis in order to meet the requirements of the certification process as well as firm-specific strategic considerations. Managers might need to develop new routines and reorganize departments in order to facilitate sustainability reporting. In addition, managers must balance investors’ care about the firm’s environmental and social initiatives with how much financial performance they are willing to trade off. The lack of a clear connection between sustainability reporting and financial metrics further exemplifies the problem. Both shareholders and potential investors struggle to verify if the expenses help to generate shareholder value due to the metrics of ESG performance do not align with the common metrics of financial performance. In addition, investors might recognize the opportunity costs that are connected to practice sustainability reporting. Investors may potentially believe that the more time and resources that are put into sustainability the less is left for more traditional profit generating activities such as R&D and advertising. To summarize, with the consideration of the amount of resources required, the non obvious connection between financial and sustainability metrics and the opportunity costs the market value of the firm could be lowered (Friske et al, 2023).

3.2 Efficient market hypothesis

The efficient market theory (EMT) is a well-known and important theory in modern finance. The term “efficiency” stands for the fact that investors do not have any opportunity

to obtain abnormal returns (difference between actual return and expected return) from capital market transactions as compared to other investors and can not thereby beat the market. In an efficient market the only option to obtain a larger profit compared to the market is to invest in higher risk assets (Titan, 2015). Generally, the theory is built on two pillars:

- In efficient markets, available information is already incorporated in stock prices.
- In efficient markets, investors cannot earn a risk-weighted excess return (Degutis & Novickyte, 2014).

The theory is controversial and of particular interest within the finance community, which is confirmed by the high amount of specialized literature. Even if the theory has its roots in the 1960s and many have tried to find the truth behind the EMT, no ultimate conclusion exists. An equivalent amount of articles supports it as there is that invalidates it. No matter what kind of economy it is, whether it is a developed economy or an emerging economy (Titan, 2015).

Around a decade after the theory's publication, the distinction of three forms of efficiency started to appear: weak, semi-strong and strong (Titan, 2015). In the weakly-efficient stock markets, the current stock prices include all information related to the stock price adjustments in the past. Information such as previous prices and trading volume. Based on the definition it then becomes impossible to make excess returns (actual return minus risk-free rate). In the semi-strong efficient markets, current stock prices additionally reflect current publicly accessible information, for instance announcement of acquisitions and dividend pay-outs to name a few. Lastly, strong efficient markets are characterized by that stock prices are reflected by all information which does not automatically have to be public. In other words, this implies that the stock prices include insider information which in reality is questionable (Degutis & Novickyte, 2014).

The efficient market theory is closely linked to other financial models and hypotheses. One key point is that the absolute or partial rationality of market participants is essential for its efficiency. Even if not all investors are rational, the trades of irrational investors are random and can thereby be assumed to not affect the stock price. Investors might have different trading methods and could be divided into groups depending on their strategy. A common divider is to categorize them into three groups: intrinsic value investors, traders and mechanical investors. The intrinsic value investors use a fundamental analysis, the traders use technical analysis and mechanical investors operate through a set of rules (e.g., index replication) (Degutis & Novickyte, 2014).

A company's ESG performance is incorporated into its stock price information as stated by the efficient market hypothesis. This reflects investor's expectations of future financial

performance and risk. Furthermore, strong ESG practices may perceive the company as more sustainable and less risky which may be interpreted to have higher valuations and lower cost of capital. On the contrary, companies with lower ESG performance might have decreased investor interest and higher cost of capital as a result of perceived risk and liabilities connected to environmental issues. Empirical studies present support for the link between market efficiency, company performance and ESG performance. Some studies found that companies with higher ESG ratings lean to have higher financial performance and valuation. This points out that investors incorporate ESG considerations into their investment decisions (Gurung & Sarkar, 2023).

3.3 Behavioral finance

The core and purpose of behavioral finance is to understand and explain actual investors and market behaviors in contrast to theories of investor behavior (Pompian, 2012). The word *behavioral* in the name suggests that the behavior of investors in the actual economy is radically different from what most academic theorizing generally assumes (Burton & Shah, 2013).

People in standard finance are rational. People in behavioral finance are normal.

— Meir Statman, PhD, Santa Clara University

This quote could be interpreted as "normal" people may behave irrationally, but the reality is that almost no one behaves perfectly rational (Pompian, 2012). Behavioralists argue that the predictions in finance must be modified to account for people's actual behavior in economic situations. One of the most commonly assumed hypotheses is that all investors act rationally. The rational person maximizes utility (satisfaction or whatever the utility function is presumed to measure), staying within of what is possible as constrained by wealth and liquidity. The exercise of maximizing utility by agents leads to predictable behavior, which ultimately leads to predictions on how market functions behave in the real world. For instance, rationality behavior, combined with some other assumed conditions, implies that resources are efficiently allocated by the price mechanism for the financial markets. Prices perform a signaling function for the economy and therefore direct agents to produce, buy and sell the "right amounts," which can be interpreted roughly, so that the economy does not waste resources (Burton & Shah, 2013).

Pompian (2012) divides behavioral finance into two distinct subtopics: micro and macro. Behavioral finance micro examines biases or behaviors of individual investors and what distinguishes them from the actors proposed from classical economic theory. Behavioral

finance macro describes anomalies in the EMH that behavioral models may explain. Each subtopic addresses a distinct set of issues which further connects the topics to the larger debate between standard finance versus behavioral finance. The micro-perspective debates whether investors are rational or not, while the macro perspective is related to whether the market is efficient instead. Briefly, standard finance theory is designed to provide mathematically elegant explanations which often in real life are complicated by imprecise, inelegant conditions. Standard finance tends to rely on assumptions that oversimplify reality, such as relying on the fact that humans make perfectly rational decisions at all times. Behavioral finance advocates argue that standard finance focuses on how investors *should* behave rather than on how they actually behave.

Behavioral finance argues that the EMH is false and that academic finance needs to rethink its foundations. That the EMH is false is explained by behaviorlists by three different arguments: logical, psychological, and empirical. The logical argument criticizes the foundations and argues that the assumptions of the EMH are unrealistic. For example, it could be argued that not all investors have all the information concerning the stock. The psychological arguments are mostly based on experiments in human psychology that cast doubt on the realism of the assumptions that underlie finance theory. These arguments could ask whether investors are rational and whether investors display systematic biases. Lastly, empirical arguments exhibit patterns "predictability" in financial data that negate the assumed "nonpredictability" of future prices. In other words, there exist data that shows predictable patterns in stock prices such as trends, momentum or reactions to news, which should not be possible by the EMH due to future prices being inherently unpredictable since all information is already reflected (Burton & Shah, 2013).

There are also several documented anomalies that contradict the EMH. There are three types: Fundamental Anomalies, Technical Anomalies and Calender Anomalies. Fundamental Anomalies occur when stock performance does not align with fundamental valuation theories, such as the EMH. Examples could be that low P/B (price-to-book) stocks consistently outperform high P/B ones and that low P/E (price-to-earnings) stocks perform better than high P/E stocks. Technical anomalies encompasses several techniques that attempt to forecast securities prices by studying past prices. Common types are based on relative strength and moving averages. Lastly, calendar anomalies are time-based patterns in returns. One such effect is the January effect. Historically, general and small stocks have delivered abnormally high returns during the month of January. The explanation is grounded in stocks rebounding following year-end tax selling. It works in the way that investors sell losing stocks in December to reduce taxable income, which creates a temporary downward pressure, and in January buy them back, leading to a price rebound (Pompian, 2012).

3.4 Early mover advantages

Lieberman and Montgomery (1988) define first-mover advantages in terms of the ability of pioneering firms to earn positive economic profits. The early advantages can arise through several different sources: technological leadership, preemption of assets and buyer switching costs. Even if early movement can result in lowering costs, advancing the product or gaining success within IP it is possible that it may become a disadvantage. Such detriments would be free-rider effects, resolution of technological or market uncertainty, shifts in technology or customer needs and incumbent inertia (Lieberman & Montgomery, 1988). Some examples of successful and sustained first-mover advantages are Uber, Twitter and eBay. These all showcased that it is difficult to overcome dominance once it is well established (Haiyang et al., 2020). Furthermore, Liberman & Montgomery (1988) identify three components that lead to an early mover advantage: the preemption of scarce resources, the learning curve effect, and the creation of buyers' set-up and switching costs.

One key factor to examine the success of early movers in environmental innovation is the market characteristics and regulations specific for each region (Cleff & Rennings, 2012). However, environmental practices differ from each other and the early mover advantages might have not been empirically examined for different types of environmental practices. This could be an explanation to the mixed results that exist between the environmental practices and the firm's performance. Another influence that plays its part is the effect on the firm's stakeholders and how it benefits the firm (Su et al., 2024). Tetrault Sirsly, and Lamertz (2008) suggested that corporate social responsibility could be an ingredient to early mover advantages if it fulfills the previously mentioned influences.

Jerome and Poretti (2025) conducted an event study regarding early adoption of nature-related disclosure and how the market reacted. The results showcased on one hand that the voluntary disclosed nature related information was negatively viewed by the market but on the other hand it was acknowledged that more evidence based research on biodiversity is needed.

4

Method

The chosen methodology for the underlying study is quantitative, which is well-suited for hypothesis testing within a deductive research framework (Bell, Bryman & Harley, 2022). Quantitative research emphasizes the measurement and statistical analysis of relationships between variables, enabling systematic comparison of financial metrics across treatment groups. This approach is particularly relevant for assessing how early adoption of the TNFD framework influences firm performance, as it facilitates the identification of statistically significant effects and supports replicability and objectivity (Bell et al., 2022).

The study adopts a longitudinal panel data approach, analyzing firm-level observations over time. Specifically, a Difference-in-Differences (DiD) framework is employed to estimate treatment effects by comparing performance trajectories of early and late adopters before and after the anticipated implementation period.

The research follows a structured process: theory-driven development, targeted sampling and matching, panel data collection, and statistical analysis through DiD-regression. Although the focus is on a clearly defined subset of firms, the quantitative design aims to yield internally valid and robust insights into the financial implications of TNFD adoption.

4.1 Literature selection rationale

The study employed a thorough literature review, where secondary data was collected and analyzed to establish the theoretical foundation for the research. According to Bell et al. (2022), a literature review aims to contextualize a study within existing research, identify concepts, and highlight gaps in the current knowledge base. The literature study in the underlying research followed a narrative review rather than a fully systematic approach, but the authors ensured that the sources used were comprehensive, relevant, and academically rigorous (Bell et al., 2022). Although systematic reviews emphasize a fully replicable and exhaustive process, a narrative review allows for greater flexibility, which was deemed to fit the underlying study well. In order to structure the literature review, the study adopted an exhaustive with selective citation approach (Bell et al., 2022), which means that a broad range of literature was reviewed, but only the sources considered most rele-

vant were cited. As previously mentioned above, relevant sources can be found in Table 2.1, Table 2.2 and Table 2.3.

In line with the guidance provided by Bell et al. (2022), the study applied a comprehensive approach to identify relevant literature, but selectively cited only the most relevant sources. The reviewed literature was, as mentioned earlier, grouped conceptually. This was necessary because there appeared to be limited research that directly matched the scope of the underlying study. Moreover, as explained by Bell et al. (2022), this approach helps to summarize previous findings and relate them to the study.

The search process was conducted using structured keyword searches, in order to ensure that literature relevant to TNFD, early/late adoption, and financial performance was included. Moreover, keywords were refined iteratively according to the “snowball method”, which Bell et al. (2022) describe as a procedure in which references in relevant articles are examined to discover additional, potentially relevant sources. This method was used to identify common methods used for similar studies and explicitly how DiD was found suitable for this study.

4.2 Sample selection and matching strategy

In order to estimate the effect of TNFD adoption on firm performance, a Difference-in-Differences framework was employed, in which early adopters were matched with a group of late adopters. Since the identification strategy relied on comparing two groups over time, it was critical that the treatment and control groups were comparable on observable firm characteristics prior to treatment. Similar matching-based DiD strategies have been employed in recent ESG-focused studies, such as Neethu & Arun (2024) and Coluccia, Fontana, and Solima (2024), which combine theory-driven sampling with so called covariate balancing to enhance internal validity. Hence, the sample construction involved two stages: identifying the treatment and control populations, and applying a matching procedure to ensure comparability.

4.2.1 Sampling design and data source

The underlying study followed a purposive sampling approach (Bell et.al, 2022), which reflects the study’s aim to compare firm performance across TNFD adoption groups within a specific, pre-defined universe, namely publicly listed firms included in East Capital’s portfolios. Portfolio data from East Capital was obtained for the following funds: East Capital Balkans, East Capital China, Global Emerging Markets Sustainable, East Capi-

tal Eastern Europe, East Capital Multi-Strategi, Espiria Global Innovation, and Espiria Hållbar Framtid. Firms that had been included in any of these portfolios at any point during the period 2017 to year-to-date 2025 were considered for the sampling process.

As such, the sampling procedure is non-random but theory-driven, targeting firms for which data availability and TNFD disclosure decisions were relevant to the research questions. Within this purposive framework, stratification was used to define two distinct groups, early adopters and late adopters, prior to matching. Although probability-based sampling is typically used to maximize generalizability, non-probability approaches can be justified when the research objective is to evaluate treatment effects within a clearly bounded and theory-relevant sample (Bell et al., 2022). In other words, the focus on a specific set of firms (East Capital’s portfolio companies) motivated a targeted sampling strategy aligned with the study’s theoretical scope.

4.2.2 Early adopters

Firms were classified as early adopters based on two criteria:

1. Public TNFD commitment: The firm must have listed itself as a TNFD early adopter as per the classification employed by TNFD, i.e., it must have declared an intention to publish TNFD-aligned disclosures by or before the release of the FY2024 financial statements.
2. Portfolio presence: The firm must have been present in East Capital’s portfolios during the 2017- year-to-date 2025 period to ensure consistent financial and return data coverage.

Applying these criteria to relevant candidates yielded 32 firms in total. After verifying data availability for the dependent variables as well as control variables, 23 firms remained in the final early adopter’s sample.

4.2.3 Late adopters and matching procedure

The initial population of late adopters consisted of 1521 firms, all other firms in East Capital’s portfolios over the same period that did not meet the early adoption criteria. For obvious reasons, this population needed to be scaled down to better match the early adopter group in terms of number of firms. For this purpose, a so-called covariate-based matching procedure was applied, drawing on the approach in Neethu & Arun (2024) and aligned with established practices in DiD design (e.g., Stuart, 2010; Dehejia & Wahba, 2002). More specifically, four firm-level covariates were selected based on relevance to

financial performance and prior literature. The following data were collected:

- X1: Natural logarithm of average market capitalization
- X2: Average leverage ratio
- X3: Average return on assets (ROA)
- X4: Total revenue growth % change

For each covariate X_i , the mean μ_i and standard deviation σ_i were calculated using the full set of 32 early adopters (prior to data availability filtering). A conservative matching criterion was used: a firm from the late adopter pool was retained only if its value for each of the four variables fell within a ± 0.5 standard deviation window around the early adopter mean:

$$X_{i,j} \in [\mu_i - 0.5 \cdot \sigma_i, \mu_i + 0.5 \cdot \sigma_i] \quad \forall i \in \{1, 2, 3, 4\} \quad (4.1)$$

This filtering ensured a tighter balance between groups while preserving a sufficient sample size. The method draws on the covariate-based matching logic in Neethu and Arun (2023) and is consistent with established practices for improving group comparability in Difference-in-Differences designs (Stuart, 2010; Dehejia and Wahba, 2002).

$$\text{Match}_j = \begin{cases} 1 & \text{if } X_{i,j} \in [\mu_i \pm 0.5\sigma_i] \quad \forall i \\ 0 & \text{otherwise} \end{cases} \quad (4.2)$$

This procedure narrowed the sample of 1521 late adopters to 36 matched firms that closely resembled the early adopters in terms of firm size, profitability, capital structure, and growth. After filtering for full data availability, 30 firms remained.

4.2.4 Final sample

Hence, the final sample consisted of:

- 23 early adopters (treatment group)
- 30 matched late adopters (control group)

This matched sample ensured that the treatment and control groups were comparable on key financial characteristics prior to treatment, supporting the internal validity of the DiD-design and strengthening the credibility of the estimated treatment effects. This approach is aligned with methodological guidance for comparative research in business and finance (Bell et al., 2022).

4.3 Data analysis

The empirical analysis was carried out in Python, using standard libraries such as *Pandas* for data handling, *Numpy* for numerical operations, *Matplotlib* for plotting, and *Statsmodels* for regression modeling. All results, including descriptive statistics and regression outputs, were exported to Excel using *openpyxl* and *xlsxwriter* for documentation and further review.

The dataset was constructed using firm-level stock return data and financial variables obtained from Bloomberg. Each firm's return history was stored in a separate sheet and then combined into a single panel structure for analysis. Binary indicators were created to identify early TNFD adopters, the post-treatment period (from March 2024 onward), and their interaction. Rolling 30-day average returns and Sharpe ratios were calculated using a 30-day window (see their respective definitions below).

4.3.1 Overview and analytical framework

The empirical strategy employed in this study aimed to evaluate whether early adoption of TNFD has a measurable and statistically significant effect on firm performance. To facilitate such measurement, as previously described, a Difference-in-Differences (DiD) approach was implemented, in which early adopters were matched with a set of late adopters before and after the anticipated adoption period. The DiD framework was well-suited for this context, because it isolates the effect of a specific treatment, namely TNFD adoption, by controlling for time-invariant firm-level characteristics and general time trends that may affect all firms simultaneously (Coluccia et al., 2023; Neethu & Arun, 2023).

The core of the DiD-design relies on two binary variables:

1. A treatment group indicator identifying early adopters
2. A post-treatment period indicator, set to 1 for all dates after March 1, 2024

These two variables are then multiplied to form a third variable, the interaction term, which is the key to the analysis. The value of this variable is 1 only for firms that are early adopters and observed after the treatment date. The coefficient on this interaction term shows the effect of TNFD adoption on the firms that adopted early. In simple terms, it gives information about how the average performance of early adopters changed after adoption, compared to the average change in the late adopters. This is known as the average treatment effect on the treated (ATT), but the main point is that it captures how

much of the change in performance seems to be driven by adopting TNFD, not by other factors.

4.3.2 Data cleaning and filtering

Prior to constructing variables and conducting the analysis, the dataset was carefully cleaned to ensure consistency and reliability. The cleaning procedure followed a structured sequence. First, as alluded to earlier, all firm-level Excel sheets were consolidated into a single panel dataset, with each observation representing a firm-date combination. Each firm was assigned a unique identifier based on its sheet name.

To address outliers in return data, observations with daily returns below -50 percent or above $+50$ percent were removed. This threshold was selected to exclude extreme values likely caused by data errors or illiquid trading, without affecting legitimate market fluctuations. Observations with missing values in key variables, particularly daily returns and treatment indicators, were also removed to ensure the integrity of rolling metric calculations and regression models.

4.3.3 Variable construction

Following data cleaning, a complete set of variables was constructed to enable the Difference-in-Differences analysis, including indicators for treatment status, time periods, firm performance metrics, control variables, and identifiers for fixed effects and clustering.

DiD structure variables

- Treatment: A binary variable equal to 1 for early adopters of TNFD and 0 for matched late adopters
- Interaction (Treatment \times Post): A binary variable equal to 1 only for early adopters during the post-treatment period. This is the key DiD variable capturing the average treatment effect on the treated (ATT)

Dependent variables

To measure performance, the study constructed two return-based dependent variables:

1. Rolling average return: the 30-day moving average of daily returns

$$\text{RollingAvgReturn}_{i,t} = \frac{1}{N} \sum_{k=0}^{N-1} r_{i,t-k} \quad (4.3)$$

Where:

- $r_{i,t}$ is the daily return for firm i on day t
- N is the window size, which is 30

2. Rolling Sharpe ratio: the 30-day moving average return divided by the corresponding rolling standard deviation

$$\text{RollingSharpe}_{i,t} = \frac{\text{RollingAvgReturn}_{i,t}}{\text{RollingStdDev}_{i,t}} \quad (4.4)$$

- $\text{RollingAvgReturn}_{i,t}$ is defined as above
- $\text{RollingStdDev}_{i,t}$ is the standard deviation of the past 30 daily returns for firm i

These rolling metrics aim to reduce short-term noise and allow for smoother trend comparisons across firms and over time. The analysis is conducted using firm-level panel data at daily frequency. The validity of this design rests, as previously mentioned, on the parallel trends assumption - that in the absence of TNFD adoption, early and late adopters would have followed similar return trajectories. This assumption is tested visually and analytically using pre-treatment data, as described in Section 4.3.4.

Control variables

In the extended model specification, the following firm-level variables were included as controls to account for residual observable differences between firms:

- Natural logarithm of current market capitalization
- Market-to-book ratio
- Leverage
- ROA
- Sales growth

These control variables were integrated into extended Difference-in-Differences models to assess the robustness of estimated treatment effects.

Fixed effects and cluster identifiers

To reinforce the main Difference-in-Differences results, we re-estimate the model using firm and month fixed effects. The model is defined in the code as:

```
fe_model_avg = smf.ols("Q('RollingAvgReturn') Treatment + Post +
Interaction + C(FirmFE) + C(Month)", data=df_clean).fit(cov_type="HC1")
(4.5)
```

This line specifies a regression of rolling average return on the treatment indicators, with `C(FirmFE)` and `C(Month)` telling Python to include dummy variables for each firm and each calendar month. This technique is known as fixed effects estimation (Wooldridge, 2019), and it serves to remove variation caused by firm-specific or month-specific factors that could bias the estimate of the TNFD effect. In practice, some firms may consistently have higher returns than others, regardless of TNFD disclosure. Similarly, some months may experience market-wide shocks (e.g., macro news, policy changes) that affect all firms equally. If these actors are not account for, those differences might mistakenly attribute the TNFD treatment. Fixed effects help solve this.

To better understand how this works in practice, it is useful to illustrate with an example. Suppose Firm A is an early adopter and Firm B is a late adopter. Their rolling average returns look like this:

Table 4.1: Fixed effects example

Firm	Month	RollingAvgReturn	Treatment	Post	Interaction
A	2024-02	0.010	1	0	0
B	2024-02	0.020	1	1	1
C	2024-02	0.005	0	0	0
D	2024-02	0.004	0	1	0

Let us say Firm A always performs 0.004 better than Firm B, and March always adds 0.003 to everyone's return. The fixed effects model removes those patterns by subtracting them:

- Firm A, Feb: $0.010 - 0.004$ (firm effect) $- 0.000$ (month effect) = 0.006
- Firm A, Mar: $0.020 - 0.004 - 0.003 = 0.013$
- Firm B, Feb: $0.005 - 0.000 - 0.000 = 0.005$
- Firm B, Mar: $0.004 - 0.000 - 0.003 = 0.001$

The regression is then run on these adjusted values. This isolates the within-firm and within-month variation, giving a more reliable estimate of the TNFD treatment effect that is not distorted by who the firm is or when the month is. To understand how this was implemented in the model, let's consider equation 4.5. Here, "FirmFE" is a categorical variable marking each unique firm (e.g., A, B, C...), allowing the model to subtract the firm's average return when estimating treatment effects. Moreover, "Month" reflects a timestamp converted to month-level granularity, so that all firm-day observations in the same calendar month are grouped.

4.3.4 Testing the parallel trends assumption

A core assumption in the Difference-in-Differences (DiD) framework is that the treatment and control groups would have followed parallel trends in the outcome variable in the absence of treatment (Callaway & Sant'Anna, 2021; Wing et al., 2018). In this study, this means that early and late adopters of TNFD should display similar performance trends before the expected implementation period in March 2024. If this assumption does not hold, the estimated effect of TNFD adoption may reflect underlying differences between the groups that were already present before adoption, rather than the effect of adoption itself. This would limit the ability to draw valid causal conclusions about whether TNFD adoption actually influenced firm performance or not. To evaluate this assumption, both visual inspection and regression-based diagnostics were conducted using only pre-treatment data.

Visual pre-trend analysis

To assess whether the performance trajectories of early and late adopters followed similar dynamics before treatment, figures 4.1 and 4.2 display the values of the two dependent variables for each group over the pre-treatment period.

Each figure includes:

- Dashed line: early adopters
- Dotted line: late adopters
- Solid line: difference between groups (early minus late)
- Vertical dashed red line: TNFD treatment cutoff (March 2024)
- Horizontal zero-reference line

4. Method

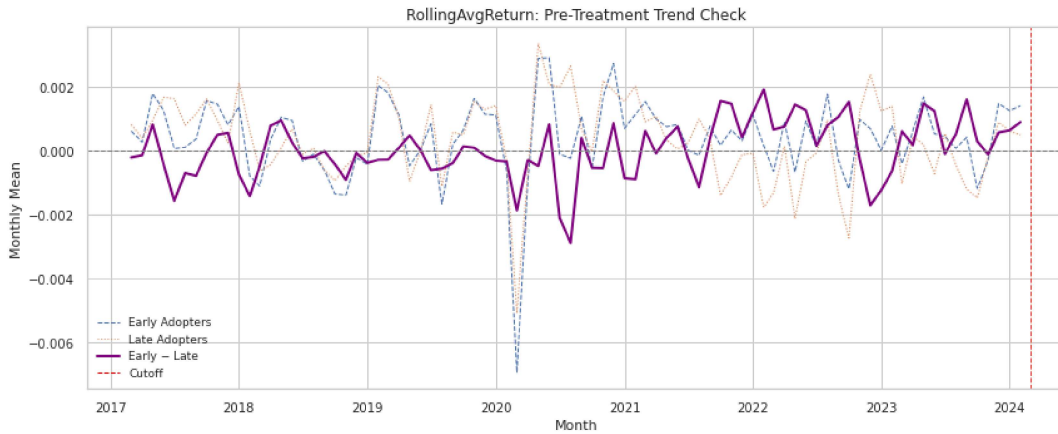


Figure 4.1: Rolling average return pre-treatment for early and late adopters

The plot shows that early and late adopters experienced fairly similar fluctuations in rolling average return during the pre-treatment period. While minor level differences exist in certain months, the overall trajectories appear reasonably aligned, and no clear divergence in trends is observed. The difference line remains relatively stable and does not show systematic drift in either direction prior to the treatment date.

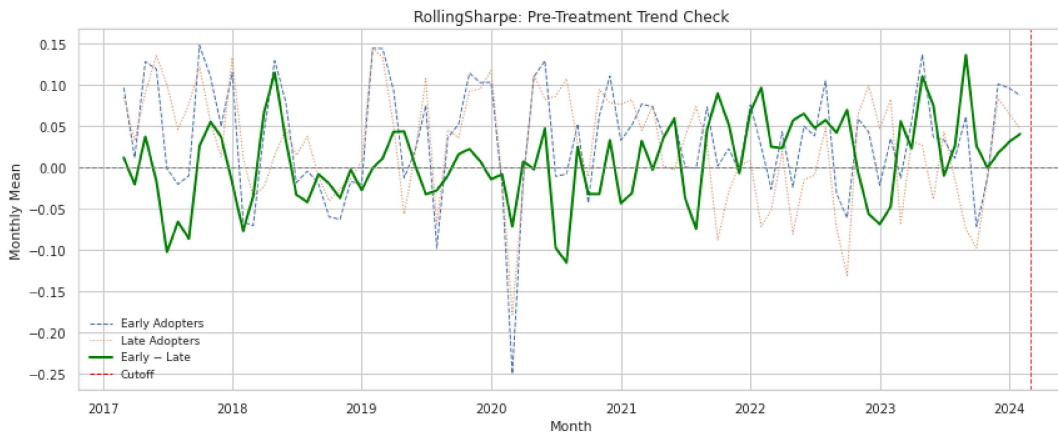


Figure 4.2: Rolling Sharpe ratios pre-treatment for early and late adopters

For rolling Sharpe ratios, the pattern is broadly similar: both groups experience parallel swings in risk-adjusted returns across market conditions. Although early adopters exhibit slightly higher average Sharpe ratios throughout much of the period, the gap appears relatively stable. Importantly, there is no obvious visual evidence of accelerating divergence leading up to March 2024, which would have challenged the parallel trends assumption.

Pre-treatment regression

To more formally investigate pre-treatment comparability, a regression was estimated using only observations prior to the cutoff-point (March 2024):

$$Y_{it} = \alpha + \beta \cdot \text{Treatment}_i + \sum_m \delta_m \cdot \text{Month}_{mt} + \varepsilon_{it} \quad (4.6)$$

Where:

- $Y_{i,t}$ is the dependent variable (either rolling average return or rolling Sharpe ratio)
- Treatment_i is a binary indicator for early adopters
- $\text{Month}_{m,t}$ are calendar month fixed effects

The coefficient β captures the average level difference between the groups in the pre-treatment period. The results obtained from running this regression are displayed in Table 4.2.

Table 4.2: Pre-treatment regression results

Dependent variable	Coefficient on treatment	p-value
Rolling average return	+0.000051	0.009
Rolling Sharpe ratio	+0.0075	<0.001

As alluded to previously, the goal at this stage of the analysis is not to observe a treatment effect, but rather to confirm that early and late adopters followed similar trends before the expected treatment period. Ideally, the treatment coefficient should be close to zero and statistically insignificant, indicating that the two groups were comparable in the pre-treatment period. However, the results in Table 4.2 show statistically significant differences between early and late adopters prior to the TNFD implementation window. Although the coefficients are small in magnitude, their statistical significance raises a potential concern about baseline imbalance. However, this does not, in itself invalidate the DiD approach, but it highlights the importance of interpreting the main results in light of these initial differences. As will be shown in the results chapter, the estimated post-treatment effects are not only larger in magnitude but also occur in the opposite direction, reinforcing the interpretation that the DiD estimates reflect a genuine shift in performance rather than a continuation of pre-existing trends.

4.3.5 Difference-in-Differences estimation

To estimate the causal effect of early TNFD adoption on firm-level performance, a Difference-in-Differences approach is implemented. This method compares how outcomes change over time between two groups: early adopters (treatment group) and matched late adopters (control group), using variation across both time and treatment status (Angrist & Pischke, 2009). The goal is to isolate the effect of TNFD adoption by accounting for general developments that would have affected both groups regardless of treatment.

As previously described, the approach relies on the parallel trends assumption, which holds that in the absence of treatment, both groups would have followed similar trajectories in the outcome variable (Callaway & Sant'Anna, 2021; Wing et al., 2018). If this assumption does not hold, estimated effects might reflect underlying group differences rather than the effect of TNFD.

The DiD model includes an indicator for whether a firm belongs to the treatment group, an indicator for the post-treatment period, and an interaction between these two. The coefficient on this interaction captures the average treatment effect on the treated, or ATT (Angrist & Pischke, 2009), representing the additional change in outcome for treated firms beyond the change observed in the control group.

Basic model specification

The basic DiD specification takes the following form:

$$Y_{it} = \alpha + \beta_1 \cdot \text{Treatment}_i + \beta_2 \cdot \text{Post}_t + \delta \cdot (\text{Treatment}_i \times \text{Post}_t) + \varepsilon_{it} \quad (4.7)$$

Where:

- $Y_{i,t}$ is the dependent variable (either rolling average return or rolling Sharpe ratio) for firm i at time t
- Treatment_i is a binary variable indicating early TNFD adopters
- Post_t is a binary variable equal to 1 from March 2024 onward
- $\text{Treatment}_i \times \text{Post}_t$ is the interaction term capturing the DiD effect
- δ is the coefficient of interest, interpreted as the causal effect of early TNFD adoption. It reflects the difference in performance change from pre- to post-treatment between early and late adopters
- ε_{it} is the error term

Robustness and extensions

To assess robustness and account for additional firm-level heterogeneity, three model extensions are estimated:

1. DiD with control variables

Additional covariates were included to account for differences in firm characteristics that could affect performance:

- Natural logarithm of current market capitalization
- Market-to-book ratio
- Leverage
- Return on assets (ROA)
- Sales growth

2. DiD with firm and time-fixed effects

To further isolate the effect of TNFD adoption, a fixed effects version of the DiD model is estimated. This specification includes two sets of dummy variables: one for each firm and one for each calendar month. These are called firm-fixed effects (γ_i) and time-fixed effects (λ_t), respectively. Firm fixed effects control for all characteristics that are specific to each firm and do not change over time, such as business model, sector, or corporate culture. Time-fixed effects, in turn, capture events or market conditions that affect all firms in a given month, such as macroeconomic news, regulatory developments, or global shocks.

Because the regression includes one dummy variable for each firm and one for each calendar month, the model already accounts for general differences between early and late adopters (captured by the firm dummies) as well as for any changes that happened across all firms in a given month (captured by the time dummies). This means that the “Treatment” and “Post” variables, which represent these same general differences, are no longer needed, they would just repeat information the model already includes. Instead, the focus is on the interaction term (Treatment \times Post), which gives information about whether early adopters experienced a different change after the TNFD adoption period compared to late adopters, after taking into account both stable firm-specific characteristics and broader changes that affect all firms at the same time.

3. DiD with clustered standard errors

In panel data, observations from the same firm are often correlated over time, for example, if a firm performs well one day, it might continue to perform well the next. This

phenomenon is known as serial correlation (Banton, 2021), and if ignored, it can lead to underestimated standard errors and overconfident conclusions (e.g., declaring effects as statistically significant when they are not). To address this, the study clusters standard errors at the firm level. This means that the statistical model allows each firm to have its own pattern of fluctuations over time, rather than assuming that each observation is independent. Importantly, this adjustment affects only the precision of the estimates (standard errors), not the coefficients themselves.

To understand this in more concrete terms, it is useful to consider an example. Imagine firm A has 200 days of return data, and firm B also has 200 days. Pretending that each of those 400 observations are fully independent, an incorrect conclusion might be drawn, namely that the results are extremely precise. However, in reality, firm A's return on day 100 is probably similar to the return on day 99. By clustering, it is acknowledged that those 200 observations from firm A are more similar to each other than they are to firm B's data.

The underlying regression model remains the same:

$$Y_{it} = \alpha + \beta_1 \text{Treatment}_i + \beta_2 \text{Post}_t + \beta_3 (\text{Treatment}_i \times \text{Post}_t) + \delta X_{it} + \varepsilon_{it} \quad (4.8)$$

However, instead of assuming that ε_{it} is independent across all observations, errors are allowed to be correlated within each firm. This leads to more realistic standard errors, making the significance tests more reliable. As explained by Cameron and Miller (2015), this is a standard and recommended approach in applied panel data analysis, especially when treatment varies at the group (firm) level and the number of time periods is large.

4.4 Methodological discussion

The aim of this section is to discuss certain methodological considerations of the underlying study, including its reliability, validity, and potential limitations. These aspects should be critically examined to strengthen the overall academic quality of the study.

4.4.1 Research quality

The quality of quantitative research is primarily assessed by means of validity, reliability, generalizability, and replicability (Bell et al., 2022). According to the authors, validity refers to the extent to which the indicators used in the study actually measure the intended concepts. Bell et al. (2022) explain that validity has several dimensions: construct

validity, which is about ensuring that hypotheses are derived logically from theoretical constructs; convergent validity, which aligns results with findings from other studies; and predictive validity, which means that results are likely to hold also under future conditions. In the underlying study, careful definition of variables is key to maintain validity.

Moreover, Bell et al. (2022) describe that reliability is about examining the consistency of measurements. Reliability can be internal, which is about applying consistent methods for processing data, or external, which is about having transparent documentation of the research process and hence reduce discrepancies in readers' interpretation of the research. Bell et al. (2022) emphasize that reliability is central in order to ensure that results are stable over time.

Generalizability, as described by Bell et al. (2022), is about whether findings are applicable also to contexts beyond the specific one in which they were derived. The underlying study acknowledges that the generalizability of its results may be limited, since the study only focuses on portfolio companies held in East Capital's funds. However, it may be that insights provided by the underlying study will still hold for other asset managers, but the study will not aim to give any proof of that. Lastly, replicability is another important aspect of research quality, as emphasized by Bell et al. (2022). This concept is about whether the study can be replicated by other researchers or not. The underlying study aims to enhance its replicability by adopting a structured and transparent approach to data collection and analysis.

4.4.2 Sources of bias and error

According to Bell et al. (2022), potential biases in quantitative research arise from choices made in sampling, the characteristics of different measurement techniques, and in the process of handling data. The underlying study acknowledges risks such as non-probability sampling bias, which arises from the use of purposive sampling rather than random selection. Although the intended sampling approach of the study is a combination of purposive and stratified sampling, which Bell et al. (2022) note may introduce subjectivity, efforts have been made to mitigate these biases by applying a structured matching procedure based on key financial characteristics. This was done to ensure comparability between early and late adopters, and to align the sample with East Capital's portfolio characteristics and the overall objectives of the study.

Bell et al. (2022) also explain that errors in the data collection process may occur. This may be in the form of sampling errors, measurement inaccuracies, coding mistakes, or data entry errors. The underlying study has aimed to adopt best practices to handle these

issues effectively, for instance by cleaning the data, handling outliers systematically, and applying consistent rules for data transformations and indicator creation in Python.

4.4.3 Critique of quantitative research

It should be noted that quantitative research methods often exhibit criticism because of their reliance on a natural science model, which some may argue is not well suited for studying social phenomena (Bell et al., 2022). For instance, the process of converting qualitative data into numerical values can, as explained by Bell et al. (2022), create a false sense of precision and objectivity. Moreover, the focus on measuring relationships between variables may lead to a static understanding, which is not necessarily connected to the real world.

The authors of the underlying study are of the belief that a quantitative approach is justified due to the study's focus on financial performance, and the comparison of outcomes between early and late TNFD adopters. It is deemed difficult to achieve the study's aim by adopting a qualitative approach. However, as correctly pointed out by Bell et al. (2022), the limitations of the quantitative approach need to be acknowledged throughout the entire research process. This includes constant critical reflection on methodological choices, such as sampling strategies, and data analysis. This reflective approach ensures that the study's findings are as robust, reliable, and meaningful as possible within the given research framework.

5

Results

This chapter presents the empirical findings of the thesis, which investigates the financial implications of the early adoption of the Taskforce on Nature-related Financial Disclosures (TNFD). Using a Difference-in-Differences (DiD) framework, the analysis compares rolling average returns and Sharpe ratios between firms that adopted TNFD early and those that adopted it later. The purpose is to assess whether early adoption of TNFD is associated with superior financial performance.

5.1 Overview of dataset characteristics

Before presenting the regression results, it is informative to explore the dataset's core characteristics. This section provides summary statistics and distribution plots for the two outcome variables: Rolling average return and rolling Sharpe ratio.

Table 5.1: Summary statistics for the full sample

Parameter/Dep. Variable	Rolling average return	Rolling Sharpe ratio
Count	104876	104876
Mean	0.0004	0.0285
Std	0.0032	0.1744
Min	-0.0250	-0.7837
25%	-0.0014	-0.0907
50%	0.0004	0.0269
75%	0.0022	0.1480
Max	0.0290	0.9351

Table 5.1 reports descriptive statistics for the full sample. Table 5.2 and Table 5.3 break these down by group (early vs. late TNFD adopters), offering a first look at potential baseline differences.

Table 5.2: Summary statistics for early adopters

Parameter/Dep. Variable	Rolling average return	Rolling Sharpe ratio
Count	45483	45483
Mean	0.0004	0.0316
Std	0.0030	0.1732
Min	-0.0250	-0.6354
25%	-0.0013	-0.0857
50%	0.0004	0.0297
75%	0.0021	0.1490
Max	0.0181	0.9351

Table 5.3: Summary statistics for late adopters

Parameter/Dep. Variable	Rolling average return	Rolling Sharpe ratio
Count	59393	59393
Mean	0.0004	0.0262
Std	0.0033	0.1752
Min	-0.0214	-0.7837
25%	-0.0015	-0.0946
50%	0.0004	0.0243
75%	0.0023	0.1474
Max	0.0290	0.7811

Overall, the distributions of both outcome variables appear centered around zero. Early adopters exhibit slightly higher mean Sharpe ratios compared to late adopters, but return differences are negligible at this stage. Standard deviations and value ranges are broadly similar across groups, suggesting that the two groups are reasonably comparable pre-treatment.

To further assess the behaviour of the dependent variables, Figures 5.1 and 5.2 show histograms for the full sample.

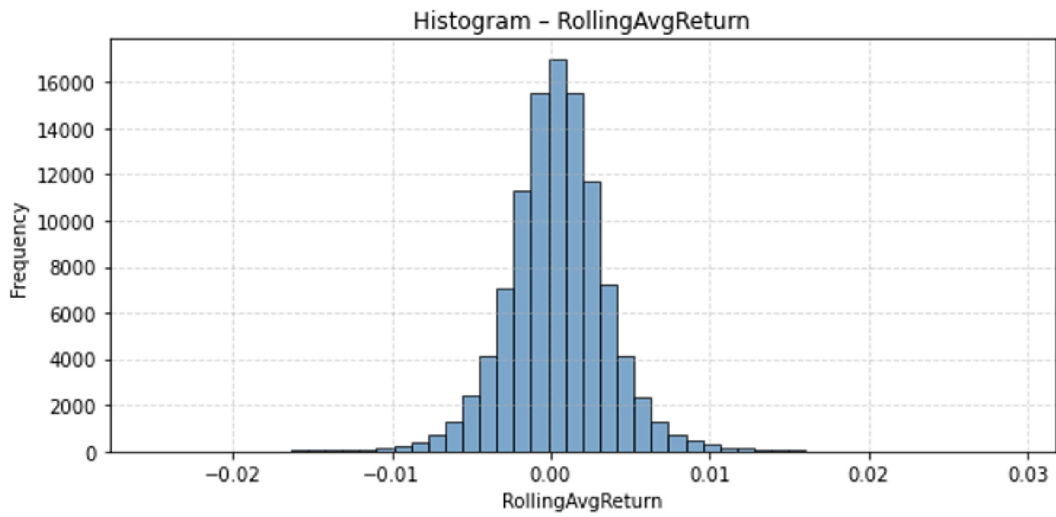


Figure 5.1: Distribution of rolling average return (full sample)

This distribution is tightly centered around zero, with most values within the -1% to +1% range. The shape is approximately normal.

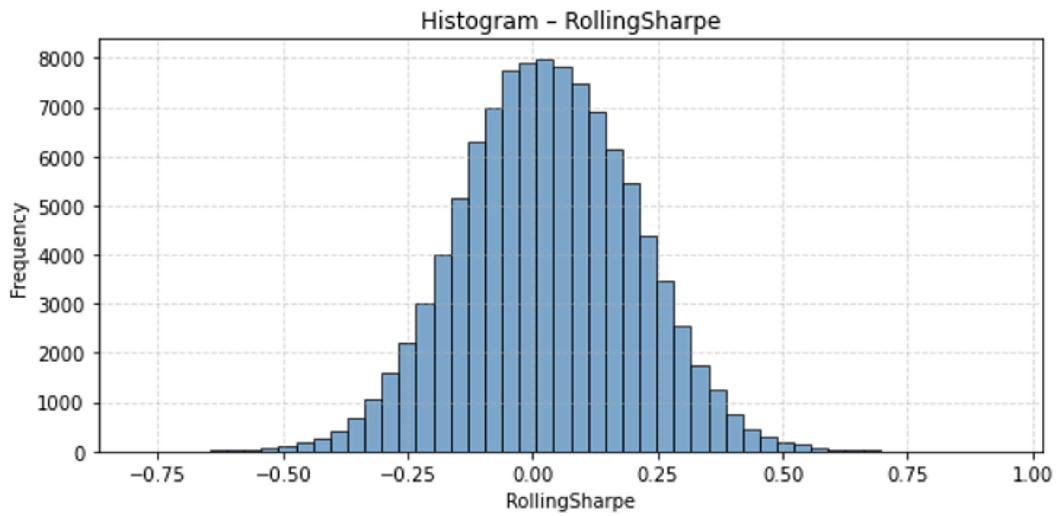


Figure 5.2: Distribution of rolling Sharpe ratio (full sample)

The rolling Sharpe ratio also follows a bell-shaped distribution, ranging from roughly -75% to +75%. This indicates substantial variation in daily risk-adjusted returns across firms and time, but no obvious signs of extreme distortion.

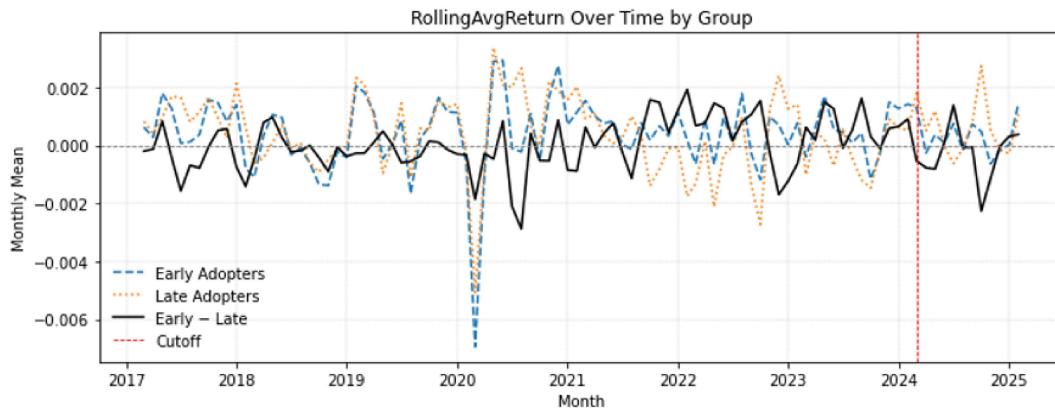


Figure 5.3: Monthly rolling average return by group

Figure 5.3 displays the monthly mean of 30-day rolling returns for early and late adopters over the full sample period. Both groups exhibit short-term variation, with fluctuations centered around zero. No persistent divergence is visually apparent across the pre- and post-TNFD periods.

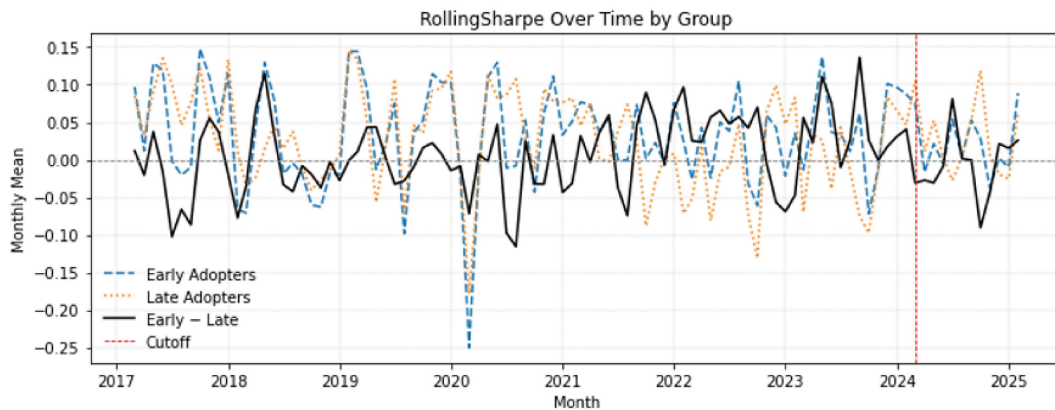


Figure 5.4: Monthly rolling Sharpe ratio by group

The rolling Sharpe ratios vary more widely over time, reflecting greater volatility in risk-adjusted performance. While differences between early and late adopters fluctuate throughout the sample, no visually clear and sustained divergence can be identified purely from the time series.

5.2 Main regression results

This section presents the results from the Difference-in-Differences regressions, aimed at identifying the effect of TNFD adoption on firm performance. For both dependent vari-

ables, four model types are estimated: a baseline DiD without controls, a model with controls, a fixed effects specification, and a final model with clustered standard errors. The key coefficient of interest in all regressions is the interaction term, which captures the differential change in outcome for early adopters after TNFD implementation.

5.2.1 Main DID model: Rolling average return

Table 5.4 reports the results from the main DiD-specification estimating the impact of TNFD adoption on 30-day rolling average returns. The model includes control variables for firm size, valuation, leverage, profitability, and sales growth.

Table 5.4: DiD results (Rolling average return)

Variable	Coefficient	Std. Error	t-statistic	p-value	CI 2.5%	CI 97.5%
Intercept	1.02E-04	5.48E-05	1.87	6.17E-02	-5.01E-06	2.10E-04
Treatment	5.78E-05	2.19E-05	2.64	8.37E-03	1.48E-05	1.01E-04
Post	2.45E-04	4.04E-05	6.08	1.18E-09	1.66E-04	3.25E-04
Interaction	-3.47E-04	5.55E-05	-6.26	3.93E-10	-4.56E-04	-2.39E-04
$\ln(\text{market cap})$	3.21E-05	5.22E-06	6.15	7.96E-10	2.18E-05	4.23E-05
Market to Book	1.09E-09	2.66E-10	4.09	4.40E-05	5.66E-10	1.61E-09
Leverage	-1.41E-06	6.97E-07	-2.02	4.29E-02	-2.78E-06	-4.48E-08
ROA	-1.21E-03	2.27E-04	-5.34	9.46E-08	-1.66E-03	-7.66E-04
Sales growth	-1.11E-05	1.91E-05	-0.582	5.61E-01	-4.86E-05	2.63E-05

The coefficient on the "Interaction" term, which captures the DiD effect, is -0.000347 and statistically significant at the 1%-level ($p < 0.01$). This indicates that early adopters experienced a 3.5 basis point lower rolling average return post-TNFD compared to the matched late adopters. The direction of the effect contrasts with the pre-period difference, where early adopters had marginally higher returns, and the magnitude is approximately seven times larger, potentially suggesting a shift in performance dynamics following TNFD alignment.

5.2.2 Main DID model: Rolling Sharpe ratio

Table 5.5 presents the regression results for the 30-day rolling Sharpe ratio, incorporating the same control variables as in the previous model.

Table 5.5: DiD results (Rolling Sharpe ratio)

Variable	Coefficient	Std. Error	t-statistic	p-value	CI 2.5%	CI 97.5%
Intercept	-8.71E-03	3.33E-03	-2.62E+00	8.84E-03	-1.52E-02	-2.19E-03
Treatment	6.82E-03	1.20E-03	5.69E+00	1.26E-08	4.47E-03	9.17E-03
Post	3.02E-03	2.23E-03	1.36E+00	1.75E-01	-1.35E-03	7.38E-03
Interaction	-1.40E-02	3.25E-03	-4.32E+00	1.58E-05	-2.04E-02	-7.65E-03
$\ln(\text{market cap})$	3.31E-03	3.23E-04	1.02E+01	1.40E-24	2.68E-03	3.94E-03
Market to Book	9.06E-08	1.59E-08	5.71E+00	1.10E-08	5.95E-08	1.22E-07
Leverage	-1.06E-05	4.36E-05	-2.43E-01	8.08E-01	-9.60E-05	7.48E-05
ROA	1.30E-02	1.34E-02	9.69E-01	3.32E-01	-1.33E-02	3.92E-02
Sales growth	-2.12E-04	6.51E-04	-3.25E-01	7.45E-01	-1.49E-03	1.06E-03

The "Interaction" term is -0.0140, statistically significant at the 1% level ($p < 0.01$). This suggests that early adopters saw a drop of 0.014 in their risk-adjusted returns relative to late adopters following TNFD adoption. Given that the pre-period difference was a modest +0.0075, the post-event shift is not only in the opposite direction but nearly twice the size, potentially indicating a relative decline in return efficiency among early adopters post-disclosure.

5.3 Robustness

This section's purpose is to describe the robustness of the results.

5.3.1 Fixed effects estimation

As a robustness check, a fixed effects (FE) model is estimated, including firm and month fixed effects. This model helps ensure that the observed effect is not driven by firm-specific factors or common time shocks.

Table 5.6: FE-regression for rolling average return. Firm and month effects included. Control variables omitted

Variable	Coefficient	Std. Error	t-statistic	p-value	CI 2.5%	CI 97.5%
Treatment	1.07E+07	2.68E+07	4.00E-01	6.89E-01	-4.19E+07	6.33E+07
Post	2.60E+08	2.08E+08	1.25E+00	2.12E-01	-1.48E+08	6.69E+08
Interaction	-3.57E-04	5.32E-05	-6.72E+00	1.78E-11	-4.62E-04	-2.53E-04

As shown in Table 5.6, the "Interaction" term remains negative and statistically significant when rolling average return is used as the dependent variable. The estimated coefficient of -0.00036 suggests that early adopters experienced, on average, a reduction in returns of 3.6 basis points per period post-TNFD relative to the matched control group.

Table 5.7: FE-regression for rolling Sharpe ratio. Firm and month effects included. Control variables omitted

Variable	Coefficient	Std. Error	t-statistic	p-value	CI 2.5%	CI 97.5%
Treatment	1.84E+09	3.67E+09	5.03E-01	6.15E-01	-5.34E+09	9.03E+09
Post	3.73E+10	3.27E+10	1.14E+00	2.54E-01	-2.68E+10	1.01E+11
Interaction	-1.49E-02	3.12E-03	-4.79E+00	1.66E-06	-2.10E-02	-8.82E-03

Turning to Table 5.7, which reports the fixed effects regression results for the rolling Sharpe ratio, the findings are consistent. The "Interaction" term remains negative and statistically significant at the 1% level. The coefficient of -0.0149 implies that early adopters exhibited, on average, a 1.49 percentage point lower Sharpe ratio post-TNFD compared to late adopters.

The fixed effects regressions reinforce the main findings from the earlier DiD models. By controlling for all firm-specific characteristics that do not change over time, such as sector, location, or structural differences, and for time-specific shocks that affect all firms in a given month, these models reduce the risk that the results are driven by omitted variables. The fact that the interaction term remains significant and negative in both outcome measures, rolling average return and rolling Sharpe ratio, provides stronger evidence that early TNFD adoption is associated with a relative decline in performance after the disclosure point. This consistency across models and variables increases confidence in the robustness of the results.

5.3.2 Clustered standard errors

To further test the robustness of the main results, standard errors were clustered at the firm level. The results are presented in Table 5.8 and Table 5.9. For both dependent variables, the coefficient on the "Interaction" term remains negative and statistically significant at the 1% level. This indicates that the earlier finding, where early TNFD adopters underperform relative to late adopters post-cutoff, remains robust even when accounting for within-firm correlation structures.

Table 5.8: DiD model with clustered standard errors (Rolling average return)

Variable	Coefficient	Std. Error	t-statistic	p-value	CI 2.5%	CI 97.5%
Intercept	1.02E-04	5.84E-05	1.75	7.96E-02	-1.21E-05	2.17E-04
Treatment	5.78E-05	2.19E-05	2.63	8.45E-03	1.48E-05	1.01E-04
Post	2.45E-04	3.98E-05	6.17	6.77E-10	1.68E-04	3.23E-04
Interaction	-3.47E-04	6.03E-05	-5.76	8.34E-09	-4.66E-04	-2.29E-04
$\ln(\text{market cap})$	3.21E-05	5.68E-06	5.64	1.71E-08	2.09E-05	4.32E-05
Market to Book	1.09E-09	2.78E-10	3.91	9.25E-05	5.43E-10	1.63E-09
Leverage	-1.41E-06	9.84E-07	-1.43	1.52E-01	-3.34E-06	5.18E-07
ROA	-1.21E-03	2.30E-04	-5.27	1.40E-07	-1.66E-03	-7.60E-04
Sales growth	-1.11E-05	1.01E-05	-1.10	2.72E-01	-3.10E-05	8.74E-06

Table 5.9: DiD model with clustered standard errors (Rolling Sharpe ratio)

Variable	Coefficient	Std. Error	t-statistic	p-value	CI 2.5%	CI 97.5%
Intercept	-8.71E-03	3.19E-03	-2.73	6.39E-03	-1.50E-02	-2.45E-03
Treatment	6.82E-03	1.20E-03	5.68	1.36E-08	4.47E-03	9.17E-03
Post	3.02E-03	2.18E-03	1.39	1.66E-01	-1.25E-03	7.28E-03
Interaction	-1.40E-02	3.30E-03	-4.25	2.17E-05	-2.05E-02	-7.55E-03
$\ln(\text{market cap})$	3.31E-03	3.11E-04	1.06E+01	2.10E-26	2.70E-03	3.92E-03
Market to Book	9.06E-08	1.52E-08	5.95	2.77E-09	6.07E-08	1.20E-07
Leverage	-1.06E-05	5.39E-05	-1.97E-01	8.44E-01	-1.16E-04	9.50E-05
ROA	1.30E-02	1.26E-02	1.03	3.03E-01	-1.17E-02	3.76E-02
Sales growth	-2.12E-04	5.54E-04	-3.82E-01	7.03E-01	-1.30E-03	8.75E-04

These estimates align closely with the baseline results, reinforcing the conclusion that early TNFD adoption is associated with a statistically significant decline in short-term return performance and risk-adjusted return (Rolling Sharpe ratio).

6

Discussion

As previously outlined, the aim of this thesis is to investigate whether early adoption of the TNFD framework can increase financial returns for asset managers, a question explored through two main research questions. The first question, whether early adopters outperform financially, was mainly addressed through the quantitative analysis presented in the results chapter, which showed evidence of short-term underperformance. The second question, focused on understanding the financial effects of TNFD adoption through established economical theory, requires a more interpretative lens. This chapter addresses that question by analyzing the findings through the lens of four theoretical perspectives: signaling theory, the efficient market hypothesis, behavioral finance, and early mover advantages. The Chapter is introduced by examining the results through signaling theory.

6.1 Signaling theory-based discussion

This section discusses the empirical findings through the lens of signaling theory. It explores why early adoption of TNFD, intended as a positive signal of sustainability leadership, may not have yielded the expected financial rewards. The discussion focuses on signal interpretation, credibility, noise, and strategic intent.

6.1.1 Interpretation of findings

As previously mentioned, signaling theory posits that firms voluntarily disclose credible information to reduce information asymmetry and shape the perception of stakeholders. In the context of sustainability, the voluntary adoption of TNFD can be seen as a signal of transparency, long-term orientation, and legitimacy. The expectation, therefore, is that early adopters would be rewarded through positive investor responses and potentially higher firm value.

However, the empirical evidence in this study paints a more nuanced picture. Contrary to the theoretical expectation of performance premiums, early adopters experienced statistically significant underperformance after disclosure, both in absolute and risk-adjusted terms. This result suggests that, in the short term, market participants may perceive sus-

tainability disclosures not solely as positive signals, but rather with doubt or skepticism.

There are several plausible interpretations aligned with signaling theory. Firstly, high signaling costs, suggesting that the implementation of TNFD-aligned reporting requires substantial organizational resources. Investors may view this resource diversion as a trade-off against near-term profitability, especially if the long-term value of such disclosures is uncertain. Furthermore, signal misinterpretation may be a factor in the result. In complex financial markets, the intended positive signals of sustainability leadership can be interpreted as signs of cost inefficiency or overreach, particularly when ESG metrics do not directly map onto financial metrics, which at the moment is the case for TNFD adoption. As signaling theory suggests, signals are only effective when they are correctly interpreted by receivers, in this case investors. In addition, there could be signs of a temporal mismatch. The value of voluntary sustainability signals may take time to materialize. Initial market reactions may be muted or negative, particularly if financial returns are not immediately evident. This is consistent with signaling theory's assertion that feedback loops can evolve over time as stakeholders update their beliefs. Lastly, there could be a heterogeneity in investor beliefs. Not all investors value ESG signals equally. For some, TNFD adoption may align with long-term strategic priorities. For others, especially short-term focused investors, such signals may not be rewarded but rather have a risk of being penalized.

6.1.2 Reconciling mixed literature and contradictory signals

While much of the existing literature highlights the reputational and informational benefits of sustainability reporting (e.g., improved legitimacy and stakeholder engagement), there is also evidence suggesting ambiguous or even negative financial implications. Particularly when disclosures require intensive resources or lack clear ties to shareholder value, which Friske et al. (2023) discuss. This study contributes to this debate by showing that even when early adopters are matched on key financial variables, they still underperform after disclosure, potentially reflecting investor concerns about costs, misalignment, or opportunity costs.

This aligns with the darker side of signaling theory: signals that are costly, misaligned, or misinterpreted can backfire or be discounted by the market. In particular, when a signal is not backed by financial performance or if the information asymmetry remains unresolved, the signal may lose its effectiveness or generate adverse inferences. There is a fine line to how much resources the firm should devote to be more sustainable without sacrificing too much, and this could be the case at the moment, but may shift towards generating higher financial returns in the future. Investors may value this sort of reporting eventually,

especially if the regulations become stricter.

The findings challenge the notion that voluntary disclosure of sustainability always yields positive financial externalities, at least in the short term. From a signaling perspective, this suggests that context and execution matter significantly. Simply sending a sustainability signal (that is, adopting TNFD) is not enough: the clarity, credibility, and alignment of the signal with investor priorities determine its efficacy.

For practitioners, this implies that the adoption of TNFD must be coupled with effective communication and tangible performance metrics that resonate with investors. Firms should be aware that early signaling carries risk, especially if the signals are not supported by clear business cases or financial benefits.

6.1.3 Types of signals and strategic intent

The findings of this study can also be interpreted through the lens of signal typologies as outlined by Connelly et al. (2011), particularly intent signals and camouflage signals. Early adoption of TNFD can be viewed as an intent signal, where firms aim to communicate proactively their long-term commitment to sustainability and regulatory readiness. This aligns with the idea of sending a message to stakeholders, especially investors, that the firm is positioning itself as a responsible, forward-looking actor in the ESG space. However, the market response observed in this study suggests that such signals may not have been received or interpreted uniformly across firms. Given the novelty and ambiguity surrounding TNFD disclosures, some early adopters may also have unintentionally sent camouflage signals. In such cases, TNFD adoption could be perceived as a strategic maneuver to divert attention from other operational or environmental vulnerabilities.

6.1.4 Signal credibility and noise

A core factor influencing the efficacy of TNFD adoption as a signal is its credibility. According to signaling theory, a signal must align with underlying firm quality and be perceived as honest and consistent to be effective, as stated by Connelly et al. (2011). If investors are unsure whether the adoption of TNFD genuinely reflects superior environmental risk management or is merely symbolic, the intended positive effect of the signal may be diluted. This interpretation aligns with the weak or mixed performance outcomes observed in the empirical results. The fact that early adopters were not consistently rewarded in terms of rolling average returns or rolling Sharpe ratios suggests that the credibility of the signal may have been questioned, or at least not uniformly accepted, by the market. The credibility of the signals may be lacking due to the complexity and novelty of the framework. Thus, investors may find it difficult to ensure that the signals

are honest and true, which could affect credibility.

Another critical element is the level of noise in the signaling environment. ESG reporting, particularly in emerging areas such as nature-related disclosures, is characterized by a high degree of variation in quality, terminology, and metrics. This heterogeneity increases the informational "noise" in the marketplace, making it harder for investors to anticipate genuine signals from symbolic or low-effort disclosures. In such a high-noise environment, even well-intentioned signals, such as early TNFD adoption, may fail to stand out unless accompanied by a highly transparent and consistent implementation. The cost of separating from the noise becomes higher and, as de Haan et al. (2011) suggest, firms may be less willing from fully differentiating through signaling if the return on that effort is unclear.

6.2 Discussion based on the EMH

The efficient market hypothesis argues that asset prices reflect all available information and that no investor can consistently achieve excess returns without taking on additional risk (Titan, 2015; Degutis & Novickyte, 2014). In the context of ESG disclosure and TNFD reporting in particular, this implies that any material financial implications of adopting sustainability frameworks should be rapidly and accurately priced into stocks.

6.2.1 Questioning ESG market efficiency

The finding that early adopters of TNFD experienced significant short-term underperformance challenges the semi-strong form of EMH, which assumes that all publicly available information (such as ESG disclosures) is quickly incorporated into stock prices. If markets were fully efficient, one would expect no persistent difference in performance between early and late adopters, once other variables are controlled. If the strong form of EMH is valid, adoption in reporting frameworks would not make a difference, since all information, by definition, should already be incorporated in the price. This would have made the findings false, since the only difference between the two groups is the adoption time and not the information itself.

One possible explanation is that markets are still inefficient in interpreting or incorporating ESG-related disclosures, particularly newer frameworks like TNFD. Unlike traditional financial data, ESG reporting often lacks standardized metrics, consistent methodologies, and clear links to future cash flows. This makes it harder for investors to accurately assess its financial relevance, delaying proper price adjustments.

Another plausible interpretation relates to market friction and information processing delays. Even in relatively efficient markets, not all information is treated equally. ESG disclosures, especially those involving complex or technical topics like biodiversity risk, may require longer periods for analysts and investors to evaluate. This "interpretive delay" can lead to short-term market responses that do not reflect the long-term strategic value of ESG leadership. This could be interpreted to mean that there is a possibility that the results change in the future, when the metrics have become clearer and standardized.

In addition, ESG data are often fragmented and difficult to compare between firms, reducing their utility for real-time investment decisions. TNFD adoption, while a step forward in standardization, may not yet have reached the critical mass needed to function as a common evaluation tool which might limit its impact on investor behavior in the short term.

6.2.2 Investor attention and bounded rationality

EMH presumes a high degree of investor rationality, but this assumption is increasingly questioned, especially in the ESG space. In practice, investor attention is limited, and not all disclosures receive equal scrutiny. Financial markets often focus more on short-term factors such as earnings reports, news, and macroeconomic developments. As a result, longer-term and non-financial issues like sustainability risks tend to receive less attention (ESMA, 2020).

It is plausible that early TNFD disclosures were overlooked or undervalued by a significant segment of the market, particularly during periods of high macroeconomic uncertainty or earnings volatility. This phenomenon, known as bounded rationality, implies that investors may delay reacting to relevant information until its implications are clearer or more widely acknowledged (Simon, 1982).

6.2.3 ESG integration is still maturing

Finally, it is worth recognizing that the ESG investment ecosystem itself is still evolving. Although there is growing evidence that ESG factors are related to firm performance, the tools, models, and norms used to evaluate ESG data are not yet fully developed. This transitional phase may lead to inconsistent or counterintuitive market reactions to sustainability disclosures.

Rather than interpreting the results as a refutation of EMH, they may reflect a temporary inefficiency in how markets process and price ESG information. As TNFD becomes more

widespread and embedded in valuation models, it is plausible that future early adopters will benefit more clearly and consistently from market recognition.

6.3 Behavioral finance perspective

Behavioral finance goes against the EMH and argues that it may not be as simple that all investors are rational and that the market may not be as efficient as stated. Instead, behavioral finance attempts to understand how the market actually is.

6.3.1 Behavioral finance and rationality assumptions

Traditional finance models, such as the efficient market hypothesis, are based on the assumption that investors behave rationally, process all available information accurately, and act to maximize utility. In contrast, behavioral finance suggests that real-world investors often deviate from these assumptions due to cognitive biases, heuristics, and emotional influences (Pompian, 2012; Burton & Shah, 2013). The findings of this study, particularly the absence of strong positive effects from early TNFD adoption, indicate that the market may not have responded to the disclosures in a fully rational or efficient manner, supporting a behavioral interpretation. The lack of understandability could be a factor in the behavior, since not all investors may have the knowledge required to fully comprehend the positive aspects of the adoption of TNFD.

From a behavioral micro perspective, investors may have misinterpreted the TNFD disclosures due to the novelty and complexity of the framework. Psychological biases such as ambiguity aversion or limited attention could explain why early adopters were not immediately rewarded with improved valuation or return metrics. Furthermore, given the lack of historical precedent and standardized metrics for nature-related risks, investors may have relied more heavily on familiar financial indicators, exhibiting status quo or confirmation biases that led them to discount the relevance of TNFD adoption. This also speaks for a potential change in the future, when nature-related metrics become more familiar, the value of reporting on them could become more linked to financial performance.

The type of investor also plays a role, as strategies can vary. Within the space of asset managers, active and passive often come up, where active are more short-term and tries to generate alpha and beat the market. In contrast, passive are more long term and tries to match index. Different investors would value the TNFD reporting in different ways and, considering that nature-related factors often are long-term, passive managers may favor it. Active, on the other hand, may detriment it due to the firm showing that they are investing more in long-term success than short-term. The investor could thereby still be

rational, but valuing different strategies.

6.3.2 Behavioral macro factors and market inefficiencies

From a behavioral macro-perspective, the results of this study align with the view that financial markets do not always operate with perfect efficiency, especially when integrating emerging and complex types of ESG information, such as TNFD disclosures. According to Pompian (2012), behavioral finance macro-aspects focuses on the collective market behavior and how it deviates from theoretical models like the efficient market hypothesis. One key argument is that pricing anomalies and delayed reactions often arise due to widespread cognitive limitations, bounded rationality, and systemic information processing challenges among market participants.

In the case of TNFD, early adopters likely intended their disclosures to serve as positive signals of proactivity and long-term management of environmental risk. However, the mixed response of the market suggests that these signals may not have been interpreted consistently or efficiently. This inefficiency may be attributed to ambiguity in what TNFD disclosures actually mean financially, limited comparability between firms, and the novelty of nature-related risk reporting. As Pompian (2012) notes, investors tend to rely on heuristics and simplified decision-making rules, particularly when faced with uncertainty or a lack of clear benchmarks. As a result, even well-intentioned signals, such as early TNFD adoption, can be misread, undervalued, or simply ignored in the short term.

Furthermore, the ESG domain, especially biodiversity-related factors, still suffers from weak integration into the mainstream valuation models. Unlike more established financial indicators, nature-related risks often lack standard metrics, clear financial linkages, and regulatory reinforcement. This contributes to what behavioral finance identifies as a high-noise environment: a setting in which valuable signals are easily lost or diluted among competing narratives, inconsistent data, and skepticism. At the moment, these sort of reporting directives are mostly voluntary, which may guide investors into believing that these kinds of nature-related factors are less valuable than, for example, climate-related factors, which are more mainstream.

Therefore, the muted or inconsistent financial performance of early adopters observed in the study may reflect macro-level behavioral inefficiencies, rather than a failure of TNFD as a framework. It underscores the larger challenge behavioral finance poses against EMH, that markets may take considerable time to recognize and accurately price new types of information. Especially when investor attention is fragmented and confidence in signal reliability is not yet established.

6.4 Reflection on early mover advantages

The concept of first-mover advantage refers to the strategic benefits a firm can gain by being among the first to adopt a new technology, enter a new market, or implement novel practices. In this case, the early adoption of TNFD-aligned sustainability reporting is such a practice. According to Lieberman and Montgomery (1988), early movers can benefit from technological leadership, asset preemption, and buyer switching costs, potentially resulting in positive economic profits. However, the presence of these benefits is neither automatic nor guaranteed, particularly in emerging areas such as environmental disclosure.

6.4.1 Lack of immediate strategic payoff

In this study, early adopters of TNFD did not experience better financial performance after adoption. Instead, they presented a statistically significant underperformance compared to the matched late adopters. This suggests that any early-mover advantages, if present, did not translate into near-term financial gains. One possible reason is that the TNFD framework is still nascent and the market itself has not matured enough for pioneering firms to take advantage of their early action into competitive dominance.

Unlike cases such as Uber or eBay, where early platform adoption led to sustained leadership through network effects, the nature-related disclosure field lacks direct consumer-facing lock-ins or switching costs. In other words, investors and stakeholders are not yet “locked in” specific firms due to their reporting quality alone. This limits the scope for early movers to build defensible lasting competitive advantage based on disclosure leadership. Even though there are no clear incentives at the moment, it could pay off to be an early mover in the future if the regulations start to include reporting on nature-related metrics. An early adoption could therefore assist firms in adapting into these kind of reporting and prepare for future regulations and save resources then.

6.4.2 High uncertainty and free-rider risks

Another plausible explanation for the observed underperformance is that the early adopters of TNFD have absorbed the initial costs of experimentation under uncertainty, such as system development, data collection, and internal restructuring. These costs create space for late adopters to free-ride, waiting for best practices and regulatory clarity to emerge before making their own lower-cost implementations. As Lieberman and Montgomery (1988) noted, early movers often face risks associated with technological or market uncertainty, and if that uncertainty is not resolved in their favor, the initial investment may

result in a strategic setback rather than an advantage.

This is supported by Jerome and Poretti (2025), whose event study revealed that voluntary nature-related disclosures were initially viewed negatively by the market, despite growing institutional support for such frameworks. The lag between strategic intent and investor recognition can reduce the immediate strategic value of early adoption.

6.4.3 Conditionality of first-mover benefits in ESG contexts

Unlike product innovation, where early movers can patent innovations or dominate market share, the competitive advantage of environmental practices, such as the adoption of TNFD, is more context dependent. As Cleff and Rennings (2012) emphasize, regulatory frameworks and stakeholder expectations differ across regions and sectors, making it difficult for early movers to uniformly leverage their actions.

In fact, the absence of strong regulatory mandates or capital market incentives may diminish the traditional learning curve and resource preemption benefits associated with first-mover status. Furthermore, the impact of TNFD adoption is not immediately visible to customers and is only indirectly tied to short-term financials. This may explain why early-mover benefits in ESG domains are often delayed or diluted, especially when the value chain or investor base may not strongly prioritize biodiversity-related disclosures.

6.4.4 Early adopters as institutional learners

Despite the lack of short-term financial rewards, early adopters of TNFD can still derive long-term strategic learning benefits. By adopting early, these firms position themselves as institutional leaders and may be better prepared for future regulation or stakeholder scrutiny. As Tetrault Sirsly and Lamertz (2008) suggest, CSR-based early mover advantages are contingent upon stakeholder recognition and alignment. If biodiversity disclosure becomes a normative expectation or regulatory requirement in the future, early adopters today may gain reputational capital and organizational agility that translate into financial gains over a longer horizon.

6.5 The impact of limitations on the results

As previously mentioned, this study has some limitations that could affect the results. Firstly, there is the limitation that the companies included in the study must be a part of East Capital's portfolio. This limitation is not expected to affect the results as much as East Capital has a global portfolio. This limits the risk that the results could only be applicable to a specific region or country. The different regulations of different regions

could have affected the results. Secondly, the group that was classified as "early adopters" by TNFD led to 23 companies in the portfolio. An increased number of companies leads to a higher degree of accuracy in the results. However, the results were statistically significant and therefore sufficient. Third, based on the limited data on when each company started to commit to TNFD, on the official TNFD website, all early adopters were set to adopt TNFD in March 2024, which in reality might vary. Not only would it be interesting to use a longer time-frame backwards but furthermore it would be interesting to conduct this study in the future as a comparison of the results. Widdup & Julier (2024) states that it is expected that nature-related disclosures are expected to be mandatory in the future, and this could be a turning point for the results. Firms that already have implemented a structured way to disclose this type of information will be more prepared and might have to put less resources into it, which can lead to better financial performance.

6.6 Summary of underlying factors explaining the financial effects

Several mechanisms have been mentioned to explain the financial effects of early adoption of the TNFD as mentioned above. Firstly, on the basis of the signaling theory, there could be several ways in which the signal, adopting the TNFD, could be interpreted. Investors could potentially view the adoption of TNFD as something that requires too much resources and, thereby, view it as a trade-off against short-term profitability. The discussion is still quite divided on how ESG-related activities affect financial performance, and this topic is complex and it might be difficult for investors to fully understand the benefits. Hence, the signal might in this case be viewed by their negative aspects such as the cost, and by being an early mover more resources have been used over a longer time, which could be an explanation to the results.

If the semi-strong form of EMH would hold, there would not have been any difference between implementing the TNFD or not, and doing it early or late. The information should already be incorporated in the price and therefore the results should be false since the only difference is the adoption time and not the information itself. An explanation is that markets are still inefficient in interpreting ESG-related disclosures because they lack standardized metrics and a clear link to future cash flows. According to ESMA (2020), financial markets tend to prioritize short-term earnings over non-financial factors. This could be the case; investors are not at the moment valuing non-financial information which leads to them only seeing that resources are being used up instead of focusing on potential long-term value that is created. Behavioral finance could explain the results in similar ways and targets the potential lack of understandability as a factor. This makes investors overlook these types of factors, which goes against the rationality principle. The difference

between early and late movers is explained by the higher amount of resources that have been consumed to keep up with the reporting, while the potential benefits have not been taken into account by the market.

Based on early mover advantages, one explanation is the free-rider effects which states that the late adopters could wait for the best practices to emerge and then making their own lower-cost implementations. The early movers do not really gain a competitive advantage since they most likely consumed more resources to find the most efficient way to report.

Although in the short-term, there was evidence of a significant decline in both rolling average returns and rolling risk-adjusted performance (Sharpe ratio), this might change in the future. One of the strongest explanations for the results was that the amount of resources invested may have been too high compared to the potential benefits.

If this type of reporting becomes mandatory in the future, it will force other companies to comply and report on this framework. This may lead to the same drop in financial performance as was viewed in this study, which the early adopters will evade since they already committed their resources. By implementing earlier, companies also have more time to adopt their business to become more sustainable compared to late adopters.

7

Conclusion

This study has achieved the intended aim by determining whether early adoption of the TNFD framework leads to better financial returns or not and how it could be explained. This study has also helped to fill a research gap, as more studies are needed on this specific topic to nuance the findings.

The results offer nuanced insights. On the empirical side, the thesis applied a Difference-in-Differences methodology to evaluate whether early adopters of the TNFD experienced superior financial returns measured through rolling average returns and rolling Sharpe ratios relative to late adopters. The results suggest that early adopters of TNFD perform relatively poorly in the short term. Specifically, the interaction term in the DiD regressions is negative and statistically significant across both return metrics and remains robust when controlling for fixed effects and clustered standard errors. The observed underperformance among early adopters may be explained by the resource demands and internal costs associated with implementing a complex framework such as TNFD. In the absence of standardized metrics and immediate financial payoffs, investors may interpret these early signals through a skeptical lens and focus more on the near-term costs than the long-term strategic value, especially in markets that continue to prioritize short-term financial results over non-financial disclosures.

Theoretically, the findings could be explained in part through signaling theory, where early adoption of TNFD acts as a voluntary disclosure that aims to demonstrate transparency and long-term ESG orientation. However, such signals may have been viewed negatively, as they are costly and could give up on short-term financial stability. This study finds that due to the novelty and complexity of TNFD, investors may lack the tools to properly assess these disclosures, leading to signal dilution in noisy ESG environments. The signals will therefore lose their credibility if investors find it problematic to understand and compare the metrics. The signals may have been too costly for the early movers; therefore, the firms can have lost short-term financial resources, which could have resulted in lower returns.

The efficient market hypothesis also plays a key role in interpreting the results. According

to EMH, public information, such as TNFD disclosures, should be priced in stocks immediately. However, the observed underperformance among early adopters suggests market inefficiencies, potentially due to investor unfamiliarity with TNFD, lack of standardized metrics, and delayed attention. In other words, markets may not yet be able to efficiently price nature-related risks. When the market is unable to include the long-term benefits of implementing TNFD, the market only sees the costs associated with it, which may partly explain the findings of this study.

This inefficiency aligns with concepts from behavioral finance, such as bounded rationality and interpretive delay. Investors may lack the capacity or tools to evaluate TNFD disclosures, especially when financial implications are uncertain or indirect. As a result, even well-intentioned and strategically meaningful disclosures may be undervalued in the short term.

Lastly, from the perspective of the first-mover advantage, early adopters could suffer from higher implementation costs, uncertainty, and lack of regulatory clarity. While they pave the way, they also face the risk of free-riding, where late adopters benefit from established best practices at a lower cost. Despite this, early movers could gain institutional learning, reputational capital, and agility that translate into longer-term gains, particularly if TNFD becomes a regulatory requirement.

In summary, early adoption of TNFD currently does not generate higher returns in the short term and may even impose a financial penalty. However, the interpretation of this result is complex. It reflects an interplay of signal credibility, market efficiency, and first mover advantages. For asset managers, this means that timing, communication, and strategic alignment are crucial in determining whether ESG signals translate into financial returns. Future research could extend this analysis over a longer horizon to capture delayed market responses and the potential realization of first-mover advantages. In other words, the result could be different in the future depending on how the market evolves its values of nature-related reporting and whether new regulations are in play.

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