

Chapter 1

A Critique on Unifying Sustainable Finance, Artificial Intelligence and Responsible Investing



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1.1 Introduction

In an era, discernible by escalating social inequality, environmental trials, and governance failures, the essence of integrating sustainability deliberations into investment decision-making routines has never been more urgent. Sustainable finance advances convincing economic rationale, by repositioning financial aims with social and environmental imperatives to harness long-term value creation, which goes beyond the mere ethical imperative. Grand Challenges, recognised by the United Nations SDGs,¹ such as well-being, climate change, social inequality, disruptive technology, environmental degradation, and the recent pandemic, remain contentious global issues. Across the globe, 193 countries share a vision to address these challenges under the 2030 agenda for sustainable development.² Sustainable finance is a catalyst for value creation, growth and social impact. Sustainable finance is gaining momentum and integrating Artificial Intelligence (AI) into financial systems for sustainable and responsible investing is making substantial disruptions. Unlike traditional investment used for the optimisation of financial returns, Vo et al. (2019) find that the AI technique, periodically, rebalances the investment portfolio

¹<https://sdgs.un.org/goals>

²<https://sdgs.un.org/2030agenda>

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and can produce better social impact compared to traditional investment, indexes and funds. This chapter reviews the significance of sustainable finance and critiques the nexus between sustainable finance and AI, elaborating on the extent to which AI can disrupt and equally revolutionise responsible investment in the financial sector.

The social purpose remains central to sustainability, whereas the financial system, in fulfilling this, remains inadequate. In contrast to the dominant view of finance, following neoclassical theorisation of value-maximisation, sustainable finance reasons and alludes to social responsibility (Sandberg, 2018). The capacity of companies to align their corporate finance and investment with the SDGs, while capitalising on existing sustainable finance solutions to support the transition towards sustainable development can have a colossal global impact.

The OECD summarises sustainable finance as follows (Boffo & Patalano, 2020):

Sustainable finance is generally referred to as the process of considering environmental, social and governance factors when making investment decisions, leading to increased longer-term investments into sustainable economic activities and projects. Its growth has been driven by the desire of investors to have an environmental and social impact, along with the economic performance of investing.

The concept of sustainable finance acknowledges that financial markets shape the economic, social, and environmental consequences of society. The European Commission recognises that sustainable finance seeks to align financial objectives with long-term sustainability goals, ensuring that alongside financial returns, investments should drive progressive environmental changes and generate social impacts.³

Moreover, sustainable finance is central to fulfilling grand objectives such as the European Green Deal and has a key role to play in delivering on the policy objectives under the Green Deal as well as the EU's global climate and sustainability commitments. Sustainable finance safeguards that corporate investments underpin a resilient global economy as well as a sustainable recovery from the COVID-19 pandemic (Europa, 2024). In a report, Deloitte outlines sustainable finance directives based on the Disclosure of Non-Financial and Diversity Information (NFRD), the action plan for sustainable growth, sustainability taxonomy regulation and the regulation on sustainable finance disclosures.⁴

The theory of sustainable finance underscores several fundamental principles and concepts, such as the Triple-Bottom-Line (TBL) approach, ESG integration, long-term value creation, shared value creation, risk management and resilience, impact reporting, stakeholder engagement and policy evaluation. Sustainable finance, recognising economic, environmental and social significance, adopts a TBL approach (Khan et al., 2023). TBL encompasses economic, environmental, and social performance as a holistic metric. Where economic performance relates to the extent to which manufacturing capacity reduces waste to generate economic prosperity; environmental performance refers to an organisational attempt to reduce waste, pollution, chemicals, and emissions; and social performance highlights an

³https://finance.ec.europa.eu/sustainable-finance/overview-sustainable-finance_en

⁴<https://www2.deloitte.com/ch/en/pages/risk/articles/sustainable-finance.html>

organisation's ability to reduce public risk and enhance well-being (Çankaya & Sezen, 2019). In a TBL approach, the stakeholders, including investors and shareholders, carry responsibilities beyond profit maximization and emphasize the importance of balancing economic prosperity with environmental stewardship and social equity. Taking the TBL approach into account, Cubas-Díaz and Martínez Sedano (2018) propose two measures, the *Relative Sustainable Performance Measure* (RSPM) and the *Measure of Commitment-failure* (MC); and find that responsible investment can lead to sustainable finance enhancing social purposes.

Sustainability has been integrated into financial decision-making for decades. ESG integration promotes the inclusion of ESG factors in the investment decision-making process, reflecting sustainable finance principles, hence popularising ESG investment. ESG framework assesses the sustainability performance of companies and investment opportunities, enabling investors to identify and prioritise investments that align with their sustainability objectives. Due to its dynamic nature, there is currently no inclusive ESG framework that includes elements to date (Ahmad et al., 2024). A concise summary of the core elements and definitions of the ESG framework is outlined in Table 1.1.

The European Banking Authority (EBA) outlines mandates and tasks in the area of sustainable finance concerning ESGs covering seven priority areas, i.e., transparency and disclosure, risk management and supervision, ESG risk and sustainability monitoring, supervising reporting, prudential treatment of exposures, greenwashing, stress-testing and standards and labels.⁵

Adopting ESG criteria into companies' performance portfolios, such as ESG disclosure, leads to the profitability and value capture for the companies (Li et al., 2018). While ESG provides a sustainable investment framework, sustainable finance emphasises the long-term value creation contrary to short-term value maximisation. By evaluating the risks and opportunities of sustainable finance associated with investment decisions, companies can mitigate risks and create long-term value for investors, communities and society. As such, sustainable finance strongly emphasises well-placed risk management at the organisational level, recognising the interplay between financial, environmental, and social systems. In particular, sustainable finance urges organisations to assess and address ESG-related risks, such as environmental change, resource scarcity, and social inequities, so that organisations can attain value creation through sustainable returns over the long term. Sustainable finance recognises that impact measurement and reporting are essential components of investing, enabling investors to quantify and communicate the social and environmental impacts of their investments. By incorporating ESG matrices, financial institutions can demonstrate their commitment to responsible investing and hold themselves accountable for their sustainability performance. Stakeholder engagement and collaboration lead to inclusive decision-making, where financial institutions engage with a diverse range of stakeholders, including investors, regulators,

⁵<https://www.eba.europa.eu/publications-and-media/press-releases/eba-publishes-its-roadmap-sustainable-finance>

Table 1.1 ESG framework

Dimension	Definition	Example of Factors
Environmental (E)	Environmental affairs that may positively or negatively influence the financial performance or solvency of an individual, entity, or sovereign	<ul style="list-style-type: none"> • GHG Emissions • Energy consumption and efficiency • Air pollutants • Water usage and recycling • Impact and dependence on biodiversity • Impact and dependence on ecosystems
Social (S)	Social issues that can positively or negatively influence the financial performance of an individual, entity, or sovereign	<ul style="list-style-type: none"> • Child, forced and compulsory labour • Workplace and customer health and safety • Discrimination, diversity, and equal opportunity • Poverty and community impact • Supply chain management
Governance (G)	Governance domains that may positively or negatively influence the financial performance of an individual, entity, or sovereign	<ul style="list-style-type: none"> • Accountability • Transparency and disclosure • Board diversity and structure • Bribery and corruption • Stakeholder engagement • Shareholder rights • Codes of conduct and business principles

civil society organisations, and communities, to understand their perspectives, address their concerns, and co-create sustainable solutions. Sustainable finance resonates with the principles of stakeholder engagement and collaboration (Abrudan et al., 2021). Nevertheless, policy and regulatory initiatives enable sustainable finance, providing the necessary incentives, frameworks, and guidelines to promote responsible investing practices. In today's technology-driven economy, sustainable business models and sustainable investment decisions can be accomplished by recognising the importance of holistic ESG risk assessment, CSR reporting, ethical considerations of AI, as well as the future of AI and FinTech (Musleh Al-Sartawi et al., 2022).

1.2 Sustainable Finance: Significance and Emerging Trends

Sustainable finance can play a significant role in shaping the financial investment landscape across the globe, with its impact on social challenges of global relevance, such as poverty reduction and the well-being of individuals with an emphasis on equality, diversity and inclusion. Table 1.2 outlines the most influential studies on sustainable finance in terms of citation (Kumar et al., 2022) and illustrates the increasing importance of sustainable finance within the disciplines of finance, social economics, welfare studies and beyond. The concept of sustainable finance shifts the orientation of capital investments traditionally made by individuals who have been seeking returns beyond simple financial gains, to financial gains that can offer a positive social and environmental impact. Sustainable finance oriented towards ESG impact enables investors to make their investments valuable with contributions towards a resilient future with clean technology, clean infrastructure, renewable energy and reduced carbon footprint. With ESG becoming an integral part of decision-making for investors, financial institutions have developed tools that can enable investors to evaluate opportunities using the lens of sustainable finance. These tools are designed to support social enterprises that promote green bonds for environmental consciousness with sustainability-linked loans for companies that score well on the ESG measurement scale. The ESG measurement scale combines financial technology (FinTech) with data analytics. Data from the measurement of ESG can help both public and government financial institutions measure the impact made by companies to offer customised and innovative financial products to their clients. Measurement of ESG based on data standardisation combined with the legitimacy of the claims made by companies about their green initiatives remains a big challenge for financial institutions. However, sustainable finance offers many dynamic opportunities for creating a better, equitable and prosperous environment for everyone.

The theory of sustainable finance manoeuvres the way through the classical theory of finance, which we have so far understood through the lenses of profit maximisation, and shareholder activism. Now, sustainable finance offers a paradigm shift in the direction of how the financial markets have a profound impact on society and the environment. By integrating sustainability into investment decision-making processes, financial institutions can contribute to building a more resilient, inclusive, equitable and sustainable global economy for future generations.

Since climate vulnerability, resource depletion, and social inequalities substantially affect the growth of the financial market (Buhr et al., 2018), growing concerns coupled with increasing awareness about environmental and social issues are extensively developing. Such concerns and awareness have intensified the demand for sustainable finance, where individuals, businesses, and institutions are seeking to align their investment decisions with sustainable prosperity. As awareness for sustainable finance gains momentum, it continues to evolve, promoting innovation and collaboration across the financial sector and beyond. In particular, stakeholders, adopting the principles of sustainable finance, are reimagining opportunities for

Table 1.2 Key Studies on sustainable finance

Author(s)	Article title	Source Title	Year	TC	C/Y
Dedusenko E.A.	Impact investing trends in Russia and tourism	<i>Journal of Business Ethics</i>	2006	655	43.67
Viviers S., Ractliffe T., Hand D.	From philanthropy to impact investing: Shifting mindsets in South Africa	<i>Journal of Banking and Finance</i>	2008	500	38.46
Roundy P.T.	Regional differences in impact investment: A theory of impact investing ecosystems	<i>Journal of Financial Economics</i>	2011	431	43.10
Agrawal A., Hockerts K.	Impact investing strategy: Managing conflicts between impact investor and investee social enterprise	<i>Journal of Banking and Finance</i>	2011	383	38.30
Lehner O.M., Harrer T., Quast M.	Building institutional legitimacy in impact investing: Strategies and gaps in financial communication and discourse	<i>Financial Analysts Journal</i>	2005	354	22.13
Kimbu A.N., Tichaawa T. M.	Determinants of impact investing for tourism development in emerging destinations of sub-Saharan Africa	<i>Financial Analysts Journal</i>	2000	340	16.19
Lee M., Adbi A., Singh J.	Categorical cognition and outcome efficiency in impact investing decisions	<i>Journal of Financial and Quantitative Analysis</i>	2001	287	14.35
Novak P.K., Amicis L.D., Mozetič I.	Impact investing market on Twitter: Influential users and communities	<i>Journal of Corporate Finance</i>	2008	268	20.62
Jackson E.T.	Interrogating the theory of change: Evaluating impact investing where it matters most	<i>European Financial Management</i>	2007	260	18.57
Phillips S.D., Johnson B.	Inching to impact: The demand side of social impact investing	<i>Journal of Banking and Finance</i>	2008	236	18.15
Agrawal A., Hockerts K.	Impact investing: Review and research agenda	<i>Journal of Sustainable Finance and Investment</i>	2015	188	31.33
Viviani J.-L., Maurel C.	Performance of impact investing: A value creation approach	<i>Journal of Business Ethics</i>	2004	185	10.88
Jafri J.	When billions meet trillions: Impact investing and shadow banking in Pakistan	<i>Business Strategy and the Environment</i>	2010	180	16.36
Höchstädter A.K., Scheck B.	What's in a name: An analysis of impact investing understandings by academics and practitioners	<i>Journal of Management</i>	2010	172	15.64
Tekula R., Andersen K.	The role of government, nonprofit, and private facilitation of the impact investing marketplace	<i>Accounting, Organizations and Society</i>	1993	172	6.14
León T., Liern V., Pérez-Gladish B.	A multicriteria assessment model for countries' degree of preparedness for successful impact investing	<i>Journal of Business Ethics</i>	2007	159	11.36

(continued)

Table 1.2 (continued)

Author(s)	Article title	Source Title	Year	TC	C/Y
Chen S., Harrison R.	Beyond profit vs. purpose: Transactional-relational practices in impact investing	<i>Journal of Man- agement and Governance</i>	2004	152	8.94
Wood D., Thornley B., Grace K.	Institutional impact investing: Prac- tice and policy	<i>Journal of Financial Research</i>	2005	151	9.44
Kappen J., Mitchell M., Chawla K.	Institutionalizing social impact investing: Implications for Islamic finance	<i>Journal of Financial Economics</i>	2012	145	16.11
Wong M.C. S., Yap R.C. Y.	Social impact investing for margin- alized communities in Hong Kong: Cases and issues	<i>Journal of Bank- ing and Finance</i>	2011	142	14.20
Jackson E.T.	Evaluating social impact bonds: Questions, challenges, innovations, and possibilities in measuring out- comes in impact investing	<i>Financial Management</i>	2012	130	14.44
Mendell M., Barbosa E.	Impact investing: A preliminary analysis of Emergent Primary and secondary exchange platforms	<i>Journal of Busi- ness Ethics</i>	2008	123	9.46
Espinosa S.	From philanthropy to impact investing: The case of Luxembourg	<i>Management Science</i>	2014	121	17.29
Urban B., George J.	An empirical study on measures relating to impact investing in South Africa	<i>Journal of Busi- ness Ethics</i>	2007	120	8.57
Lieberman D.	Impact investing 2.0—not just for do-gooders anymore	<i>Journal of Busi- ness Finance and Accounting</i>	2007	116	8.29

TC Total citations, C/Y Average citations per year

Source: Kumar, S., Sharma, D., Rao, S., Lim, W. M., & Mangla, S. K. (2022). Past, present, and future of sustainable finance: insights from big data analytics through machine learning of scholarly research. *Annals of Operations Research*, 1–44

inclusive growth, social equity, and economic prosperity in the years to come (Abrudan et al., 2021). Sustainable finance allocates capital to optimise sectors like renewable energy, clean technology, and sustainable agriculture so that the financial sector can achieve the social purpose of investing. Similarly, sustainable finance emphasises the social implications of investing, such as labour rights, social capital, and civic and human rights, which can lead to social cohesion, employment opportunities, poverty mitigation, and inclusive growth. The other aspect that sustainable finance focuses on is excellence in governance. Efficient governance ensures transparency, accountability, and ethical conduct within financial institutions and the companies they invest in. In 2022, the global sustainable finance market carried \$4562.85 billion in value and is projected to reach \$29,111.04 billion

by 2032, with a Compound Annual Growth Rate (CAGR) of 20.36% during the forecast period from 2023 to 2032.⁶

1.3 Challenges in Sustainable Finance

Sustainable finance encounters several challenges for its adoption and integration into the financial system, despite its significance and implications relating to the ecosystem and sustainability mandates. Within a progressive financial system, a uniform taxonomy for sustainability is crucial, but it is conspicuously lacking. Investors find it difficult to assess the sustainability performance of companies due to a lack of standardised ESG metrics and reporting frameworks. This concern is coupled with the perception that sustainable investments yield lower financial returns compared to traditional investments, discouraging some investors from allocating capital towards sustainable assets. The absence of a standardised format for the presentation of ESG data by companies makes financial institutions feel uncertain about the ESG claims made by companies, thereby doubting the effectiveness of their ESG initiatives. Investors normally have a short-term view of the investments they make. This deters them from financing sustainable projects and instead funds projects that may not have any positive impact. During July 2023 the European Banking Authority made several renewals to enhance monitoring for ESG considerations.⁷ The inability of developing economies to be a partner in such projects funded for sustainable finance due to the lack of resources available to them increases risks for global sustainability and becomes a challenge for global equality. Innovation and technology can play a critical role in overcoming these challenges. Particularly, AI with machine learning and language processing algorithms can foster and facilitate environmental and social governance mandates (Musleh Al-Sartawi et al., 2022).

1.3.1 Ethical Considerations

Ethical issues remain contentious for sustainable finance. Addressing ethical issues improves the broader impact of investments on society and the environment, where financial returns do not always align with the investment motives. In sustainable finance, ethical considerations promote collaboration between stakeholders, institutions, regulators, and civil society for transparency, disclosure, accountability, and responsible investing (Cunha et al., 2021). Moreover, social justice such as labour

⁶<https://www.precedenceresearch.com/sustainable-finance-market>

⁷<https://www.eba.europa.eu/publications-and-media/press-releases/eba-collecting-institutions-data-environmental-social-and>

rights, community cohesion, income distribution, financial inclusion and access to essential services can be achieved through ethical purposes of sustainable finance; otherwise, pure financial priorities can exacerbate social inequalities. Similarly, ensuring that sustainable finance initiatives benefit everyone, including marginalised and disenfranchised communities, is crucial. So, in pursuing ethics in sustainable finance, ethical investors and institutions should recognise that certain groups are not excluded or should not perpetuate systemic inequalities. To avoid the conflict of interest between their duty to maximise returns for investors and their obligation to promote sustainability, investors and institutions should align their short-term gains with long-term ESG benefits.

Using AI in the field of sustainable finance helps significantly reduce human errors and biases, the tool however introduces unfamiliar ethical pitfalls such as unintended biases and discrimination, compelling the finance industry to cogitate on the ethics of contemporary models. Most algorithms and AI systems have the autonomy to act on their ecosystem (such as in ESG assessment or corporate investment data) without the need for immediate human intervention. Still, such a level of autonomy leads to algorithmic bias, hence raising ethical concerns when those automatic decisions influence humans, firms and society (European Commission, 2018). Moreover, Harbi et al. (2023) emphasise the diversity and context-dependence nature of ethical ideologies across cultures. They suggest that while high-level ethical codes for AI are deep-rooted, their implementation in the global sustainable finance context remains challenging in ensuring that AI-powered sustainable finance programs respect local societal norms and values.

The ethical concerns in the case of AI-powered ESG scorings penalising companies have drawn the attention of the European Commission. AI-powered scorings, in contrast to the analyst-driven rating practice recommended by the Standard Ethics, are challenging the sustainable governance of AI in the field. For instance, it is reported that the use of AI is in contradiction with international guidelines on human rights. Some examples are social scoring, which is largely undertaken by the Chinese authorities, and the usage of facial recognition. (Standards Ethics Research Office, 2023).

Transparency in AI technologies across all domains, including sustainable finance, is fundamental for accountability and trust of stakeholders. Unfortunately, the opaqueness of many AI typologies faces the “black box” problem, whereby it is challenging to understand and explain their decision-making processes. In using AI to measure risk in high-frequency trading and sustainable finance decisions, AI can have the reverse effect of increasing risks and market volatility, having a snowballing impact on financial stability and market dynamics.

1.3.2 Regulatory Considerations

Regulatory concerns affect the way sustainability is integrated into financial institutions and their long-term implications on the financial market (Ahlström &

Monciardini, 2021). Robust data governance measures and compliance with regulations, i.e., the General Data Protection Regulation (GDPR) enhance the safeguarding of investment and prevent breach of privacy. For governance of sustainable finance, regulatory bodies are pushing for transparency to discourage greenwashing that tends to mislead investors. Regulations enable investors to make informed decisions using information that fosters growth. The lack of regulations allows greenwashing that uses misinformation to divert investors towards products that lack credentials, do not offer clear information or disclose information regarding ESG factors. Although the requirements of regulations can be complex and not comprehensive or standardised across regions, and will be different for different regions. In the European Union, the landmark regulation for Sustainable Finance empowers investors to make evaluations by strictly enforcing disclosure of processes followed by financial institutions for integrating ESG-related requirements into the products they offer. Regulatory frameworks if introduced, will enable investors to make a comparison and make sustainable investment decisions based on standardised measurement and consistent reporting about the performance of ESG factors.

1.4 Artificial Intelligence in Sustainable Finance

Artificial intelligence (AI) denotes ‘*systems that display intelligent behaviour by analysing their environment and taking actions—with some degree of autonomy—to achieve specific goals*’ (European Commission, 2018). Lately, AI is converging and evolving the field of sustainable finance, which is itself embryonic (Musleh Al-Sartawi et al., 2022). AI tools such as the Financial Maximally Filtered Graph (FMFG) algorithm substantially advance the processing and analysis of extensive ESG datasets, hence simplifying sustainable investment decisions. For data analysis, AI uses natural language processing (NLP) when the data is unstructured and in the form of reports, documents, articles, etc. to evaluate the products offered on parameters of ESG practices, thereby providing an overview of sustainability initiatives reported by the company in the public domain, for example social media. AI uses algorithms to process complex data to offer insights that can help investors align their investments towards their objectives. The algorithms used also have the power to predict risks such as social unrest or public sentiment, or risk to climate, and simultaneously offer solutions to mitigate risks. So far advanced analytics and machine learning are used to assess economic, governance and environmental considerations.

Unlike conventional financial measures to assess the companies’ performance, geodetic data, nightlight data, and social media footprints are several alternative data sources that can be used to delve deeper into companies’ ESG practices. Particularly, AI algorithms can efficiently manage risks and optimise investment portfolios, integrating diverse data sets and generating trends to identify patterns and address anomalies in the investment process so that existing and potential investors can make

informed decisions beyond the motives of profit maximisation. A report by BCG highlights the importance of generative AI in finance and compares traditional AI vs. generative AI.⁸ Hence, while the use of AI for sustainable finance is an emerging field that continues to develop, investors need to recognise issues like biases that may exist in the data being used by AI and the impact the biased data may have on the algorithms of AI. Therefore, it is important to be careful in the selection of data and be prepared for the mitigation of associated risks. These concerns related to the nature of algorithms used are higher when the AI models lack transparency. Therefore, the ethical and responsible use of AI for sustainable finance should be studied scientifically by scholars.

Sustainable finance increasingly requires a standardised and transparent impact reporting framework, where AI can substantially contribute by creating a feed-forward loop offering real-time feedback. Given the predictive ability of AI, AI-led impact reporting would be more accurate for undertaking informed decisions for investors and stakeholders. Particularly, AI-led impact reporting integrated into investment strategies can promote the practices of ESG, as well as enhance the prospect of socially responsible investing (Daugaard et al., 2024). One of the concerns that affects sustainable finance is the extent to which the investments are transparent and traceable. AI-led blockchain with its decentralised distributed ledger can provide a secure and protocol-sharing platform to trace, record and authenticate sustainable investments. AI, using its predictive analytics, can identify investment opportunities that align with the ESG framework and create automated insights to invest responsibly. Particularly, AI is efficient in detecting ESG risks and opportunities through its machine learning and natural language processing tools. Natural language processing algorithms can filter both structured and unstructured data to assess the sustainable performance of the firms. A study by Kumar et al. (2022) identified several major themes surrounding sustainable finance that can benefit from big data analytics through machine learning and natural language processing, such as responsible investing, environmental/green financing, net-zero investing and sustainable impact investing.

AI-enabled predictive analytics can be used to conduct scenario analysis so that financial institutions can mitigate ESG-related risk and leverage portfolio optimisation. When an industry or a particular company, for example, is susceptible to a variation of regulatory change or climate change, AI can precisely identify the potential risk and offer foresight to investors to undertake precautionary measures to protect their investment portfolio.

⁸<https://www.bcg.com/publications/2023/generative-ai-in-finance-and-accounting>

1.4.1 Barriers to Adopt AI

Despite the growing importance of AI in the field of sustainable finance being widely acknowledged, the adoption, implementation and integration of AI remain challenging due to several barriers that restrict its adoption by financial institutions and investors. Key challenges that limit the adoption include factors such as lack of expertise, inordinate cost, regulatory changes, and limitation of the data sphere etc. The high cost of initial investment into technology, its implementation and later maintenance for data storage, data processing and employing teams with required expertise deters financial institutions and investors from considering the use of AI, which can be a game changer for all the stakeholders. Furthermore, the efficiency of the AI model implemented for sustainable finance on ESG parameters depends on the comprehensiveness and accuracy of the data on which it has been trained. Lack of transparency can lead to failure or loss for investors as the mismatch or fitment of the recommendations with the resource availability will falter. Therefore, implementing AI incurs an additional cost of training the managers who will be using the information, analysis and solutions offered by AI. Knowledge of mechanisms applied by AI to make recommendations will help managers effectively use the inputs being offered. The International Data Corporation (IDC) highlights that the global data space will grow exponentially, almost tenfold, from 16.1 ZB in 2016 to 163 ZB in 2025 (IDC, Data Age 2025, 2017). Similarly, Statista, one of the largest global data and visualisation companies, reports that in 2023, the cost of implementing and leveraging AI exceeded over \$150 billion.⁹

The ethical and regulatory issues affect the integration of AI in sustainable finance. Particularly, ethical issues arising from faulty AI language processing algorithms can produce biased investment exclusion criteria, such as excluding certain groups of underrepresented investors due to their demographic, social choice or other civic affiliation.

1.4.2 Regulatory Uncertainty and Data Privacy

Uncertainty about the application of regulatory frameworks for sustainable finance and privacy issues related to data are important concerns for investors and financial institutions. The long-term planning becomes challenging for financial institutions using ESG credentials, as everyday evolving regulations as regards ESG regulations fail to provide clarity for confidence, and delay both national and international transactions. Simultaneously, standardisation of data collection sensitivity, ownership of data collected and standardised format for reporting results, if not followed transparently, ethically and responsibly, can encourage greenwashing, which may

⁹<https://www.statista.com/statistics/1446052/worldwide-spending-on-ai-by-industry/#:~:text=Worldwide%20spending%20on%20AI%2Dcentric,of%2019.7%20billion%20U.S.%20dollars>

discourage investors and shrink markets. Simultaneously, on the international turf, global regulations with standardised reporting frameworks will grow the scope for sustainable finance.

1.4.3 AI in Sustainable Finance and Responsible Investing

Responsible investing in the context of sustainable finance refers to the use of ESG factors for the assessment of products to ensure financial returns for investors with some degree of risk tolerance. The use of AI for analysing anecdotes to assess products that will earn better financial returns for investors can improve the impact of sustainable finance on sustainability and deteriorate the impact of greenwashing. AI has the capability to investigate complex historical data for predicting sustainability-related future trends and divert investments and resources towards opportunities that will create a safer future environment for all with positive environmental and social change. Hence, the adoption of responsible AI-related practices is becoming increasingly important for sustainable finance. Responsible AI ensures that the AI model is transparent and capable of offering a fair and accurate assessment of ESG factors using an AI algorithm that is free from any kind of bias, analysis is robust, insights are based on the data that is used under GDPR guidelines and offers solutions for mitigating potential risks. Anecdotes refer to AI as an augmented tool which complements human judgement with insights useful for investors while the decisions related to investments empower other stakeholders.

1.4.4 Snapshot of AI in Sustainable Finance

Lately, financial institutions are integrating and implementing AI-enabled routines to advance the process of sustainable finance, adopting two significant perspectives, i.e., institutional and societal (Pashang & Weber, 2023). The institutional perspective focuses on ESG investing, and the societal perspective centres around financial inclusion initiatives. For example, BlackRock Inc., a fixed-income and asset management multinational, is leveraging AI and machine learning to create a seamless interface between the firm and investors. Their AI lab underscores the importance of AI in promoting financial well-being, which they believe can identify ESG risks and opportunities and lead to enhanced sustainable analytics. Their AI lab highlights:¹⁰

(continued)

¹⁰<https://www.blackrock.com/corporate/ai>

The AI Labs conducts research at the intersection of artificial intelligence and finance, synthesizing ideas to drive innovation in both fields. BlackRock's unique position as a global leader in finance and fintech provides a distinctive set of problems for AI and related fields that inspire novel approaches and techniques. We currently apply our expertise in statistics, machine learning, optimization, stochastic control, and decision theory to various problems throughout the firm, including retirement, trading, alternatives, and ETFs.

1.5 Conclusion

This chapter explores the transformative nexus between sustainable finance and AI, emphasising AI's potential to redefine existing financial practices in alignment with ESG principles. As stakeholders increasingly demand transparency, accountability, and responsible investment, AI emerges as both a catalyst and a means for advancing the practice of sustainable finance. AI routines, ranging from machine learning algorithms to natural language processing, are now capable of processing extensive datasets to detect ESG risks, identify greenwashing, and evaluate the long-term value of sustainability of investments. While ethical concerns—such as bias, privacy, and the risk of poor investment decisions—have been discussed earlier, sustainable finance fundamentally hinges on ethical decision-making in corporate strategy and investment. It positively influences the ESG standards expected by stakeholders. Integration of AI and its adaptability harmonises corporate motives with broader societal and environmental welfare. Thus, AI integration in sustainable finance leverages transparency, auditability, and inclusivity. Ethical AI development, grounded in ESG-compatible values, becomes not merely a technical objective but a strategic imperative for financial institutions and policymakers alike. The integration of AI into sustainable finance can therefore accelerate the transformation of the economy and society toward responsible and sustainable global development.

Conflict of Interest Statement There are no conflicts of interest to declare.

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