Essays in Entrepreneurial & Green Finance

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Declaration

I hereby certify that this material, which I now submit on the programme of study leading to the award of Doctor of Philosophy is entirely my own work, and that I have exercised reasonable care to ensure that the work is original, and does not to the best of my knowledge breach any law of copyright, and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my own work.

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List of Abbreviations

ANOVA	Analysis of Variance
BEIS	Department for Business, Energy and Industrial Strategy
BVD	Bureau Van Dijk
CDSD	Climate Disclosure Standards Board
CF	Crowdfunding
CH	Companies House
CRO	Companies Registration Office
CSO	Central Statistics Office
CSRD	Corporate Sustainability Reporting Directive
DEFRA	Department for Environment, Food and Rural Affairs
DFID	Department for International Development
EBITDA	Earnings before interest, tax, depreciation and amortistaion
EC	European Commission
ECB	European Central Bank
ECF	Equity Crowdfunding
EFAA	European Federation of Accountants and Auditors
EFRAG	European Financial Reporting Advisory Group
EIBIS	European Investment Bank Investment Survey
ESG	Environmental, Social and Governance
ESR	Environmental Sustainability Reporting
EU	European Union
EV	Electric Vehicle
FAME	Financial Analysis Made Easy
FE	Fixed Effects
FSB	Financial Stability Board
GHG	Greenhouse Gas
GRI	Global Reporting Initiative
GSSB	Global Sustainability Standards Board
H	Hypothesis
HTPOH	High Technology Pecking Order Hypothesis
IAASB	International Auditing and Assurance Standards Board
IAS	International Accounting Standards
IASB	International Accounting Standards Board
ICF UK	International Climate Fund United Kingdom
IEA	International Energy Agency
IFAC	International Federation of Accountants
IFRS	International Financial Reporting Standards
IPCC	Intergovernmental Panel on Climate Change
IR	Integrated Reporting

ISSB	International Sustainability Standards Boards
KPIs	Key Performance Indicators
NFRD	Non-Financial Reporting Directive
NGEU	NextGenerationEU
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
ORBIS	Subset of Bureau Van Dijk 'ORBIS' tools
POT	Pecking Order Theory
R&D	Research and Development
RQ	Research Question
SAFE	Survey on the Access to Finance of Enterprises
SASB	Sustainability Accounting Standards Board
SDGs	Sustainable Development Goals
SMEs	Small and Medium Sized Enterprises
SMPs	Small and Medium Sized accounting Practitioners
TCFD	Task Force on Climate-Related Financial Disclosures
UN	United Nations
UK	United Kingdom
VC	Venture Capital
VRF	Value Reporting Foundation
WEF	World Economic Forum

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Abstract

The European Green Deal focuses on investment which will mobilise at least €1 trillion of sustainable investments and development of an 'enabling framework' which will facilitate and stimulate the transition to a climate-neutral, green and inclusive economy while ensuring companies report their sustainable activities. This thesis focuses on two-strands, financing of Clean Technology (Cleantech) firms and sustainability reporting. The analysis is presented in four studies. Study 1 analyses the financing of Cleantech firms that raised equity crowdfunding on platforms in Europe. Crowdfunding has a positive impact on innovation and growth opportunities of Cleantech firms, and in the post-crowdfunding period firms raise significantly greater amounts of external equity, suggesting signalling effects. Study 2 examines equity funding of Cleantech firms in the UK. 739 firms are analysed through the lens of the pecking order theory. A primary finding is that firms with lower intangible assets are more likely to raise equity funding. The study questions the restrictiveness of IAS 38 and the patient capital gap for Cleantech firms. Study 3 investigates the feasibility, potential and financial implications of environmental sustainability reporting. The study analyses the views of 203 Small-to-Medium sized accounting practitioners (SMPs). The greatest perceived benefit for firms adopting sustainability reporting is an improved company image. Respondents detail resourcing implications, providing an estimate of the additional cost. An impediment in implementing sustainability reporting is the lack of knowledge and training, not only for small firms but also for accounting professionals. Study 4 investigates the challenges and the non-regulatory benefits and incentives for SMEs to engage with the EU Green Taxonomy. Using practical case studies, respondents are invited to participate in a focus group and survey. Resourcing and knowledge are the main deterrents for firms to implement. Government supports, simplified disclosure requirements and assistance further along the supply-chain will be essential.

Chapter 1: Introduction

1.1 Introduction

The Paris Agreement, a legally binding international treaty on climate change, has a vision of accelerating technological development and transfer to reduce harmful carbon emissions (United Nations, 2015). Governments and international agencies have emphasised the development of new and innovative disruptive technologies to ameliorate and reverse the harmful effects of carbon emissions (Polzin, 2017; Owen *et al*., 2018). Action on climate change is now the top priority of governments globally, epitomised by the COP26 conference in Glasgow held in November 2021[1]. It is increasingly evident that national governments and global coalitions are required to make substantial policy and financing commitments to reduce carbon and other greenhouse gas emissions in order to contain global warming to within a 1.5° net increase above pre-industrial levels by achieving net zero emissions by 2050 or sooner.

The UN Intergovernmental Panel on Climate Change (IPCC) have published several high-profile reports that provide stark perspective on 'now or never' warnings on the risks of the current climate situation and future prospects with action required as a matter of urgency (United Nations, 2021, 2022). Both Bloomberg (Bloomberg NEF, 2021) and the International Energy Agency (IEA, 2021) estimate that current global climate change investments are less than half of the annual run-rate costs required, estimated at $2.35T.

Due to the arrangements under the Paris Agreement along with continuous stark warnings by leading climate change experts through the IPCC reports, the European Commission presented the European Green Deal Investment Plan (EU Commissions, 2020a).

1.2 The research context: Sustainable Finance and the European Green Deal

The European Union's (EU) European Green Deal (hereinafter, 'Green Deal') is the main growth strategy to transition the EU economy to a sustainable economic model that is striving to be the first climate-neutral continent. The Green Deal was first presented in December 2019, and aims to result in a cleaner environment, more affordable energy, smarter transport, new jobs and an overall better quality of life. In striving to achieve this, the Green Deal focuses on investment which will mobilise at least €1 trillion of sustainable investments and development of an 'enabling framework'

[1] COP26 - https://ukcop26.org/

which will facilitate and stimulate the transition to a climate-neutral, green and inclusive economy while ensuring companies report their sustainable activities.

The Green Deal presents a roadmap for making the EU's economy sustainable by turning climate and environmental challenges into opportunities across all policy areas and making the transition just and inclusive for all. The Green Deal aims to boost the efficient use of resources by moving toward a clean, circular economy, stopping climate change, reverting biodiversity loss, and reducing pollution.

The benefits of implementing the Green Deal are laid out by the EU which will improve the well-being and health of citizens and future generations by improving some of the following: fresh air, clean water, healthy soil and biodiversity; renovated energy-efficient buildings; cleaner energy and cutting-edge clean technological innovation; longer lasting products that can be repaired, recycled, and re-used; future-proof jobs and skills training for the transition; and globally competitive and resilient industries. To achieve these targets, investment and accountability are required which is why sustainable financing within the Green Deal focuses on both financing and reporting. The EU Commission has developed an action plan and published policy areas of the Green Deal:

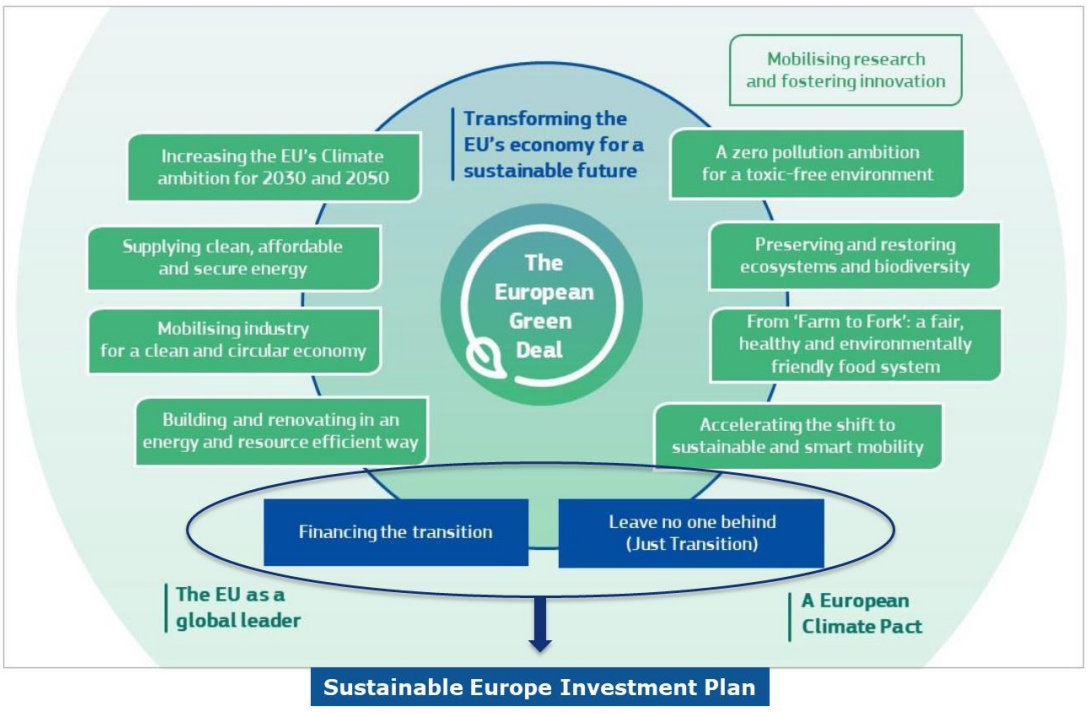


Figure 1.1 Sustainable Europe Investment Plan - European Green Deal[2]

[2] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52019DC0640&from=ET

As per the Green Deal, the key actions fall under the following headings:

- Climate
- Energy
- Agriculture
- Industry
- Environment and oceans
- Transport
- Finance and regional development
- Research and innovation

Each of these actions has a specific plan on how carbon neutrality can be sought by 2050. Finance and regional development are other specific actions regarding the role of finance in achieving the 2050 goal. The EU Commission defines sustainable finance as the process of considering environmental, social and governance (ESG) when making investment decisions in the financial sector, leading to long-term investments in sustainable economic activities and projects. It also eludes to the fact that sustainable finance encompasses transparency when it comes to risks related to ESG factors that may have an impact on the financial system, and the mitigation of such risks through the appropriate governance of financial and corporate actors, through sustainability reporting. It is clear that sustainable finance includes the financing of firms assisting in the Green Deal goals but reporting the environmental impact is also a major requirement under sustainable finance. Furthermore, within the sustainable finance component of the Green Deal policy document, key specifications are broken down under the following headings[3]:

- Sustainable finance and investing
- EU Taxonomy for sustainable activities
- European green bond standard
- Corporate disclosure of climate-related information
- EU labels for benchmarks (climate, ESG) and benchmarks' ESG disclosures
- Sustainability-related disclosure in the financial services sector
- International platform on sustainable finance

Specific to sustainable investing, 30% of the EU's multiannual budget (2021-2028) and the EU's unique NextGenerationEU (NGEU) instrument to recover from the COVID-19 pandemic have

[3] https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance_en

been allocated for green investments. EU countries must devote at least 37% of the financing they receive under the €672.5 billion Recovery and Resilience Facility to investments and reforms that support climate objectives. All investments and reforms to be financed in this manner must do no significant harm to the EU's environmental objectives. The InvestEU[4] project was established that will support sustainable investments in all sectors of the economy and will contribute to the dissemination of sustainable practices among private and public investors. At least 30% of the InvestEU Programme, in line with the European Green Deal objectives, shall support financing for investments that contribute to the EU's climate objectives. Moreover, 60% of the investments supported under the "Sustainable Infrastructure Window" of the InvestEU Fund will contribute to the EU's climate and environmental objectives.

A standout feature of sustainable finance within the Green Deal is the focus on reporting and disclosure requirements. It is clear that sustainable finance is not solely focused on sustainable investing, the financing of environmentally friendly firms, and the disclosure and reporting of environmental impacts. There are four components of the Green Deal that include reporting: EU Taxonomy for sustainable activities, corporate disclosure of climate-related information and sustainability-related disclosure in the financial services sector.

The EU Green Taxonomy (hereinafter, 'Taxonomy') is a classification system that establishes a list of environmentally sustainable economic activities. It is suggested that the Taxonomy could play an important role in helping the EU scale up sustainable investment and implement the European Green Deal. The Taxonomy will provide companies, investors and policymakers with appropriate definitions for which economic activities can be considered environmentally sustainable. In this way, it should create security for investors, protect private investors from greenwashing, help companies become more climate-friendly, mitigate market fragmentation and help shift investments where needed. The Taxonomy was published in the Official Journal of the European Union on 22 June 2020[5] and entered into force on 12 July 2020. It establishes the basis for the EU Taxonomy by setting out overarching conditions that an economic activity has to meet to qualify as environmentally sustainable. The Taxonomy regulation establishes six environmental objectives:

1. Climate change mitigation
2. Climate change adaptation

[4] https://investeu.europa.eu/index_en
[5] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ%3AL%3A2020%3A198%3ATOC

3. The sustainable use and protection of water and marine resources
4. The transition to a circular economy
5. Pollution prevention and control
6. The protection and restoration of biodiversity and ecosystems

Prior to the Taxonomy, EU Law also required certain large companies to disclose information on the way they operate and manage social and environmental challenges. This helps investors, civil society organisations, consumers, policymakers and other stakeholders to evaluate the non-financial performance of large companies and encourages them to develop a responsible approach to business. This was through Directive 2014/95/EU[6], also called the Non-Financial Reporting Directive (NFRD), which lays down the rules on the disclosure of non-financial and diversity information by certain large companies. This directive amended the first Accounting Directive 2013/34/EU. Under Directive 2014/95/EU, large companies must publish information related to[7]:

- environmental matters
- social matters and treatment of employees
- respect for human rights
- anti-corruption and bribery
- diversity on company boards (in terms of age, gender, educational background, and professional background)

In April 2021, the Commission adopted a proposal for a Corporate Sustainability Reporting Directive (CSRD)[8] that would amend the existing reporting requirements of the NFRD. This proposal will:

- extend the scope to all large companies and all companies listed on regulated markets (except listed micro-enterprises)
- require the audit (assurance) of reported information
- introduce more detailed reporting requirements, and a requirement to report according to the mandatory EU sustainability reporting standards
- require companies to digitally 'tag' the reported information, so it is machine readable and feeds into the European single access point envisaged in the capital market union action plan

[6] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32014L0095
[7] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013L0034
[8] https://ec.europa.eu/info/publications/210421-sustainable-finance-communication_en#csrd

In June 2022, the Commission updated the rules surrounding the CSRD that introduces more detailed reporting requirements and ensures that large companies are required to report on sustainability issues such as environmental rights, social rights, human rights and governance factors. They also highlighted the key dates of the rules being implemented:

- 1 January 2024 for companies already subject to the non-financial reporting directive
- 1 January 2025 for large companies that are not presently subject to the non-financial reporting directive
- 1 January 2026 for listed SMEs, small and non-complex credit institutions and captive insurance undertakings
- An opt-out will be possible for SMEs during the transitional period, meaning that they will be exempted from the application of the directive until 2028

They also state that reporting must be certified by an accredited independent auditor. To ensure that companies comply with the reporting rules, an independent auditor or certifier must ensure that sustainability information complies with the certification standards adopted by the EU. Finally, and specifically to EU sustainability reporting standards under the Green Deal. The commission has suggested the development of standards that will be tailored to EU policies, while building on and contributing to international standardisation initiatives. The first set of standards will be adopted by October 2022 and are currently being developed by the European Financial Reporting Advisory Group[9] (EFRAG).

1.3 SMEs and sustainability

As a key part of the economy, the participation and inclusion of SMEs are critical to the success of the sustainability transition. SMEs feel this pressure, as evidenced in the 2021-2022 SME associations' survey, which found that more than 90% of SME associations reported SMEs experiencing strong or very strong external pressure to achieve climate neutrality (European Commissions, 2022). SMEs are critical to the success of sustainability transition in the EU. Although individual SMEs have a small emission footprint, given their large numbers, SMEs significantly contribute to the emission total. This poses a challenge, as any reduction in CO2 emissions depends critically on the SMEs. The analysis shows that SMEs are responsible for more than 60% of all greenhouse gas emissions by enterprises (European Commission, 2022). Therefore, it is important for SMEs to increasingly invest in sustainable technologies and acquire the skills and knowledge to

[9] https://ec.europa.eu/info/publications/210308-efrag-reports_en

transform their businesses into more sustainable ones, including the reporting of such sustainability activities and remaining competitive. (European Commission, 2021c; 2022; OECD, 2021c).

The OECD's (2021c) "No net zero without SMEs" report reviewed the environmental footprint of SMEs and found that in some cases, the response to the sustainability transition strongly depends on the specific niche of an SME and individual owner-managers. In contrast, SMEs are important drivers of sustainable innovation, as highlighted by previous research (OECD, 2013).

Accessing financial resources is a key prerequisite for SMEs to 'green' their business models and drive transitions through eco-innovation. However, many small businesses are challenged by insufficient financial and human resources to undertake green actions. The nature of sustainability investments, which are usually capital intensive and have long payback periods (Rowlands, 2009; De Lange, 2016; Owen *et al.*, 2018), is an additional obstacle for SMEs in terms of obtaining the financing they need. To this end, targeted policy interventions addressing this market failure might be necessary (European Commission, 2021b, 2022). Financing the sustainability transition of SMEs requires not only the availability of financial resources, but also ability and willingness of firms to use these resources to invest. The sustainability transition of SMEs translates into various types of investments that can be broken down into two main categories; energy and resource efficiency and innovation and development of new products (European Investment Fund, 2021). Energy and resource efficiency also categorise energy cost savings and the measurement and reporting of these cost savings. From the two types of investments listed above, it can be concluded that financing the green economy is generally capital intensive and/or risky and thus may involve long payback periods (Green Policy Platform, 2015), adding an additional layer of complexity for SMEs to obtain the financing they need. This is confirmed by findings from the European Investment Bank Investment Survey (EIBIS, 2020) which revealed that 28.3% of SMEs in the EU considered access to finance a major obstacle to their sustainability investments, and the share further increased to 28.8% and 31.7% for small and micro firms, respectively. The findings from the EIBIS (2020) revealed that access to finance generally represents one of the main issues that companies, and SMEs in particular, face in financing their sustainability transition. To further disentangle the relationship between the sustainability transition of SMEs and their access to finance, it is crucial to assess their available financing options are (European Commission, 2020b; 2022; European Investment Bank, 2020; OECD, 2021b).

As part of the Green Deal, the European Innovation Council (EIC) has been tasked with awarding funding to 'game-changing' start-ups and SMEs that contribute to the objectives of the Green Deal. The first round of grants awarded in 2020, saw over €307m invested in 64 Cleantech

companies. Another major initiative, as part of the Green Deal, was aimed at SMEs in the SME Strategy for a Sustainable and Digital Europe[10]. Aside from opportunities to engage in digital innovation hubs, the EU Startup Nations Standard will see the Commission mobilise member states to share and adopt best practices to accelerate the growth of high tech SMEs and start-ups with the goal of making Europe the most attractive start-up and scale-up continent in the world. They aim to assist SMEs in obtaining greater access to finance for scaling-up and pay particular attention to firms assisting in the Green Deal objectives. Sustainability Advisors will work through the Enterprise Europe Network to provide information on solutions to sustainability challenges for SMEs, including reporting on sustainability performance and impact. Another initiative, 'Innovate to transform' provides support for SMEs' sustainability transition (part of the Horizon Europe Framework Programme). The programme aims to help encourage SMEs to achieve the European Green Deal objectives, notably a climate-neutral and resource-efficient economy.

Sustainable finance covers both sustainable investment and reporting of impacts (European Commission, 2021b). Reporting requirements indirectly encourage businesses to identify areas to improve their sustainability performance, which can also lead them to identify business opportunities and efficiency improvement options, boosting their innovation and even improving their risk management. There is also growing awareness among investors that sustainability issues can put the financial performance of companies at risk. In the past decade, sustainability reporting regulatory instruments have been on the rise and large enterprises have been under increasing public scrutiny for their sustainability impacts. Currently, policies on sustainability reporting often address SMEs indirectly (notably, by requiring supply chain due diligence from large and listed companies), but there are currently no specific EU requirements for SMEs to produce sustainability reports. However, the discussion suggests it may roll out to SMEs in 2026[11].

The transformation to a sustainable economy is a key political priority for the EU. Hence, various proposals by the EC address this issue and will continue to do so in the future, sometimes directly addressing some categories of SMEs and impacting most SMEs indirectly through their participation in global supply chains. Additionally, sustainability is becoming a key determinant of the success of all businesses and their ability to demonstrate sustainability commitments is considered a competitive advantage in the market. Since a large proportion of SMEs are innovative by nature and seek to contribute to sustainability goals, many will have an intrinsic interest in developing a convincing presentation of their sustainability competence. (European Commission, 2022). To

[10] https://digital-strategy.ec.europa.eu/en/news/sme-strategy-launched-european-commission
[11] EC Interinstitutional File: 2021/0104(COD)

mobilise SMEs to take part in the sustainability transition, it is essential that policies are designed to facilitate and encourage compliance by SMEs and to reduce, as far as possible, any bureaucratic burden (European Central Bank, 2021). This means in particular that policymakers must ensure an appropriate definition of SMEs in these policies and ensure the proportionality of the measures taken for the business structure of SMEs. Any adoption of reporting requirements for SMEs should be preceded by an assessment of their potential impact on SMEs (including the trickle-down effects of new requirements through value chain obligations).

Given the urgency to reduce emissions and achieve carbon neutrality as soon as possible, SMEs should be supported by public policies, both at the EU and national levels, to accelerate their transition to sustainability. In general, there is a need for policies that specifically focus on SMEs. Several studies have called for further research to fill gaps in the availability of data and information related to SME financing (European Investment Bank 2020; OECD, 2021b, 2021c) and reporting of sustainability activities (European Commission, 2020c; 2022).

1.4 Background

As stated, sustainable finance covers both the financing of climate action and related reporting of the impact within the Green Deal. This thesis focuses on two-strands: the financing of Clean Technology (Cleantech) firms and sustainability reporting, with an emphasis on early stage start-ups and SMEs.

1.4.1 Financing Cleantech firms

Under the Green Deal, there has been significant resources provided for investment in sustainability-related activities but a lot of attentions has been provided to those 'game-changing' firms in the Cleantech sector who are contributing to climate change mitigation. Within Europe, it is not just the EU that provides substantial supports. The UK International Climate Finance (ICF) plays a crucial role in addressing climate change with three government departments (DFID, BEIS, and DEFRA) responsible for investing in the UK's £5.8bn of ICF between 2016 and 2021, along with a recent announcement of a UK Government 'Ten Point Plan' to mobilise £12bn in green investment by 2030. This shows the serious commitment of policymakers, and the implementation of these policies requires investment in and by SMEs, the most important sector of the private economy. Small early stage ventures play a significant role in innovation and invention (McDaniels and Robins, 2017; Owen *et al*., 2018) although they typically lack sufficient resources to develop and scale their businesses (Ghosh and Nanda, 2010; Giudici at al., 2018; Hornuf and Schweinbacher, 2018a). Early stage Cleantech firms require long-term intensive R&D that can span from proof of concept to early

stage commercialisation (Mazzucato and Semieniuk, 2018) making them particularly vulnerable. They experience *valley of death* periods along with a higher *liability of newness* compared with other new ventures (Lehner and Nicholls, 2014; Lehner *et al*., 2018). This is due to their hybrid business-models (Quélin *et al*., 2017) which aims to combine commercialisation with an environmental mission (Doherty *et al*., 2014). Owing to their long-term R&D, Cleantech firms often struggle to obtain sufficiently high levels of private investment required to reach commercialisation (Rowlands, 2009; BEIS, 2017; Owen *et al*., 2019). There has been diminished interest in investment in Cleantech startups prior to 2020 (De Lange, 2016, 2017, 2019: Cumming *et al*., 2017), possibily because the financing gap is a greater problem for the diverse forms of Cleantech ventures that are capital intensive, have a high technology risk profile and uncertain exit opportunities for investors (Ghosh and Nanda, 2010; Hamilton, 2016; Rodriguez *et al*., 2020).

Efforts have focused on larger infrastructural projects (Mazzucato and Semieniuk, 2018), and far less attention has been paid to early stage Cleantech SME investments (Owen *et al*., 2018). Previous studies have identified an equity investment gap in knowledge-intensive firms (Sadler, 2016; Wilson *et al*., 2018; Lerner and Ramana, 2020) and there is a need for a greater understanding of finance for new low-carbon businesses and innovations (Rizos *et al*., 2016; McDaniels and Robins, 2017). It has been argued that innovation financing for Cleantech SMEs should be an essential cornerstone of policies to tackle climate change (Owen *et al*., 2020).

Equity funding for Cleantech firms has soared in recent years with venture capital funding for Cleantech hitting £40bn in 2020 and 2021 which exceeded the total for the previous two years by 37 per cent (Pitchbook, 2021). Until this point, venture capital funding for Cleantech firms dried up following large investments from 2006 to 2011 which resulted in the loss of half of venture capitals $25bn investment (Gaddy *et al*., 2017). Crowdfunding provides young entrepreneurial firms with an additional source of external equity financing, which plays an increasingly important role (Ahlers *et al*., 2015; Bruton *et al*., 2015; Cumming and Vismara, 2017) and has a particular impact on innovation (Stanko and Henard, 2016: Paschen, 2017) and growth opportunities (Signori and Vismara, 2018; Eldridge *et al*., 2021).

According to the IEA (2021), half of the technologies required to achieve net zero emissions have not yet been developed. The World Economic Forum calls for large corporations and venture capital firms to increase their spending on Cleantech firms as a matter of urgency (WEF, 2021). Understanding the financing requirements of these technologies. One aim of this research is to provide the first evidence on the financial influences of Cleantech firms raising equity financing. As equity investment is set to increase in the Cleantech industry (Statista, 2021), it is important to know

more about these considerations, something which this study aims to achieve by examining the role of crowdfunding and other methods of external equity finance.

1.4.2 Sustainability reporting

Two key components under the sustainable finance framework of the Green Deal focus on reporting sustainable activities: the EU Taxonomy for sustainable activities and corporate disclosure of climate-related information. Regulation (EU) 2020/852 establishes the basis for the EU Green Taxonomy by setting conditions that an economic activity must meet to qualify as environmentally sustainable. Taxonomy regulations for certain larger entities were published in the Official Journal of the European Union in June 2020 and entered into force in July 2020. Prior to this, Directive 2014/95/EU set out rules for the NFRD. The NFRD currently applies to large public-interest companies with more than 500 employees, covering approximately 11,700 large companies, and groups across the EU, including listed companies, banks, insurance companies and other companies designated by the national authorities as public-interest entities. In April 2021, the EU Commission adopted a proposal for a Corporate Sustainability Reporting Directive (CSRD) that amended the existing reporting requirements of the NFRD. The CSRD introduces several significant changes. Of particular importance is that it widens the scope of the reporting obligations to apply to all non-SMEs and certain SMEs with securities listed on EU regulated markets, capturing an estimated 49,000 companies. The EU level discussion suggests that it may be 2026, before sustainability reporting requirements directly impact SMEs.

Outside EU regulations, there are several additional environmental sustainability reporting frameworks. The Global Reporting Initiative (GRI) was established in 1997 to create the first accountability mechanism to ensure that companies adhere to responsible environmental conduct principles, which were then broadened to include social, economic and governance issues. Several changes were implemented following the NFRD Directive in 2014. In 2015, the GRI adapted the Sustainable Development Goals (SDGs) into its framework and constantly developed its standards on a regular basis, including the launch of the GRI Academy in 2020. The GRI is the most widely used standards for Environmental Sustainability Reporting (ESR) globally, and this thesis focuses on both the Taxonomy and the GRI.

Another widely used standard, with a primary focus on listed firms is the Task Force on Climate-Related Financial Disclosures (TCFD). The TCFD was created in 2015 by the Financial Stability Board (FSB), whose role since its establishment in 2009 after the global financial crisis, is to promote international financial stability. The focus of TCFD is reporting on the impact an

organisation has on the global climate. This particular set of standards is focused on financial markets with certain stock market indices that requires mandatory disclosures under the TFCD, and aims to provide clear, comprehensive, and high-quality information on the impacts of climate change.

Questions have been raised regarding the role of the accounting profession, particularly the International Financial Reporting Standards (IFRS) and the International Accounting Standards Board (IASB), and their role in promoting and developing sustainability reporting standards. Amid the backdrop of COP26, was the formation of the International Sustainability Standards Board (ISSB), now part of the IFRS Foundation and IFRS Sustainability. This initiative forms part of a consolidation of a number of standard-setters including, the Climate Disclosure Standards Board (CDSB), Value Reporting Foundation (VRF), Integrated Reporting (IR) and Sustainability Accounting Standards Board (SASB). The ISSB formation proposes issuing two IFRS Sustainability Disclosure Standards that would require a company to disclose information that enables investors to assess the effect of significant sustainability-related risks and opportunities on its enterprise value and establish disclosure requirements specific to climate-related risks and opportunities. The ISSB is currently considering comments on exposure drafts when developing its final requirements. It plans to consider the comments in the second half of 2022 and aims to finalise the requirements by the end of 2022 with the launch of prospective reporting standards in 2023.

As the role of businesses in confronting climate change gains urgency, standard-setters have consolidated their efforts to provide more robust and unified guidance. ESR by businesses of all sizes is becoming integral to the strength of traditional financial metrics, in terms of sales, access to trade credit and finance (European Commission, 2021b; Papoutsi and Sodhi, 2020). While SMEs have not been completely ignored in sustainability-related developments (Arena and Azzone, 2012; IIRC, 2011), there has been insufficient policy level attention devoted to the barriers and challenges SMEs encounter in any endeavour to engage in ESR. There have been concerns regarding SMEs capability to engage in ESR, which already serves as an important form of communication to lenders, suppliers and customers (Thoradeniya *et al*., 2022; Palea, 2018). Thus, one aim of this research is to assess the feasibility, costs and consequences of implementing ESR in the form of the GRI and the Taxonomy.

SMEs typically rely on their SMPs for their reporting requirements (Collins *et al.*, 2011; Nigri and Del Baldo, 2018) as well as for consultancy and advice, particularly on the implementation of new initiatives and processes (Blackburn and Jarvis, 2010; Jarvis and Rigby, 2011). The findings of the European Federation of Accountants and Auditors' (EFAA) 2018 survey of the non-financial reporting requirements for European SMEs encourage SMPs to prepare for the future ESR, suggesting that their input is essential for SMEs. More recently, IFAC (2021) highlight the

opportunities for SMPs to report sustainability information to SME clients. The role of the accounting profession in respect to the introduction and practice of ESR has been largely overlooked (Humphrey *et al*., 2017; Rinaldi *et al*., 2018). This study aims to address this research gap and further enhance the knowledge of ESR for SMEs and the role of the SMP in doing so.

1.5 Aims and objectives of research

This thesis aims to examine the financing of early stage Cleantech firms and assess the feasibility of SMEs to report their environmental impact. In doing so, the research is divided into four studies and takes a two-strand approach: financing of Cleantech firms and ESR for SMEs. Figure 1.2 provides a high-level overview of the research. The research is related to the Green Deal and specifically focuses on sustainable finance. The sustainable finance component of the Green Deal covers both financing and reporting, and this study focuses on SMEs.

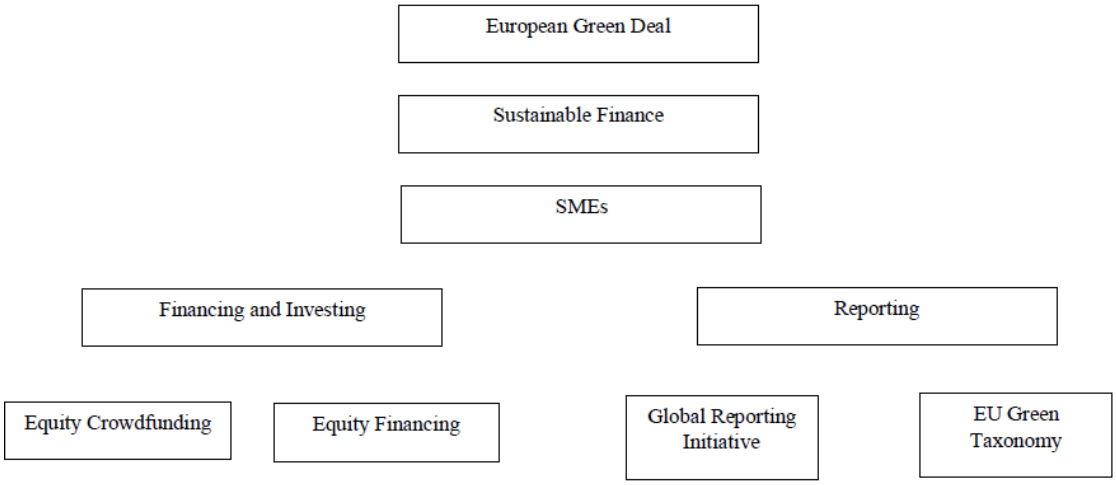


Figure 1.2 Overview of research

First, from a financing perspective, this study focuses on early stage Cleantech firms with a particular focus on external equity financing. One objective of this study is to assess the role of crowdfunding in financing Cleantech firms. Following the global financial crisis (2007-2008), small firms often struggled to obtain traditional sources of finance (Lee *et al.*, 2015), leading to the emergence of alternative methods of external equity financing such as peer-to-peer lending and crowdfunding, including donation-based, reward-based and equity-based crowdfunding. Crowdfunding provides young entrepreneurial firms with an additional source of external equity finance, one that plays an increasingly important role (Ahlers at el., 2015; Bruton *et al*., 2015;

Cumming and Vismara, 2017) and has a particular impact on innovation (Stanko and Henard, 2016: Paschen, 2017) and growth opportunities (Signori and Vismara, 2018; Eldridge *et al*., 2021). Hörisch (2015) noted that in the context of environmentally oriented ventures, crowdfunding's potential is not sufficiently used but this is increasingly developing and due to the increased focus on environmental issues at government, agency and investor levels, this is something that will surely increase in the coming years. However, there has been limited research on the role of crowdfunding in environmentally oriented ventures; specifically, there is scant research on equity crowdfunding in environmentally oriented ventures. Accordingly, this study examines the role of crowdfunding in financing Cleantech firms. A unique dataset is prepared by obtaining equity crowdfunding information of all European firms that raise equity on crowdfunding platforms along with firm specific accounting and finance data (Chapter 2). Regression analysis was employed to assess the determinants of equity crowdfunding along with the potential determinants of debt and equity pre and post-crowdfunding. The second research objective, with regard to financing, is to examine the determinants of access to equity financing for UK Cleantech firms. This assessment is conducted from the perspective of the pecking order. This is done using another separate dataset of UK Cleantech firms and tests are undertaken to examine the potential determinants of raising equity finance for Cleantech firms in the UK (Chapter 3).

Secondly, by focusing on sustainability reporting, the objective is to assess the feasibility of the GRI as an ESR framework for SMEs. This was examined by developing a proposed sustainability reporting framework based on the GRI which was distributed to the SMPs along with a semi-structured survey. In the survey, participants were asked what sustainability information they considered feasible for SMEs to report along with financial and resource implication questions. Finally, with a focus on potential future mandated ESR frameworks, another research objective is to assess the implications of the implementation of the EU Green Taxonomy for SMEs. Focus groups are used as a method to capture survey responses on the Taxonomy with participants required to provide their assessment of the feasibility of the implementation of the Taxonomy, supports required, and the envisaged consequences of implementing this framework.

The richness of the datasets employed in this study adds significant value. Several sources were integrated into large datasets along with presenting survey participants with subjective frameworks and case studies to assess their opinions on the research aim and objectives.

Figure 1.3 highlights the overall aim of the research and provides a mapping to the specific research aim, subsequent research objectives and research questions in each of the four studies presented.

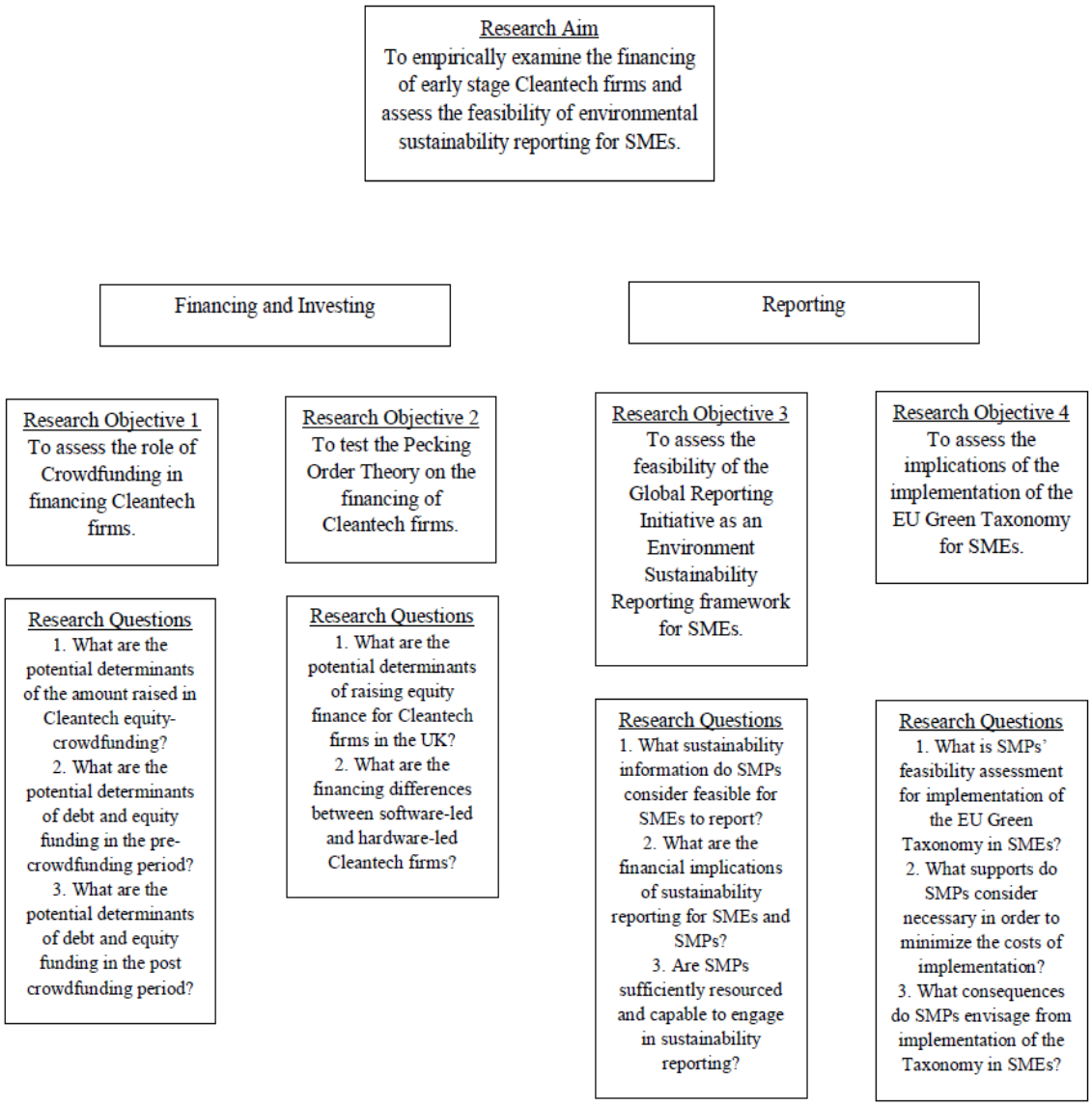


Figure 1.3 Research aim mapping to research questions

1.6 Theoretical frameworks

The study employs a number of theoretical frameworks to examine the research questions set out under each of the four research objectives. Each study has a summary of previously related literature and its own constructed and detailed sample and methodology.

From a financing perspective, Chapter 2, examines signalling effects in equity crowdfunding of Cleantech firms. Research suggests that capital structure theory in small firms derives from corporate finance theory specifically that Modigliani and Miller contribute (1958, 1963). The

Modigliani and Miller (1958) propositions were based on the assumption that insiders and outside investors were privy to symmetric information. An alternative approach to capital structure theory is based on the assumption of asymmetry of information. This implies that market prices of firms' securities do not contain all available information, and therefore managers or 'insiders' may use financial policy decisions to reveal information about firms' revenue streams and risk. Information asymmetries refers to the differences between the knowledge and information among business owners and managers about the value of assets and future growth opportunities of the business that outsiders can only estimate based on their observed information on the business, and thus led to further theorectical frameworks being developed.

The signalling theory was developed by Spence (1973) to explain behaviour in labour markets. Signalling is a reaction to informational asymmetry in markets because company management has information that investors do not have. Asymmetries can be reduced if a party has more information to others. Signalling theory states that information on a company's financial health is not available to all parties in a market at the same time. There have been several developments in signalling theory in finance since Spence (1973). Another approach based on information asymmetries is the signalling model proposed by Ross (1977), whereby managers convey inside information to investors through the proportion of debt in the capital structure. Successful firms with greater revenue streams can support greater leverage than those with lower revenue streams. The market believes that only the manager knows the true distribution of a firm's returns. The manager is incentivised to signal of the firm's quality to the market, as he or she benefits if the firms' securities are more highly valued by the market but are penalised if the firm goes bankrupt. Thus, investors take higher debt levels as a signal of higher quality. Leland and Pyle (1977) propose an alternative signalling approach based on managerial risk aversion. As with Ross (1977), this approach proposes a positive relationship between the level of leverage and firm value.

There are two contrasting views in the literature on the sources of information asymmetry in SME finance markets. Garmaise (2001) states that external finance suppliers have superior information on the value of a firm's investment projects and prospects for survival; therefore, SMEs bear the costs of information asymmetries. Cooper *et al*. (1988) support this view by detailing the entrepreneur's excessive optimism about business prospects and the high non-survival rates among new firms (Audretsch, 1991; Cressy, 2006). Berger and Udell (1990) state that banks have adequate information to appraise a project and 'sort-by-observed-risk' by requiring more risky projects to provide collateral; thus, less risky projects are not required to do so. The opposing point states that this view of information asymmetries is more appropriate for established firms (Garmaise, 2001),

which prefer the pecking order of financing (Myers, 1984; Myers and Majluf, 1984). According to Berger and Udell's (1990) paradigm, this view corresponds with the traditional approach of banks. Thus they 'sort-by-privateinformation' by requiring collateral to protect against default in the event of project failure.

Specific to start-ups and early stage ventures, potential investors try to evaluate the unobservable characteristics of start-ups by interpreting the signals of entrepreneurs (Connelly *et al.*, 2011). Similarly, signalling theory has been used to explain which types of information lead investors to invest in start-ups (Goldfarb *et al*., 2007; Nahata, 2008; Cosh *et al*., 2009; Agrawal *et al*., 2010; Cole and Sokolyk, 2012; Robb and Robinson, 2014). This helps to minimise the information gap between investors and stockholders (Miller and Del Carmen Triana 2009). Davila *et al.*, (2003) argue that entrepreneurs can also signal the unobservable characteristics of their start-ups by affiliating themselves with third parties such as venture capitalists. Likewise, Megginson and Weiss (1991) and Gulati and Higgins (2003) show that ties to prominent venture capitalists or investment banks are effective signals in the IPO context and can also act as forms of external certification. Hsu (2004) shows that entrepreneurs are, therefore, willing to pay for venture capital affiliation because they believe that venture capitalists can beget a reputation effect that will facilitate growth (Davila *et al.*, 2003). Ahlers *et al*. (2015) highlight that reliable signals are not typically available from start-ups, because they may not have a credit history yet.

Specific to equity crowdfunding, Ahlers *et al*. (2015) provide the first study exploring the significance of signals in equity crowdfunding. Ahlers *et al.* (2015), find strong empirical evidence that signalling plays an important role for investors, especially concerning potential risk factors, the share of equity offered, and board structure and size. Several studies have examined signalling in equity crowdfunding and highlight key signals that impact both firms and investors. These include the amounts raised (Vismara, 2016), social networks (Nitani and Riding, 2017), human capital (Piva and Rossi-Lamastra, 2018), project updates (Block *et al.*, 2018), campaign communications (Dorfleitner *et al.*, 2017), entrepreneurs education and experiences (Piva and Rossi-Lamastra, 2017), team quality (Angerer *et al*., 2017), and marketing strategies (Bapna 2017; Davis *et al*., 2017; Ralcheva and Roosenboom 2016). A few studies (Vulkan *et al.* 2016; Lukkarinen *et al*. 2016) have focused on the effect of specific campaign characteristics on funding performance that contribute to what constitutes a signal effect. A limited number of studies have assessed post-crowdfunding performance. Hornuf *et al*. (2017) analysed follow-up funding and subsequent firm failure, highlighting that the number of senior managers and the number of initial venture capital investors positively impacted obtaining post-campaign financing. Signori and Vismara (2018) show that in

their sample of firms that raised equity crowdfunding through Crowdcube, 35% raised follow-on funding in the form of either private equity injections (9%) or follow-on crowdfunding offerings (25%) suggesting a possible positive signalling effect. Vanacker *et al*. (2018) summarised post-crowdfunding performance and found mixed signals regarding firm failure and post-campaign funding.

This thesis adds to the signalling theory literature by examining pre- and post-crowdfunding signals. As such, this study differs from previous studies in that the signals can be identified as pre-crowdfunding and can assess whether raising finance on an equity crowdfunding platform can act as a signal for post-campaign funding. It should also be noted that there has been limited research on the impact of accounting variables and financial reporting information on crowdfunded firms. Donovan (2020), Pattanapanyasat (2020), Yang (2020) and Jo and Yang (2021) are some of the studies to incorporate accounting variables into a campaign success. This study includes more detailed financial reporting information and assesses the determinants of equity crowdfunding as well as funding pre and post-crowdfunding.

Chapter 3's examination of equity financing in UK Cleantech firms is framed within pecking order theory. The pecking order theory in small firms originates from corporate finance theory (Myers, 1984; Myers and Majluf, 1984). Over time, it has emerged as the primary theoretical lens through which to view SMEs' and small unlisted firms' capital structure and financing decisions (Chittenden *et al*., 1996; Jordan *et al*., 1998; Berggren *et al*., 2000; Watson and Wilson., 2002; Cosh *et al*., 2009; Mac an Bhaird and Lucey, 2010; Hanssens *et al*., 2016; McGuinness *et al*., 2018). Pecking order theory argues that costs related to asymmetric information drive financial decision-making. Entrepreneurs and firms prefer for internal financing. If this becomes unavailable, they will seek external debt financing and finally, as the least preferential option, will raise external equity financing. Other studies indicate that SMEs' financing preferences adhere to a modified pecking order, such as the High Technology Pecking Order Hypothesis (HTPOH) (Oakey, 1984; Brierley, 2001; Hogan and Hutson, 2005). This theory posits that firms with a particular profile (technology firms with potential for high-growth rates) prefer to finance investment from internal equity, followed by external equity and debt financing.

In seeking to explain the apparent adherence of firms in the SME sector to the pecking order theory, the primary question is whether it is imposed by supply-side factors or due to demand-side choices. This is the first study of its kind to examine the consistencies of the pecking order theory while focusing on Cleantech firms and highlights the differences in financing between hardware-led and software-led Cleantech firms. Tests were performed to examine the role of patents, which are

considered from the perspective of signalling theory. Specifically, patents reduce information asymmetries in entrepreneurial finance by acting as signals for start-up financing (Conti *et al.*, 2013b). Lerner *et al.* (2002), find that small, capital-constrained firms have a higher propensity for patents than do larger firms. One reason for this is the financial role of patents. The Berkeley Patent Survey (Graham *et al*., 2009) finds that one of the main reasons for start-up firms to obtain a patent is to secure financing. Often, high technology start-ups with little or no track record face the problem of financing costly development of new inventions or the R&D required to reach commercialisation. A patent can also be considered an asset that can be used as collateral for debt financing (Yang *et al*., 2021). Previous studies that have examined the role of patents in firm financing find a positive relationship between patents and venture capital financing (Conti *et al.*, 2013b; Hsu and Ziedonis, 2013). Conti *et al*. (2013b), when distinguishing between types of external investors, find that venture capitalists are endogenous to the process, but private investors are not, and that firms with more patents attract venture capital rather than private investment. Studies show that patents, and the amount of time and resources invested in R&D are two of the most important proxies for technological capabilities (Baum *et al*., 2019: Peters *et al*., 2012). Some studies indicate that such supply-driven technological innovations are particularly important in Cleantech (Horbach, 2008; Rehfeld *et al*., 2007). Dangelico (2017) stated that new technologies and environmental commitment related to technological aspects are relevant factors that drive the radical nature of green products or services. Patents, grants, and awards can be aligned with Spence's (1973) original conceptualization of signals of quality insofar as they act as certifications of novel and useful inventions, which can be viewed as a proxy for quality and provide investors with external quality assessments (Hsu and Ziedonis, 2007). Patents play an important role in the development of innovative firms by acting as a signal for quality (Hottenrott *et al.*, 2015), obtaining venture capital financing (Haeessler *et al*., 2012) and used as collateral for debt financing (Conti *et al*., 2013b). Graham *et al*., (2009) and Knight (2013) suggest that early stage ventures patent to protect their competitive advantages in technology from possible imitators. One of the objectives of the research is to assess the role of the pecking order theory in Cleantech firms which also contributes to the signalling theory.

From a reporting perspective, distinct, but related, theoretical angles are considered when examining the ESR frameworks for SMEs in Chapters 4 and 5. Legitimacy theory suggests that, SMEs aim to strengthen their legitimacy by conveying that their activities conform to societal norms of desirability and appropriateness (Ashforth and Gibbs, 1990; Suchman, 1995). By virtue of their size and sometimes vulnerable positions in supply chains, SMEs aim to strengthen their legitimacy (Russo and Perrini 2010). This is particularly apparent in financial reporting and relative narrative disclosures (Goncalves, Gaio and Ramos, 2022; Tang and Tang, 2016). SMEs typically contract

SMPs to meet financial reporting and regulatory requirements. (Collins *et al*. 2011; Nigri and Del Baldo, 2018). The voluntary provision of environmental disclosures, using frameworks such as the GRI, presents opportunities to influence stakeholders' perceptions of SMEs' legitimacy. It also leads to an advantage when such disclosures are mandated, for instance in a supply chain context, or via the introduction of legislation such as that which had been introduced with regard to the Taxonomy. Legitimacy theory suggests that such disclosures may have substantive or symbolic bases (Deegan *et al*., 2000; Deegan, 2002, 2014). Symbolic legitimation operates using acts to connote value standards. It presupposes the existence of a symbolic universe and a set of coding rules that allow the expression of value standards through these acts. Symbolic legitimation concerns are integrated into a larger social context and ultimately depend on that context for its effectiveness. Substantive legitimation involves the structural transformation of actions that conform to social values. (Richardson, 1985). Legitimacy theory provides a suitable framework for considering the aim of this research and assessing the implementation of the GRI and the EU Green Taxonomy by SMEs.

Institutional theory focuses on the roles of social, political and economic systems in which companies operate and gain legitimacy (DiMaggio and Powell, 1983; Mizruchi and Fein, 1999). Institutional theory is an approach to understanding organisations and management practices as the product of social rather than economic pressure. For example, it has been used to explain why some managerial innovations become adopted by organisations or diffuse across organisations despite their inability to improve organizational efficiency or effectiveness (Damanpour, 1991). According to institutional theory, the explanation is based on the key idea that the adoption and retention of many organisational practices are often more dependent on social pressures for conformity and legitimacy than on technical pressures for economic performance. As institutional theory has grown, it has, to an extent, converged toward behavioral theories. Direct dialogue between the perspectives has been acknowledged by researchers who have noted that the organizational change processes examined by behavioral theory are influenced by the institutional context (Wezel and Saka-Helmhout, 2006).

As noted, SMEs face the prospect of mandatory disclosures under the Taxonomy regulation. Many studies have adopted institutional theory to examine the introduction of mandatory requirements for SMEs (Bealing *et al.*, 1996; Spiller, 2009; Baker *et al.*, 2014; Greve and Argote, 2015; Nurunnabi, 2015; Reynolds *et al.*, 2016 and Chiu, 2019). From this perspective, SMEs as small resource-constrained entities, may believe that their provision of ESR disclosures is unnecessary and unfeasible. Therefore, they would wait until it became mandatory to conform to regulatory requirements, likely aided by government-sponsored grants, subsidies and related supports. In the field of statutory reporting and auditing, Baker *et al*. (2014) find that actors in the institutional field

of professional regulation, under pressures from powerful external forces, seek to enhance their legitimacy while maintaining internal flexibility and a certain capacity for resistance against external pressures in the institutional field. Other studies have focused on the regulation of statutory auditing (Thornburg and Roberts, 2008; Shapiro and Matson, 2008; Söderberg, 2008; Humphrey *et al.*, 2009 and Anantharaman, 2012). These studies highlight the consensus that small firms would wait until statutory audit requirements are met before conforming. It can be argued that the same applies to any mandating on ESR reporting for SMEs.

The studies presented in Chapters 4 and 5, that focus on ESR can be considered from a legitimacy (Chapters 4 and 5) and institutional theoretical (Chapter 5) stance. One could argue that parties within supply chains and broader stakeholders exert pressure on firms to adopt ESR irrespective of whether it is mandated by legislation. However, as the GRI does not appear on regulatory agendas in the EU, the feasibility of the GRI for SMEs is examined solely using a legitimacy theoretical approach. The Taxonomy will be mandated for larger firms from 1 January 2024, and is currently expected to be a requirement for SMEs in 2026. Therefore, this study can be couched within both theories as SMEs can voluntarily disclose their sustainability impact in the interim period with a legitimacy rationale. Given that not all SMEs are adequately resourced to do so institutional theory is also pertinent to those firms that regulators will inevitably pressurise to conform to reporting requirements. Both studies support these theories.

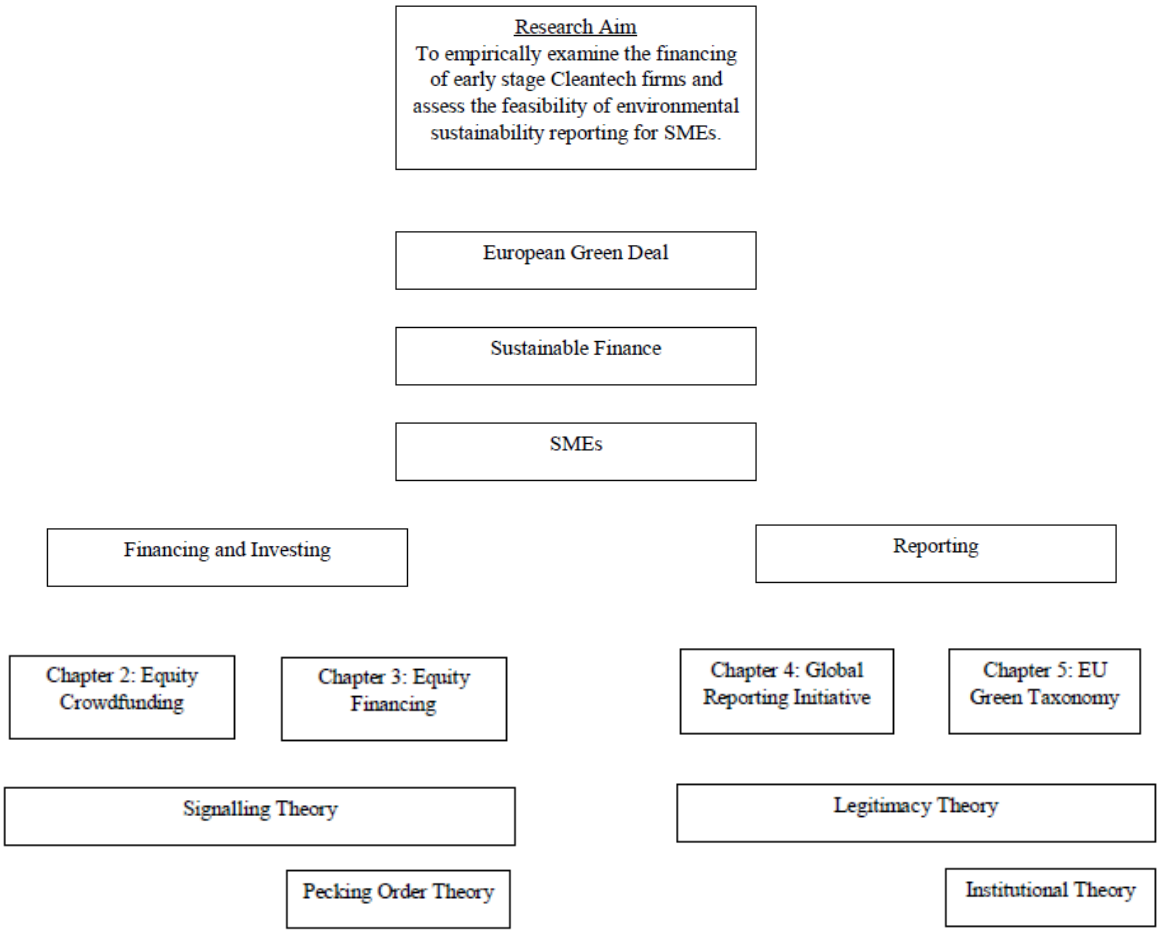


Figure 1.4 Theoretical frameworks underpinning studies

1.7 Research philosophy

While this thesis implements various methodologies, it is important to be cognisant of influencing factors. To understand one's own stance about research, it is necessary to clarify the research philosophy and paradigm. Research philosophies contain important assumptions about the way a researcher views the world. These assumptions underpin the research strategy and methods chosen as part of this strategy (Saunders *et al*., 2015). The main influence is likely to be a particular view of the relationship between knowledge and the process by which it is developed. A researcher who is concerned about facts is likely to have a very different view on how research should be conducted by the researcher concerned with the feelings or attitudes of given individuals (Saunders *et al.*, 2009, 2015). The implemented strategies and methods differ considerably based on these views. Figure 1.5, from Saunders *et al.* (2006) highlights the different philosophies, approaches, and strategies as part of their research 'onion' explanation.

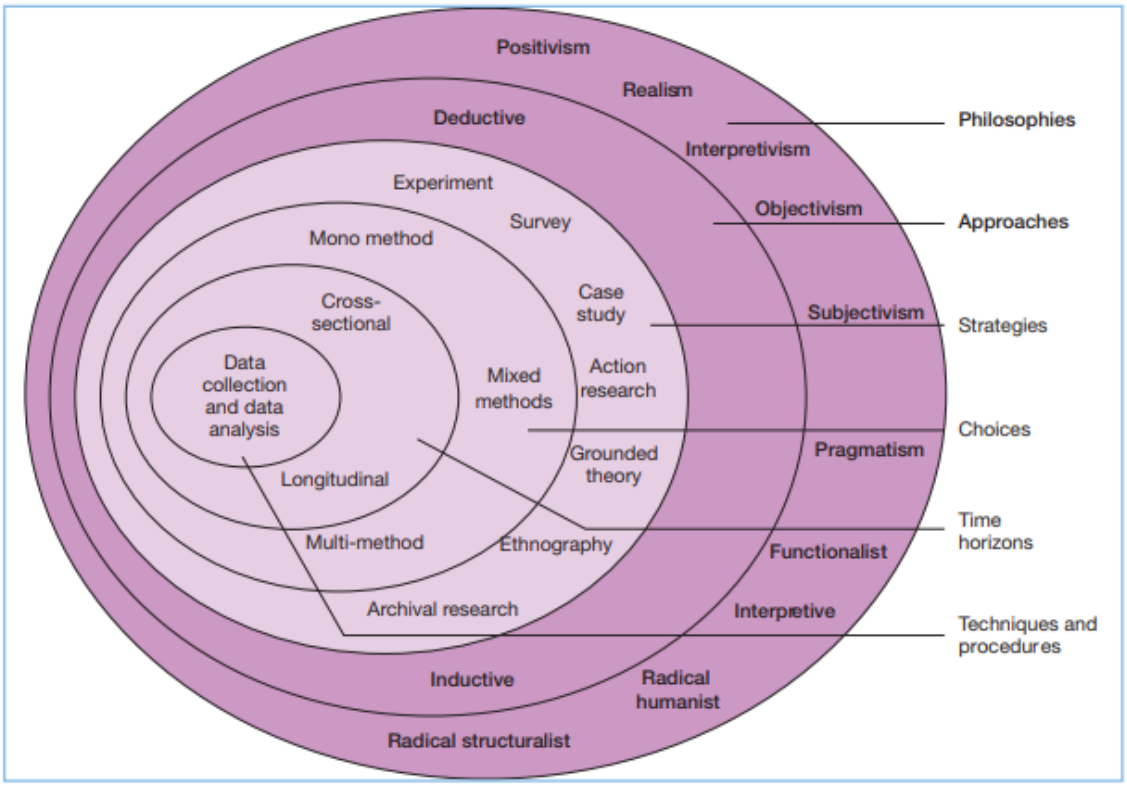


Figure 1.5 The Research 'Onion' (Saunders et al., 2006)

Researchers in scientific disciplines employ techniques that are accepted and commonly used by other researchers in their disciplines. When adopting the norms and traditions of their discipline, researchers choose methods of analysis compatible with their assumptions about the nature of scientific knowledge (epistemology), their assumptions about the nature of reality (ontology), and how that knowledge is collected (methodology). Based on the stance taken on these dimensions, research paradigms emerge that manifest as shared beliefs within research communities, helping guide researcher action, choice, and approach when studying any phenomenon.

Epistemology concerns what constitutes acceptable knowledge in a field of study. A researcher who considers data on the resources needed is likely to be more akin to the position of the natural scientist. The researcher is embracing what is called the positivist position to the development of knowledge whereas the' feelings' researcher is adopting the interpretivist perspective. Plato defined epistemology as justified true belief, and he identified three fundamental issues: the nature of belief, the basis of truth, and the problem of justification (Ryan *et al.*, 2002). Theories of knowledge acquisition differ according to whether knowledge is acquired from experience (empiricism), acquired by a priori processes (rationalism), or constructed by human thought (constructionism). Rationalists, such as Descartes (1931), believe that knowledge is acquired by a

priori processes, that is, in the form of reasoned concepts not derived from experience. The essence of rationalism is that what the senses show us as reality is the truth that objects have an existence independent of the human mind. The theory of rationalism states that reality is independent of the mind. In this sense, rationalism is opposed to idealism, the theory that only the mind and its content exist. Rationalism is a branch of epistemology that is similar to positivism in that it assumes a scientific approach to knowledge development. This assumption underpins the collection and understanding of these data. This meaning (and in particular, the relevance of rationalism for business and management research) becomes clearer when the two forms of realism are contrasted. Constructionists believe that knowledge is constructed by researchers and not discovered from experience. Contrary to empiricism, constructionists believe that all knowledge is constructed through human thought. Therefore, epistemological assumptions are made based on whether knowledge is something that has to be personally experienced or whether it is something that can be acquired (Burrell and Morgan, 1979). This emphasises the difference between conducting research among people rather than objects. The term 'social actors' is significant here. The metaphor of theatre suggests that humans play a part in the stage of human life.

On the other hand, ontology is concerned with the nature of reality. To a greater extent than epistemological considerations, this raises questions about the assumptions that researchers make about the way the world operates and the commitment held to particular views (Saunders *et al*., 2015). The first aspect of ontology is objectivism. This portrays the position that social entities exist in reality, external to social actors concerned with their existence. The second aspect, subjectivism, holds that social phenomena are created from the perceptions and consequent actions of social actors concerned with their existence. Objectivists assume that social phenomena are external to social actors, and that the characteristics of material objects, people, and societies can be explained in terms of the complexity of the organization of matter (Benton and Craib, 2001, p. 4). In contrast, subjectivists believe that social phenomena are constantly being accomplished by social actors, and that the ultimate reality is intellectual or spiritual. Objectivism portrays the position that social entities exist in reality external to social actors. The subjectivist view is that social phenomena are created by the perceptions and consequent actions of social actors. What is more, this is a continual process in that, through the process of social interaction, these social phenomena are in a constant state of revision. Remenyi *et al.* (1998, p. 35) stressed the necessity to study 'the details of the situation to understand the reality or perhaps a reality working behind them'. This is often associated with the terms constructionism or social constructionism.

Johnson *et al*. (2004) suggest that two opposing research philosophies reside at either end of the research philosophy continuum. These are the positivist and interpretivist approaches. A positivist is a science-based hypothesis-deductive approach, primarily associated with quantitative data analysis techniques. The diametrically opposed approach is an interpretive or inductive view that is traditionally associated with qualitative data analysis techniques. Much debate has taken place over the years among the research community regarding the relative merits and demerits of both qualitative and quantitative approaches (Hammersley, 2002). The emphasis in these 'paradigm wars' (Johnson and Turner, 2003) is misplaced. The issue to be addressed is the most appropriate research strategy and design to answer the research question(s) posed by the researcher (Domegan and Fleming, 2009). In some cases, quantitative approaches may suffice, while in others, qualitative approaches alone may be the most appropriate. It is argued that both approaches can be integrated in one study if the research problem requires methodological triangulation to increase the validity and reliability of the study (Patton, 2002). This combination of opposing positivist and interpretivist research approaches in one study serves to highlight the overall research philosophy of the researcher, which can best be described in research philosophic terms as pragmatic (Shields, 2004; Feilzer, 2010). Saunders *et al*. (2012) note that for pragmatists, the nature of the research question, the research context, and likely research consequences are driving forces that determine the most appropriate methodological choice (Nastasi *et al*., 2010). Both quantitative and qualitative research are valued by pragmatists and the exact choice will be contingent on the particular nature of the research' (p.164).

The most commonly used methodological approach in business and management research is positivism (Benton and Craib, 2001). Positivism is thought to explain acts in the social world by searching for regularities and causal relationships between constituent elements (Burrell and Morgan, 1979). It is characterized by a belief in absolute truths, assuming implicitly or explicitly that reality can be objectively measured and is free of value bias (Quinn-Patton, 2002; Sobh and Perry, 2006). Positivists believe that human behavior can be defined by quantifiable variables that can be studied and which theories can be developed to explain stable cause-and-effect relationships, preferring sequences that persist over time and space. Positivists thus maintain the empiricist account of the natural sciences, favoring quantitative methods. A positivist believes in being separate from the world he studied, and through measured and careful study, empiricism, and repeated examination, the 'truth' will be attained (Krauss, 2005). The epistemological perspective of positivism is described as dualist and objectivist, assuming the existence of an objective reality independent of the knower (Holton, 1993). Studies adopting this approach tend to describe empirical objects as causal relationships among variables and apply inferential statistics to quantitative data to test the

hypotheses. The hypotheses are stated in a prepositional form and subjected to empirical testing for verification (Guba and Lincoln, 1994).

The debate is often framed in terms of the choice between either positivist or interpretivist research philosophy. Even if you accept Guba and Lincoln's (1994) argument that questions of method are secondary to questions of epistemology and ontology, choosing between one position and the other is somewhat unrealistic in practice. If this view is undertaken, then the position of the pragmatist is adopted. Pragmatism argues that the most important determinant of the adopted research philosophy is the research question. One approach may be 'better' than the other for answering specific questions. Moreover, if the research question does not unambiguously suggest that either positivist or interpretivist philosophy is adopted, this confirms the pragmatist's view that it is perfectly possible to work with both philosophies. Mixed methods, both qualitative and quantitative, are possible and possibly highly appropriate (Tashakkori and Teddlie 1998). This methodologically combined approach has increased in popularity in recent years (Johnson and Onwvegbozie, 2004; Tashakkori and Teddlie, 2008; Plano *et al*. 2011). Table 1.1 adapted by Suanders *et al*. (2012, 2015), highlights the differences, including typical methods of each philosophy.

Researchers' stances on these issues determine the methodology or research approach adopted. Variables, instruments to measure those variables, populations on which those measurements are made, and analytical techniques that are used to interpret those measurements (Bygrave, 1989; Saunders *et al.*, 2009, 2015; Van Burg and Romme, 2014; Biedenbach, 2015). The most commonly used research approaches are quantitative, qualitative, and mixed methods.

Table 1.1 Comparison of five research philosophies in business and management research (Saunders et al., 2009, 2012)

Ontology (nature of reality of being)	**Epistemology** (what constitutes acceptable knowledge)	**Axiology** (role of values)	**Typical Methods**
Positivism			
- Real, external, independent - One true reality (universalism) - Granular (things) - Ordered	- Scientific method - Observable and measurable facts - Law-like generalisations Numbers - Casual explanation and predictions as contribution	- Value-free research - Researcher is detached, neutral and independent of what is researched - Researcher maintains objective stance	Typically deductive, highly structured, large samples, measurement, typically quantitative methods of analysis, but a range of data can be analysed
Critical Realism			
- Stratified/layered (the empirical, the actual and the real) - External, independent Intransient - Objective structures - Casual mechanisms	- Epistemological relativism - Knowledge historically situated and transient - Facts are social constructions - Historical causal explanation as contribution	- Value-laden research - Researcher acknowledges bias by world views, cultural experience and upbringing - Researcher tries to minimise bias and errors - Researcher is as objective as possible	Retroductive, in-depth, historically situated analysis of pre-existing structures and emerging agency. Range of methods of data types to fit subject matter
Interpretivism			
- Complex, rich - Socially constructed through culture and language - Multiple meanings, interpretations, realities - Flux of processes, experiences, practices	- Theories and concepts too simplistic - Focus on narratives, stories, perceptions and interpretations - New understandings and worldviews as contribution	- Value-bound research - Researchers are part of what is researched, subjective - Researcher interpretations key to contribution - Researcher reflexive	Typically inductive. Small samples, in-depth investigations, qualitative methods of analysis, but a range of data can be interpreted

This research thesis draws mainly from the research paradigms of positivism and post-positivism. Stemming from the discussion of positivism as a research philosophy, the positivist paradigm orients around objectivity, measured and rigorous study, empiricism, and repeated examinations. The ontological position is one of realism and objectivism; objects exist independent of the knower, and the researcher and the researched are independent entities (Scotland, 2012). The epistemological perspective of positivism is described as dualist and objectivist, assuming the existence of an objective reality independent of the knower (Holton, 1993). Studies adopting this approach tend to describe empirical objects as causal relationships among variables and apply

inferential statistics to quantitative data to test the hypotheses. The hypotheses are stated in a prepositional form and subjected to empirical testing for verification (Guba and Lincoln, 1994).

In practice, there is a continuum from quantitative to qualitative methods. While this thesis has primarily been inclined towards a quantitative orientation, a considerable amount of qualitative data was collected through a survey instrument, which leans itself to quantitative analysis. Chapters 2 and 3 lend themselves to a positivist approach using econometric testing on large datasets. Chapters 4 and 5 are based on a positivist and post-positivist approach using a survey instrument and quantitative analysis of the results of these findings.

Table 1.2 Research philosophies - adapted from Saunders, Lewis and Thornhill (2009; 2012); Van Burg and Romme (2014); Biedenbach (2015)

	Positivism	Post-positivism	Constructivism	Pragmatism
Ontology: Researcher view of the nature of reality	External, objective, independent of social actors	External, assumed to exist but imperfectly apprehendible	Socially constructed, subjective, may change, multiple	External, multiple, chosen to best answer of research question
Epistemology: Researcher view of what constitutes acceptable knowledge	Only observable phenomena provide credible data/facts. Focus on causality, reducing phenomena to simplest elements	Objectivity remains as 'regulatory ideal'. Replicated findings probably true but subject to falsification	Subjective meanings and social phenomena. Focus upon details of the situation, a reality behind these details, subjective meanings	Observable phenomena and subjective meanings can provide acceptable knowledge. Focus on practical applied research, integrating different perspectives to interpret data
Axiology: Researcher view of the role of values	Research is undertaken in a value-free way, the researcher is independent of data, objective	Research should be undertaken in a value-free way yet true objectivity may not be possible	Research should be undertaken in a value-free way yet true objectivity may not be possible	Values play a large role in interpreting results, the researcher adopting both objective and subjective points of view
Common data collection	Highly structured, large samples, measurement, usually quantitative	Highly structured, large samples, measurement, usually quantitative	In-depth investigations, qualitative interview, focus group, case study, narratives	Mixed or multiple method designs, quantitative and qualitative, expert interviewing, usability testing
Common data analysis	Common data analysis	Controlled experiment, case study, survey	Qualitative thematic analysis phenomenological research, discourse analysis	Mixed – design-based interpretation, lead user testing, Delphi-method, data mining

1.8 Research methodology

The National Framework for Doctoral Education (HEA, 2020) in Ireland commits key stakeholders in Irish graduate education and research to the highest standards in the provision of doctoral education and research through the endorsement of key principles. One of the key principles covers research methodology, which states that "doctoral education significantly increases students' depth and breadth of knowledge of their discipline and develops their expertise in research methodology, which is applicable to both a specific project and a wider context. It provides high-quality research experience, training, and output consistent with international norms and best practice" (HEA, 2020, p. 4). This doctoral study employs several different methodologies that are suitable for a specific project and a wider context that adds value to the overall research aim and objectives of this thesis. Several distinct methodologies were used in this study. Each study had its own constructed and detailed dataset and methodology. Each chapter includes a description of the methodological approach specific to that specific study. Quantitative and qualitative methods were used in this study. However, the analysis was undertaken with a primary focus on quantitative methods. Table 1.3, presents a summary of the methodologies used in each study.

Table 1.3 Summary of methodologies used

Chapter	Title	Database	Sample Size (N)	Method
2	Financing Early Stage Cleantech Firms	Crowdfunding platforms, Crunchbase, Orbis Europe	177	Quantitative – Econometrics – OLS
3	*Born-to-be-Green*: Financing of Cleantech firms in the UK	Beauhurst, Crunchbase, FAME, Orbis Europe, PATSTAT	739	Quantitative – Econometrics – Probit and OLS
4	Environmental Sustainability Reporting for Small and Medium Sized Enterprises: Is the Global Reporting Initiative a feasible approach?	GRI Framework developed. Semi-structured, self-administered survey	203	Qualitative – Survey (Quantitative analysis on responses)
5	The implications of the implementation of the EU Taxonomy for Small to Medium Sized Enterprises	Case study and practical example developed. Semi-structured, self-administered survey	192	Qualitative – Survey (Quantitative analysis on responses)

1.8.1 Data sources and preparation

Chapters 2 and 3 employ data from various databases. Chapter 2 examines firms in the Cleantech sector that have successfully raised equity crowdfunding on platforms in 16 European countries. Each crowdfunding campaign was examined on an individual crowdfunding platform (see Appendix A). All relevant information is obtained for each campaign, such as the amount of equity raised, number of investors, and use of funds. To capture other financial data on these firms, other equity financing raised pre- and post-crowdfunding are examined via the Crunchbase database (previously TechCrunch). Crunchbase is a platform for obtaining business information about private and public companies. It provides intelligent prospecting software powered by live-company data[12]. Crunchbase provides investor insight and equity financing for public and private companies once an equity financing round is disclosed. Therefore, this database provides information on the financing patterns of pre- and post-crowdfunding. In Chapter 3, equity financing data are obtained using Beauhurst. Beauhurst[13], established in 2011, is the leading specialist in providing early stage SME equity financing data in the UK and produces the British Business Bank's annual UK Small Business Equity Tracker reports. The Beauhurst data provide information on external equity funding for Cleantech firms across the UK. This dataset was then cross-referenced with Crunchbase to ensure its completeness.

The firm-specific data for the aforementioned chapters were obtained from the FAME and ORBIS Europe databases, which are both supplied by Bureau van Dijk Moody's. FAME and ORBIS Europe contain accounting information derived from accounts filed through relevant government accounting filing systems, such as the Companies Registration Office (CRO) in Ireland and Companies House (CH) in the UK. The study also draws upon and cross-references firms' patent portfolios using PATSTAT and Espacenet to examine the status of patents granted or pending before and after equity financing. The databases were then merged and cleaned to allow for regression analysis.

Several recent studies in entrepreneurial finance have used Crunchbase to investigate their research hypotheses (Hornuf *et al*., 2018; Walthoff-Borm *et al*., 2018; Kaminski *et al*., 2019; Brown and Rocha, 2020; Eldridge *et al*., 2021). Crunchbase uses a new and innovative method for gathering data. Crunchbase provides up-to-date data on equity funding deals on a global scale that covers types of funding such as: Pre-Seed, Seed, Series, Angel, Private Equity, Convertible Notes, Grants,

[12] Crunchbase - https://www.crunchbase.com/
[13] Beauhurst - https://www.beauhurst.com/

Crowdfunding, and other undisclosed equity financing types. An OECD working paper discusses the use of Crunchbase for research on innovative start-ups and private companies, noting its potential to enrich, expand, and develop relevant economic and managerial literature (Dalle *et al*., 2017). Specifically, this paper notes the rapid discovery of Crunchbase by scholars from different fields to the extent that it has informed studies on specific sectors as well as those of networks in the start-up ecosystem. Dalle *et al*. (2017) suggest that many more valuable avenues for economic and managerial research can be opened through the combination of Crunchbase and selected supplementary data sources. Their study specifically mentions matching Crunchbase with firm-specific variables of patent information through PATSTAT, which was undertaken as part of this thesis. Ferrati and Muffatto (2020), discuss the use of Crunchbase in entrepreneurship research highlighting the usefulness of the database in assessing financing, key personnel, investors, merger and acquisition activities and firm exit data. They also suggest that future research should integrate the information provided by Crunchbase with that collected from other sources. Although this has been partially explored, they suggested that there is scope for future research. The integration of different types of data, together with the use of advanced data-mining techniques, could provide new elements to better understand the key elements of companies (Ferrati and Muffatto, 2020).

The FAME and Orbis Europe databases have been used extensively in a wide range of economic and managerial research. Bureau van Djik Moody's platform provides extensive details on individual private firms. Aside from basic company information, such as location, industry, and activities, the platform provides a breakdown of financial statements. The financial data include balance sheets and profit and loss line items, as well as detailed financial ratios. The FAME database captures firms registered in Ireland and the UK, while Orbis Europe provides information on European firms, including Ireland and the UK.

It should be noted that, as European firms may be required to submit different types of forms or company accounts via their national companies' registration office, some of the key headings may vary from one country to another. Therefore, the Orbis Europe platform has its own standardised financial statement format for comparability purposes. One downside of the Bureau van Djik Moody's platform is the potential incompleteness of data. As firms that do not reach an audit threshold are not required to submit full financial statements, abridged financial statements are uploaded to the CRO or CH, which are subsequently transferred to Bureau van Dijk Moody's platform. Abridged financial statements include a summary balance sheet; therefore, certain firms may not include a detailed breakdown of their income and expenditures. While this has been documented in a number of studies (Coad *et al*., 2017; Cerpentier *et al*., 2021; Eldridge *et al*., 2021),

other studies have alluded to this and work undertaken by Cowling *et al.* (2008) show that missing data in FAME are effectively random, and there is no evidence of any pattern in missing data; therefore, confidence is assured in the FAME databases.

The data was initially cleaned with each excel file downloaded. To work with this data in STATA (version 16), all data must be in a long format, which means that all written letters for missing data, such as (n.a., n.s., etc.) had to be removed. Once this was completed, the individual excel files were saved in a comma delimited format to be ready for import in STATA. Subsequently, it was necessary to construct the variables of interest for this study. For example, dummy variables were created to examine the research questions set out in this study and to increase insight into the testing (for example, setting additional liquidity ratio thresholds or including the specific use of funds in crowdfunding campaign pitches). A list of all the variables included in these studies can be found in Table 2.1 and Table 3.2.

1.8.2 Ordinary least squared regression

Upon cleaning and preparing the dataset to test on STATA, the decision on the model used to test the variables was based on the aims of the research and the specific research questions within this study. Ordinary least squared (OLS) regressions was deemed most appropriate for examining the determinants of: equity crowdfunding (Table 2.5), financing pre-crowdfunding (Table 2.6), financing post-crowdfunding (Table 2.7), equity financing (Table 3.6) and debt financing (Table 3.7). OLS is a common technique for estimating the coefficients of linear regression equations which describe the relationship between one or more independent quantitative variables and a dependent variable (Brooks, 2019). To use OLS, a linear model is required, as is the case in this study.

OLS is the most-used regression estimation technique (Stock and Watson, 2006: Studenmund, 2017) with at least three important reasons for using OLS to estimate regression models (Brooks, 2019): (1) OLS is relatively easy to use, (2) The goal of minimising the summed, squared residuals is a reasonable goal for an estimation technique is quite appropriate from a theoretical point of view, and (3) OLS estimates have a number of useful characteristics. The classical assumptions of an OLS model are: (1) The regression model is linear, is correctly specified, and has an additive error term; (2) the error term has a zero population mean; (3) all explanatory variables are uncorrelated with the error term; (4) observations of the error term are uncorrelated with each other (no serial correlation); (5) the error term has a constant variance (no heteroskedasticity); (6) no explanatory variable is a perfect linear function of any other explanatory variable(s) (no perfect multicollinearity); and (7) the error term is normally distributed (this assumption is optional but usually is invoked).

These assumptions are incorporated into the models used in this study. Accounting-related variables were computed at T-1 and T+1, suggesting that OLS was suitable for this type of dataset. Although a number of variables are closely related, correlation tests do not suggest a high degree of first-order collinearity among the independent variables. The base models included in the testing uses the purely theoretical equation:

$$Y_i = \beta_0 + \beta_1 X_i + \beta_2 X_{2i} + \ldots \varepsilon_i$$

and uses a set of data to create an estimated equation, where ε is the base of a natural log, which can be transformed by taking the natural log of both sides of the equation, which has been incorporated in this study:

$$\ln (Y_i) = \beta_0 + \beta_1 \ln(X_i) + \beta_2 \ln(X_{2i}) + \ldots \varepsilon_i$$

1.8.3 Probit regression

In Chapter 3, a probit model is used to assess the likelihood of raising external equity financing. An OLS model was not used to assess the likelihood of firms raising equity financing, and ultimately to test the pecking order theory hypotheses incorporated in this study, as there are two main problems using OLS to estimate the coefficients of an equation with a dummy dependent variable (Studenmund, 2017). The first problem is that R^2 is not an accurate measure of overall fit. For models with a dummy dependent variable, tells us very little is known about how well the model explains the choices of decision makers. The second problem is that D_i is not bounded by 0 and 1, as D_i is a dummy variable and is expected to be limited to a range of 0 to 1.

The decision then arose between the types of statistical model used to model the binary or dichotomous dependent variables. Probit models are used to predict the probability of the occurrence of an event. The probit model determines the likelihood that an item or event falls into one of a range of categories by estimating the probability that observations with specific features belong to a particular category. In the probit model, the dependent variable is categorical and can only take on one of the two values: yes or no, or true or false. Logit models are used to predict the probability of an event occurring and to model situations in which there are two possible outcomes. The logit model is used to model the odds of the success of an event as a function of the independent variables. For the majority of the applications, the probit and logit models give very similar characteristics of the data because the densities are very similar, with both approaches much preferred to the linear probability model. (Brooks, 2019). Stock and Watson (2006) suggest that the logit approach was traditionally preferred because the function does not require the evaluation of an integral, and thus,

the model parameters could be estimated faster. However, this argument is no longer relevant given that the computational speeds are now achievable, and the choice of one specification rather than the other is now usually arbitrary. Regarding entrepreneurial finance, recent studies on equity crowdfunding have incorporated probit models (Vanacker *et al*., 2017: Walthoff-Borm *et al*., 2018; Eldridge *et al*., 2021).

The probit model is used to determine the likelihood that an item or event belongs to a range of categories by estimating the probability that observations with specific features belong to a particular category (Kumar, 2020). Therefore, this study incorporates a probit model when assessing the likelihood of raising external equity financing (Table 3.5) based on the assumption of the following equation:

$$Pr(Y = 1|X) = \Phi(Z) = Z = \Phi(0 + \beta_1 X_i + \beta_2 X_{2i} + \ldots.. + \beta nXn)$$

The full equations and variables used are specified in the methodology sections of Chapters 2 and 3. The uniqueness of the data used in this study is clear. Although policy documents and recent studies have called for the integration of Crunchbase with other sources, this study is the first of its kind to incorporate several sources into a given dataset for equity crowdfunded Cleantech firms. The information used in Chapters 2 and 3 was obtained via Crunchbase, Beauhurst, FAME, Orbis Europe, PATSTAT, Espacenet, and individual crowdfunding platforms. This is a contribution of this study and paves the way for future research in entrepreneurial finance using big data and the integration of a number of open-source databases.

1.8.4 Survey

Chapters 4 and 5 incorporate semi-structured, self-administered surveys distributed via Survey Monkey. The items used in the survey served to gather both qualitative and quantitative data but are primarily quantitative items and hence are consistent with the overall quantitative methodologies employed herein. In both studies, unique frameworks and case studies were designed to form part of the discussion in focus groups for SMPs. Chapter 4 focuses on ESR for SMEs where an amended version of the Global Reporting Initiative (GRI) was designed (Table 4.1) to share with SMPs in advance. In designing the research instrument, it was considered more fruitful to present the SMPs with a proposed sustainability reporting framework, rather than asking questions in the abstract about the perceived challenges, opportunities and cost of implementing sustainability reporting. This approach has two advantages: (1) a proposed framework which can be used (or form the basis) for sustainability reporting, and (2) SMPs' responses are based on a specific objective framework, eliminating the potential for subjective views on the feasibility of sustainability reporting.

Chapter 5 takes a similar approach but along with the proposed framework, also incorporates a case study to highlight the practical implications of implementing the Taxonomy for SMEs. The focus group participants were presented with two real-life case studies and an accompanying framework (Tables 5.1a and 5.1b) to assess their opinion on the implications for SMEs via a semi-structured survey. These case studies provided participants with a basic overview of the practicalities of the Taxonomy and how SMEs may report their alignment. As part of this study, and with particular focus on Chapters 4 and 5, all major Professional Accountancy Bodies in Ireland engaged in focus groups and assisted with hosting virtual focus groups and CPD sessions for their members.

Due to the fact the Green Deal and the reporting requirements are relatively new and ever changing, it was decided to derive frameworks and illustrative case studies relevant to the sample population. These were used to inform participants prior to their completion of the surveys to ensure that they were sufficiently literate in the relevant standards and regulations. This ensured reliable responses and enhanced the validity of the survey instrument employed. Following this, detailed consultation of the literature on survey design and distribution was conducted. After consulting Kervin (1999), Dillman (2000), Fink (2003a, 2003b), deVaus (2002), Ghauri and Grønhaug (2005), Dillman *et al*. (2014), Stern *et al*. (2014), Saunders *et al*. (2015), Dilman (2017) and Dilman (2022) a decision was made regarding the best survey collection method. To capture survey responses the literature guided the sample selection process. Again, because the Green Deal and sustainability reporting are in their infancy, seeking the views of SMPs is more beneficial than seeking the views of SME management who have little reporting experience (Rinaldi *et al.*, 2018; IFAC, 2021). However, due to the ever-changing regulatory scenario surrounding ESR, it was suggested that perhaps respondents may not have the sufficient knowledge or expertise on this area if it proposed to seek survey responses via email (Witmer *et al*., 1999; Dillman, 2000; Dillman *et al*., 2014), telephone (Saunders *et al*., 2015) or structured interviews (Saunders *et al*., 2015; Dillman, 2017). Dillman (2000) suggests that if respondents have insufficient knowledge or experience, they may deliberately guess the answer, a tendency known as an uninformed response. This is particularly likely when the questionnaire was incentivised. This was particularly relevant in this case, as the majority of SMP participants obtained continuous professional development (CPD) hours for engaging in the focus group and survey. Dillman *et al*. (2014) also stated that respondents to self-administered questionnaires are relatively unlikely to answer the researcher, or because they believe certain responses are more socially desirable. Drawing on Stern *et al*. (2014), Saunders *et al*. (2015), and Dilman (2017), we implemented 'different modes for different survey situations'. Due to COVID-19, the opportunity to engage in online focus groups and workshops became quite appealing, presenting an opportunity to obtain high response rates. Stern *et al.* (2014) proposed that a solution

to the current challenges associated with individual mode surveys is to recruit panels of respondents who agree to complete a series of surveys over the Internet as part of their focus groups. Dillman (2022) highlighted the impact of COVID-19 on survey collection and future opportunities and challenges. Online workshops and survey collections present a new and innovative method of survey collection (Dillman, 2022).

Contact was made with all major professional accountancy bodies in Ireland (Chartered Accountants Ireland, ACCA Ireland, CPA Ireland, and CIMA Ireland) to engage their members in focus groups. As part of the focus groups, the current ESR regulatory landscape including current EU level and global initiatives, was discussed and practical illustrative examples of the different ESR frameworks presented. The frameworks and case studies developed as part of this research were presented, and a walk-through was undertaken. Following this, they were instructed to participate in the survey, which was circulated in advance and through the Zoom chat function, and administered via SurveyMonkey. This led to increased engagement and a high completion rate among participants. This method of survey collection is quite unique as participants were briefed on the background to ESR and presented with a real-life scenario.

The survey design undertaken as part of this study was guided by the works of Ghauri and Grønhaug (2005), Dillman (2000, 2014), Dillman *et al*. (2017), and Stern *et al*. (2017). Robson (2002) stated that surveys work best with standardised questions that will be interpreted in the same way by all respondents. Most questionnaires included a combination of open and closed questions. Open questions, sometimes referred to as open-ended questions (Dillman, 2000), allow respondents to provide answers in their own way (Fink, 2003a). Closed questions are sometimes referred to as closed-ended questions (Dillman, 2000) or forced-choice questions (DeVaus, 2002). The survey also included ranking questions, but as studies suggest, may deter respondents due to the effort required, such that the number of items to be ranked should not exceed eight, and survey design should keep this length or shorter (Kervin, 1999). A breakdown of the survey questions is provided in Appendices B and C, respectively.

Bell (2005), Dillman *et al.* (2014), and Saunders *et al.* (2015) highlight the importance of pilot testing a project because, without a trial run, there is no way of knowing if a survey will succeed. A pilot survey was conducted in collaboration with ACCA Ireland. First, a pilot for Chapter 4 was conducted with an SMP network group (Midlands SMP network) on the 26th August 26, 2021. Second, a pilot for Chapter 5 was undertaken with another SMP network group (the Dublin City SMP network) on 3rd March 2022. Consistent with the advice of Saunders *et al.* (2015), the pilot focus

groups provided further validation (Saunders *et al*., 2015) of the studies and provided insight into the opinions of SMPs and the feasibility of the survey, including the suggested completion time.

1.8.5 Robustness and multicollinearity

In statistical and quantitative analysis, there can be several issues when running tests such as multicollinearity, heteroscedasticity and endogeneity. Therefore, it is essential to undertake additional robustness tests and checks for any issues surrounding statistical errors with the data. Multicollinearity is a statistical concept where several independent variables in a model are correlated. Two variables are perfectly collinear if their correlation coefficient is +/- 1.0. Multicollinearity among independent variables will result in less reliable statistical inferences. It is advisable to run robustness checks to assess the level of collinearity between different variables.

To test multicollinearity there are several methods that can be incorporated. A Correlation Coefficient Matrix table can be developed that displays the correlation coefficients for different variables. The matrix depicts the correlation between all the possible pairs of values in a table. It is good to summarise large datasets and to identify and visualise patterns in the given data. A correlation matrix consists of rows and columns that show the variables. Each cell in a table contains the correlation coefficient. Correlation coefficient matrix for Chapter 2 and 3 are included in the Appendices B and D. In terms of understanding the meanings of the correlation coefficient matrix, it can be summarised as having a value between -1 and 1 where: -1 indicates a perfectly negative linear correlation between two variables; 0 indicates no linear correlation between two variables; and 1 indicates a perfectly positive linear correlation between two variables. Therefore, the further away the correlation coefficient is from zero, the stronger the relationship the two variables. Ideally, the closer to zero the correlation coefficient is, there will be no multicollinearity issues when undertaking tests.

Another method to check multicollinearity is to undertake a Variance Inflation Factor (VIF). A VIF provides a measure of multicollinearity among the independent variables in a multiple regression model. Detecting multicollinearity is important because while multicollinearity does not reduce the explanatory power of the model, it does reduce the statistical significance of the independent variables. A large VIF on an independent variable indicates a highly collinear relationship to the other variables that should be considered or adjusted for in the structure of the model and selection of independent variables. This test is performed following regression analysis and will show the levels of multicollinearity between variables. The formula for VIF is: Where R_i^2 represents the unadjusted coefficient of determination for regressing the i^{th} independent variable

on the remaining ones. When R_i^2 is equal to 0, and therefore, when VIF or tolerance is equal to 1, the i^{th} independent variable is not correlated to the remaining ones, meaning that multicollinearity does not exist. In terms of understanding the VIF, it can be summarised as follows: VIF equal to 1 = variables are not correlated; VIF between 1 and 5 = variables are moderately correlated; and VIF greater than 5 = variables are highly correlated. The higher the VIF, the higher the possibility that multicollinearity exists, and further research is required. When VIF is higher than 10, there is significant multicollinearity that needs to be corrected. VIF's for Chapter 2 and 3 are included in the Appendices C and E. In this study, both Correlation Coefficient Matrixes and VIF's have been conducted and show no high level of multicollinearity, any issues have been noted in Chapters 2 and 3.

Other issues in regression analysis that may occur are heteroskedasticity and endogeneity. Heteroskedasticity refers to situations where the variance of the residuals is unequal over a range of measured values. When running a regression analysis, heteroskedasticity results in an unequal scatter of the residuals, also known as the error term. When observing a plot of the residuals, a fan or cone shape indicates the presence of heteroskedasticity. This can be seen as a problem because regressions involving OLS assume that the residuals are drawn from a population with constant variance. If there is an unequal scatter of residuals, the population used in the regression contains unequal variance, and therefore the analysis results may be invalid. There are a number of methods to fix heteroskedasticity and these include: transform the dependent variable; redefine the dependent variable; and use a weighted regression. In Chapters 2 and 3, the dependent variable is transformed and is included at the log number. This is incorporated across all models within these Chapters.

Endogeneity is another issue that can arise in quantitative analysis. An endogenous variable is a variable in a statistical model that's changed or determined by its relationship with other variables within the model. An endogenous variable is synonymous with a dependent variable, meaning it correlates with other factors within the data. Therefore, its value may be determined by another variable. In this study, it is quite important to be aware of endogeneity as there are a several accounting related variables that form part of the same variable, such as retained earnings, share capital, other reserves. To combat any issues of endogeneity, each variable is completely separated from each other in Chapters 2 and 3 and therefore all accounting variables are completely standalone variables and should not be determined by its relationship with another variable.

Throughout the regression analysis in this study, additional multicollinearity testing is undertaking to included Correlation Coeffiecient Matrixes and VIFs.

1.8.6 Innovation in methodological approach

As highlighted thus far, one of the contributions of this study is the uniqueness of the methodological approach undertaken, including the distinct methods used across different studies. As stated in recent OECD discussion papers (Dalle *et al*., 2017), academic researchers were called upon to include several sources when utilising the Crunchbase database, which has been integrated and implemented in this study. Studies have repeatedly highlighted the benefits of big data in quantitative research (Saunders *et al*., 2015; Frizzo-Barker *et al*., 2016; Wang *et al.*, 2018) including the incorporation of several different sources, particularly in entrepreneurship research (Ferrati and Muffatto, 2020). Incorporating several different sources provides greater insights and the ability to undertake deeper analyses (Dalle *et al*., 2017; Frizzo-Barker *et al*., 2016; Ferrati and Muffatto, 2020). Upon merging all relevant information, including detailed cleaning of the database, a number of models and hypotheses were tested using OLS regression (Chapters 2 and 3), and a probit regression was employed (Chapter 3).

Second, studies have highlighted the changing nature of surveys and the value of online surveys (Fowler Jr, 2013; Evans and Mathur, 2018) stating that survey techniques are still regularly transformed by new technologies and suggest that hybrid surveys will be widespread in the future. They discussed the role of alternative methods for collecting survey responses. Kitzinger (1995) introduced focus groups as a key method in qualitative research, setting out the benefits that allow researchers to look beyond facts and numbers, while also obtaining a greater number of opinions than that of individual detailed interviews. However, there can be disadvantage of focus groups due to 'groupthink', dishonest responses and difficult to capture a cross-section of society depending on the target demographic or group of individuals (Folwer Jr, 2013). Recent studies by Ochieng *et al*. (2018) and Gundumogula (2020) have once again set the importance of focus groups in qualitative research. The role of online focus groups has developed significantly in recent years, particularly due to COVID-19. Several benefits are stated as part of online focus groups. First, it enhances access to participants suitable for a particular topic. Second, it offers convenience to the participants, increasing the likelihood of survey completion. Third, consistent with the theme of the study, it reduced participants' carbon footprint by avoiding transportation. Finally, focus group discussions can be recorded and documented easily (Gundumogula, 2020).

The studies undertaken in this thesis highlight the innovative approach adopted to collect survey responses. A hybrid approach was undertaken where focus group participants engaged in a practical workshop and their opinions were provided via a survey. Another unique step in this approach is to design a specific objective framework and practical case study, eliminating the

potential for subjective views on the feasibility of sustainability reporting. Due to the large response rate and fully completed survey responses across both surveys, inferences drawn from descriptive statistics and tests for variance in the samples may be made with relatively strong certainty.

As with any study, there may be limitations to the methodological approach implemented. Potential limitations have been addressed by cross-referencing open-source external financing databases. Due to the early stage nature of ESR, focus groups and large response rates are more fruitful than interviews, as it would be difficult to achieve consistency in the quality of data collected through interviews. This problem was avoided using an objective case study, and the proposed framework was presented to participants as part of an online focus group rather than subjective views on feasibility.

Overall, this thesis incorporates a number of different methodological approaches to achieve the research aim and objectives. Innovative approaches have been undertaken that provide greater insight and analysis that have an impact on theory and policy.

1.9 The structure of the thesis

This thesis is structured in the form of four linked studies. Each study has its own constructed and detailed sample and methodology. The structure is as follows: Chapter 2, titled *Financing Early Stage Cleantech Firms* analyses the financing of firms in the Cleantech sector that have successfully raised equity crowdfunding on platforms in 16 European countries. This study finds that firms with lower total assets and higher cash balances raise greater amounts of crowdfunding. In the pre-crowdfunding period, illiquid firms raise less finance and firms with greater assets raise more debt. In the post-crowdfunding period, crowdfunded firms raise significantly greater amounts of external equity suggesting signalling effects. This study highlights the ameliorating liquidity effects of crowdfunding, which are especially important for early stage firms developing new technologies.

The second stage of the research on Cleantech firms examines the financing of UK based Cleantech firms, examining the role of equity financing while drawing on the pecking order theory. This is documented in Chapter 3 entitled *Born-to-be-Green: Financing of Cleantech firms in the UK*. This chapter investigates the financing of 739 Cleantech firms in the UK that have recently raised equity financing. Small and Medium Sized Cleantech firms raise external equity because of financial constraints and ameliorate illiquidity. This study also provides evidence that intangibility does not play an important role in raising equity financing and discusses the role of IAS38 in Cleantech firms. This study provides evidence that software-led Cleantech firms raise greater amounts of financing than hardware-led firms. The study then provides further evidence of the potential equity gap for long

horizon, capital-intensive and complex innovative hardware-led Cleantech firms. In addition, the study provides recommendations for the need for the government and large corporations to provide long horizon, deep pocket investment to assist Cleantech firms to reach commercialisation.

Chapters 4 and 5 tie into the 'enabling frameworks' set out by the EU Green Deal on firms reporting sustainability activities with a focus on SMEs. Chapter 4, titled *Environmental Sustainability Reporting for Small and Medium Sized Enterprises: Is the Global Reporting Initiative a feasible approach? The Small and Medium Sized Accounting Practitioners perspective,* investigates the feasibility and ultimate financial implications of the use of environmental sustainability reporting by SMEs. This chapter analyses the views of 203 Small and Medium Sized accounting Practitioners (SMPs) on a proposed reporting framework, which is based on the Global Reporting Initiative Framework. Interestingly, this study finds that the greatest perceived benefit for firms adopting environmental sustainability reporting is an improved company image. Respondents detailed the financial and resourcing implications for SMEs, providing an estimate of additional costs. A significant perceived impediment in implementing sustainability reporting is the lack of knowledge and training, not only for SMEs but also for accounting professionals. Respondents validated the metrics used in the framework provided, and while sustainability reporting is not yet mandatory for SMEs, this study suggests policy and practical implications for its adoption.

Adopting a different methodological approach, Chapter 5 examines the implementation of the EU Green Taxonomy and its implications for SMEs. Chapter 5, titled *The implications of the implementation of the EU Taxonomy for Small to Medium Sized Enterprises*, investigates the feasibility of implementing the Taxonomy for SMEs and assesses the prospective consequences that may accrue from the provision of Taxonomy disclosures. This study analyses the views of 192 SMPs by adopting a novel methodological approach which has enabled the exploration of research questions by engaging participants with the topic in a unique manner using case studies. This study suggests that SMPs believe that the requirements within the Taxonomy are feasible for SMEs to report on, but highlight the requirement for resourcing supports as the costs of implementation are significant, and current IT systems appear incapacitated to capture and manage the requisite data. Overcoming cost- and resource-related obstacles is central to its broad adoption. Government grants and incentives appear attractive to many SMPs as a means of assisting SME clients with Taxonomy implementation. Evidence also suggests an important role for education in accelerating Taxonomy adoption. The study finds that a major non-regulatory benefit yielded by Taxonomy implementation may be the reduction in costs and potential savings for businesses. This study is positioned within

legitimacy theory and find evidence to support its contentions but air caution regarding the potential for greenwashing to skew the reliability of Taxonomy disclosures.

1.10 Key findings from the research

The key findings of the research undertaken in this thesis are as follows:

- Firms with lower total assets and higher cash balances raise more crowdfunding.
- In the pre-crowdfunding period, illiquid firms raise less finance and firms with greater assets raise more debt.
- In the post-crowdfunding period, crowdfunded firms raise significantly greater amounts of external equity, suggesting signalling effects.
- Crowdfunding ameliorates liquidity effects, which are especially important for early stage firms that develop new technologies.
- There is a potential equity gap for long-horizon, capital-intensive, hardware-led Cleantech firms.
- Cleantech firms are financed consistent with the pecking order theory, except on intangible assets.
- The role of intangibility and IAS 38 is highlighted in this study, finding that firms with higher levels of intangible assets raise debt, and firms with lower levels of intangible assets raise equity.
- Software-led Cleantech firms are more likely to raise greater amounts of equity funding.
- Patient capital is required for long-term, capital-intensive, and complex innovative hardware-led Cleantech firms.
- SMPs believe that the GRI framework is feasible for SMEs, but there are several concerns about costing and resourcing.
- SMPs believe the perceived benefit of firms that adopt environmental sustainability reporting is an improved company image.
- A significant perceived impediment in implementing sustainability reporting is the lack of knowledge and training, not only for SMEs but also for accounting professionals.
- SMPs believe that the requirements within the Taxonomy are feasible for SMEs to report on, but highlight the requirement for resourcing support as the costs of implementation are significant, and current IT systems appear inadequate to capture and manage the requisite data.

- Government grants and incentives appear to be attractive to many SMPs as a means of assisting SME clients with Taxonomy implementation.
- A major non-regulatory benefit yielded by Taxonomy implementation may be the reduction in costs and potential savings for businesses.
- Education and the role of professional accountancy bodies are essential for accelerating Taxonomy adoption.

1.11 Output from this research to date

One study from this thesis has been accepted for publication in The Institute of Electrical and Electronics Engineers (IEEE) Transactions on Engineering Management (ABS3). This publication formed part of the IEEE Transactions on Engineering Management special issue on Entrepreneurial Finance for Green Innovative SMEs. In addition to this, the three other studies have been accepted for and peer-reviewed for a number of international accounting and finance conferences. The peer-review process including presentations has helped critique and advance the research in this thesis. The following details the published paper based on Chapter 2, papers currently under review in peer-reviewed journals, and conferences in which each of the studies were presented are based on Chapters 3 through 5.

Journal Publications

- S. O'Reilly, C. Mac an Bhaird and D. Cassells (2021). Financing Early Stage Cleantech Firms. *IEEE Transactions on Engineering Management*. Available at: https://doi.org/10.1109/TEM.2021.3095373
- O'Reilly, S. and Mac an Bhaird, C. (2022). Patents, Innovation and Growth Opportunities: Evidence from Crowdfunded European Cleantech Firms. *International Review of Entrepreneurship. (June 2022 – revise and resubmit).*
- O'Reilly, S., Mac an Bhaird, C., Gorman, L. and Liu, Z. (2022). Environmental Sustainability Reporting for Small and Medium Sized Enterprises: Is the Global Reporting Initiative a feasible approach? The Small and Medium Sized Accounting Practitioners perspective. *Accounting Forum, Under Review (May 2022).*
- O'Reilly, S., Mac an Bhaird, C. and Gorman, L. (2022). The implications of the implementation of the EU Taxonomy for Small to Medium Sized Enterprises. *Accounting Forum, Special Issue on the EU Green Taxonomy, Under Review (July 2022).*

Conferences

- O'Reilly, S., Mac an Bhaird, C., Gorman, L. and Liu, Z. (2022), Environmental Sustainability Reporting for Small and Medium Sized Enterprises: Is the Global Reporting Initiative a feasible approach? The Small and Medium Sized Accounting Practitioners perspective.

Academy of Sustainable Finance, Accounting, Accountability & Governance, 2nd Annual Conference, Istanbul Medipol University, Turkey, 25 June 2022. (Online).

- O'Reilly, S., Mac an Bhaird, C., Owen, R. and Lodh, S. (2022), Born-to-be-Green: Financing Cleantech Firms in the UK. *Academy of Sustainable Finance, Accounting, Accountability & Governance, 2nd Annual Conference,* Istanbul Medipol University, Turkey, 25 June 2022. (Online).
- O'Reilly, S., Mac an Bhaird, C. and Gorman, L. (2022), The implications of the implementation of the EU Taxonomy from the perspective of Small to Medium Sized Enterprises, *Irish Accounting & Finance Association 34th Conference,* Maynooth University, 9 June 2022.
- O'Reilly, S., Mac an Bhaird, C., Owen, R. and Lodh, S. (2022), Born-to-be-Green: Financing Cleantech Firms in the UK. *ISBE Entrepreneurial Finance Special Interest Group,* Birmingham City University, 19 May 2022.
- O'Reilly, S. and Mac an Bhaird, C. (2021), Environmental Sustainability Reporting: A proposed framework for Irish Small to Medium Sized Accounting Practitioners. *CSEAR Ireland Conference, Building Back for the Common Good*, University of Limerick, 22 October 2021. (Online).
- O'Reilly, S., Mac an Bhaird, C. and Cowling, M. (2021). High-Growth Firms: The tortoise and the hare. *Journal of Business Venturing Special Issue on Scaling Firms Paper Development Workshop*, 21 September 2021. (Online).
- O'Reilly, S. and Mac an Bhaird, C. (2021). Integrated Reporting for Irish SMEs: The role of the SMP**.** *Business Strategy and the Environment Paper Development Workshop*, 4 June 2021. (Online).
- O'Reilly, S. and Mac an Bhaird, C. (2021). Do firms with patents attract more crowdfunding: Evidence for European Cleantech firms**.** *ISBE Entrepreneurial Finance Special Interest Group,* 2 June 2021. (Online).
- O'Reilly, S. and Mac an Bhaird, C. (2020). Financing Early Stage Cleantech Firms: Ex-Ante and Ex-Post Crowdfunding**.** *ISBE Annual Conference,* 11 November 2020. (Online).
- O'Reilly, S. and Mac an Bhaird, C. (2019). Crowdfunded Cleantech Firms: Evidence from European Platforms. *ISBE Annual Conference,* Newcastle, 15 November 2019.
- O'Reilly, S. and Mac an Bhaird, C. (2019). Resourcing High-Growth Firms. *ISBE Annual Conference,* Newcastle, 15 November 2019.
- O'Reilly, S and Mac an Bhaird, C. (2019). Crowdfunded Cleantech Firms: Evidence from UK Platforms. *ISBE Entrepreneurial Finance Special Interest Group*, Birmingham City University, 27 September 2019.
- O'Reilly, S. and Mac an Bhaird, C. (2019). Financing Cleantech Firms: Evidence and Issues from Public Venture Capital. *ISBE Special Interest Group*, Kingston University London, 20 June 2019.

Chapter 2: Financing Early Stage Cleantech Firms.

2.1 Introduction

The report by the Intergovernmental Panel on Climate Change (IPPC, 2018) highlighted the need to reduce greenhouse gas emissions and strive for decarbonisation in order to restrict global warming. The Paris Agreement, a legally binding international treaty on climate change, has a vision of accelerating technology development and transfer (United Nations, 2015) in order to reduce harmful carbon emissions. Development of new and innovative disruptive technologies to ameliorate and reverse the harmful effects of carbon emissions is emphasised by governments and international agencies (Bailey and Tatikonda, 2018; Lee *et al*., 2015; Lerner, 2010; Zhang *et al*., 2019). Large incumbent firms are well resourced to conduct this Research and Development (R&D), although small early stage ventures also play a significant role in innovation and invention (McDaniels and Robins, 2017; Owen *et al.*, 2018). New enterprises have advantages of agility, testing and implementing new business models quickly (Owen *et al*., 2018) although they typically lack sufficient resources to develop and scale their business successfully (Ghosh and Nanda, 2010; Giudici *et al*., 2018; Hornuf and Schweinbacher, 2018a; Josefy *et al*., 2017).

Cleantech firms commercialise clean energy technologies, which entails developing, integrating, deploying, or financing new materials, hardware or software, focused on energy generation, storage, distribution, and efficiency (Gaddy *et al*., 2017). Many of these firms are in the early stages of development. In the UK, for example, firms less than 5 years old constitute 90 per cent of all Cleantech enterprises (Marra *et al*., 2015). This study defines early stage Cleantech firms as private for-profit Small and Medium Sized Enterprises (SMEs) less than 5 years old whose aim is to develop and adopt innovative technologies to reduce carbon dioxide emissions in their products and processes (Kenton, 2018). The sample of Cleantech firms operate in the Energy Efficiency, Recycling and Waste Management, Renewable Energy and Transportation sectors.

Notwithstanding criticism of the lack of urgency of governments in addressing climate change (Owen *et al*., 2020; Rizos *et al*., 2016), the public sector has promoted investment in green technologies (Mazzucato and Semieniuk, 2018), a notable factor in increasing investment in the Cleantech industry, which peaked at $301.7 billion globally in 2020 (Statista, 2020). Considerable focus has been on larger scale projects funded by governments, such as developing Green Investment Banks and tackling larger infrastructural renewable energy projects, including wind farms (Mazzucato and Semieniuk, 2018). By contrast, the financing requirements of early stage firms developing innovations in the Cleantech sector (Owen *et al.*, 2018, McDaniels and Robins, 2017;

Rowlands, 2009) have received less attention. There is a lacuna in the literature on empirical studies on financing new low-carbon businesses and innovations (Bocken, 2015; McDaniels and Robins, 2017; Rizos *et al.*, 2016). While access to finance is a common obstacle for start-up firms, Cleantech start-ups experience particular challenges in raising finance (Ghosh and Nanda, 2010; Mazzucato and Semieniuk, 2018). Firstly, Cleantech firms may have long horizon Research and Development (R&D), subsequently struggling to obtain sufficient levels of patient private investment to reach commercialisation. This is exacerbated if the capital requirement is large (BEIS, 2017; Owen *et al.*, 2019; Rowlands, 2009). Secondly, information asymmetries of start-up firms are particularly acute because of newness and lack of a credit or trading history (Mac an Bhaird and Lynn, 2015) and this is especially severe for Cleantechs. Thirdly, it is difficult to value new, untested technologies and intangible assets which have high obsolescence rates, with unpredictable future success rates. Investors thus view early stage Cleantech investment as particularly risky (Lehner, 2016; Polzin, 2017).

Crowdfunding has emerged as a new source of external equity finance that plays an increasingly important role in the financing of young entrepreneurial firms (Ahlers *et al.*, 2015; Bruton *et al.*, 2015; Cumming and Vismara, 2017), and has a particular impact on growth opportunities (Eldridge *et al.*, 2019). The Crowdfunding market has increased dramatically over the last decade (Statista, 2020), second only to venture capital in number of deals completed in 2020. The European Equity Crowdfunding market was valued at $2.3 billion in 2020 (Statista, 2020) of which $189 million was directly attributable to Cleantech firms. According to the Crunchbase database, 2,967 equity crowdfunding campaigns between 2014 and 2019. 177 of these were Cleantech firms, representing 5.9% of all equity crowdfunding campaigns. The number of Cleantech firms engaging in equity crowdfunding in Europe rose from 8 firms in 2014 to 51 firms in 2019. It is anticipated that this will continue to grow rapidly in the future with the global crowdfunding market expected to reach $40 billion by 2026 (Statista, 2020).

This study focuses on these 177 early stage Cleantech firms that have raised funding through European Equity Crowdfunding platforms. The aim of this study is to obtain a deeper understanding of the financing of crowdfunded European Cleantech firms, which is investigated by posing the following research questions: (1) What are the potential determinants of the amount raised in Cleantech equity-crowdfunding?; (2) What are the potential determinants of debt and equity funding in the pre-crowdfunding period?; and (3) What are the potential determinants of debt and equity funding in the post crowdfunding period?. A novel contribution of this study is that it examines the potential effect of accounting ratios on the financing of Cleantech firms. This study seeks to

contribute to the understanding of financing early stage Cleantech firms by analysing the financing of firms that have successfully raised equity crowdfunding for the first time. A novel feature of this study is that it investigates the potential influence of accounting metrics on financial decision-making pre and post-crowdfunding.

In Section 2.2 a review the related previous literature on crowdfunding and the financing of Cleantech firms is undertaken. In Section 2.3, the methodological approach is discussed. In Section 2.4, results are discussed and major findings of this study. Finally, Section 2.5 provides suggestions on any possible practical implications for Cleantech firms, investors and policymakers are discussed.

2.2 Previously related literature

2.2.1 Financing Cleantech

Essential to the development of new low-carbon businesses and innovations is an understanding of their resourcing requirements (Criscuolo and Menon, 2015; Huhtala, 2003; Rizos *et al*., 2016). Cleantech firms differ slightly from other for profit-SMEs insofar as on top of their commercial goal is the goal to develop innovative technologies that aim to reduce CO2 emissions in their products and processes (Kenton, 2018). The financing gap is a greater problem for the diverse forms of Cleantech ventures which are capital intensive, have a high technology risk profile and uncertain exit opportunities for investors (Ghosh and Nanda, 2010; Hamilton, 2016; OECD, 2011; Parhankangas and Renko, 2017; Scoones *et al*., 2015). Early stage Cleantech firms are considered particularly vulnerable as they often exhibit long horizon intensive R&D with long *valley of death* periods spanning proof of concept to early commercialisation Mazzucato and Semieniuk, 2018. Additionally, they suffer from a higher *liability of newness* compared with other new ventures (Lehner *et al*., 2018; Lehner and Nicholls, 2014), because of hybrid business-models (Quélin *et al*., 2017) that aims to combine commercialisation with an environmental mission (Doherty *et al*., 2014). Since investors may not be rewarded for the full environmental-societal value, the risk-reward balance is often viewed as unfavorable (Bak, 2017; Bocken, 2015; Owen *et al*., 2018). As a result, there is resource-scarcity in these ventures with large funding-gaps within these firms (BEIS, 2017; Lehner, 2016). Kaminker and Stewart (2012) question the role of institutional investors in financing clean energy and state the lack of suitable investment vehicles providing the risk-return profile investors require, suggesting that pension funds could provide patient capital required for such long-term projects. Gaddy *et al.,* (2016), suggests that venture capital is the wrong model for energy innovation due to the long horizon of such projects and the return venture capital requires. Owen *et al.,* (2020), argue that Cleantech SME innovation financing should be an essential cornerstone of

policies to tackle climate change, since they have the potential to develop significant technologies to address future low-carbon economic requirements if they can successfully scale their business model (Lerner, 2010; Lerner, 2012a; Owen *et al.*, 2019; Popp, 2012). The need for a clear research and policy agenda to assist early stage Cleantech financing has never been greater (Owen *et al*., 2020).

2.2.2 Crowdfunding

Crowdfunding has emerged as a new source of external equity finance that plays an increasingly important role in the financing of young entrepreneurial firms (Drover *et al*., 2017; Short *et al*., 2017; Vasileiadou, 2016). Equity crowdfunding is a form of financing in which entrepreneurs make an open call for funding on the Internet, hoping to attract a large group of investors. The open call and the investments take place on an online platform that provides the means for the transactions (Ahlers *et al*., 2015).

Crowdfunding in a variety of forms has greatly increased in use in the past decade (Harrison 2013; Lehner, 2014; Vasileiadou, 2016). Following continued growth, the global equity crowdfunding market expanded to $13.9 billion in 2019 (Cambridge Centre for Alternative Finance, 2020). Studies show it is important to differentiate between different crowdfunding types, including donation, peer-to-peer lending-based, reward-based and equity-based crowdfunding (Fleming and Sorenson, 2016; Mazzucato and Semieniuk, 2018; Vismara, 2016), because the crowds motives to back a campaign are significantly different between these crowdfunding types (Cholakova and Clarysse, 2015; Cumming and Johan, 2013). Each type of crowdfunding has certain needs of the startup or project initiator (Mollick, 2014). Studies have increasingly examined the crowdfunding phenomenon which has primarily focused on the factors that lead to success on crowdfunding platforms (Chan and Parhankangas, 2017; Courtney *et al*., 2017; Cumming *et al.*, 2016; Davis *et al*., 2017; Hornuf and Schweinbacher, 2018b; Moreno-Moreno *et al.*, 2019; Skirnevskiy, 2017).

This study focuses on equity-based crowdfunding, which entails investors pledging or investing money to become a beneficial shareholder of that company, and receive the returns and the risks associated with being an equity shareholder. This coincides with other studies on crowdfunding which solely focuses on equity-based crowdfunding (Ahlers *et al*., 2015; Signori and Vismara, 2018) due to the fact investor motivates are different between donation-based and reward-based to that of equity-crowdfunding. Previous research highlights that equity-based crowdfunding platforms raise more than reward-based platforms (Vulkan *et al*., 2016). The Cleantech firms analysed are those providing shares in return for investment. The funding model on platforms examined are known as

'all or nothing' models of equity crowdfunding, where the firm sets a fundraising goal and only receive investment if the total funding target is achieved.

2.2.3 Crowdfunding in Cleantech

Owen *et al*. (2020), suggest that while crowdfunding is viewed as an important financing method within both developed and developing countries' innovation and finance ecosystems (Hörisch, 2015; Lam and Law, 2016), its potential is not sufficiently used in the context of environmentally oriented ventures. Whilst there have been a number of studies on Cleantech and sustainable ventures in relation to other forms of crowdfunding such as reward-based (Adhami, *et al*., 2017; Bonzanini *et al*., 2016; Cumming *et al*., 2017), there is scant amount of research undertaken on equity crowdfunding in Cleantech.

Specific to Cleantech firms, Cumming *et al*. (2017), examined a reward-based platform, Indiegogo, and found that Cleantech crowdfunding is negatively related to individualism and is more common when oil prices are rising. Bonzanini *et al*. (2016) examined crowdfunding of renewable energy projects across 13 different platforms on different types of crowdfunding. Their study explored the determinants of the campaign success. Bento *et al*. (2019a), using a reward-based platform, Kickstarter, also examined the extent specific project characteristics influence the ability to raise funds on a reward-crowdfunding platform and to explain their survival post-campaign, which showed an average survival rate over 70% after one year of operations suggesting the supporting sustainability effects of crowdfunding. Adhami *et al*. (2017), examined a number of different specialised 'green' platforms across Europe but did not focus solely on one type of crowdfunding. They found significantly positive effects of green crowdfunding activity on two different indexes of environmental performance and wellbeing at the local level. Bento *et al*. (2019b), assessed the risk and returns of crowdfunding across 17 different platforms but did not focus solely on one type of crowdfunding. They found that technological risks contribute to decreases in the excess of returns of the projects and countries' technological capacity and cultural dimensions explain variances in returns. They also concluded that larger average investments are associated to projects with superior return/risk profiles. Analysing Peer-to-Peer lending platforms in France, Slimane and Rouseau (2020), assessed the success factors of crowdfunding campaigns for renewable energy projects. Vismara (2019), finds that that being a sustainability-orientated firm does not increase the chances of success or of engaging professional investors, although it attracts a higher number of restricted investors. There is a significant gap in the crowdfunding and Cleantech literatures of firm specific analytic studies, and this study addresses this lacuna. It is worth noting that there are specific crowdfunding platforms that allow investment in "Green" projects only. However, these platforms

are crowdlending and reward-based crowdfunding which differs from equity crowdfunding in the motivations of investors (2017). Cleantech firms are somewhat unique in equity crowdfunding platforms in that they make up a small percentage of overall campaigns, this could be due to the large capital outlay that Cleantech firm's experience in their early stage development which can be off-putting for investors. Investment in the Cleantech industry is growing rapidly (Statista, 2020), and from this study also find that there has been an increase in the amount of European early stage Cleantech firms turning to equity crowdfunding as an alternative source of financing.

2.2.4 Accounting information in crowdfunding

While most campaigns must disclose financial performance information including future forecasts, there is limited research on disclosure of this data and its effect on crowdfunding campaigns. Financial statements provide detailed data for investors considering equity crowdfunding offerings (Leuz, and Wysocki, 2016) and have potential to influence investing decisions. However, the potential effect of financial data for equity crowdfunding campaigns has not been investigated. Pattanapanyasat (2020) states that the verified information in financial statements is likely the most credible channel for investors to evaluate firms' viability and the truthfulness of other disclosures. The study provides evidence that financial statements influence investors' decisions and facilitate borderless capital formation and that the provision of financial statements appears to enhance how investors view other aspects of disclosure, suggesting a positive reporting externality. Yang (2020) finds mixed evidence regarding crowd wisdom in accounting in the equity-based crowdfunding market. Focusing on forecasts the study finds that entrepreneurs systematically overestimate sales, earnings, profit margin, and assets, and underestimate leverage suggesting investors put more focus on future forecasts than past financial performance. Shafi (2019) finds that financial metrics disclosed in campaign descriptions do not predict funding success for crowdfunded firms, stating that crowdfunding investors pay little attention to financial information contained in campaigns, consistent with the idea that they find financial information difficult to evaluate. However, when financial stakes in the form of equity offered in the campaign are high, crowd investors incur the costs of assessing complex financial information. Using a European database, Nitani *et al.* (2019) suggest that participants in the crowdfunding market are rational, interpreting signals derived from firm attributes and financial statements in appropriate ways to minimise risk and maximise returns. Donovan (2020) finds that there is positive association between financial reporting and capital raised, suggesting that accounting reduces information asymmetry with potential investors. The study also finds that financial reporting is indirectly associated with better ex-post performance by increasing the likelihood of raising capital. It is clear that past financial performance is a key indication as to

why firms would seek crowdfunding and for the first time this study incorporates accounting information for crowdfunded Cleantech firms.

This study seeks to add to the literature by investigating several the issues discussed above on the sample of Cleantech firms. The below are hypotheses developed to answer research questions. For the tests on amount raised, it is proposed that firms with higher pre-money valuation will raise more money for a smaller amount of equity (Ahlers, 2015; Allison *et al*., 2017; Mollick, 2014). There is an expectation and assumption that firms with higher intangible assets will raise more money during the crowdfunding campaign. It is likely that firms with greater tangible assets will raised less equity crowdfunding and use collateral for debt financing which coincides with studies on tangible assets and debt financing (Burger and Udell, 1998; Myers and Majluf, 1984). While firms with more intangible assets will be pushed to seek external equity financing (Mac an Bhaird and Lucey, 2010; Vanacker and Manigart, 2010), including equity crowdfunding. Therefore:

H1. Accounting information and asset structures are an important determinant for Cleantech firms when raising equity crowdfunding.

Similarly, for financing pre-crowdfunding, this study proposes that older firms with higher tangible assets will raise more debt financing and those with higher intangible assets will raise more equity pre-crowdfunding and thus:

H2. Cleantech firms with greater assets will raise greater amounts of debt financing pre-crowdfunding

This study also proposes that liquidity thresholds could have an impact on the financing options and choices available to Cleantech firms before they embark on crowdfunding campaigns (Walthoff-Borm *et al*., 2018). Therefore:

H3. Cleantech firms with liquidity constraints with raise greater amounts of equity financing pre-crowdfunding.

For financing post-crowdfunding, this study proposes that previous amount of funding raised will have an impact on the financing options and choices available to Cleantech firms and expect that firms who have previously raised debt financing to continue this trend and raise additional debt financing (Coakley *et al*., 2018). Finally, this study proposes that the amount raised during a campaign can have positive signalling effects for financing post-crowdfunding, (Ahlers *et al*., 2015; Coakley *et al*., 2018). Therefore:

H4. Cleantech firms that raise equity crowdfunding will raise greater amounts of financing post-crowdfunding.

2.3 Methodology and data

This study aims to investigate the role of equity crowdfunding in financing Cleantech firms across Europe. The sample compiles a database of 177 Cleantech firms that have successfully raised equity on crowdfunding[14] platforms, for the first time, in the UK, Finland, Sweden, Germany, Italy, Belgium, France, Estonia, Switzerland, Ireland, Austria, Denmark, Latvia, Netherlands, Norway and Spain. The sample includes all firms that have raised finance between 2014 to 2019 on the following crowdfunding platforms: Crowdcube, Seedrs, Syndicate Room, Invesdor, FundedByMe, Spreds, Symbid, OnePlanetCrowd, Spark, Seedmatch, BacktoWork, MamaCrowd, The Angel Crowd, Crowd for Angels, WiSeed, SoWeFund, FundWise, Funderbeam and Companisto. This is the entire universe of firms who sought equity crowdfunding on European platforms. Each platform is analysed filtering for Cleantech firms and subsequently cross-referenced via the Crunchbase database.

The data comes from several sources. An analysis of the websites of European based equity crowdfunding platforms to identify and collect data on the firms that have successfully applied for and raised equity crowdfunding during the 2014–2019 period (inclusive). Detailed checks were undertaken on the validity of each of the equity crowdfunding platforms used in this study by cross-referencing them with the Crunchbase database ensuring completeness of all Cleantech firms that raised equity crowdfunding on European platforms. In terms of the countries selected as part of this study, it was dictated by the validity of the equity crowdfunding platforms cross-referenced using the Crunchbase database. Data is then gathered including the amount raised, the number of investors, and the equity given to investors on the platform's websites. An examination of the the pitch in each campaign to get information on the purpose of funding and classify the primary use of funding in each campaign is undertaken. Then, using multiple sources to collate data on each specific firm. This is done through obtaining accounting data from the Orbis Europe database managed by Bureau Van Dijk (BVD). Orbis Europe contains high-quality accounting data on privately held and publicly traded European firms (Faccio *et al.*, 2011; Walthoff-Borm *et al*., 2018). Then a detailed search on each firm on the Crunchbase database is undertaken to assess whether firms have raised equity financing before and/or after the crowdfunding campaign (Hornuf *et al.*, 2018; Signori and Vismara, 2018).

[14] This study includes firms who successfully raised equity crowdfunding for the first time. It does not examine campaign specific variables on any other successfully funded campaigns beyond the first campaign. It excludes mini-bond offerings, offerings of convertibles bonds, and equity offerings by companies that have previously raised capital through equity crowdfunding.

Table 2.1 Definitions of variables used in statistical models

Country – Country in which firm is registered.
Firm Age at CF – Age of the firm from incorporation date to raising crowdfunding.
Firm Age Now – Age of the firm from incorporation date to current year (2020).
Investors – Number of Investors who contributed to crowdfunding campaign.
Amount Raised – Monetary amount (€) raised as part of crowdfunding campaign.
Equity Given – The amount of equity (%) that the firm released in crowdfunding campaign.
Pre-Money Valuation – The valuation of the firm prior to crowdfunding campaign.
Post-Money Valuation – The valuation of the firm post the crowdfunding campaign. This is calculated using the amount of equity raised / equity given (%).
Dissolved/Failed – Number of firms who are no longer trading or who are in liquidation.
Number of Directors – The number of directors actively involved in the running of the firm at time of Crowdfunding.
Equity Funding Pre-CF – Monetary amount (€) of equity raised before crowdfunding campaign.
Debt Funding Pre-CF - Monetary amount (€) of debt raised before crowdfunding campaign.
Equity Funding Post-CF - Monetary amount (€) of equity raised after crowdfunding campaign.
Debt Funding Post-CF - Monetary amount (€) of debt raised after crowdfunding campaign.
Liquidity (T-1) – The liquidity ratio (current assets / current liabilities - expressed in x:1) one year prior to crowdfunding campaign.
Liquidity (T+1) - The liquidity ratio (currents assets / current liabilities - expressed in x:1) one year after crowdfunding campaign.
Illiquid (<0.75) – Firms with liquidity ratio's between 0.51:1 - 0.75:1
Illiquid (<0.50) – Firms with liquidity ratio's less than 0.50:1
Intangibles (T-1) – The monetary value of intangible assets (€) one year prior to crowdfunding campaign.
Intangibles (T+1) - The monetary value of intangible assets (€) one year after crowdfunding campaign.
Total Assets (T-1) – The monetary value of total assets (€) one year prior to crowdfunding campaign.
Total Assets (T+1) - The monetary value of total assets (€) one year after crowdfunding campaign.
Gearing (T-1) – The gearing level (total debt / total equity – expressed in %) one year prior to crowdfunding campaign.
Gearing (T+1) - The gearing level (total debt/ total equity – expressed in %) one year after the crowdfunding campaign.
Cash (T-1) – The monetary value of the cash balance (€) one year prior to crowdfunding campaign.
Cash (T+1) - The monetary value of the cash balance (€) one year after crowdfunding campaign.
Shareholder Funds (T-1) – The monetary value of the shareholder funds (€) one year prior to crowdfunding campaign.
Shareholder Funds (T+1) - The monetary value of the shareholder funds (€) one year after crowdfunding campaign.

Capital (T-1) – The monetary value of capital (€) one year prior to crowdfunding campaign.
Capital (T+1) - The monetary value of the capital (€) one year after crowdfunding campaign.
Use of Funds – The use of funds provided by the firms in their crowdfunding campaign (see classification below):
Use of Funds: *Expansion, IT Development, Research & Development, Sales & Marketing and Working Capital*
Sector – The specific Cleantech sector (see classification below):

Sector Classification: *Energy Efficiency, Recycling/Waste Management, Renewable Energy and Transportation.*
Country – The specific country in which campaign took place (see list below):
Countries: Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Latvia, Netherlands, Norway, Spain, Sweden, Switzerland, United Kingdom

Definitions of variables used to test various models are provided in Table 2.1. Summary descriptive statistics are presented in Tables 2.2 and 2.3. This study is solely focused on firms that are Cleantech specific (Adhami, 2017; Bento, 2019). The sector classification covers Cleantech firms that operate in Energy Efficiency, Recycling and Waste Management, Renewable Energy and Transportation which coincides with the sectoral classification of the MIT energy initiative (Gaddy *et al.*, 2017). This study focuses on campaign specific data, including use of funds, financial accounting data, and equity financing data. Time (t) in the below table is the year of the crowdfunding campaign (i.e., when the firm received the equity financing via the crowdfunding campaign).

Table 2.2 Summary descriptive statistics of variables

Variable	N	Mean	Median	SD	Min	Max
Age (Years)	177	5.05	4.00	3.80	0.00	26.00
Investors (N)	177	776	368	2,280	16	2,2712
Amount Raised (€)	177	828,918	450,000	1,392,670	50,000	11,200,000
Target Capital (€)	166	605,356	399,925	1,070,427	37,500	10,000,000
Equity Given (%)	166	0.11	0.09	0.08	0.01	0.58
Equity Offered (%)	166	0.09	0.07	0.05	0.01	0.25
Pre-Money Valuation	177	7,674,794	4,000,000	13,998,693	416,667	40,000,000
Post-Money Valuation	177	8,229,337	4,283,180	17,228,187	415,476	42,379,182
Number of Directors	177	5.16	4.00	4.77	1.00	34.00
Liquidity Ratio (T-1)	177	2.07	0.60	11.51	0.00	149.74
Liquidity Ratio (T+1)	177	3.61	1.26	9.76	0.00	110.24
Intangibles (€) (T-1)	177	270,327	0.00	1,725,775	0.00	21,464,000
Intangibles(€) (T+1)	177	373,920	0.00	2,221,695	0.00	24,946,000
Total Assets (€) (T-1)	145	1,715,566	560,000	3,817,914	1,000	31,905,000
Total Assets (€) (T+1)	143	2,035,972	693,000	4,814,116	3,000	42,499,000
Gearing Ratio (%) (T-1)	177	64.61	0.00	139.41	0.00	854.39
Gearing Ratio (%) (T+1)	177	63.63	3.13	126.94	0.00	812.40
Cash (€) (T-1)	145	317,793	45,000	739,146	0.00	672,3000
Cash (€) (T+1)	143	283,902	52,000	662,168	0.00	498,2000
Shareholder Funds (€) (T-1)	145	610,344	117,000	1,526,243	-1,813,000	12,009,000
Shareholder Funds (€) (T+1)	143	832,881	214,000	2,158,487	-1,765,000	20,484,000
Capital (€) (T-1)	145	253,779	10,000	767,570	0.00	6,125,000
Capital (€) (T+1)	143	272,104	10,000	806,488	0.00	6,500,000

Table 2.3 Descriptive firm statistics

Panel 1				**Panel 2**				**Panel 3**		
Age of Firm	N	%		**Type of Cleantech Firm**	N	%		**Use of Funds**	N	%
Start-Up	6	3.39		Energy Efficiency	56	31.64		Expansion	51	28.81
1-3 years	61	34.46		Recycling/Waste Management	30	16.95		IT Development	18	10.17
4-9 years	95	53.67		Renewable Energy	52	29.38		Research & Development	66	37.29
10-15	12	6.78		Transportation	39	22.03		Sales & Marketing	29	16.38
<15	3	1.69						Working Capital	13	7.34
	177	**100%**			**177**	**100%**			**177**	**100%**

Table 2.4 Descriptive statistics on funding pre and post-crowdfunding

Debt Funding Pre-crowdfunding		Debt Funding Post-crowdfunding	Equity Funding Pre-crowdfunding	Equity Funding Post-crowdfunding
Average Age (Yrs) (at CF)	6.3	6.6	6.2	4.5
Number of Firms	75 (42%)	89 (50%)	68 (38%)	35 (20%)
Total Raised (€)	65,421,000	65,490,000	75,936,000	90,450,000
Average Raised (€)	872,287	735,845	1,167,000	2,584,000
Average Total Assets (T-1 Pre) / (T+1 Post)	2,300,000	2,512,000	1,900,000	2,761,000
Average Intangible Assets (T-1) / (T+1 Post)	490,000	715,685	550,000	1,216,000
Sector				
Energy Efficiency	20 (27%)	25 (28%)	23 (34%)	14 (40%)
Recycling/Waste Management	9 (12%)	13 (15%)	8 (12%)	5 (14%)
Renewable Energy	24 (32%)	27 (30%)	19 (28%)	11 (31%)
Transportation	22 (29%)	24 (27%)	18 (26%)	5 (14%)
Use of Funds				
Expansion	20 (27%)	26 (29%)	24 (35%)	12 (34%)
IT Development	6 (8%)	5 (6%)	1 (1%)	3 (9%)
R&D	27 (36%)	36 (40%)	23 (34%)	14 (40%)
Sales & Marketing	17 (23%)	16 (18%	14 (21%)	3 (9%)
Working Capital	5 (7%)	6 (7%)	6 (9%)	3 (9%)

Table 2.4 assesses the descriptive statistics on the types of funding pre- and post-crowdfunding. In relation to the asset valuations pre- and post-crowdfunding, the table shows the average tangible and intangible asset values immediately before and after the crowdfunding campaign. It is clear that there is a large increase in asset values post the crowdfunding campaign. Thus, suggesting that the financing obtained via crowdfunding is in fact used to the purchase tangible assets or in fact develop intangible assets. Table 2.4 also highlights the number of firms that sought debt and equity financing and by breakdown of sector. In terms of use of funds on the crowdfunding campaign, it is interesting to note that those who have previous debt financing and have obtained debt financing and equity financing post the crowdfunding campaign are suggesting in their campaign pitch that R&D is the main purpose of the funds on the crowdfunding campaign.

There has been limited research on accounting information and the role of past financial performance in crowdfunding. Drawing upon related studies which include financial data in their methodologies (Donovan, 2020; Pattanapanyasat, 2020; Scoones *et al*., 2015; Walthoff-Borm *et al*., 2018), key accounting ratios and indicators are included in the regressions. Accounting data variables investigated as part of this research include Gearing ratio (Walthoff-Borm *et al*., 2018), Total Assets (Donovan, 2020; Pattanapanyasat, 2020; Walthoff-Borm *et al*., 2018), Intangible Assets (Donovan, 2020; Pattanapanyasat, 2020; Walthoff-Borm *et al*., 2018), Cash (Donovan, 2020), Shareholder's Funds (Pattanapanyasat, 2020; Scoones *et al*., 2015) and Capital (Pattanapanyasat, 2020; Scoones *et al*., 2015) and are computed at T-1 and T+1. Liquidity ratios are also included that draws upon a study by Walthoff-Borm *et al*. (2018) who measure excessive debt levels under three different criteria examining total debt to total assets. Cleantech firms tend to have long R&D cycles and may lack the required patient capital (McDaniels and Robins, 2017; Owen *et al*., 2018; Rowlands, 2009). The World Economic Forum (2021) define patient capital as 'investing with the expectation of holding an asset for an indefinite period of time by an investor with the capability of doing so'. Given that little attention has been given to the financing gap of early stage Cleantech firms (BEIS, 2017; Nitani *et al*., 2019) this study measures and examines the short-term liquidity of these firms which could demonstrate the immediate impact of crowdfunding on these firms. A dummy variable is developed to include an 'illiquid firms' variable based off the liquidity ratios computed at T-1, similar to previous studies (Walthoff-Borm, 2018). A classification is made on illiquid firms into two different dummy variables. An assumption is made to state that illiquid firms are those who have liquidity ratios less than 0.50:1 (defining liquidity ratio as current assets / current liabilities). Another variable classifies another cohort of firms who have liquidity ratios of between 0.51 – 0.75:1. The rationale behind this was to examine whether there would be any differing outcome of those firms with very poor liquidity ratios (Illiquid <0.50) and those that have more manageable liquidity ratios (Illiquid <0.75), and whether financing employed would be different. These tests include the illiquid variables in the tests focusing on T-1 to assess the short-term financial performance and the impact on financing before and after crowdfunding. The purpose is to assess any differences in how illiquid a firm may be.

The models are tested empirically, using ordinary linear regression, employing amount raised in the equity crowdfunding campaign as the dependent variable. The base model (Table 2.5) to test hypothesis 1 is specified as follows (Equation 1):

$$Y = \beta_0 + \beta_1 AGE + \beta_2 \#INVS + \beta_3 EQGIV + \beta_4 PREVAL + \beta_5 \#DIRS + \beta_6 PREV + \beta_7 GEAR_{t-1} + \beta_8 LIQ_{t-1} + \beta_9 ILLIQ_{t-1} + \beta_{10} INTAN_{t-1} + \beta_{11} TASS_{t-1} + \beta_{12} CASH_{t-1} + \beta_{13} SH_{t-1} + \beta_{14} CAPITAL_{t-1} + \varepsilon$$

In this instance, Y = amount raised on equity crowdfunding platform. Independent variables are stated as $\beta_0 + \beta_1$AGE + β_2#INVS + β_3EQGIV + β_4PREVAL + β_5#DIRS+ β_6PREV with the control accounting variables being $\beta_7 GEAR_{t-1}$+ $\beta_8 LIQ_{t-1}$ + $\beta_9 ILLIQ_{t-1}$ + $\beta_{10} INTAN_{t-1}$ + $\beta_{11} TASS_{t-1}$+ $\beta_{12} CASH_{t-1}$ + $\beta_{13} SH_{t-1}$+ $\beta_{14} CAPITAL_{t-1}$ + ε

In relation to the potential determinants of debt and equity funding pre-crowdfunding the base model (Table 2.6) to test hypothesis 2 and 3 is specified as follows (Equation 2):

$Y = \beta_0 + \beta_1 AGE + \beta_2 \#DIRS + \beta_3 RDEBTPRE + \beta_4 REQUITYPRE + \beta_5 LIQ_{t-1} + \beta_6 ILLIQ_{t-1} + \beta_7 INTAN_{t-1} + \beta_8 TASS_{t-1} + \beta_9 CASH_{t-1} + \beta_{10} SH_{t-1} + \beta_{11} CAPITAL_{t-1} + \varepsilon$

In this instance Y = debt funding pre-crowdfunding in the first model and Y = equity funding pre-crowdfunding in the second model. Independent variables are stated as $\beta_0 + \beta_1$AGE + β_2#DIRS + β_3RDEBTPRE + β_4REQUITYPRE with control accounting variables being $\beta_5 LIQ_{t-1} + \beta_6 ILLIQ_{t-1} + \beta_7 INTAN_{t-1} + \beta_8 TASS_{t-1} + \beta_9 CASH_{t-1} + \beta_{10} SH_{t-1} + \beta_{11} CAPITAL_{t-1} + \varepsilon$

In relation to the potential determinants of debt and equity funding post-crowdfunding the base model (Table 2.7) to test hypothesis 4 is specified as follows (Equation 3):

$Y = \beta_0 + \beta_1 AGE + \beta_2 \#INVS + \beta_3 ARAISED + \beta_4 EQGIV + \beta_5 PREVAL + \beta_6 POSTVAL + \beta_7 \#DIRS + \beta_8 RDEBTPRE + \beta_9 REQUITYPOST + \beta_{10} RDEBTPOST + \beta_{11} REQUITYPOST + \beta_{12} LIQ_{t+1} + \beta_{13} INTAN_{t+1} + \beta_{14} TASS_{t+1} + \beta_{15} CASH_{t+1} + \beta_{16} SH_{t+1} + \beta_{17} CAPITAL_{t+1} + \varepsilon$

In this instance Y = debt funding post-crowdfunding in the first model and Y = equity funding post-crowdfundijng in the second model. Independent variables are stated as β_1AGE + β_2#INVS + β_3ARAISED + β_4EQGIV + β_5PREVAL + β_6POSTVAL + β_7#DIRS with control accounting variables being $\beta_8 RDEBTPRE + \beta_9 REQUITYPOST + \beta_{10} RDEBTPOST + \beta_{11} REQUITYPOST + \beta_{12} LIQ_{t+1} + \beta_{13} INTAN_{t+1} + \beta_{14} TASS_{t+1} + \beta_{15} CASH_{t+1} + \beta_{16} SH_{t+1} + \beta_{17} CAPITAL_{t+1} + \varepsilon$

Cross-sectional OLS-regressions were run using data collected for all firms, initially ignoring t sectoral, 'purpose for which funding is sought', and country factors. Coefficients of this model are presented as the 'base model' in Table 2.5. Subsequently, models to include country, sector and use of funds control variables were run, which are presented as extended models 1-4 in Table 2.5. Variables that are assessing the determinants of equity crowdfunding and funding pre-crowdfunding are assessed at t-1 (the year prior to the crowdfunding campaign). Those assessing financing post-crowdfunding are at t+1 (the year after the crowdfunding campaign).

This study also examines funding of Cleantech firms pre and post- crowdfunding. The second set of models employ debt and equity raised pre-crowdfunding as dependent variables, and

coefficients for these tests are presented in Table 2.6. As with the previous approach, test the base model, before running extended models to include country, purpose and sectoral control variables. In the third and final set of models, investigates debt and equity raised post-crowdfunding as dependent variables. Consistent with the previous tests, the base model, which are computed at T+1, are tested, before running extended models to include country, purpose and sectoral control variables, and coefficients for these tests are presented in Table 2.7. Although a number of variables are closely related, correlation tests do not suggest a high degree of first-order collinearity among the independent variables. Correlation Coefficient Matrix are presented for all variables in Appendix B. Additional tests were undertaken for multicollinearity, namely Variance Inflation Factors (VIF) and are presented in Appendix C. The variance inflation factor is a useful way to look for multicollinearity amongst the independent variables. The mean VIF across the 3 models are as follows: Model 1 – 2.26; Model 2 – 2.43; and Model 3 – 3.96. As a rule of thumb, a variance whose VIF values are greater than 10 may merit further investigation. Across the 3 models, only one variable is greater than 10. To ensure there are no heteroscedasticity issues in the testing, the dependent variables are transformed. This is done by means of having a logged numbers in our variables, this is particularly important with the accounting variables included in the models. The OLS model must also consider endogeneity which refers to situations in which a predictor (e.g., treatment variable) in a linear regression model is correlated to the error term. The common sources of endogeneity can be classified as: omitted variables, simultaneity, and measurement error. There are no endogeneity issues in the models presented.

2.4 Empirical results and discussion

2.4.1 Descriptive statistics

Tables 2.2, 2.3 and 2.4 present the summary statistics for the 177 firms in the sample. The average age of the firms from date of incorporation to crowdfunding was 5 years with an average of 5 directors, including founders. The average pre-money firm valuation was €7.6 million. Firms operating in Energy Efficiency (32%), Recycling and Waste Management (17%), Renewable Energy (29%) and Transportation Sectors (22%) conducted equity crowdfunding campaigns. The primary use of funds of these firms was Research and Development (37%) and Expansion (29%) suggesting these Cleantech firms are in the development stages and require equity crowdfunding to develop their business further. Regarding equity crowdfunding campaign characteristics, the average amount of

capital raised during the campaign was €828,918[15]; the average number of investors was 776 and the average equity given was 11%. Overall, 105 firms (59%) obtained follow-up funding after their equity crowdfunding campaign, and 24 firms (13.5%) went insolvent, were liquidated, or were dissolved.

In terms of funding pre and post-crowdfunding the study finds that 68 firms raised equity funding pre-crowdfunding (38%) with an average investment at €1,167,000 and 75 firms raised debt funding pre-crowdfunding (42%) averaging €872,287. Post-crowdfunding, the study finds that 35 firms raised equity (20%) with an average investment at €2,584,000 and 89 firms raised debt funding (50%) averaging €735,845 per firm, which indicates that debt funding remained stable before and after crowdfunding campaigns. This is because older firms with greater total assets sought debt funding; see summary statistics on funding pre and post-crowdfunding in Table 2.4.

The accounting data provides a good insight into the financial performance of firms pre and post-crowdfunding campaigns. Median liquidity ratios are at 0.60 before crowdfunding and 1.26 after crowdfunding, showing the immediate positive impact of receiving additional funding. In total, 54% of firms had liquidity ratios of less than 0.75, which would suggest these firms were illiquid or suffering from liquidity issues prior to the crowdfunding campaign. To further this point, cash balances improve immediately after crowdfunding; pre-campaign the median cash balance was €45,000 and after the campaign rose to a median of €52,000. In relation to total assets, the median total asset value is €560,000 and €693,000 for pre and post-crowdfunding respectively. This suggests that firms used the funding raised to invest immediately and to expand. As expected, shareholder funds' also increases positively in the year proceeding the campaign. Median shareholder funds' were €117,000 prior to the campaign and increases to €214,000 after the campaign.

2.4.2 Amount of crowdfunding raised

Table 2.5 reports coefficients for models investigating hypothesis 1. Coefficients for the base model are presented in column 1. Hypothesis 1 states that accounting information and assets structures are an important determinant for Cleantech firms when raising equity crowdfunding. The results of the tests undertaken support hypothesis 1.

In relation to accounting data and past financial performance, firms with lower tangible assets raised greater amounts through crowdfunding. Equally important for investors was the current financial position within a given firm as there is a positive relationship between the amounts raised

[15] To ensure comparability of firms from Europe and the United Kingdom, the EUR/GBP exchange rate is used as of the date of the campaign end and convert the volumes from GBP to EUR.

and cash balances and shareholders' funds. The ability to have a positive cash position along with positive shareholders' funds was a contributing factor to raising more funds. Specific to accounting ratios, such as, gearing, liquidity and illiquid firms, there is no evidence suggesting investors pay particular attention to this.

There is a positive relationship between the amounts raised and firm age. Older firms in Cleantech tend to raise more funding, and this is possibly due to the nature of their business in that it takes time to develop their concepts and reach a viable commercialisation stage so naturally they will seek crowdfunding after a number of years and pose a lesser perceived risk for investors. There is a negative relationship between amount raised and number of investors; this could suggest that there are more institutional investors investing in Cleantech firms or that individual investors are in fact investing greater amounts in Cleantech firms than other firms due to the 'social good' of doing so. Looking at previous studies, Hornuff *et al.* (2018), examines 413 firms from UK and Germany that raised equity crowdfunding, and find that the average amount raised was €424,438 with an average of 366 investors. A study on Crowdfunding for Green Projects in Europe (Adhami *et al*., 2017) shows that on specialised 'green' project platforms, the average value of investment on a given campaign was €452,491. Slimane and Rousseau (2020) examine French Crowdlending platforms specialising in renewable energy projects show average amounts raised of €229,725 across 167 projects. This study shows a greater average amount raised (€828,918) which could suggest that institutional investors are investing in these projects or that there is positive sentiment for Cleantech firms, along with the fact that equity crowdfunding firms raise more, in comparison to reward-based crowdfunding, (Cumming *et al*., 2017; Vulkan *et al.*, 2016).

Unsurprisingly, firms who were prepared to give more equity away raised greater absolute amounts. The study finds that for every additional 0.56% equity given, firms raise €100,000. Thus, estimating the price of 2% of firm equity at €400,000. Firms that had a greater pre-money valuation raised more money during their campaigns (Allison *et al*., 2015; Block *et al.*, 2018; Butticè *et al*., 2017). Firms that had previously raised financing before embarking on crowdfunding also raised more finance. This suggests that they are slightly older firms and further along in their development. In the majority of cases, firms were seeking funding for the purpose of research and development and expansion, rather than working capital or marketing.

The F-statistics across the base model (15.86), extended model 1 (10.62), extended model 2 (9.46) and extended model 3 (8.33) are significant.

In testing for country, purpose and sectoral control variables, there is no statistical significance between any specific sector, use of funds and amount raised. The rationale for including country in the testing is the assess whether being located in different jurisdictions has an impact on the amount of equity crowdfunding raised. Similarly, to purpose of funding along with sectoral control variables is to assess whether seeking funding for certain purposes or being aligned to a certain type of Cleantech specific sector leads to raising greater sums of equity crowdfunding. In terms of country specific variables, however, find that there are significant differences between the UK and all other countries. A large number of previous studies conducted on the UK crowdfunding market (Vasileiadou *et al.*, 2016; Vismara, 2018; Walthoff-Borm *et al*., 2018) indicate that the UK is one of the world's most advanced and established crowdfunding markets (Vismara, 2016). The results reaffirm that the UK crowdfunding market is one of the most developed in Europe, as the finding suggests that UK firms raise more funding than their European counterparts, with statistical significance for all countries in this sample.

Table 2.5 Potential determinants of amount raised in equity crowdfunding

Dep. Var.	Amount Raised			
	Base Model	Ext Model 1	Ext Model 2	Ext Model 3
Firm Age	.0300*	.0201	.0222	.0237
	(.0186)	(.0180)	(.0185)	(.0188)
Investors	-.0002***	-.0002***	-.0002***	-.0002***
	(.0000)	(.0000)	(.0000)	(.0000)
Equity given	5.6833***	5.3259***	5.4486***	5.4850***
	(.7909)	(.8328)	(.8675)	(.8758)
Pre-Money Valuation	8.0000***	8.0000***	8.0000***	7.0000***
	(1.0900)	(1.0400)	(1.0700)	(1.0000)
Number of Directors	.0078	.0276	.0264	.0268
	(.0167)	(.0181)	(.0186)	(.0191)
Raised Financing Pre-Crowdfunding	.1081	.3070**	.3160**	.3159**
	(.1393)	(.1377)	(.1408)	(.1431)
Gearing (T-1)	-.0000	.0000	-8.000	.0000
	(.0004)	(.0004)	(.0004)	(.0004)
Liquidity (T-1)	.0010	-.0005	-.0000	-.0002
	(.0049)	(.0046)	(.0047)	(.0048)
Illiquid (<0.75)	-.1128	.0429	.0455	.0421
	(.1302)	(.1295)	(.1312)	(.1359)
Intangible Assets	-2.0000	3.0400	2.0000	2.0000
	(4.0000)	(4.0000)	(4.0000)	(4.0000)
Total Assets (T-1)	-1.0000***	-1.0000***	-1.0000***	-1.0000***
	(4.0000)	(4.0000)	(4.0000)	(4.0000)
Cash (T-1)	2.0000**	1.1200	1.0100	1.0000
	(1.0000)	(9.0000)	(9.0000)	(9.0000)
Shareholders' Funds (T-1)	3.0000***	2.0000***	2.0000***	3.0000***
	(1.0000)	(1.0000)	(1.0000)	(1.0000)
Capital (T-1)	-1.6300*	2.0000	1.2900	-5.0000
	(9.2600)	(1.0500)	(1.0000)	(1.0000)
Constant	11.6754***	11.8105***	11.7555***	11.7881***
	(.1815)	(.2080)	(.2296)	(.2688)
Country		Yes	Yes	Yes
Sector			Yes	Yes
Use of Funds				Yes
# Obs.	166	166	166	166
Adj. R2	55.77	62.83	62.13	61.53
F	15.86	10.62	9.46	8.33

Table 5 reports the results of the Amount Raised regression models. The base regression model specifications are as per Eq, (2) and Eq. (3) respectively, with the full model extending the base model with country, sector and purpose fixed effects. All variables are defined in Table 3. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1%, 5% and 10% levels respectively.

2.4.3 Funding pre-crowdfunding

In this subsection, an analysis of the debt and equity funding raised by the sample firms in the pre-crowdfunding period is undertaken. There are two hypotheses related to the tests undertaken. Hypothesis 2 suggestes that Cleantech firms with greater tangible assets will raised greater amounts of debt pre-crowdfunding and hypothesis 3 suggets that Cleantech firms with liquidity constraints will raise greater amounts of equity pre-crowdfunding.

Table 2.6 reports regression coefficients for debt and equity funding pre-crowdfunding, using lagged accounting variables (T-1). The results are the tests undertaken support both hypotheses 2 and 3.

A standout finding is that liquidity and asset structures have a significant effect on the types of funding Cleantech firms avail of. In relation to debt financing, liquidity ratios of less than 0.50 are negatively related to the amount of debt funding pre-crowdfunding. However, liquidity ratios between 0.51 - 0.75 are negatively related to the amount of equity funding pre-crowdfunding When examining this further, greater debt and lower equity funding for firms with higher liquidity ratios. This indicates that debt financing providers will not finance firms with poor liquidity ratios, in this case being <0.50. It also suggests that firms with poor liquidity ratios are more likely to seek equity financing and it is likely that equity investors will fund these types of projects based on future outlook and potential, rather than current short-term liquidity. In total 96 out of the 177 firms (54%) fall under the illiquid targets that have been set in this study which is a liquidity ratio of less than 0.75:1. One could argue that the reason Cleantech firms have sought equity crowdfunding is because they are not in a position to secure debt financing and will revert to an alternative option.

There is also a positive relationship between firm age and tangible assets. This stands to reason as older firms will have a track record, and time to accumulate tangible fixed assets as collateral on borrowings. Shareholders' funds is negatively related to debt funding pre-crowdfunding, suggesting that debt providers are more concerned with assets and collateral requirements than on the past financial performance, which is a key component of shareholders' funds. This suggests that asset structure is a significant issue for Cleantech firms when it comes to their early stage financing. In summary, firms with tangible assets fulfill the collateral requirements of debt providers, and firms with high levels of intangible assets are attractive investments for equity providers. In relation to capital introduced in firms from incorporation, this is favorable for equity investors pre-crowdfunding, suggesting that they wish to invest in founders who have 'skin in the game' and have been willing to invest their own funds into their business at incorporation. As previously stated, asset structure in Cleantech firms is significant when making the capital structure decision, and the findings highlight the challenges Cleantech firms with good ideas, patents and potential face in trying to raise debt financing unless they have the required collateral.

Firms that had raised debt or equity financing pre-crowdfunding often raised the alternative type of funding. An example of this is that firms who raised debt financing also had the likelihood of raising equity financing. All of this before they raised on crowdfunding platforms. This suggests

signalling for firms who already had some method of financing and therefore had a better prospect at obtaining additional financing.

The F-statistics across the base model 1 (5.03), extended model 1 (2.88), base model 2 (3.19) and extended model 2 (2.03) are significant.

In terms of country specific variables, UK Cleantech firms raise more equity funding pre-crowdfunding than firms in other countries, apart from Finnish and Danish firms. To reaffirm this when analysing debt funding pre-crowdfunding where there is a finding that UK Cleantech firms raise less debt than those of all other countries apart from Finland and Germany. Looking at sector specific variables, there is no statistical significance of funding choice pre-crowdfunding campaigns. Finally, when including the use of funds, firms who sought funding for IT Development raised less equity pre-crowdfunding than firms who sought funding for Expansion purposes, suggesting equity investors pre-crowdfunding would rather invest in firms who are further along in their development stage.

Table 2.6 Potential determinants of debt and equity funding pre-crowdfunding

Dep. Var.	Debt Funding Pre-Crowdfunding		Equity Funding Pre-Crowdfunding	
	Base Model	Ext Model	Base Model	Ext Model
Firm Age	.4373*** (.1370)	.3702*** (.1422)	.2487* (.1465)	.1877 (.1536)
Number of Directors	-.2010* (.1221)	.0913 (.1495)	.1034 (.1287)	.0795 (.1597)
Raised Debt Funding Pre Crowdfunding			1.3505* (1.017)	1.2581 (1.1135)
Raised Equity Funding Pre Crowdfunding	1.712* (.9479)	1.5609 (1.0116)		
Liquidity (T-1)	.0341 (.0382)	.0327 (.0380)	.0412 (.0401)	.0351 (.0405)
Illiquid (<0.75)	1.5954 (1.3049)	2.1303 (1.3448)	-3.2155** (1.3518)	-2.959** (1.4176)
Illiquid (<0.50)	-3.4814*** (1.2729)	-4.8244*** (1.3711)	1.3789 (1.3636)	1.0296 (1.5215)
Intangibles (T-1)	2.0100 (3.6100)	4.1400 (3.8700)	3.7500 (3.7900)	3.8500 (4.1400)
Total Assets (T-1)	1.1000*** 3.2700	8.1800*** (3.3400)	-1.900 (3.5000)	-3.8200 (3.5800)
Cash (T-1)	-1.1400 (7.5900)	-1.1700 (7.6800)	-2.9600 (8.0200)	5.5500 (8.2400)
Shareholders' Funds (T-1)	-1.7400** (7.8800)	-1.3000* (7.9300)	2.8300 (8.3700)	7.5900 (8.4800)
Capital (T-1)	8.0100 (7.0500)	-1.2400 (8.5600)	1.4000* (7.3700)	1.8700** (9.0800)
Constant	3.6409*** (1.017)	-.8895 (1.7156)	3.4825*** (1.0736)	5.2571*** (1.775)
Country		Yes		Yes
Sector		Yes		Yes
Use of Funds		Yes		Yes
# Obs.	177	177	177	177
Adj. R2	20.13	26.05	12.03	16.18
F	5.03	2.88	3.19	2.03

Table 6 reports the results of the Funding Pre-Crowdfunding regression models. The base regression model specifications are as per Eq, (2) and Eq. (3) respectively, with the full model extending the base model with country, sector and purpose fixed effects. All variables are defined in Table 3. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1%, 5% and 10% levels respectively.

2.4.4 Funding post-crowdfunding

This subsection analyses the debt and equity funding raised by the sample firms in the post-crowdfunding period. Hypothesis 4 suggests that Cleantech firms that raised equity crowdfunding will raise greater amounts of a) debt and b) equity post-equity crowdfunding. Table 2.7 reports

regression coefficients for debt and equity funding raised post-crowdfunding as dependent variables. These tests employ campaign specific and accounting variables at T+1 to examine the post-crowdfunding impact on accounting data. The leading variables at T+1 is set in the year post-crowdfunding, as such they are completely separate variables from those used in the analysis on testing hypotheses 1, 2 and 3. Multicollinearity tests also show no issues between these variables. Similar to debt funding pre-crowdfunding, there is a positive relationship between firm age and total tangible assets with the amount of debt funding raised. This further highlights the nexus between asset tangibility and capital structure of Cleantech firms. When examining equity funding post-crowdfunding, the tests find that tangible assets is negatively related to the amount of equity financing raised post-crowdfunding. This suggests that the financing decisions of Cleantech firms is influenced by asset type and sector they operate in. Firms that raised debt financing pre-crowdfunding also raised more debt and equity funding post-crowdfunding. Specific to debt financing post-crowdfunding, the testing finds that firms that have previously used bank finance are more likely to continue that trend and build upon the relationship they have with their debt provider (Myers and Majluf, 1984). It could be argued that they have used crowdfunding to test the market, signal for future investment at a later stage and do not wish to give any more equity away now therefore continuing with debt financing. The testing also finds that for equity funding post-crowdfunding those who raised debt financing pre-crowdfunding raised more equity post-crowdfunding. When isolating these firms and examine their capital structure pre and post-crowdfunding, that pre-crowdfunding these firms had substantially larger assets than most other firms averaging €2.2 million. However, their intangible assets were quite small with 50% of firms having no intangible assets and the remaining firms' intangible assets averaging at €340,000. This leading to the belief that firms' had used tangible assets to secure debt funding pre-crowdfunding and required much higher amounts later so resorted to financing by way of equity post-crowdfunding. There is also the possibility that all assets were already committed to other loans. When examining the debt financing pre-crowdfunding, the average borrowing was just over €200,000, while these firms raised equity funding post-crowdfunding, they also increased their debt funding to an average of €620,000 post-crowdfunding.

An interesting finding on closer examination of firms that raised equity funding post-crowdfunding, is the fact that the average equity obtained pre-crowdfunding was €280,000 but rose substantially to just over €2.5 million after the crowdfunding campaign. This makes a clear distinction that firms that raised equity-funding post-crowdfunding required significantly greater amounts. A striking finding from firms that raised equity-funding post-crowdfunding was in the year following a crowdfunding campaign, intangible assets rise significantly from €340,000 to €620,000. This coincides with the findings on funding pre-crowdfunding that debt providers require collateral in the

form of tangible assets, while equity investors require growth opportunities, particularly high levels of intangible assets. It also indicates that the additional equity funding required was primarily used for further development and creation of intangible assets, this is something not witnessed with debt funded firms. When examining the specific sectors of firms that raised equity-funding post-crowdfunding, the majority of them are in Energy Efficiency (40%) and Renewable Energy (31%), with the use of funding for the crowdfunding campaign focused on R&D (40%) and Expansion (34%). This indicates the preference of external equity holders to invest in firms with more intangible assets and those focused on development.

Another finding suggesting the importance of a successful crowdfunding campaign for firms seeking further equity investment is that there is a positive relationship between the amount raised on a campaign and post equity financing. The testing finds that for each unit of finance raised during the equity crowdfunding campaign, firms raise X10 of equity post-crowdfunding. This indicates a positive signalling effect of crowdfunding to equity investors, providing them with validation from the crowd who believe in the firm as to the potential for their business model. This can provide an extension of the 'wisdom of the crowd' view, suggesting that there is a reputational effect gained from crowdfunding that further increases the firm's potential for attracting additional equity. The amount raised through crowdfunding has a positive effect on the post-money valuation of the firm, which is greatly beneficial to firms seeking to raise additional financing externally. This highlights the importance of the initial pre-money valuation and the decision on the amount of equity given as part of the campaign.

Of the firms that raised equity post-crowdfunding, 51% of these firms raised equity financing from corporate venture capital. 25% of firms who raised equity post-crowdfunding from this sample raised finance subsequently through equity crowdfunding platforms. The average equity investment on crowdfunding, subsequent to the first round, rose substantially to an average of €1.5 million from an average of €828,918 in the first campaign. Thus, showing the confidence firms had to return to equity crowdfunding suggesting their experience was positive and see it as a valuable method of raising finance.

In analysing funding post-crowdfunding, there appears to be a positive effect of larger entrepreneurial teams (Agrawal *et al.*, 2013; Ahlers *et al.*, 2015; Frydrych *et al.*, 2014). There is a positive relationship between firms with a greater number of directors and the amount of equity funding post-crowdfunding. This highlights the importance of directors and the social networks they have (Colombo *et al.*, 2015; Leyden *et al.*, 2014; Wang *et al.*, 2019), which suggests the more directors involved in a firm the better opportunities available to raise external equity financing. The

opposite is the case for firms that raise debt funding post-crowdfunding. Debt funding post-crowdfunding and the amount of debt raised is positively related which further demonstrates the importance of entrepreneurial teams for raising external financing.

The F-statistics across the base model 1 (7.30), extended model 1 (3.94), base model 2 (2.98) and extended model 2 (1.90) are significant. Overall, it is clear that equity crowdfunding acts as a signal for both debt and equity financing post-crowdfundign and as such support is provided for hypothesis 4.

In terms of country specific variables, UK Cleantech firms are more likely to raise equity funding post-crowdfunding, and apart from German and Swedish firms, receive more equity funding post-crowdfunding than any other country. The opposite is observed when analysing debt funding post-crowdfunding, where UK Cleantech firms raise less debt than those of all other countries apart from Finland, Italy and Sweden. Looking at sector specific variables and use of funds, there is no statistical significance for debt and equity funding post-crowdfunding.

Table 2.7 Potential determinants of debt and equity funding post-crowdfunding

Dep. Var.	Debt Funding Post-Crowdfunding		Equity Funding Post-Crowdfunding	
	Base Model	Ext Model	Base Model	Ext Model
Firm Age Now	.9965*** (.2587)	1.1056*** (.3111)	.5943** (.2849)	.5201 (.3494)
Investors	.0002 (.0004)	.0000 (.0005)	-.0005 (.0004)	-.0002 (.0005)
Amount Raised	4.0000 (8.0000)	8.0000 (8.0000)	1.0000* (8.0000)	1.0000* (9.0000)
Equity Given	4.0000 (8.0000)	4.5981 (6.6621)	-4.0000 (6.0000)	-10.000 (7.0000)
Pre-Money Valuation	6.0000 (1.0000)	-2.0000 (1.0000)	-1.0000 (1.0000)	-2.0000 (1.0000)
Post-Money Valuation	-1.0000 (1.0000)	2.0000 (1.0000)	-5.0000 (1.0000)	-7.0000 (1.0000)
Number of Directors	-.0838 (.1066)	-.2666** (.1333)	.2552** (.1120)	.2799* (.1447)
Raised Debt Funding Pre-Crowdfunding	6.7691*** (.8467)	7.4014*** (.9181)	-3.2113*** (1.049)	-2.979*** (1.1911)
Raised Equity Funding Pre-Crowdfunding	.8557 (.8997)	1.2066 (.9812)	1.0136 (.9588)	.4478 (1.0655)
Debt Funding Post-Crowdfunding			1.6745 (1.0504)	2.1474* (1.1404)
Equity Funding Post-Crowdfunding	1.2694 (1.0407)	1.6398 (1.1084)		

Liquidity (T+1)	-.0030 (.0390)	-.01268 (.0398)	-.0250 (.0416)	-.0159 (.0431)
Intangibles (T+1)	-1.0000 (2.0000)	-4.0000 (3.0000)	9.0000 (2.0000)	1.0000 (3.0000)
Total Assets (T+1)	4.0000 (2.0000)	5.0000* (2.0000)	-4.0000 (2.0000)	-3.0000 (3.0000)
Cash (T+1)	2.0000 (7.0000)	3.0000 (7.0000)	-6.0000 (8.0000)	-6.0000 (8.0000)
Shareholders' Funds (T+1)	-2.0000 (5.0000)	-4.0000 (6.0000)	1.0000** (6.0000)	8.0000 (6.0000)
Capital (T-1)	3.0000 (5.0000)	-1.0000 (7.0000)	-1.0000* (6.0000)	-3.0000 (7.0000)
Constant	-.6766 (1.1764)	.2434 (1.9821)	.8203 (1.2563)	1.7689 (2.1396)
Country		Yes		Yes
Sector		Yes		Yes
Use of Funds		Yes		Yes
# Obs.	166	166	166	166
Adj. R2	37.91	40.37	16.12	17.16
F	7.30	3.94	2.98	1.90

Table 7 reports the results of the Funding Post-Crowdfunding regression models. The base regression model specifications are as per Eq, (2) and Eq. (3) respectively, with the full model extending the base model with country, sector and purpose fixed effects. All variables are defined in Table 3. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1%, 5% and 10% levels respectively.

2.5 Conclusion

This study provides new evidence of potential determinants of amount of finance raised by early stage Cleantech firms through equity crowdfunding in Europe. The study also analyses the financing patterns of Cleantech firms before and after crowdfunding. Using a dataset of 177 Cleantech firms that ran first time equity crowdfunding campaigns in Europe across 19 platforms. This study find that firms raise substantially more amounts of external equity post-crowdfunding suggesting signalling effects. The study provides evidence that firms that raised financing before the campaign raised more money during the campaign itself. Asset structure is important for raising equity crowdfunding for Cleantech firms, insofar as firms with lower tangible assets raised more money. This suggests that investors are willing to invest in firms with greater intangible assets and future prospects. There is also a finding that investors are more willing to invest in firms with positive cash positions and proven track record by examining their shareholder's funds. In terms of accounting ratios, such as, liquidity and gearing, the findings suggest that investors focus more on the crowdfunding campaign, previous financing arrangements and future potential, rather than accounting information. In analysing financing of Cleantech firms in the pre-crowdfunding period, the study finds that debt providers are more willing to finance firms with greater tangible assets, while

equity investors are more willing to invest in firms with greater intangible assets. Regarding the level of liquidity within firms and their financing patterns, debt providers are less likely to finance firms with poor liquidity ratios but that equity investors are willing to finance them. Finally, in analysing the post-crowdfunding period, find that firms that have raised debt financing pre-crowdfunding are more likely to raise debt and equity funding after the crowdfunding campaign. This study also shows the positive impact of a successful equity crowdfunding campaign on equity investment post-crowdfunding in that the average amount of equity funding has increased substantially to just over €2.5 million. The sample shows that 25% of firms who obtained equity financing post-crowdfunding returned to equity crowdfunding suggesting their experience was positive and see it as a valuable method of raising finance. Overall, it can be said that equity crowdfunding for early stage Cleantech firms is a very valuable method of financing with positive impacts on financial performance and the ability to raise financing post-campaign.

This study also has clear limitations. First, the study has examined firms who obtained crowdfunding from 2014 to 2019 with some of those firms yet to be in a position to raise financing post-crowdfunding and the metrics used examine the year before and the year after the campaign. A dataset with a longer timeframe and a re-examination of those firms in the future would be beneficial to examine financial patterns and decision making over a longer period and to assess whether many of these firms have had any major changes such as an acquisitions or liquidation. Second, other legal and regulatory factors might lead to differences in the number and amount of investors of the coefficients for European platforms compared to those in the UK. The UK equity crowdfunding market is one of the most advanced in the world and perhaps more needs to be known about the differences and the impact of pre and post funding on these firms. Potential explanations could be the UK tax advantage[16] and London as a financial central hub (Vulkan *et al.*, 2016). Third, this sample examines European firms who raised equity crowdfunding on European platforms only. There is a possibility they may have raised equity crowdfunding in other markets, in particular, the US. Further studies may aim to add to this by using a dataset with a longer time span, investigate firms who also raised outside of European platforms and compare Cleantech firms to that of other firms in different industries.

[16] The United Kingdom provides two tax reliefs for investors. Both the Enterprise Investment Scheme and the Seed Enterprise Investment Scheme offer tax relief of up to 30% and 50%, respectively.

2.6 Practical and policy implications

The study adds to the literature in several ways. First, determinants of amount raised can assist Cleantech firms seek equity crowdfunding and highlight the significance of correct business valuation and the importance of financial management. Second, there is an acknowledgment of the differing financing options available to Cleantech firms based on their asset structure and show a clear pathway for firms with greater tangible assets as opposed to intangible assets. Third, funding post-crowdfunding can assist policymakers evaluate whether equity crowdfunding is an efficient and worthwhile form of financing for Cleantech firms. From this study, evidence is provided that shows for each unit of crowdfunding raised that there is a tenfold increase in equity post-crowdfunding which shows positive signalling effects.

In terms of policy implications for government, and in order to put greater emphasis on the immediate climate crisis by supporting innovative Cleantech firms, they could increase crowdfunding Co-Financing programmes along with Public-Private Principally Venture Capital Co-Financing (Owen *et al.*, 2019), arrangements for Cleantech firms. The early and long horizon innovations of Cleantech firms represents uncertainty, which needs further funding to develop. It is refreshing to see the British Business Bank recently launch the Future Fund, which can further assist businesses and investors. In some UK crowdfunding platforms, the opportunity to invest via the Future Fund is available which provides investors with further tax incentives. While the UK has advanced tax incentives for investors, other countries around Europe could follow to improve investment efficiency and interest from prospective investors. The European Commission, along with other partners have also established an ambitious *European Green Deal*, which aims to ensure that the EU will be carbon neutral by 2050. This will require huge policy implementations and funding, and with this in mind, it will be important for innovative SMEs to obtain some of this funding to ease the patient capital gap burden that exists.

With the global crowdfunding market expected to reach $40 billion by 2026 (Statista, 2020), it is clear that this alternative method of financing is now becoming a stable source of finance for innovative SMEs and has a positive impact on Cleantech firms, something that is sure to grow into the future.

Chapter 3: *Born-to-be-green*: Financing Cleantech Firms in the UK

3.1 Introduction

Action on climate change is now the top priority of governments globally. It is increasingly evident that national governments and global coalitions are required to make substantial policy and financing commitments in order to reduce carbon and other greenhouse gas emissions. Recent UN IPCC reports (United Nations, 2021, 2022) provides stark 'now or never' warnings on the risks of climate change. Both Bloomberg (Bloomberg NEF, 2021) and the International Energy Agency (IEA, 2021) estimate that current global climate change investments are under half of the annual run-rate costs required, estimated at $2.35T. The European Commission presented the European Green Deal Investment Plan (EU Commissions, 2020a), which will provide over €1 trillion of sustainable investments over the next decade. The UK International Climate Finance (ICF) plays a crucial role in addressing climate change with three government Departments (DFID, BEIS and DEFRA) responsible for investing the UK's £5.8bn of ICF between 2016 and 2021, along with a recent announcement of a UK Government 'Ten Point Plan' to stimulate £12bn in green investment by 2030. This shows the serious commitment by policymakers, and implementation of these policies requires investment in and by the most important sector of the private economy, small and medium sized enterprises (SMEs). According to the IEA (2021), half of the technologies required to achieve net zero emissions have not been invited yet. Understanding the financing requirements for these technologies is essential. Yet there has been little attention to early stage (*Seed/Series A*) Cleantech innovation that develop potentially game-changing technologies that can contribute and assist in decarbornisation and climate mitigation (Polzin, 2017; Owen *et al*., 2018, 2019, 2020; Owen, 2021).

Cleantech firms typically lack sufficient resources to develop and scale their business (Ghosh and Nanda, 2010; Giudici *et al*., 2018; Hornuf and Schweinbacher, 2018a) which is why resourcing and financing is such a key issue. Due to their long horizon, capital intensive and complex R&D innovations, Cleantech firms often struggle to obtain sufficient, frequently high, levels of private investment required to reach commercialisation (Rowlands, 2009; BEIS, 2017; Owen *et al*., 2019). Previous studies have identified an equity investment gap in knowledge-intensive firms (Sadler, 2016; Wilson *et al.*, 2018; Lerner and Ramana, 2020). British Business Bank Equity Tracker (2021) data suggests a record year for Cleantech investment, but major shortfalls in all stages in terms of size of funding rounds (3-5x smaller than US funding rounds), particularly underfunding knowledge-intensive, long-horizon firms (Rowlands, 2009). Cohesive and notably better-funded early stage public-private financing programmes are suggested and repeatedly explored by Owen *et al.* (2019, 2021). It is argued that Cleantech SME innovation financing should be an essential cornerstone of

policies to tackle climate change (Owen *et al.*, 2020). There has been a recent policy focus, highlighted by UK Green Finance Institute (2019), to develop integrated policies and financing to leverage private investment into large-scale infrastructure projects such as, renewable energy, carbon capture, and EV transport.

This study defines Cleantech firms as private for-profit SMEs whose aim is to develop and adopt innovative technologies to reduce carbon dioxide emissions in their products and processes (Kenton, 2018). Cleantech firms commercialise clean energy technologies, which entails developing, integrating, deploying, or financing new materials, hardware or software, focused on energy generation, storage, distribution, and efficiency (Gaddy *et al*., 2017). Deep technology (*Deeptech*) is a hardware-led classification of an organisation, or more typically startup company, with the expressed objective of providing technology solutions based on substantial scientific or engineering challenges (TechWorks, 2021). *Deeptech* firms present great challenges requiring lengthy research and development, and large capital investment before successful commercialisation (Gourévitch *et al*., 2021). This study differentiates between hardware-led Cleantech (e.g. large scale renewable energy projects) and software-led Cleantech (e.g. energy efficiency technology solutions).

The UK is an aspiring '*World leader*' (HM Treasury/BIS, 2011) promoting green finance in its Clean Growth Strategy (2017), Green Finance Strategy (2019) and hosting of COP26, addressing the global Climate investment shortfall. This study focuses on the UK Cleantech market with a sample including 739 Cleantech firms, split between firms that have raised equity financing and those that have not. The aim of this study is to investigate the financing of early stage firms in the Cleantech industry and also to obtain a deeper understanding of the key financial characteristics of those firms that raise equity financing. Therefore, addressing the following research questions: (1) What are the potential determinants of raising equity finance for Cleantech firms in the UK? (2) What are the financing differences between software-led and hardware-led Cleantech firms?. To address these research question a number of hypotheses are formulated from the pecking order theory (Myers and Majluf, 1984). This study aims to provide first-time evidence on the financial influences on Cleantech firms raising equity financing. As equity investment is set to increase in this industry (Statista, 2021), it is important to know more about these considerations, something which the study aims to achieve.

The rest of the chapter is organised as follows. Section 3.2 reviews previous related literature and development of hypotheses. In Section 3.3, the methodological approach and the data used is discussed. In Section 3.4, the results and major findings of this study are presented. Finally, in Section 3.5, there results and suggested practical implications for Cleantech firms, investors, and policymakers are discussed before concluding in Section 3.6.

3.2 Previous related literature

3.2.1 Financing Cleantech

Equity funding for Cleantech firms has soared in recent years with venture capital funding for Cleantech hitting £40bn in 2020 and 2021 which exceeded the total for the previous two years by 37 per cent (Pitchbook, 2021). Until this, venture capital funding for Cleantech firms dried up following large investments from 2006 – 2011 which resulted in the loss of half of venture capitals $25bn investment (Gaddy *et al.*, 2017). Governments have also committed to increase spending on green initiatives and financing early stage Cleantech firms (EU Commission, 2020: ICF UK, 2021).

However, investing in early stage Cleantech firms is complex. There has been diminished interest in investment in Cleantech start-ups prior to 2020 (De Lange, 2016, 2017, 2019: Cumming *et al*., 2017), this could be due to the fact the financing gap is a greater problem for the diverse forms of Cleantech ventures which are capital intensive, have a high technology risk profile and uncertain exit opportunities for investors (Ghosh and Nanda, 2010; Hamilton, 2016; Rodriguez *et al*., 2020). The transition from the demonstration phase to full commercialisation is especially challenging (Balachandra *et al*., 2010). The typical investment model of Cleantech start-ups follows several steps which is in line with technology development (Siegel *et al*., 2003; Zahra and Nielsen, 2002) which includes discovery, R&D, demonstration and commercialisation (Bürer and Wüstenhagen, 2009). The development of Cleantech is often characterised by long development times and high capital intensity (Gaddy *et al*., 2017; D'orazio and Valente, 2019) and it is at the demonstration and commercialisation stage which studies have likened Cleantech development as the *valley of death* (Bürer and Wüstenhagen, 2009; Balachandra *et al.*, 2010) whilst also experiencing a higher *liability of newness* compared with other new ventures (Lehner and Nicholls, 2014; Lehner *et al*., 2018). It is at this stage where Cleantech firms may struggle where valuable time can be spent aiming for commercialisation which never materialises and this can be down to their hybrid business-models (Quélin *et al*., 2017) that aims to combine commercialisation with an environmental mission (Doherty *et al.*, 2014). Due to their long horizon R&D, Cleantech firms often struggle to obtain sufficient, frequently high, levels of private investment required to reach commercialisation (Rowlands, 2009; BEIS, 2017; Owen *et al*., 2019). Due to all of this, investors may not be rewarded for the full environmental-societal value and the risk-reward balance is viewed as unfavourable to investors (Bocken, 2015; Bak, 2017). Studies have also highlighted the gap in provision of equity finance (Cosh *et al*., 2009; Cressy and Olofsson, 1997; Cressy, 2012; Cumming and Johan, 2013; Lopez de Silanes *et al.*, 2015). These problems are likely to be heightened in knowledge-intensive firms, such as Cleantech, which requires greater sunk cost investment and are likely to take longer to generate

revenue after product/service development since their customer bases and offerings are more complex and/or client specific and assets are intangible. The challenges are exacerbated in rapidly changing environments (Wilson *et al*., 2018). These factors combine to make risk assessment, viability and revenue projection problematic for equity investors that are reluctant to invest, thus, increasing the equity gap for these firms. Studies have recognised a second valley of death giving rise to a second equity gap (Sadler, 2016; Wilson *et al.*, 2018) involving firms beyond the initial start-up revenue generation phase and that are considered knowledge-intensive. Another concern for early investors is not being able to raise follow-up capital (Nanda and Rhodes-Kropf 2017; Howell *et al*., 2020) and the preferences of large late-stage investors can shape where early stage investors are willing to invest.

Apart from the evidence from recent business reports (Pitchbook, 2021; British Business Bank Equity Tracker, 2021), recent studies indicate that there is increasing interest from investors who are valuing sustainability (Hawn *et al*., 2017; Durand *et al*., 2019). Therefore, understanding the type of Cleantech firms that raise equity financing will assist firms, investors and policymakers in the future. However, far less attention has been given to early stage Cleantech SME investment (Owen *et al*., 2018). A number of studies have discussed the role of governmental and patient capital required to assist in climate change mitigation and the development of Cleantech firms (Gaddy *et al*., 2017; WEF, 2018, Ivashina and Lerner, 2019). This study aims to bridge this gap with specific focus on equity funding of Cleantech firms and provide first time evidence of the role of different types of technologies along with examining the pecking order theory for Cleantech firms.

3.2.2 Equity financing in Cleantech…but what type of tech?

Venture capital firms have a preference for investing in software-led technology companies (Tech, 2014). There has been a large shift in focus of venture capital firms away from hardware and towards software and service businesses (Lerner and Nanda, 2020). Venture capital investors typically raise funds for a specific (usually a ten-year) period (Lerner, 2012b). This time frame implies that venture capitalists are naturally drawn to investment opportunities where the ideas can be commercialised and their value realised through an "exit" within a reasonably short period, which studies have suggested does not fit the Cleantech model (Gaddy *et al*., 2017). Technological changes over the past two decades have made it quicker and cheaper to learn about demand for a new software business. By way of contrast, many other sectors including Cleantech, new materials, and others are less amenable (*Deeptech* firms) to such rapid learning. Software and service businesses, which are typically based on proven technologies, often have short development times and can benefit from quick market feedback, are amenable to this approach (Lerner and Nanda, 2020). These constraints

imply that equity investors often exit their investments well before growth opportunities are fully realised (Farre-Mensa *et al*., 2020). Owen at al. (2019) provide examples of life science firms that have corporate pharmaceutical investors and seed to Series A hurdles that can be risk assessed, whilst new Cleantech platforms do not. Their timelines to investment exits vary greatly from under five years for shorter horizon digitech firms, to potentially decades for longer horizon capital intensive *Deeptech* (hardware) Cleantech firms (Owen *et al*., 2020). Numerous studies point to the valley of death (Mazzucato and Semieniuk, 2018) of deep, long horizon, capital intensive, expensive technology R&D innovations which can take decades to commercialise and consider these as hardware-led Cleantech firms. Therefore, proposing:

Hypothesis 1. Cleantech firms that are considered software Cleantech are (a) more likely to raise equity financing and (b) more like to raise greater amounts of equity financing.

3.2.3 The pecking order theory and Cleantech firms raising equity financing

The pecking order theory (Myers, 1984; Myers and Majluf, 1984) argues that costs relating to asymmetric information drives financial decision making. Entrepreneurs and firms have a preference for internal financing. If this becomes unavailable, they will then seek external debt financing and finally, as the least preferential option, will raise external equity financing. Studies have found that firms prefer using cheaper internal funds (Cosh *et al*., 2009; Mac an Bhaird and Lucey, 2010; Hanssens *et al*., 2016). Vanacker and Manigart (2010) show that firms with more profit, high-growth capabilities and internally generated funds gradually replace external financing. Michaelas *et al*. (1999) also find that small UK firms will use internally generated funds first and those using external funds having lower profit levels. However, Cleantech firms suffer due to long horizon of projects and the return and profitability levels are lower (Gaddy *et al*., 2017). Due to the vast number of studies and in line with the pecking order theory, firms with more internally generated funds will finance using internal funds before raising any external financing. Thus, proposing that:

Hypothesis 2. Cleantech firms with more internally generated funds are less likely to raise external equity funding.

3.2.4 Do banks finance Cleantech? Or no option but equity?

If Cleantech firms can generate internal funds, why should they look for funds from outside? Debt is a burden and firms will be pushed to raise external and alternative methods of financing when they have insufficient internal financing. As previously stated, the pecking order theory suggests that when firms need external financing, they will first raise debt before they raise equity (Myers and

Majluf, 1984). However, if a firm has reached its debt capacity, they may have no choice but to seek additional financing elsewhere. As the level of debt within a firm increases, so does the probability of failure due to liquidation or bankruptcy (Carpenter and Peterson, 2002). Firms that have reached their debt capacity or have excessive debt levels may be forced to raise equity financing (Lemmon and Zender, 2010; Vanacker and Manigart, 2010: Walthoff-Borm *et al*., 2018). The excessive debt measures used in this consists of a gearing ratio of greater than or equal to 90%. This ties in with other studies in entrepreneurial finance assessing the pecking order theory (Walthoff-Borm *et al*., 2018). Whether Cleantech firms differ in their ability to attract debt financing is unknown but this study proposes that:

Hypothesis 3. Cleantech firms with excessive debt levels are more likely to raise external equity funding.

3.2.5 To (be able to) capitalise or not? Asset structures for Cleantech firms

Does asset structure differ for Cleantech firms? Tangible assets are easier to value and maintain more of their value in case of bankruptcy than intangible assets (Myers, 1984) and for this reason firms with more tangible assets have fewer information asymmetries. Banks require collateral and one key reason firms experience raising debt financing is due to their ability to provide collateral (Berger and Udell, 1998). Intangible assets are different. Intangible Assets (IAS 38), outlines the accounting requirements for intangible assets, which are non-monetary assets which are without physical substance and identifiable either being separable or arising from contractual or other legal rights. Intangible assets often include R&D expenses, patents, trademarks or licences. IAS 38 is considered conservative in its criteria to recognise development costs (Tan, 2020) where firms must demonstrate the bellow criteria in order to capitalise their development expenditure (IAS Plus):

- the technical feasibility of completing the intangible asset (so that it will be available for use or sale)
- intention to complete and use or sell the asset
- ability to use or sell the asset
- existence of a market or, if to be used internally, the usefulness of the asset
- availability of adequate technical, financial, and other resources to complete the asset
- the cost of the asset can be measured reliably

The above list is quite extensive, one that early stage Cleantech firms may be unable to demonstrate. Studies have shown that early stage Cleantech firms show more technological novelties than those of other technology related firms and that supply-drive technological innovations are

particularly important in Cleantech (Horbach, 2008; Rehfeld *et al.*, 2007). Dangelico (2017) states that new technologies and environmental commitment related to technological aspects are relevant factors that drive the radical innovative nature of green products or services. Jensen *et al.* (2020) find that Cleantech start-ups have higher technological capabilities compared with other start-ups and provide evidence that Cleantech start-ups develop more market novelties than any other control peer groups used in their study.

Knowledge-intensive firms often must undertake specific investment in intangible assets such as know-how for particular customer relationships. In new markets, such firms may need to reposition themselves to develop a successful business model consistent with market demand (Lerner, 2002). Hence the presence of greater intangible assets is likely to increase the equity funding-gap (Wilson *et al.*, 2018). High technology firms face challenges to access credit needed to invest in innovation, in part because the knowledge-based capital they create is an unfamiliar asset class (Brassell and Boschmans, 2019). One key component of intangible assets is that of patents. However, patents can be very difficult to value under the IAS 38 criteria and unless there is an existence of a market. If criteria are met under IAS 38 the patent can be capitalised but the value may only be included as the cost of the patent application itself and all R&D expenditure to develop the patent cannot be capitalised. Patents reduce information asymmetries in entrepreneurial finance (Conti *et al*., 2013a) and can act as a signal for start-up financing. Patents play an important role in the development of innovative firms by acting as a signal for quality (Hottenrott *et al*., 2015) and studies have shown that having patents increases the likelihood, as well as the amount, of external equity (Hsu and Ziedonis 2013; Mann and Sager 2007; Haeussler at al., 2009; Hoenen *et al*., 2014; Zahringer *et al*., 2017). However, studies have also shown that a patent can also be considered an asset that can be used as collateral for debt financing (Conti *et al.*, 2013a; Conti *et al.*, 2013b; Yang *et al*., 2021). Therefore, Cleantech firms may struggle to capitalise their R&D to have a higher intangible asset value but by having a patent granted can raise financing, both debt and equity, easier.

Returning to asset structure, there are ample studies that show firms with more intangible assets will be pushed to raise external equity financing (Gompers and Lerner, 2003; Thornhill and Gellatly, 2005; Mac an Bhaird and Lucey, 2010: Vanacker and Manigart, 2010: Walthoff-Borm *et al*., 2018). A recent study by Lim *et al*. (2020) state that identifiable intangible assets support debt financing as much as tangible assets do. However, identifying these intangible assets may be more complex for Cleantech firms and thus, based on previous studies in entrepreneurial finance for SMEs this study proposes that:

Hypothesis 4. Cleantech firms with (a) less tangible assets and (b) more intangible assets are more likely to raise equity financing.

3.2.6 Liquid vs illiquid

Firms with "excessively" liquid assets are in the best position to finance projects (Myers and Rajan, 1998) suggesting firms with surplus cash or internally generated funds will more than likely use these funds to finance future projects. Petersen and Rajan (1997) find that firms with financial constraints have difficulty accessing funds. Working capital management is vital for SMEs because they often lack external funding (Fazzari and Petersen, 1993; Fu *et al.*, 2002; Porumboiu, 2016; Petersen and Rajan, 1997). Due to this, to support running their operations, the reliance on internal funding is said to be crucial for SMEs (Padachi, 2006). Moscalu *et al*. (2020) find that financing constraints hamper SMEs' growth and firms with liquidity issues will struggle to obtain debt financing. Sabki *et al*. (2019) find that firms with access to bank loans are more liquid and have higher liquidity ratios and suggest that firms with lower liquidity ratios will be restricted and raise alternative financing. In this study, liquidity contraints are classified as firms with a liquidity ratio of less than 0.75:1. Thus:

Hypothesis 5. Cleantech firms with liquidity constraints are more likely to raise equity financing.

3.3 Methodology and data

The data comes from a number of sources. Data is obtained on UK Cleantech firms for the period 2011 – Q1 2020 (applying Gaddy *et al*., 2017 definitions) from Beauhurst (Owen *et al*., 2020; British Business Bank Equity Tracker, 2021). Beauhurst, established in 2011, is the leading specialist in providing early stage SME equity financing data in the UK and produces the British Business Bank's annual UK Small Business Equity Tracker reports. The Beauhurst data provides information on external equity funding for Cleantech firms across the UK (828 firms). The UK has become a Cleantech investment hub with more Cleantech start-ups having received equity funding than any other European country (PwC, 2021) while London is also represented in the top 5 Cleantech ecosystems in the world (Startup Genome, 2021). The raw data shows the date of the equity investment, the amount raised, the amount of equity given, the type of equity provided and follow-on equity funding, if any. They also provide non-financial information on the location of the firm, specific industry within Cleantech, the main equity investors in each deal along with the company registration number. Beauhurst provides limited financial information on each firm, therefore, the FAME database managed by Bureau van Dijk Moody's and Companies House is used. FAME

contains high-quality accounting data on privately held and publicly traded UK and Irish firms and along with Orbis Europe, has been extensively used in recent studies on privately held SMEs (Vanacker *et al.*, 2017: Walthoff-Borm *et al.*, 2018; Eldridge *et al.*, 2021). Using the company registration number for each of the firms provided in the Beauhurst database, then obtaining accounting related variables on FAME. Data is also captured from Orbis Europe which contains basic information on the patent and royalty portfolio of each firm to obtain patent-related variables including patents granted and patents pending.

Finally, upon cleaning the combined databases comprising of Beauhurst, FAME and Orbis Europe and excluding listed firms, firms that breach the SME thresholds and firms that do not have sufficient financial data. The final samples consist of 739 firms of which 478 raised external equity funding, 261 that did not raise any equity funding.

Definitions of variables used to test the various models are provided in Table 3.2. Summary statistics are presented in Tables 3.1, 3.3 and 3.4. The sole focus on this study is on firms that are Cleantech specific and sector classification covers Cleantech firms that operate in Energy Efficiency, Recycling and Waste Management, Renewable Energy/Energy Generation and Transportation which coincides with the sectoral classification of the MIT energy initiative (Gaddy *et al*., 2017).

Table 3.1 Descriptive firm statistics (All firms)

Location (All Firms)				***Industry Classification (All Firms)***				***Raised Equity***		
	N	**%**			**N**	**%**			**N**	**%**
London	209	28.28		Energy Efficiency	268	36.27		Yes	478	64.68
South	190	25.71		Recycling & Waste Management	138	18.67		No	261	35.52
East	77	10.42		Renewable Energy / Energy Generation	224	30.31			**739**	**100%**
North	89	12.04		Transportation	109	14.75				
West	74	10.01			**739**	**100%**				
Scotland	65	8.80								
Wales	26	3.52		***Type of Technology***				***Active Firms***		
Northern Ireland	9	1.22			**N**	**%**			**N**	**%**
	739	**100%**		Hardware	279	37.75		Yes	582	78.75
				Software	460	62.25		No	157	21.25
					739	**100%**			**739**	**100%**

To test hypothesis 1, and building upon *Deeptech* (British Business Bank Equity Tracker, 2021; Owen and Vedanthachari, 2022) this study attempts to identify firms that are considered Cleantech with hardware specifications (e.g. large scale renewable energy projects) and Cleantech that are more software focused (e.g. energy efficiency solutions). In order to identify these firms, the initial classification under Beahurst is analysed which ties into Gaddy *et al.* (2017) sectors, and then

further analysis of NACE codes using FAME is undertaken. Following this, firms are classified into hardware or software-led Cleantech firms. The testing includes a dummy variable equal to 1 when a firm is considered sotware, and 0 otherwise. In total there are 460 firms classified as software-led versus 279 classified as hardware-led.

To test Hypothesis 2, measuring internally generated funds as accumulated retained profits or losses pre-equity funding. A dummy variable is included, *profitable pre-funding*, equal to 1 when firms have positive retained earnings (Scoones *et al*., 2015; Pattanapanyasat, 2021) at any stage pre-equity funding, and 0 otherwise. Previous studies have shown that firms with more retained profits will have more internal funds available and will have a preference to use this for funding future projects (Chittenden *et al*., 1996; Michaelas *et al*., 1999).

To test Hypothesis 3, that measures excessive debt as a dummy variable equal to 1 when firms have a gearing ratio of greater than 95%, and 0 otherwise (Vanacker and Manigart, 2010; Vander Bauwhede *et al*., 2015: Walthoff-Borm *et al*., 2018). Firms with excessive levels of debt will find it very challenging to attract additional debt financing due to a higher probability of going bankrupt and will need additional equity to strengthen their financial position (Vanacker and Manigart, 2010).

To test Hypothesis 4, using fixed asset ratios which is measured by the ratio of tangible fixed assets to total assets and intangible assets to total assets (Degryse *et al*., 2012; Walthoff-Borm *et al*., 2018; Donovan, 2021). Tangible assets are frequently used as collateral for debt funding, therefore, firms with more tangible assets tend to have higher debt capacity (Brav, 2009; Cassar, 2004; Cassar and Holmes, 2003). The testing then include intangible assets to assess whether firms with greater intangible raise equity funding. Studies show that firms invest in intangible assets, including R&D, patents, trademarks etc. to generate future growth opportunities but intangible assets are less suited as collateral and can limit debt capacity (Myers, 1984). Therefore, firms with more intangible assets will be pushed to raise external equity financing (Davila *et al*., 2003; Mac an Bhaird and Lucey, 2010; Vanacker and Manigart, 2010) However, patents which are a key component of intangible assets (IAS38) can be used for debt collateral (Conti *et al*., 2013a; Conti *et al*., 2013b) something which is important for Cleantech firms due to their long horizon intensive R&D (Mazzucato and Semieniuk, 2018) which can make them particularly vulnerable along with a higher *liability of newness* compared with other new ventures (Lehner and Nicholls, 2014; Lehner *et al*., 2018).

To test hypothesis 5, a number of measures are included for liquidity. First, constructing a dummy variable (illiquid) equal to 1 when firms have a liquidity ratio of less than 0.75:1 and 0

otherwise. Studies find that firms with access to bank loans are more liquid and have higher liquidity ratios suggesting that firms with lower liquidity ratios will be restricted and raise alternative financing (Sabki *et al.*, 2019; Wasiuzzaman, 2018). Mac an Bhaird and Lucey (2010) supports Bougheas' (2004) view that liquidity constraints due to inadequate retained profits necessitates additional resources for investment in R&D and thus will require external equity funding. To ensure robustness and completeness over the tests, there is also the inclusion of the monetary value for a firm's bank position. Another dummy variable is included for short-term debt and overdraft equal to 1 when firms have short-term debt outstanding or are in an overdraft position. One would assume that firms with structured debt financing (even that of short-term) would not necessarily raise equity funding, once within a given threshold, but those in an overdraft, and therefore, highly illiquid, would.

In addition, the testing controls for a range of variables that might provide insight into Cleantech firms that raise equity funding. At firm level, controlling for firm age (measured as the number of years since incorporation), whether a firm is inactive (dissolved or liquidated) or has experienced high-growth (OECD definition) and number of employees (t-1). The testing controls for specific sector, location and type of equity funding obtained. A number of accounting specific variables are also included such as revenue, EBITDA, cost of debt, current assets, current liabilities, issued capital, ordinary shares, total reserves and share premium. These variables are lagged at t-1. As part of robustness testing a number of additional variables are included to measures for patents. Having obtained information on whether a firm has a patent granted or patent pending pre-equity funding, there is a dummy variable equal to 1 when a firm has a patent granted pre-equity funding and 0 otherwise included. Another dummy variable is included that equals to 1 when a firm has a patent pending pre-equity funding. Studies have shown that having patents increases the likelihood, as well as the amount, of external equity (Hsu and Ziedonis 2013; Hoenen *et al.*, 2014; Zahringer *et al*., 2017). Small early stage ventures play a significant role in innovation and invention (McDaniels and Robins, 2017; Owen *et al.*, 2018) and as such may seek to file patent applications as a signal of quality for external financing (Vo, 2019; Hall, 2019).

To ensure completeness over the testing, a number of additional tests are undertaken using ordinary linear regressions. The testing examines the determinants of the amount of equity raised and the determinants of the amount of debt raised respectively. Although a number of variables are closely related, correlation tests do not suggest a high degree of first-order collinearity among the independent variables. Correlation Coefficient Matrix are presented for all variables in Appendix D. Additional tests were undertaken for multicollinearity, namely Variance Inflation Factors (VIF) and are presented in Appendix E. The variance inflation factor is a useful way to look for multicollinearity

amongst the independent variables. The mean VIF across the 2 models are as follows: Model 1 – 2.07; and Model 2 – 2.03. As a rule of thumb, a variance whose VIF values are greater than 10 may merit further investigation. Across both models, there are no variables with a VIF over 5. To ensure there are no heteroscedasticity issues in the testing, the dependent variables are transformed. This is done by means of having a logged numbers in our variables, this is particularly important with the accounting variables included in the models. The OLS model must also consider endogeneity which refers to situations in which a predictor (e.g., treatment variable) in a linear regression model is correlated to the error term. The common sources of endogeneity can be classified as: omitted variables, simultaneity, and measurement error. There are no endogeneity issues in the models presented.

A probit model is used to assess the likelihood of raising external equity financing. An OLS model was not used to assess the likelihood of firms raising equity financing, and ultimately to test the pecking order theory hypotheses incorporated in this study, as there are problems using OLS to estimate the coefficients of an equation with a dummy dependent variable (Studenmund, 2017). A decision was undertaken to test using either a probit or logit model. In the probit model, the dependent variable is categorical and can only take on one of the two values: yes or no, or true or false. Logit models are used to predict the probability of an event occurring and to model situations in which there are two possible outcomes. For most of the applications, the probit and logit models give very similar characteristics of the data because the densities are very similar, with both approaches much preferred to the linear probability model. (Brooks, 2019). Stock and Watson (2006) suggest that the logit approach was traditionally preferred because the function does not require the evaluation of an integral, and thus, the model parameters could be estimated faster. However, this argument is no longer relevant given that the computational speeds are now achievable, and the choice of one specification rather than the other is now usually arbitrary. Regarding entrepreneurial finance, recent studies on equity crowdfunding have incorporated probit models (Vanacker *et al*., 2017: Walthoff-Borm *et al*., 2018; Eldridge *et al*., 2021).

Table 3.2 Variable definitions

Variable	*Definition*
Raised Equity Financing	Dummy = 1 if a firm raised equity financing for the first time (0 otherwise)
Dummy Variables (Dummy = 1 (0 otherwise)	Profitable Pre Funding, Excessive Debt, Short-Term Debt, Overdraft, Illiquid, Software, Hardware, Patent Granted Pre Funding, Patent Pending Pre Funding, Inactive, High-Growth,
Firm Age	Number of years since incorporation
Employees	Number of employees in firm at financial year-end
Amount Raised	Amount of equity financing raised (£), first round
Revenue	Total amount of sales (£) in given financial year
Retained Earnings	Retained earnings (£) at financial year-end
EBITDA	Earnings before interest, tax, depreciation and amortisation (£) in given financial year
Tangible Assets	Tangible asset values (£) at financial year-end
Intangible Assets	Intangible asset values (£) at financial year-end
Tangible Asset Ratio	Ratio of tangible assets to total assets
Intangible Asset Ratio	Ratio of intangible assets to total assets
Debt Finance Pre Funding	Amount of debt financing raised (£), prior to equity financing
Cost of Debt Pre Funding	Average cost of debt (%), accumulated interest costs to debt outstanding prior to equity financing
Bank	Bank balance at financial year-end
Short-Term Loans	Short-term loans at financial year-end
Overdraft	Overdraft at financial year-end
Current Assets	Current asset values (£) at financial year-end
Current Liabilities	Current liabilities values (£) at financial year-end
Issues Capital	Issued capital value (£) at financial year-end
Ordinary Shares	Ordinary shares value (£) at financial year-end
Total Reserves	Total reserves value (£) at financial year-end
Share Premium	Share premium value (£) at financial year-end
Sector	Specific Cleantech sector classification: *Energy Efficiency, Recycling & Waste Management, Renewable Energy & Energy Generation and Transportation.*
Location	Specific location in the United Kingdom: *London, South, East, North, West, Scotland, Wales and Northern Ireland.*
Type of Equity Funding	Specific equity financing type: *Angel, Crowdfunding, Venture Capital and Government.*

Table 3.3 Summary descriptive statistics of variables

Variable	**N**	**Mean**	**Median**	**SD**
Firm Age (at equity investment)	739	2.78	1.00	2.44
Firm Age (now)	739	9.49	9.00	4.71
Employees (n)	739	19	5	48
Revenue (£)	739	4,943,288	97,466	12,087,603
Retained Earnings (£)	739	3,026,482	0.00	13,189,385
EBITDA (£)	739	-277,242	0.00	3,187,020
Current Assets (£)	739	6,594,895	10,093	47,325,050
Current Liabilities (£)	739	1,544,864	15,162	24,609,687
Short-Term Loans (£)	739	170,101	0.00	1,127,515
Overdraft (£)	739	21,661	0.00	167,052
Bank (£)	739	498,549	1,608	4,178,714
Tangible Assets (£)	739	432,785	565	2,474,002
Intangible Assets (£)	739	429,579	0.00	2,377,407
Tangible Assets Ratio (%)	739	0.36	0.00	1.47
Intangible Assets Ratio (%)	739	0.12	0.00	0.29
Liquidity Ratio (%)	739	2.05	0.22	7.47
Issues Capital (£)	739	578,239	100	8,581,341
Ordinary Shares (£)	739	525,399	100	8,576,164
Total Reserves (£)	739	4,863,578	0.00	16,883,642
Share Premium (£)	739	3,163,789	459,174	12,067,839

3.4 Empirical results and discussion

3.4.1 Descriptive statistics

Tables 3.1, 3.3 and 3.4, present summary statistics for the firms in the sample. Firms in the Energy Efficiency sector are most represented with 268 (36%) firms followed by Renewable Energy and Energy Generation with 224 firms (30%) firms. In terms of location, the majority of firms are based in London (28%) and the South of England (26%), as London is one of the world's leading ecosystems for Cleantech firms (Startup Genome, 2021). In total, 478 firms (65%) raised equity financing, of which 282 raised additional equity post their first round. In total, 157 firms (21%) in the sample that are subsequently inactive, of which 95 (61%) raised equity finance. Of the 478 firms that raised equity finance, most are early stage firms with 69% being less than 4 years since incorporation. In terms of the type of funding provided to these firms, statistics suggests that venture capital plays a significant role with 220 (46%) firms receiving equity investment from venture capital. When examining the type of technology used, 460 (62%) of the firms are classified as software-led Cleantech firms, while 279 (38%) firms representing hardware-led firms. Overall, £312,615,561 was invested into the 478 firms that obtained equity financing with an average amount of £781,623 at an average cost of equity of 14.97% (cost of equity is provided in the Beauhurst database. This average is made up of all the cost of equity data provided by Beauhurst). When analysing this a little bit further, firms that raise venture capital obtain a much higher average than any other type of funding at £1,195,100 and venture capital contributed to a total of £262,921,963 (70%) of all equity investment in UK Cleantech firms. Crowdfunding had a higher average invested amount compared to angel investment and government funding with an average of £730,021 showing that the emergence of Crowdfunding has provided young entrepreneurial firms with an additional source of external equity finance, one that plays an increasingly important role (Ahlers at el., 2015; Bruton *et al*., 2015; Cumming and Vismara, 2017; Herve and Schweinbacher, 2018). In terms of the funding by sector, firms in Recycling and Waste Management have the highest average amount raised of £1,157,259 suggesting a larger capital outlay required for firms in this sector. Of the firms that raised equity financing, 44 of those firms had raised debt financing prior to obtaining equity financing, the average of which was £229,856 per firm with an absolute amount of £109,871,030 of debt financing across these firms. Post-equity financing, 140 firms obtain debt financing at an average of £554,711 with an absolute amount of £265,151,842. Of the 261 firms that did not raise equity finance, they had average debt per firm of £1,809,442 leading to a total of £472,264,573 in debt financing over the period in this sample.

Pre-money valuation for Cleantech firms has seen a sharp rise in recent years (Purdom and Zou, 2021; Bullard, 2021). Somewhat surprisingly, on average, firms raising equity finance on crowdfunding platforms had the highest pre-money valuation at £7,928,158 highlighting the role of setting high valuation ranges for firms listed on crowdfunding platforms (Cumming and Vismara, 2017)

Finally, when identifying the firms that raise equity financing post their first raise, 282 firms raise multiple rounds averaging £4,850,605 per firm which is substantially higher than their first round. In total, an additional £1,367,870,519 was raised by way of equity financing post first raise in the sample of UK Cleantech firms. Firms in the Energy Efficiency (38%) and Renewable Energy and Energy Generation (31%) sectors make up the majority of the post-round 1 equity deals. In relation to the type of funding, once again, find that venture capital is involved in the most number of deals at 42%. Upon further analyses, venture capital contributes to £742,629,710 of post-round 1 equity financing making up 54% of the monetary amount of Cleantech post-equity financing at an average of £6,240,585 per firm.

Table 3.4 Descriptive firm statistics – firms who raised equity

Location				***Firm Age (At Equity Funding)***				***Type of Equity Funding***		
	N	**%**			**N**	**%**			**N**	**%**
London	132	27.62		Start-Up	74	15.49		Angel	86	17.99
South	128	26.78		1-3 Years	303	63.39		Crowdfunding	60	12.55
East	55	11.51		4-9 Years	92	19.62		Venture Capital	220	46.03
North	58	12.13		10-15 Years	7	1.46		Government	112	23.43
West	43	9.00		<15 Years	2	0.04			**478**	**100%**
Scotland	43	9.00			**478**	**100%**				
Wales	15	3.14						***Industry Classification***		
Northern Ireland	4	0.84							**N**	**%**
	478	**100%**						Energy Efficiency	181	37.87
								Recycling & Waste Management	85	17.78
								Renewable Energy / Energy Generation	134	28.03
								Transportation	78	16.32
									478	**100%**

	Amount of Equity Raised				
	N	**Mean**	**Median**	**SD**	**Absolute**
Amount Raised (£)	478	781,623	171,250	3,490,580	373,615,561
Cost of Equity (%)	478	14.97	11.17	13.65	
Amount Raised – Post Round 1 (£)	282	4,850,605	814,712	20,647,055	1,367,870,519
	Amount of Debt Raised				
Debt Pre-Equity Funding (£)	478	229,856	0	2,788,719	109,871,030
Debt Post-Equity Funding (£)	478	554,711	0	5,553,412	265,151,842
Total Debt Funding (£)	478	5,547,734	5,018	71,604,130	375,022,872
	Amount of Debt Raised (firms who did not raise equity)				
Total Debt Funding (£)	261	1,809,442	760,520	8,515,310	472,264,573
	Equity Raised – Sector				
	N	**Mean**	**Median**	**SD**	**Absolute**
Energy Efficiency	181	730,021	159,930	3,651,627	132,133,876
Recycling & Waste Management	85	1,157,259	172,500	4,613,444	98,366,987
Renewable Energy / Energy Generation	134	483,386	208,335	719,661	64,773,732
Transportation	78	1,004,371	150,000	4,390,704	78,340,965
	478				
	Equity Raised (£) – Type of Funding				
	N	**Mean**	**Median**	**SD**	**Absolute**
Angel	86	492,370	150,009	766,205	42,343,789
Crowdfunding	60	730,021	232,895	1,340,457	43,801,246
Venture Capital	220	1,195,100	204,554	5,032,372	262,921,963
Government	112	219,184	37,498	352,013	24,548,563
	478				
	Pre-Money Valuation (£) - Type of Funding				
	N	**Mean**	**Median**	**SD**	**Absolute**
Angel	86	4,507,107	2,439,785	6,633,736	
Crowdfunding	60	7,928,158	2,065,046	18,149,933	
Venture Capital	220	6,498,660	1,754,546	22,069,376	
Government	112	4,203,902	1,765,971	6,116,067	
	478				

3.4.2 Identification strategy and main results - Likelihood of accessing external finance

In this section, testing the hypotheses developed with the following model (Equation 1) where a binary dependent variable *Raised Equity* equals to 1 if a firm raised equity financing for the first time, and 0 otherwise is used. The employment of a probit regression to estimate this model is undertaken.

$$Prob(RaisedEquity_i) = \Phi(\beta_1 Profitable\ PreFunding_i + \beta_2 Exceessive\ Debt_i + \beta_3 Short\ term\ Debt_i + \beta_4 Over\ Draft_i + \beta_5 Bank_i + \beta_6 TAR_i + \beta_7 IAR_i + \beta_8 Illiquid_i + \beta_9 Software_i + \beta_{10} FirmAge_i + \beta_{11} Employees_i + \beta_{12} PatentGranted_i + \beta_{13} PatentPending_i + \beta_{14} Inactive_i + \beta_{15} HighGrowth_i + \beta_{16} Revenue_i + \beta_{17} EBITDA_i + \beta_{18} Cost\ of\ Debt_i + \beta_{19} Current\ Assets_i + \beta_{20} Current\ Liabilities_i + \beta_{21} Issued\ Capital_i + \beta_{22} Ordinary\ Shares_i + \beta_{23} Total\ Reserves_i + \beta_{23} Share\ Premium_i + \beta_{24} Sector_i + \beta_{25} Location_i + \beta_{26} FundingType_i)\ Equation(1)$$

$$where, RaisedEquity = 1\ if\ RaisedEquity > 0\ \&\ , RaisedEquity = 0\ if\ RaisedEquity \leq 0$$

TAR is tangible asset ratio and IAR is intangible asset ratio. Φ is cumulative normal distribution. All the variables are defined in Table 3.2. To compute estimates of β_i and their associated standard errors, using a maximum likelihood technique. The marginal effects at the sample mean is reported in Table 3.5. The marginal effects for binary explanatory variables determine the discrete change while for the continuous explanatory variables, the marginal effects measure the instantaneous rate of change. The baseline model are presented in Model 1. Sector, location and type of equity funding fixed effects variables is then added in Model 2. Firm-specific control variables are included into Model 3 before incorporating accounting-related variables only into Model 4. Model 5 incorporates both firm-specific control variables and accounting-related variables while Model 6 includes all variables as well as sector, location, and type of equity funding fixed effects variables.

Hypothesis 1 predicts that Cleantech firms that are considered software Cleantech are (a) more likely to raise equity financing and (b) more like to raise greater amounts of equity financing. The results in Table 3.5, models 1 through 6 shows positive coefficients suggesting an increase from the mean to the mean + 1 standard deviation increases the likelihood of raising equity by between 8% and 23% for software-led Cleantech firms. In Table 3.6, an OLS is used to further test the hypothesis. The results suggest that software-led Cleantech firms are raising up to 1.85x more than hardware-led Cleantech firms. Therefore, the results find support for Hypothesis 1.

Hypthosis 2 predicts that Cleantech firms with more internally generated funds are less likely to raise external equity funding. The results are presented in Table 3.5, models 1 through 6 indicate that firms that experience any yearly profitability prior to equity investment and therefore, have internally generated funds, are less likely to raised equity financing which is consistent with Hypothesis 2. These findings are not only statistically significant but also show that there is economic meaning insofar as an increase from the mean to the mean + 1 standard deviation in a firm's internally generated funds decreases the likelihood of raising equity by 25.6%.

Hypothesis 3 predicts that Cleantech firms with excessive debt levels are more likely to raise external equity funding. This is effectively measured using four different but relatable variables. Apart from the *excessive debt* dummy variable, additional variables also include dummy variables for firms that have short-term loans outstanding and for firms that are in overdraft. To ensure completeness of this hypothesis and to compare firms in overdraft, the testing also includes bank balances at the financial year-end prior to equity investment. The results find that firms with excessive debt levels are more likely to raise equity financing. There is also statistical significance across the other variables included to measure excessive debt and find that firms that have short-term debt are less likely to raise equity financing. This could be perhaps due to the fact that these firms are not experiencing *excessive debt* levels and are managing their short-term debt in an efficient manner and this is not a reason to pursue equity financing. This is because short-term debt channels are more sensitive to credit conditions (D'Amato 2020). However, there are differences for those firms that are in overdraft. Firms that are utilising their overdraft facilities are more like to raise equity financing. The results show that an increase from the mean to the mean + 1 standard deviation in a firm's overdraft increases the likelihood of raising equity financing by 19.5%. Finally, firms with a positive cash position are less likely to raise equity financing. Therefore, the results support Hypothesis 3 in that firms with excessive debt levels will raise equity financing.

Table 3.5 also investigates the role of assets in the likelihood of raising equity financing and have mixed results in support of Hypothesis 3. First, there is a significant impact of tangible assets on the probability that firms raise equity financing and see that firms with more tangible assets are less likely to raise equity financing. Therefore, finding support for Hypothesis 4A. When analysing the intangible assets ratio, there is no finding of support for Hypothesis 4B, which is one of the indistinct findings in this particular study. Not only is there a finding of statistical significance across all models but also there is economic meaning in them with results varying from a decrease from the mean to the mean + 1 standard deviation in a firm's intangible asset ratios, thereby increasing the likelihood of raising equity financing by 20%.

Hypothesis 5 predicts that Cleantech firms with liquidity constraints are more likely to raise equity financing. The results in Table 3.5 show positive coefficient when examining liquidity and whether firms that are financially constrained (liquidity ratio <0.75), the testing finds statistical significance in all models insofar as that firms that are *illiquid* are more likely to raise equity financing. In model 3, an increase from mean to the mean + 1 standard deviation in firm's that are under the 0.75:1 liquidity ratio, increases the likelihood of raising equity financing by 18.7%. Therefore, providing support for Hypothesis 5.

Table 3.5 Regression analyses of the probability of raising external equity financing

Dep. Var.	Raised Equity					
	Model 1 Marginal Effects	Model 2 Marginal Effects	Model 3 Marginal Effects	Model 4 Marginal Effects	Model 5 Marginal Effects	Model 6 Marginal Effects
Independent Variables						
Profitable Pre Funding	-0.256*** (0.723)	-0.276*** (0.739)	-0.226*** (0.113)	-0.400*** (0.086)	-0.374* (0.268)	-0.380* (0.285)
Excessive Debt	0.213*** (0.039)	0.204*** (0.041)	0.114*** (0.046)	0.243*** (0.047)	0.180*** (0.095)	0.169** (0.122)
Short-Term Debt	-0.488*** (0.068)	-0.494*** (0.069)	-0.523*** (0.125)	-0.378*** (0.088)	-0.217* (0.160)	-0.240* (0.166)
Overdraft	0.158** (0.078)	0.168** (0.076)	0.111 (0.085)	0.183** (0.096)	0.139 (0.025)	0.109 (0.024)
Bank	-0.022*** (0.004)	-0.021*** (0.004)	-0.027*** (0.006)	-0.022*** (0.008)	-0.016 (0.015)	-0.013 (0.016)
Tangible Asset Ratio	-0.077*** (0.318)	-0.086*** (0.032)	-0.090*** (0.034)	-0.081** (0.039)	-0.082** (0.066)	-0.069* (0.072)
Intangible Asset Ratio	-0.202*** (0.071)	-0.229*** (0.073)	-0.221*** (0.091)	-0.111* (0.084)	-0.148* (0.155)	-0.146* (0.172)
Illiquid	0.187*** (0.046)	0.190*** (0.047)	0.238*** (0.061)	0.045* (0.067)	0.152* (0.110)	0.154* (0.126)
Software	0.161*** (0.043)	0.234*** (0.058)	0.081*** (0.048)	0.232*** (0.069)	0.088** (0.077)	0.072* (0.102)
Control Variables						
Firm Age			0.229*** (0.018)		0.320*** (0.093)	0.331*** (0.168)
Employees			0.027 (0.022)		0.060 (0.045)	0.061 (0.529)
Patent Granted			0.067 (0.064)		0.086 (0.117)	0.101 (0.130)
Patent Pending			-0.090 (0.065)		-0.093 (0.112)	-0.074 (0.118)
Inactive			-0.103* (0.061)		-0.203*** (0.084)	-0.192** (0.088)
High-Growth			-0.128 (0.137)		-0.007 (0.189)	-0.046 (0.192)
Revenue				-0.016*** (0.004)	-0.014* (0.088)	-0.015* (0.011)
EBITDA				0.018 (0.011)	0.004 (0.028)	0.003 (0.028)
Cost of Debt				0.057 (0.037)	0.078 (0.096)	0.077 (0.105)
Current Assets				-0.027* (0.015)	-0.036 (0.026)	-0.036 (0.031)
Current Liabilities				0.010 (0.013)	-0.016 (0.021)	-0.019 (0.023)
Issued Capital				-0.323 (0.386)	-0.164 (0.588)	-0.151 (0.428)
Ordinary Shares				0.319 (0.386)	0.169 (0.458)	0.156 (0.424)
Total Reserves				-0.010* (0.006)	-0.003 (0.012)	-0.001 (0.012)
Share Premium				-0.032*** (0.006)	-0.033*** (0.014)	-0.034*** (0.021)
Sector		Yes				Yes
Location		Yes				Yes
Type of Funding		Yes				Yes
# Obs.	739	739	739	739	739	739
LR-chi2	328.64	340.28	653.55	468.46	712.30	720.71
Pseudo-R2	34.24	35.45	68.09	48.81	74.21	75.09

Notes: Table 6 presents the result of probit regression model. The dependent variable is Raised Equity, a binary variable equals to 1 if a firm raised equity financing for the first time, and 0 otherwise. The independent variables are Profitable Pre-Funding, Excessive Debt, Short-Term Debt, Overdraft, Bank, Tangible Asset Ratio, Intangible Asset Ratio, Illiquid and Software. We have controlled for firm level characteristics such as Firm Age, Employees, Patent Granted, Patent Pending, Inactive and High-Growth. We also have controlled for firm level accounting characteristics such as Revenue, EBITDA, Cost of Debt, Current Assets, Current Liabilities, Issued Capital, Ordinary Shares, Total Reserves and Share Premium. We have also included Sector, Location and Type of Equity Funding fixed effects. All variables are defined in Table 4.
*** Statistical significance at the 1% level.
** Statistical significance at the 5% level.
* Statistical significance at the 10% level.

3.4.3 Additional tests

A number of additional tests are performed. To ensure completeness, using ordinary linear regressions, the determinants of equity funding are examined using the amount raised as the dependent variable, and coefficients for these tests are presented in Table 3.6, Model 1 - 4. Testing the base model, before running extended models, to include location, sector and type of equity funding. Then, including additional control variables before extending the model. Throughout these tests, there are similar findings as presented in the results. It is noted that during these tests that all hypotheses, 1–5 are supported and coincide with the core-analysis presented in Table 3.5 and analysed in Section 3.4.2. Using an OLS will show the impact on the monetary amounts rather that the probability shown in the probit model in Table 3.5. There is statistical significance in a number of areas but demonstrating a distinct finding surrounding intangible assets and Cleantech firms, sees that there is a significance that firms with higher level of intangible assets are raising less equity. The testing also finds that firms with patents pending are raising more equity financing and that firms that are considered software Cleantech are a key determinant in the amount of equity raised.

The results suggest that software-led Cleantech firms are raising up to 1.85x more than hardware-led Cleantech firms. Across all the models in Table 3.6, finds that firms located in London will raise more equity financing than all of the other locations. There is no statistical significance between any sectoral and type of equity funding and the amount of equity finance being raised.

In relation to including additional accounting-related variables, the results find that firms that are generating revenue are less likely to raise equity financing which ties into the findings on firms with internally generated funds. There is a decrease in the likelihood of firms with positive current assets raising equity financing which can be linked to several the independent variables. Standing to reason, there is a decrease in the likelihood of firms that have share premium and are raising equity finance. Across all the models in Table 3.5, there is no statistical significance between any sectoral, location and type of equity funding and the likelihood of raising equity financing.

Finally, undertaking another ordinary linear regression on the determinants of debt financing. An examination on the amount of debt raised prior to the first equity raise is undertaken. The amount of debt raised is the dependent variable, and coefficients for these tests are presented in Table 3.7, Model 1 - 4. Testing the base model, before running extended models to include location, sector and type of equity funding. Additional control variables are then included before extending the model. While there are not as many statistically significant results as in the previous testing, there are some clear findings. Firms with greater tangible assets will raise more debt coinciding with a hypotheses earlier in this study. For the sample of Cleantech firms, it is clear that debt providers are financing firms with intangible assets. There is no statistical significance when analysing the determinants of debt raised and patents granted or pending. There is minor statistical significance in software-led Cleantech firms and raising less debt financing. Across all the models in Table 3.7, there is no statistical significance between any sectoral, location and type of equity funding and the amount of debt being raised.

Table 3.6 Regression analyses of the determinants of equity amount raised

Dep. Var.	**Amount Equity Raised**			
	Base Model 1	Ext Model 1	Base Model 2	Ext Model 2
Retained Earnings	-0.178***	-0.147***	-0.090**	-0.087**
	(0.051)	(0.495)	(0.043)	(0.043)
Debt Pre-Equity Funding	-0.152***	-0.117**	-0.154***	-0.152***
	(0.057)	(0.054)	(0.048)	(0.048)
Short-Term Loans	-0.238***	-0.207***	-0.197	-0.098
	(0.074)	(0.070)	(0.063)	(0.061)
Overdraft	0.227***	0.1993***	0.128*	0.109*
	(0.080)	(0.075)	(0.068)	(0.066)
Bank	-0.158***	-0.147***	-0.223***	-0.232***
	(0.050)	(0.047)	(0.042)	(0.042)
Tangible Assets	-0.191***	-0.129***	-0.171***	-0.158***
	(0.050)	(0.049)	(0.043)	(0.043)
Intangible Assets	-0.092***	-0.093***	-0.076***	-0.084**
	(0.044)	(0.042)	(0.038)	(0.037)
Liquidity Ratio	-0.361***	-0.259***	-0.083	-0.063
	(0.121)	(0.115)	(0.104)	(0.102)
Software	1.270***	1.853***	0.855***	0.626**
	(0.370)	(0.482)	(0.314)	(0.409)
Firm Age			0.933***	0.913***
			(0.071)	(0.075)
Employees			0.450***	0.364***
			(0.129)	(0.128)
Patent Granted			0.648	0.612
			(0.542)	(0.536)
Patent Pending			1.790***	1.407***
			(0.516)	(0.516)
Constant	1.051***	1.604***	1.7899***	1.750***
	(0.250)	(0.452)	(0.329)	(0.572)
Location		Yes		Yes
Sector		Yes		Yes
Type of Funding		Yes		Yes
# Obs.	739	739	739	739
Adj. R2	34.00	41.66	53.67	57.33
F	48.52	26.10	66.76	36.79

Notes: Table 7 reports the results of determinants of equity amount raised regression models. The regression model above includes the full model extending the base model with Sector, Location and Type of Equity Funding fixed effects. All variables are defined in Table 4. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1%, 5% and 10% levels respectively.

Table 3.7 Regression analyses of the determinants of debt amount raised

Dep. Var.	Amount Debt Raised			
	Base Model 1	Ext Model 1	Base Model 2	Ext Model 2
Retained Earnings	0.029 (0.033)	0.029 (0.033)	0.029 (0.032)	0.025 (0.033)
Short-Term Loans	0.896*** (0.034)	0.894*** (0.034)	0.864*** (0.034)	0.860*** (0.034)
Overdraft	-0.004 (0.051)	-0.003 (0.051)	-0.025 (0.051)	-0.033 (0.051)
Bank	0.107*** (0.032)	0.100*** (0.032)	0.079*** (0.032)	0.074** (0.032)
Tangible Assets	0.137*** (0.032)	0.131*** (0.033)	0.107*** (0.032)	0.101*** (0.033)
Intangible Assets	0.049*** (0.028)	0.052** (0.029)	0.030** (0.028)	0.030* (0.028)
Liquidity Ratio	0.071 (0.078)	0.081 (0.078)	0.060 (0.078)	0.062 (0.078)
Software	-0.308 (0.240)	-0.177 (0.312)	-0.315* (0.237)	-0.140 (0.314)
Firm Age			0.062 (0.054)	0.051 (0.057)
Employees			0.534*** (0.095)	0.556*** (0.096)
Patent Granted			-0.601 (0.409)	-0.460 (0.411)
Patent Pending			0.243 (0.389)	0.286 (0.396)
Constant	0.582*** (0.161)	0.251*** (0.309)	0.438* (0.249)	0.336 (0.439)
Location		Yes		Yes
Sector		Yes		Yes
Type of Funding		Yes		Yes
# Obs.	739	739	739	739
Adj. R2	71.04	71.37	72.20	72.50
F	259.64	92.96	160.75	78.83

Notes: Table 8 reports the results of determinants of debt amount raised regression models. The regression model above includes the full model extending the base model with Sector, Location and Type of Equity Funding fixed effects. All variables are defined in Table 4. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1%, 5% and 10% levels respectively.

3.5 Discussion

This study provides new evidence on equity financing for Cleantech firms. Using a unique database, an examination is undertaken on the financing of Cleantech firms. The findings are consistent with predictions of the pecking order theory. Profitable Cleantech firms are less likely to raise equity finance. Cleantech firms with *excessive debt* are likely to raise equity financing. This also ties into the predictions on *illiquid* firms, finding that raising equity finance is primarily due to financial constraint. The prediction of firms that have less tangible assets raising equity financing is also proven in this study and explained by these firms employing tangible assets as collateral for debt financing. However, the study raises some key questions on the role of intangible assets in equity financing. Previous studies find that firms with intangible assets raise external equity financing

(Gompers and Lerner, 2003; Thornhill and Gellatly, 2005; Mac an Bhaird and Lucey, 2010: Vanacker and Manigart, 2010: Walthoff-Borm *et al*., 2018), although evidence from this study suggests a nuanced version of this finding. The results find that firms with lower intangible assets are more likely to raise equity financing and greater amounts. One potential reason is that the capitalisation of intangible assets, under IAS 38, is quite restrictive (Ahmed and Falk, 2006). Therefore, Cleantech firms, that are already considered more technologically innovative than other firms (Dangelico, 2017), will struggle to capitalise their R&D expenditure. Another potential reason is that equity investors are more concerned about the promise of success and want to invest at an early stage, especially in an emerging and developing industry with great social and environmental benefits where intangible assets are possibly not a main priority. The Cleantech industry has seen a very significant increase in investment, both at public and private investment levels over the last number of years, suggesting that Cleantech firms obtain equity financing regardless of the development of intangible assets. Recent studies have also shown that venture capital firms are targeting investment in more *born-to-be-green* firms (Mrkajic *et al*., 2019) and in fact, identifiable intangible assets can be just as important for firms raising debt financing as tangible assets (Lim *et al.*, 2020). Patents constitute significance of intangible assets and are an important role for innovative Cleantech firms in protecting their intellectual property. A number of studies where multiple research suggest patents attract external investment (Hoenen *et al*., 2014; Zahringer *et al*., 2017; Vo, 2019) but also that patents can be used for debt collateral from banks (Conti *et al.*, 2013a, 2013b; Yang *et al*., 2021). There is no evidence that suggests Cleantech firms with patents, granted or pending, are more likely to raise equity finance. As part of robustness testing and examining the determinants of the amount of equity raised, there are statistical significance findings that firms with patents pending prior to raising equity funding will raise a lot more. This suggests that equity investors are willing to invest at an early stage on the promise of success and the potential of a patent being granted or could argue that those firms that already have a patent granted are more likely to use it as collateral for debt financing (Conti *et al*., 2013a). Patents pending could also be a reason why firms with lower levels of intangibles are raising greater amounts of equity finance as the future value of these patent applications cannot be capitalised.

Previous studies have suggested that there is an equity gap for knowledge-intensive *Deeptech* firms (Owen and Vedanthachari, 2022; Lerner and Nanda, 2020; Wilson *et al*., 2018) and believe the results highlight the increasing equity funding gap for hardware-led Cleantech firms. The study finds that equity investors are more likely to invest in software-led firms, and these firms will also raise greater amounts. This further raises the question of the role of equity financing for hardware type

firms (Lerner and Nanda, 2020) and the issues surrounding the type of funding required (Gaddy *et al*., 2017; Owen *et al*., 2019, 2020; Ivashina and Lerner, 2019; Wilson *et al*., 2018; WEF, 2021).

3.5.1 Practical and policy implications

The study has important implications for policymakers. As investment in Cleantech has increased dramatically and external equity investors are eager to invest, it is vital to understand Cleantech firms contemplating equity financing and investors willing to invest. Evidence is provided that software-led Cleantech firms are more likely to raise equity financing and greater amounts. This further highlights the equity gap for long-horizon *Deeptech* Cleantech firms and greater focus and supports are required for these types of firms through to commercialisation (WEF, 2021).

Specific to Cleantech firms and through the lens of the pecking order theory evidence is provided as to the key financial and accounting influences in raising equity financing. Throughout the testing, it becomes clear that firms with internally generated funds that are not in excessive debt with strong liquidity, will raise debt financing. Cleantech firms raise equity financing due to financial constraints. However, there are interesting findings on the role of intangible assets. Previous studies suggest that firms with greater intangible assets will raise equity financing, however, the opposite applies in this study.

There has been debates on the role of intangible assets in financial reporting (FASB, 2018: Mazzi *et al*., 2019). Ahmed and Falk (2006), find that R&D capitalised expenditure is positively and significantly associated with the firm's future earnings which is why firms seek to capitalise on their R&D as a signal for external investors as investors perceive the capitalisation of R&D to be related to successful R&D projects (Shah *et al*., 2013). Oswald *et al*. (2017) find that R&D capitalisation has information value for prospective investors which encourages external investment. However, the findings show that Cleantech firms do not necessarily need to obsess over developing intellectual property, and capitalising on R&D expenditure in order to increase their intangible asset value. The OECD (2021a) published a report on bridging the gap in the financing of intangibles. They also state there is a significant financing gap for innovative technology firms with extensive reliance on intangible assets. In their suggested recommendations and policies to close the financing gap, they specifically mention the conservative nature of the accounting rules (IAS 38) and believe there should be a reduction in the opacity of information. They also recommend banks increase intangibles pledgeability to provide additional supports and financing to these types of firms, but this study shows banks are financing firms with intangibles and recent studies have also shown this (Lim *et al*., 2021;

Yang *et al*., 2021). Finally, their report states the need for patient venture capital, targeted government supports, and tax incentives for both firms and investors.

What can be done? The missing ingredient in innovation in the race to net zero, is 'patience' (WEF, 2018). The World Economic Forum define patient capital as 'investing with the expectation of holding an asset for an indefinite period of time by an investor with the capability of doing so'. Ivashina and Lerner (2019) highlight the immediate need for patient capital in referring to the current climate change crisis. Studies have repeatedly explored and indicated the need for a better-funded early stage *Deeptech* public-private finance escalator (Owen *et al*., 2019, 2020; Owen and Vedanthachari, 2022). Wilson *et al*., (2018) also highlight the need for patient capital in knowledge-intensive firms. The question is what type of investors can invest for an indefinite 'period of time'? The role of government and large corporations is crucial in the financing of Cleantech firms due to their greater resources which can be patient. The World Economic Forum calls on large corporations and venture capital firms to increase their spending in hardware-led Cleantech firms as a matter of urgency (WEF, 2021).

3.6 Conclusion

Equity financing for Cleantech firms is complex due to the nature of the long horizon, capital intensive, expensive technology R&D innovations which can take decades to commercialise. There has been a rapid increase in equity financing for Cleantech firms in recent years with this trend set to continue. This study provides a first-time breakdown of the technological component of Cleantech firms and identify software-led and hardware-led Cleantech firms and find clear results that software-led Cleantech firms are more likely to raise equity financing and a much greater amount. This highlights the equity gap for knowledge-intensive hardware projects and once again highlights the need for patient gap for these type of firms. It also shows that equity investors, even in an uncertain industry such as Cleantech, are more willing to invest in software-led firms. Through a pecking order theory lens, this study also investigates factors in which Cleantech firms' raise equity financing. Using a unique dataset of 739 firms which comprises a number of sources, find that Cleantech firms raise equity finance when they are financial constraint (i.e. when they have exhausted their internally generated funds, have excessive debt capacity and have poor liquidity). A distinct finding in this study is that Cleantech firms raise equity financing regardless of the intangibility of their assets which contradicts a number of studies in accounting and entrepreneurial finance around the role of intangible assets and external financing. There is a correlation between a lower level of intangible assets and the amount of equity financing raised and also see find that debt providers are in fact financing Cleantech firms with greater levels of intangible assets.

As with any research, this study has limitations, which may be important avenues for future research. First, the Beauhurst database does not provide insight into firms that sought equity financing and were unsuccessful. As such, the sample is split between Cleantech firms that raised equity finance and those that did not. Second, the equity funding information collated is based on equity deals from 2011 – Q1 2020 and perhaps there are some spillover effects from Brexit which could not be incorporated into this study. Third, the sample only focuses on UK firms and perhaps other supports or partnerships in other countries are in place but the data does not account for this. Forth, reasonable assumption are made on the classification of firms that are considered software and hardware, this is done by analysing each sector classification and then undertake a high-level scoping exercise of NACE codes through the FAME database. There are a number of avenues available for future research. Following on from this study, it would be good to distinguish between the UK market and other European countries. Examining the sequencing and timing of external equity investment is another fruitful area of research and could indicate the amount of equity required during the early stage development of Cleantech firms and could identify areas of bridging the equity gap, and second equity gap (Sadler, 2016; Wilson *et al*., 2018) for knowledge-intensive firms. Studies provided evidence that the time horizon for Cleantech firms is different to other type of technology start-ups (Lehner and Nicholls, 2014; Quélin *et al.*, 2017; Lehner *et al.*, 2018). Wilson *et al.* (2018) show estimated coefficients in their study which states that knowledge-intensive firms' will achieve stability after 11 years. Therefore, examining the post-equity funding performance of these firms and their funding cycle over a long-time period will be very important for policymakers.

As urgent action is required which is emphasised by governments and international agencies (United Nations, 2022) the development of new and innovative disruptive technologies to ameliorate and reverse the harmful effects of carbon emissions is essential (Lerner 2010; Lee *et al*., 2015; Zhang *et al.*, 2019). According to the IEA (2021), half of the technologies required to achieve net zero emissions have not been invented yet. Understanding the financing requirements for these technologies is essential. Owen *et al*. (2021), argue that Cleantech SME innovation financing should be an essential cornerstone of policies to tackle climate change. This study provides a new focus for Cleantech firms, equity investors and policymakers. It is hope this study will further stimulate scholars, practitioners and industry experts to continue to investigate the financing of Cleantech firms.

Chapter 4: Environmental Sustainability Reporting for Small and Medium Sized Enterprises: Is the Global Reporting Initiative a feasible approach? *The Small and Medium Sized Accounting Practitioners perspective*

4.1 Introduction

Amid growing expectations that environmental concerns are considered across supply chains, Environmental Sustainability Reporting (ESR) by businesses of all sizes is becoming integral to the strength of traditional financial metrics, in terms of sales, access to trade credit and finance (European Commission, 2021a; Papoutsi and Sodhi, 2020). As the role of businesses in confronting climate change gains urgency, standard-setters have consolidated their efforts so as to provide more robust and unified guidance. While SMEs have not been completely ignored in these developments (Arena and Azzone, 2012; IIRC, 2011), insufficient policy level attention has been devoted to the barriers and challenges SMEs encounter in any endeavour to engage in ESR. Large global firms have taken over a decade to adopt the process as implementation carries significant financial, time and human resource requirements (Dumay *et al.*, 2017). This raises the concern as to the ability of SMEs to effectively engage in ESR, which in the coming years may serve as an important form of communication to lenders, suppliers and customers (Thoradeniya *et al*. 2022; Palea, 2018). Thus, this study identifies in qualitative and quantitative terms, the challenges and costs associated with ESR.

SMEs have typically encountered challenges when faced with technological change and competition from multinationals, particularly in times of economic difficulty. Maintaining financial liquidity and servicing debt finance are priority concerns for many (Ślusarczyk and Grondys, 2019). Innovation and enhancement of stakeholder communications tends to be a luxury that many cannot devote time and resources to. This problem has been exacerbated by the global pandemic, with many SMEs ceasing operations while those who remain face stricter resource constraints with respect to developing and reporting sustainability activities (Rowan and Galanakis, 2020).

The majority of academic and policy discussion around sustainability reporting has converged upon large firms and multinational enterprises. Indeed, EU level discussion suggests that it may be 2026[17] before sustainability reporting requirements directly impact SMEs. This lack of urgency notwithstanding, the capacity for SMEs to engage in sustainability reporting merits timely and focused consideration. Firstly, indirect pressures from larger companies in supply chains to provide basic measures of environmental impact are likely to amplify reporting demands on SMEs

[17] EC Interinstitutional File: 2021/0104(COD)

in the short term (Centobelli *et al.*, 2021; Graafland, 2018; Johnson and Schaltegger, 2016; Sarkis *et al*., 2011). Secondly, the environmental aspects of the European Central Bank (ECB) action plan may also serve to accelerate SMEs' propensity to measure their environmental impact, and the environmental risks facing them, before seeking bank financing (ECB, 2021; UN Environment Programme Finance Initiative and European Banking Federation 2022). Finally, SMEs represent 90% of businesses globally (World Bank, 2022) and Irish SMEs account for 99.8% of the total enterprise population (Central Statistics Office, 2020). Measurement of SMEs' environmental impact is a rational step toward meeting the 2030 climate objectives, particularly with regard to those with sizeable operations. Accordingly, this study seeks to shed insight into the feasibility of measuring and reporting on the environmental impact of these businesses which constitute such a vast component of economies globally. Ireland presents a particularly suitable context in which to examine the capacity of SMEs to adjust to and adopt a sustainability reporting framework. In the Irish context, an SME comprises under 250 employees and has either an annual turnover of less than €50m and/or an annual Balance Sheet total not exceeding €43m. From the outset, it is important to clarify that the enterprises of concern to this study exclude micro-enterprises (enterprises with fewer than 10 persons engaged in employment) which are encompassed by this definition. Given, their small size, it would not currently be reasonable to expect such firms to have the resources to devote to ESR.

SMEs have typically relied on their Small and Medium Sized Accounting Practitioners (SMPs) for their reporting requirements (Collins *et al.*, 2011; Nigri and Del Baldo, 2018) as well as for consultancy and advice, particularly on the implementation of new initiatives and processes (Blackburn and Jarvis, 2010; Jarvis and Rigby, 2011). A small business accounting survey, undertaken by Clutch (Panko, 2018), finds that almost half of all SMEs employ neither an accountant nor a bookkeeper. Among the companies that employ accounting staff, the largest percentage (22%) employ a full- or part-time outsourced accountant. The survey findings also indicate that external accountants are a primary 'go-to' advisor for SME business advice and reporting requirements. A number of studies highlight the important role of SMPs, often referred to as the SMEs' 'most trusted advisor' (Spence *et al.*, 2012: IFAC, 2016; World Bank, 2017; EFAA, 2018; Arnold, 2021). SMEs' reliance on SMPs increased throughout COVID-19, when many SMPs supported businesses in rebuilding and steering their way through the pandemic (ACCA, 2020). As SMEs face uncertainty, financial realities, and negative macroeconomic trends, business owners are increasingly turning to their most trusted advisors to ensure long-term viability, and SMPs are well-positioned to add value and ensure their clients can survive in a sustainable manner in the future (Arnold, 2021). The role of the SMP has evolved over time. In general, the majority of SMPs' revenue is generated by traditional

services including compliance, audit, and taxation. However, following a growth in demand for business advice, SMPs are now experienced in the roles of advisor, confidant, analyst, facilitator, and educator to their clients (Alam and Nandan, 2010; Blackburn *et al.*, 2010, 2014; Devi and Samujh, 2010).

In 2012, the International Federation of Accountants (IFAC) called upon SMPs to play a role in 'greening' small business, viewing SMPs as being best positioned to encourage and advise their SME clients on sustainable practices and reporting. This advice has remained constant over the past decade, and in a more recent report, IFAC (2021) highlights the opportunities for SMPs in reporting sustainability information for their SME clients. It advises that SMPs' preparation of accessible, relevant and reliable sustainability information for SMEs will enable more informed business decision-making, enhance strategic planning and risk management, and therefore foster integrated thinking. It further maintains that the reporting of sustainability information to external stakeholders and business partners will naturally be influenced by SMPs. The findings of the European Federation of Accountants and Auditors' (EFAA) 2018 survey of the non-financial reporting requirements for European SMEs supports this view and also encourages SMPs to prepare for future implementation of sustainability reporting, suggesting their input will be essential for SMEs.

Notwithstanding this commentary, the role performed by the accounting profession with respect to the introduction and practice of ESR has been largely overlooked (Humphrey *et al.*, 2017; Rinaldi, Unerman and De Villiers, 2018). Accordingly, this study focuses on the role of the SMP for SMEs in ESR and examines the potential for sustainability reporting by the majority of firms by investigating the following research questions: (1) What sustainability information do SMPs consider feasible for SMEs to report? (2) What are the financial implications of sustainability reporting for SMEs and SMPs? and (3) Are SMPs sufficiently resourced and capable to engage in sustainability reporting? This is done by developing a unique framework which respondents review in advance of undertaking a detailed survey.

The proposed framework is derived from the Global Reporting Initiative (GRI) Standards for Sustainability Reporting. The GRI standards are employed to examine the feasibility of ESR for SMEs for a number of reasons. First, the GRI is the most world's most widely used framework (KPMG, 2017). Secondly, despite the evolution and consolidation of various international sustainability and integrated reporting frameworks, few have accommodated the unique requirements of SMEs. According to the GRI (2018), a chief objective of the initiative is to assist SMEs globally in adopting responsible business practices. Third, the majority of SMEs do not currently face specific sustainability reporting requirements, on a voluntary or mandatory basis, although the accountancy

profession emphasise the importance of preparation (EFAA, 2021; ICAEW, 2021). Operational standards of measuring environmental impact, such as those included in the GRI, are required in order for small firms to make meaningful environmental sustainability disclosures in the future, both in Europe and globally (ACCA Ireland, 2022; Del Baldo, 2017; Krawczyk, 2021; Thompson, 2019). Nonetheless, the suitability of the GRI to SMEs is contentious. Complexities exist in implementing the GRI's Key Performance Indicators (KPIs) for SMEs (Arena and Azzone, 2012; Dissanayake, 2020). Moreover, determination of materiality has been cited as issue in the SME context (Calabrese *et al*., 2016; Del Baldo, 2017; Dumay *et al*., 2016). This study explores the research questions through the lens of those responsible for reporting, the accounting profession, and thus shed new and practical perspectives to the debate.

4.2 Previously related literature

4.2.1 Theoretical context

This study is framed within the context of organisational and professional challenges associated with the incorporation of sustainability within corporate reporting (Lai and Stacchezzini, 2021). Lai and Stacchezzini (2021) present the role of the accountant in a fourth wave of sustainability reporting. Having progressed from the stages in which sustainability was firstly neglected, before being experimented with, and then enhanced, reporting is now conducted in an era where the reporting of sustainability information is integrated with the reporting of financial and other non-financial information. This introduces new policies with which, and actors with whom, the accountant must become familiar and as such, creates a challenge for the SMP as well as the SME client. A key research issue to explore in this respect then becomes the manner in which the area of expertise of the accountant will evolve in line with the needs of their clients. More specifically, it is necessary to investigate the precise nature of the role of the SMPs will play in ESR for SMEs and to examine the current feasibility of such a role.

Non-financial reporting is widely recognised for the potential benefits it offers companies. Large firms who engage in non-financial and integrated reporting enjoy a lower cost of capital as it enables them to communicate how shareholders' wealth is being maximised in a more meaningful way (Muttakin *et al*., 2020; Zhou, Simnett and Green, 2017). Social psychology theorists point toward improvements in stakeholder trust and legitimacy (Marquez, 2016; Romero *et al*., 2019; Vitolla, *et al*., 2020). Over the past decade, stakeholders including financiers, suppliers, customers, current and prospective employees and society as a whole, have sought information on companies' impacts on the natural environment and their efforts to negate climate change. As the corporate sector

responds to these demands, a variety of Integrated Reporting (IR) and ESR standards have evolved globally[18].

Large companies have a clear incentive to invest in IR and ESR as Environmental, Social and Governance (ESG) investing becomes a dominant feature of contemporary capital markets (Adams and Abhayawansa, 2021). Given that the majority of SMEs' reliance on external equity differs considerably to larger entities, the rewards they realise from any investment in ESR will inevitably differ (Loucks *et al.*, 2010). In fact, SMEs who invest in ESG disclosures are found to experience a higher cost of capital (Gjergji *et al.*, 2021). This may be because the benefits arising from such, have yet to be realised.

4.2.2 The benefits arising from environmental sustainability reporting

From the SMP's perspective, it is necessary to consider the benefits arising from ESR, as communication of the benefits of ESR is likely to enhance the level of collaboration they achieve with clients with respect to data aggregation and management and overall reporting quality. In effect, the information SMEs communicate to external stakeholders such as prospective employees, lenders and potential future funding sources, and parties upward and downward in the supply chain is often critical to the companies' future growth, and often survival, as well as to the perceived legitimacy of their management (Berrone *et al.*, 2009; Colwell and Joshi, 2013).

Internally, companies as users of the reports themselves, may realise areas in which they can increase productivity by means of more efficient use of natural resources. It is conventional wisdom in the field of accounting that a primary user of a company's financial reports is the company itself as they, together with management accounts, enable a time-series analysis of financial performance, the establishment of future targets and the identification of areas where costs can be reduced. It is reasonable that companies may employ ESR in a similar manner. Such measurement has been found to lead to energy cost savings in the areas of energy (Meath *et al.*, 2016; Tsalis *et al.*, 2013), waste management (Mattila *et al.*, 2020; Redmond *et al,*.2008) and materials (García-Arca *et al.*, 2017; Oláh *et al.*, 2019), as well as informing capital investment decisions (Thomson and Georgakopoulos, 2010). SMEs that monitor and report their environmental sustainability performance have also been found to enjoy further benefits such as product innovation (Muñoz-Pascual *et al.*, 2019) and participation in new business networks (Abbas *et al.*, 2019)

[18] Examples of such standards have been established by parties including the IRRC, the SASB and the CDSB (now the ISSB), the Task Force on Climate-related Financial Disclosures (TCFD), the Global Reporting Initiative (GRI) and the International Financial Reporting Standards (IFRS) Sustainability Standards Board.

Empirical evidence regarding the extent to which communication of SMEs' efforts toward environmental sustainability improves access to finance is mixed. In the UK context, Demirel and Parris (2015) find that SMEs which engage in sustainable business practices are more likely to access finance from government authorities than from banks or via venture capital. One explanation for this may be that environmental investment is perceived as risky by lenders (Cui *et al*., 2018). Cariola *et al*. (2020) note that SMEs' capacity to make valuable use of debt finance with respect to environmental innovation relies on the extent to which regulators encourage the provision of such financing. Cariola *et al*. (2020) recommend that in countries where SMEs' commitment to environmental sustainability is high, regulators should work to improve access to debt financing for SMEs to further invest in sustainable business operations. The European Commission's *Strategy for financing the transition to a sustainable economy* announce in July 2021 seeks to promote SME's access to finance for green investments by encouraging banks to make loans available to support the transition (European Commission, 2021b). Furthermore, specific funding and grant initiatives made available under the plan may serve to incentivise SMEs to report on their environmental sustainability performance.

Regulatory initiatives and guidance offered by Non-Governmental Organisations have encouraged companies to monitor environmental sustainability throughout their supply chains (Seuring and Müller, 2008). Such a development can pressurise smaller companies to report their environmental impact to larger suppliers (Centobelli *et al*., 2021; Graafland, 2018; Johnson and Schaltegger, 2016), particularly in concentrated industries where large consumers face little switching costs (Jaiswal *et al*., 2018). Machado *et al*. (2020) further note that many SMEs adopt certified environmental practices, for example conforming to ISO 14001, by virtue of a larger first-level customers' requirement. As pressure to reduce Scope 3 greenhouse gas emissions grows (European Union Eco-Management and Audit Scheme, 2021), it is likely that SMEs will face particular demands to reduce their environmental impact with regard to energy use and methods of transportation, and report on their progress in doing so.

Attracting and retaining key employees can be seen a major challenge for SMEs. By measuring and reporting their environmental impact and efforts toward environmental sustainability, companies can attract prospective employees who are motivated by environmental goals (Renwick *et al.*, 2013). Empirical evidence indicates companies which leverage these values among employees enjoy enhanced employee retention (Islam *et al*., 2021) and financial performance (O'Donohue and Torugsa, 2016). While such an effect is not generation-specific, it has particularly significant implications for recruitment in light of anecdotal evidence, and academic and media commentary

which suggests that contemporary graduates, or the 'millennial' generation have place strong values on environmental sustainability.

It appears that many SMEs recognise that environmentally sustainable business practices can lead to cost savings and improved stakeholder relations; however, the variety of diverging frameworks creates confusion (Girella *et al.*, 2019). The limitations of SME management in measuring and reporting these savings and efficiencies considered, a potential role for the accountant emerges (Collins *et al.*, 2011). Given the synergies between the traditional function of the SMP and that of measuring and reporting environmental impact and performance (Johnstone, 2020; Nigri and Del Baldo, 2018), the feasibility of formalised ESR by SMEs is a pertinent issue to explore.

4.2.3 The challenges arising from environmental sustainability reporting

A thorough assessment of the feasibility of ESR for SMEs invariably addresses the challenges faced by SMPs in adapting to this form of non-financial reporting. These challenges may be considered within three broad categories of (i) an absence of ESR guidelines appropriate to SMEs, (ii) SMPs' literacy in and access to relevant data and (iii) a lack of incentives to meaningfully engage.

Either due to their own aspirations, future regulatory requirements or other external pressures, SMEs confront the task of ESR in a policy context very much directed toward larger firms. It would appear that the initial intention of the International Integrated Reporting Council (IIRC), which administers one of the most globally recognised Integrated Reporting frameworks, was to develop a scalable IR framework from which SMEs could derive utility (IIRC, 2011). Nevertheless, the literature strongly suggests that SMEs struggle to work within existing frameworks, and would benefit from a simplified approach aimed at enabling them to effectively link issues of sustainability to their objectives, strategy and performance (Del Baldo, 2017). In spite of the, now established recognition of a firm's responsibility to non-shareholder stakeholders, evidence suggests that IR frameworks remain very much oriented toward shareholder communications, which tends not to be a necessity for SMEs (Reuter and Messner, 2015).

Amongst the differences between SMEs and larger firms is the fact that SMEs have traditionally faced only minimal financial reporting requirements, responsibility for which tends to be that of the SMP. Since many do not rely on external investors for financing and are often family-owned entities or derived therefrom, they lack formal governance and control structures. Consequently, not only are many SMEs inexperienced in the area of reporting, but they also lack the expertise in recording and managing extensive data, financial or non-financial, and communicating it to their SMPs (Giovannoni and Maraghini, 2013; Gnan, Montemerlo and Huse, 2015). These

factors suggest a need for a flexible set of guidelines which account for the diversity and complexity of operations, levels of experience, and resource capacities among SMEs. At EU level, regulatory development in this respect is delayed by opposition from member states who believe that legislative requirements for SMEs to produce non-financial reports imposes costs which SMEs simply cannot afford (Kinderman, 2020). Policy in this respect would however offer clarity to smaller firms, and their SMPs, on the concept of double materiality and offer appropriate guidance as to best practice in new and unfamiliar form of reporting (Calabrese *et al.*, 2016; Del Baldo, 2017; Dumay *et al.*, 2016).

The literature on the management and assurance of environmental data tends to focus on larger firms (Farooq and De Villiers, 2017; Kaenzig *et al*., 2011; Park and Brorson, 2005) and generally suggests that management information systems are employed. Given that the financial resources necessary to invest in such systems are limited in SMEs, the reporting SMP may be faced with inconsistent and crudely aggregated data, much of which they have not received formal training in interpreting. Despite research on methods of cost-effective environmental data collection and storage (Jasch, 2003; Olsthoorn *et al*., 2001), SMEs which implement environmental management systems appear to be in the minority with those companies who choose to adopt the ISO 14000 standard perhaps providing the best examples (Garengo and Biazzo, 2013; Heras and Arana, 2010). The fact that many information systems are tailored to the requirements of larger firms appears to be a significant problem (Mbuyisa and Leonard, 2015, 2017). Unlike financial information, the interpretation and reporting of environmental sustainability data is a new departure for the accountancy profession. The shortcomings in SMEs' ability to manage the data creates further complexities to the challenge facing SMPs.

Focusing specifically on the task facing the SMP in conducting ESR for SMEs, a primary issue that then arises is the lack of formalised education or training in environmental sustainability measurement for accountants, either in higher education or at professional level (Cho *et al.*, 2020; Lamberton, 2005; Thoradeniya *et al.*, 2015). This introduces a further challenge for the profession which may impact the final cost incurred by the client. Coupled with the costs associated with adapting information systems (Isenmann *et al*., 2007) and the additional workload imposed on the SMP, estimating and attributing an overall cost to ESR for SMEs appears to be a challenge in itself.

Lastly, the issue of SMEs' willingness to engage creates a challenge that extends beyond the accountant's remit. The accuracy and reliability of the environmental sustainability report produced by the accountant fundamentally relies upon the SME's willingness to record data regarding their use of energy, materials and water, production of waste, or impact on biodiversity. At an external level, companies' willingness to engage in environmentally sustainable practices may vary internationally

due to cultural and regulatory differences (Cucchiella *et al.*, 2017). Evidence from the small number of trans-European studies which consider Ireland indicates that engagement in environmental sustainable practices is better than the EU average but lags with regard to energy consumption (Miralles-Quiros *et al.*, 2017). There is also evidence to suggest that urban-based companies are more willing to engage than those in rural settings (Berenguer *et al*., 2005). This has notable implications in certain countries such as Ireland, where urbanisation is below the European average.

The administrative burden associated environmental data collection and management possibly provides one of the key explanations as to the unwillingness of many SMEs to engage. The European Central Bank's (ECB) twice yearly survey on the access to finance of enterprises (ECB, 2021) reports that between April and September 2021, one in ten European SMEs experienced administrative burdens with respect to regulatory compliance, while almost one third lacked a sufficiently skilled labour force (ECB, 2021). Although the resources required to adapt to environmentally sustainable business practices are not considered by the ECB, the academic literature indicates that a lack of time and sufficiently skilled human resources serves as a significant barrier to the uptake of sustainability initiatives in SMEs (Bergmann and Posch, 2018; Ismail *et al*., 2011; Johnson and Schaltegger, 2016; Neto *et al.*, 2017). The evidence in this respect consistently indicates that SMEs lack the time and funding to educate existing staff, or to recruit sufficiently experienced and educated personnel. Indeed, the literature predominantly indicates that the most significant factor impeding companies', particularly SMEs', willingness to engage in environmentally sustainable business practices, and by extension environmental data management is the associated costs. Since SMEs cannot achieve economies of scale on a level comparable to larger companies, many are reluctant to risk any investment, anticipating that the costs will likely outweigh the economic benefits derived (Arena and Azzone, 2012; Mourtzis *et al.*, 2016). Many are deterred by a potentially large initial outlay (Hjorth and Brem, 2016) and this problem is exacerbated by inaccessibility to necessary capital (Bocken, 2015; Ismail *et al*., 2011). Hence, a fundamental challenge to the SMP's role in ESR is disengagement by the client.

Having established that potential operational efficiencies and improved stakeholder relations may motivate SMEs to contract SMPs for the purposes of ESR, it is reasonable to argue that certain information may be disclosed. In light of the data management and literacy issues considered, the question arises as to what information is feasible to report. Thus, presenting the first research question:

RQ1: What sustainability information do SMPs consider feasible for SMEs to report?

The benefits and costs of ESR for SMEs considered, there is an evident need for a simplified and cost-effective method of ESR that SMPs can implement for SMEs. A tangible estimate of the cost has however, yet to be derived, particularly in a manner considerate of the benefits accruing from ESR. Accordingly, this poses a second research question:

RQ2: What are the financial implications of sustainability reporting for SMEs and SMPs?

The literature strongly indicates a considerable resource shortage for SMPs with respect to ESR for SME clients. As doubt is cast over the extent to which SMPs are fully educated on sustainability issues and specifically trained to conduct ESR, posing a third research question:

RQ3: Are SMPs sufficiently resourced and capable to engage in sustainability reporting?

4.3 Methodology

The dataset comprises survey responses from accounting professionals (SMPs), who, as discussed, work very closely with SMEs, perform the roles of advisor, confidant, analyst, facilitator, and educator to their clients (Alam and Nandan, 2010; Blackburn *et al*., 2010a, 2014; Devi and Samujh, 2010) and are likely better informed of the requirements of sustainability reporting for SMEs (IFAC, 2021). In addition, this means of data collection is more efficient, as each accounting professional may work with several SMEs. In designing the research instrument, it was considered more fruitful to present the SMPs with a proposed sustainability reporting framework, rather than ask questions in the abstract about the perceived challenges, opportunities and cost of implementing sustainability reporting. This approach has two advantages: (1) This method proposes a framework which can be used (or form the basis) for sustainability reporting, and (2) SMPs' responses are based on a specific objective framework, eliminating the potential for subjective views on the feasibility of sustainability reporting.

The study develops a sustainability reporting framework (Table 4.1) based on key environmental indicators of the Global Reporting Initiative (GRI). In effect, this is an abridged version of the framework used by large corporates, more appropriate for SMEs. A workshop and focus group were organised with senior Irish SMPs through an ACCA Ireland SMP network group on Thursday 26 August 2021. In this workshop, the full set of detailed GRI standards expected of larger firms was presented to the SMP participants. Feedback was sought on the subsections within each GRI standard which might be applicable for an SME. Using this guidance, the key metrics were selected in each subsection based on the feasibility and practicality for an SME to capture this data.

The resultant framework encompasses the following areas: Materials - GRI 301 (301-1, Materials used by weight or volume, 301-2, Recycled input materials & 301-3, Reclaimed products and their packaging materials); Energy - GRI 302 (302-1, Energy consumption within the organisation, 302-4, Reduction of energy consumption & 302-5, Reductions in energy requirements of products and services); Water - GRI 303 (303-3, Water withdrawal & 303-4, Water discharge); Biodiversity - GRI 304 (304-1, Operational sites owned, leased, managed in, or adjacent to, protected areas and areas of high biodiversity value outside protected areas); Emissions - GRI 305 (305-1, Direct (Scope 1) GHG emissions, 305-4, GHG emissions intensity & 305-5, Reduction of GHG emissions) and Waste - GRI 306 (306-3, Waste generated & 306-4, Waste diverted from disposal). The key measurements used in the framework correspond with the GRI metrics which includes: Materials – Kilograms; Energy – Kilowatt Hours / Euro (€); Water – Megalitres / Euro (€); Biodiversity – Square Kilometres / Biodiversity Characteristics; Emissions – Carbon Dioxide / Kilometres Travelled / Euro (€); Waste – Metric Ton. This framework was developed with the input of the focus group of leading Irish SMPs. The framework in Table 4.1 is based off a condensed version of the GRI. The key metrics were selected upon designing a much larger framework and assessing SMPs opinion on the appropriateness of each standard. Equal weighting was provided throughout each of the metrics in the framework.

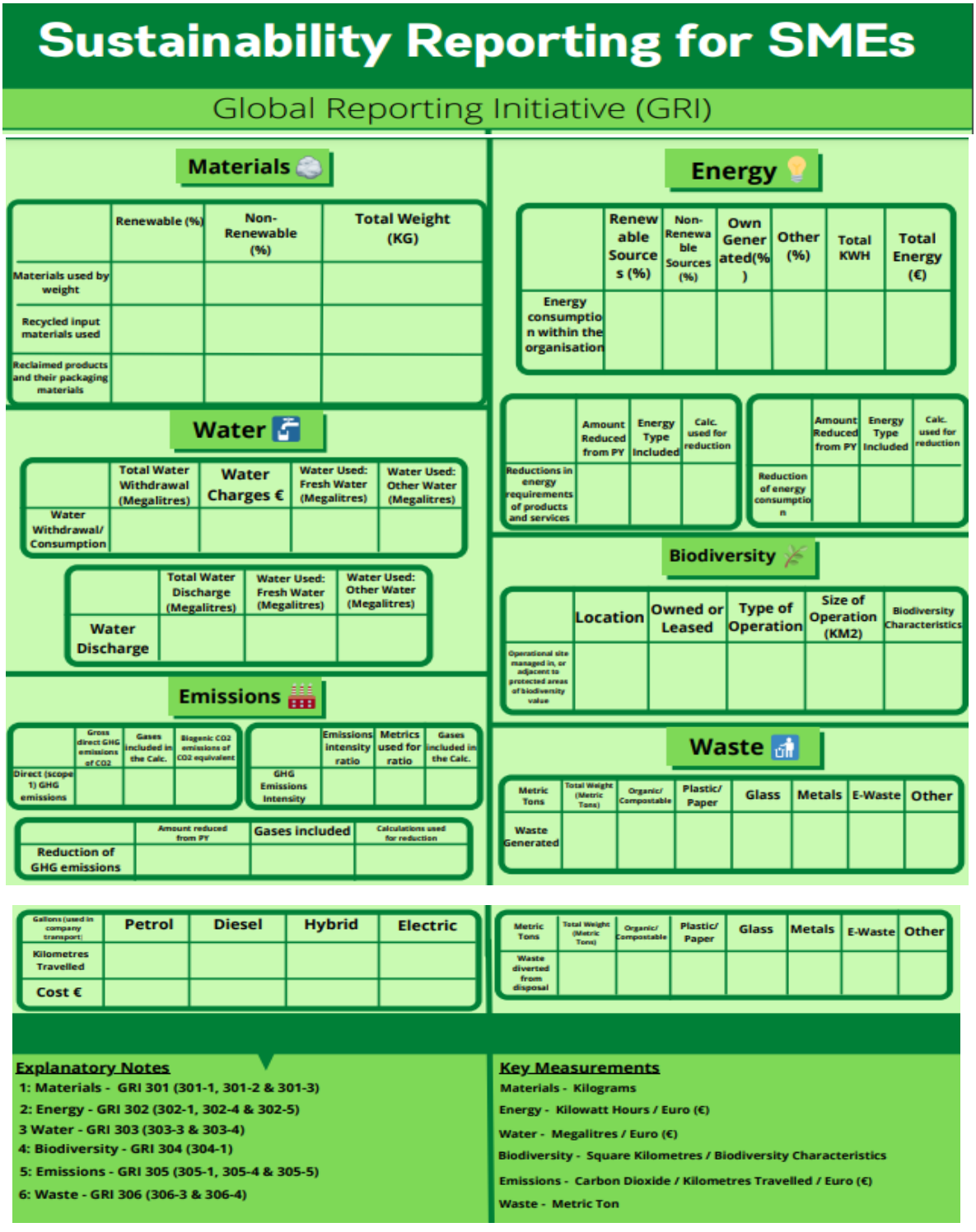
Alongside the proposed framework, a semi-structured survey was developed which addressed the following research questions: (1) What sustainability information do SMPs consider feasible for SMEs to report? (2) What are the financial implications of sustainability reporting for SMEs and SMPs? and (3) Are SMPs sufficiently resourced and capable of engaging in sustainability reporting? The survey instrument consisted of 21 questions in total, including three items to capture basic demographic information.

The framework and accompanying survey instrument were distributed electronically to the sample frame. This comprised a list of all registered qualified SMPs in Ireland based on their registration status on Chartered Accountants Ireland, the Association of Chartered Certified Accountants Ireland, or Institute of Certified Public Accountants in Ireland, resulting in approximately 1,700 accounting firms. Consistent with the methodology proposed by Stern, Bilgen and Dillman, (2014) and Dillman (2017), multiple electronic email requests were sent to a sample to optimise the response rate. In addition, participated in an ACCA Ireland event for SMPs on Thursday 9 September 2021, which yielded 41 additional responses. This framework and survey instrument was also presented to Chartered Accountants Ireland on Wednesday 29 September 2021, at the Sustainable Finance segment on their Executive Diploma in IFRS, which was specifically aimed at accountants who run their own practices or work in small and medium sizes practitioners. These latter

events provided an opportunity to discuss the framework in greater detail with SMPs, and provided additional internal validity for this study. In all disseminations of the survey, participants were instructed to consider the framework, and complete the survey, with the requirements and capabilities of their SME clients in mind, excluding those that are considered micro-enterprises.

The methodology employed resulted in 289 respondents. When incomplete and partially completed surveys were excluded, the sample totaled 203 fully completed responses. This represents a response rate of approximately 12%.

Table 4.1 Sustainability reporting framework



Sustainability Reporting for SMEs

Global Reporting Initiative (GRI)

Materials

	Renewable (%)	Non-Renewable (%)	Total Weight (KG)
Materials used by weight			
Recycled input materials used			
Reclaimed products and their packaging materials			

Water

	Total Water Withdrawal (Megalitres)	Water Charges €	Water Used: Fresh Water (Megalitres)	Water Used: Other Water (Megalitres)
Water Withdrawal/ Consumption				

	Total Water Discharge (Megalitres)	Water Used: Fresh Water (Megalitres)	Water Used: Other Water (Megalitres)
Water Discharge			

Emissions

	Gross direct GHG emissions of CO2	Gases included in the Calc.	Biogenic CO2 emissions of CO2 equivalent
Direct (scope 1) GHG emissions			

	Emissions intensity ratio	Metrics used for ratio	Gases included in the Calc.
GHG Emissions Intensity			

	Amount reduced from PY	Gases included	Calculations used for reduction
Reduction of GHG emissions			

Energy

	Renewable Sources (%)	Non-Renewable Sources (%)	Own Generated(%)	Other (%)	Total KWH	Total Energy (€)
Energy consumption within the organisation						

	Amount Reduced from PY	Energy Type Included	Calc. used for reduction
Reductions in energy requirements of products and services			

	Amount Reduced from PY	Energy Type Included	Calc. used for reduction
Reduction of energy consumption			

Biodiversity

	Location	Owned or Leased	Type of Operation	Size of Operation (KM2)	Biodiversity Characteristics
Operational site managed in, or adjacent to protected areas of biodiversity value					

Waste

Metric Tons	Total Weight (Metric Tons)	Organic/ Compostable	Plastic/ Paper	Glass	Metals	E-Waste	Other
Waste Generated							

Gallons (used in company transport)	Petrol	Diesel	Hybrid	Electric
Kilometres Travelled				
Cost €				

Metric Tons	Total Weight (Metric Tons)	Organic/ Compostable	Plastic/ Paper	Glass	Metals	E-Waste	Other
Waste diverted from disposal							

Explanatory Notes

1: Materials - GRI 301 (301-1, 301-2 & 301-3)
2: Energy - GRI 302 (302-1, 302-4 & 302-5)
3 Water - GRI 303 (303-3 & 303-4)
4: Biodiversity - GRI 304 (304-1)
5: Emissions - GRI 305 (305-1, 305-4 & 305-5)
6: Waste - GRI 306 (306-3 & 306-4)

Key Measurements

Materials - Kilograms
Energy - Kilowatt Hours / Euro (€)
Water - Megalitres / Euro (€)
Biodiversity - Square Kilometres / Biodiversity Characteristics
Emissions - Carbon Dioxide / Kilometres Travelled / Euro (€)
Waste - Metric Ton

4.4 Results and discussion

Summary descriptive statistics for the 203 respondents are presented in Tables 4.2 and 4.3. The majority of the respondents are partners, directors or owners (54%) of SMP firms, and the remainder consist of managers (29%), non-managers (11%), and others (6%). The age demographic of the majority of the respondents is in the 50-60 age category (41%), followed by 31-49 year olds (27%), with the remainder being in the 18-30 year old (24%) and 60+ (8%) categories. The responses find that partners, directors and owners, along with those in the 50-60 and 60+ age categories provided complete, detailed answers across all of the questions in the survey, whereas younger SMPs and non-managers appear to have found it difficult to provide complete responses, particularly in in relation to an estimate on the financial cost of implementation of ESR.

Table 4.2 Role

	%	N
Partner/Director/Owner	54%	110
Manager	29%	59
Non-Manager	11%	22
Other	6%	12
Total	**100%**	**203**

Table 4.3 Age

	%	N
18-30	24%	49
31-49	27%	55
50-60	41%	83
60+	8%	16
Total	**100%**	**203**

4.4.1 Information feasible for SMEs to report

Survey participants were invited to review the proposed framework (Table 4.1), and asked to assess the feasibility of capturing and reporting data on key metrics. Respondents firmly believe that it is feasible for SMEs to capture and report data relating to materials (95%), waste (95%), energy (94%), water (91%) and biodiversity (85%) (Table 4.4). The least feasible metric under the GRI headings is emissions, with 22% of respondents of the view that their clients are not in a position to capture data on greenhouse gas (GHG) emissions. These views provide confidence that the implementation of ESR is feasible for SMEs, the data required is readily available and accessible, and that the proposed framework is an appropriate methodology. It does however raise concern

regarding the feasibility of monitoring reductions in GHG emissions, particularly at scope three level, as encouraged throughout the EU and globally.

Respondents' views relating to the feasibility of this framework under cost, willingness to provide data, availability of data, reliability of data and the suitability of the metrics are presented in Table 4.5. These issues were reported on a ranking scale of 1-5, with 1 being the most feasible and 5 being the least feasible. Consistent with findings in the previous section, 62% of respondents ranked the suitability of metrics highest, thus indicating it to be the most feasible dimension of the framework. Additionally, 48% of respondents believe that SMEs are willing to provide the requisite data. Respondents believe that cost is the greatest impediment to implementing ESR, with the majority of respondents (62%) stating that cost is the least feasible dimension. This rises to 75% when the second least (4) feasible dimension is included. This finding is consistent with previous studies on sustainability reporting (Ismail, Jeffery and Van Belle, 2011; Johnson and Schaltegger, 2016; Bergmann and Posch, 2018).

Respondents were invited to suggest the most significant challenges of implementing sustainability reporting for SMEs apart from cost. 60% of respondents stated that time was the most challenging issue for SMEs. 30% of respondents stated that lack of staff with expertise or knowledge to capture environmental metrics is a key challenge. 25% of respondents believe that as there is no legislative requirement to engage in ESR at present, SMEs will not partake on their own initiative because of the additional administrative burden. This view reflects the administrative challenges facing SMEs cited by the ECB (2021) and is consistent with evidence indicating that the greatest challenge for SMEs is lack of personnel and time (European Commission, 2020c). Thus, the greatest challenge in implementing sustainability reporting by SMEs is not related to environmental issues *per se*, but the well-established lack of personnel and resources.

Table 4.4 Feasibility of key metrics (Yes or No)

	Yes		No	
	%	N	%	N
Materials	95%	193	5%	10
Energy	94%	190	6%	13
Water	91%	185	9%	18
Biodiversity	85%	173	15%	30
Emissions	78%	158	22%	45
Waste	95%	193	5%	10

Table 4.5 Feasibility of framework (Ranking)

	1		2		3		4		5		Total	Average
	%	N	%	N	%	N	%	N	%	N	N	Score
Suitability of Metrics	61.58%	125	12.11%	25	10.53%	21	7.89%	16	7.89%	16	**203**	**4.12**
Willingness to provide data	17.61%	36	30.11%	61	17.05%	35	26.70%	54	8.53%	17	**203**	**3.22**
Availability of data	4.65%	9	27.91%	57	36.05%	73	26.16%	53	5.23%	11	**203**	**3.01**
Reliability of data	2.78%	6	24.44%	50	32.78%	66	28.33%	58	11.67%	23	**203**	**2.78**
Cost	12.99%	26	5.65%	11	6.21%	13	12.99%	26	62.16%	127	**203**	**1.94**

4.4.2 Perceived benefits of environmental sustainability reporting

Respondents also related information on perceived benefits of implementing the proposed framework and engaging in sustainability reporting (Table 4.6). These issues were reported on a ranking scale of 1-7, with 1 being the most beneficial and 7 being the least beneficial. The highest ranked response to the benefits of implementing sustainability reporting is to 'improve the company image'. 31% of respondents selected improvement of the company image as being the greatest benefit accruing from clients' engagement in sustainability reporting, and 24% of respondents selected this as the second most beneficial aspect, indicating that 55% of SMPs consider positive publicity a potential incentive for ESR in SMEs. While this may suggest a desire to improve stakeholder relations, it also raises concerns regarding the potential for greenwashing.

The next most beneficial aspects of implementing sustainability reporting are to increase productivity in an environmentally friendly manner, prepare for future regulatory compliance, and increase consumer and supplier demands respectively. The finding regarding productivity enhancements is encouraging to the extent that there appears to be a realisation, among SMEs' advisors at least, that ESR can promote more efficient use of natural resources. Furthermore, their acknowledgement of future compliance issues suggests that SMPs are considerate of ESR as a future aspect of the SME accounting landscape. The perceived benefit of increased consumer and supplier demands effectively focuses on the end consumer, and the role of suppliers to large corporates, who are concerned with indirect carbon emissions and traceability issues in the supply chain. A recent example of this is the requirements set by Tesco (Hegarty, 2021) which shows the growing pressures on SMEs to engage with their environmental responsibilities as a matter of urgency. The research finds that effects such as attracting employees, access to finance and reducing costs are perceived as the least beneficial effects of engaging in sustainability reporting. While the latter finding may appear to contradict the aforementioned indication of enhanced productivity, it may well be the case that

SMPs predict that the costs of implementing ESR practices will outweigh any cost savings derived in terms of energy, materials or waste management for example. In fact, SMPs' perceptions surrounding sustainability reporting strongly suggest that it is going to be a costly exercise, and it is perhaps unsurprising that reducing costs appears to be the least beneficial aspect. The fact that access to finance tends not to be considered beneficial is interesting. A number of financial institutions have recently stated that obtaining finance may become challenging for SMEs unless they engage in responsible sustainable activities (European Commission, 2021a). When examining this, along with the issue of attracting employees, solely from the perspective of respondents in the (i) 18–30 year-old age and (ii) non-manager categories, the study finds that access to finance and attracting employees to be regarded among the top three benefits. This suggests that younger respondents believe that there are greater benefits for firms engaging in environmental reporting in terms of attracting employees and access to finance, suggesting that younger SMPs may be more attuned to current trends (Islam *et al.*, 2021). A number of large graduate recruiters are putting this at the forefront of their recruitment campaigns (Edgecliffe-Johnson and O'Dwyer, 2021) which suggests why younger demographics consider this a greater perceived benefit.

The results suggest that ESR is feasible for SMEs, both in terms of the availability of data and the feasibility of implementing the proposed framework, using the GRI as a reference point. It is perhaps surprising that SMPs and accountants perceive the greatest benefit of implementing sustainability reporting to be an improved company image. This indicates that whilst there may be considerable environmental and societal benefits in adopting sustainability reporting, SMEs perceive that managing stakeholders' impression of the company is of priority to SMEs. The potentially concerning implications for the integrity of the reports produced suggest that accounting for environmental sustainability may well need to accompanied by auditing of sustainability reports, in a phased approach at least.

Table 4.6 Benefits of implementing sustainability reporting (Ranking)

	1		2		3		4		5		6		7		Total	Average
	%	N	%	N	%	N	%	N	%	N	%	N	%	N	N	Score
Improve Company Image	31%	64	24%	48	12%	25	11%	22	8%	17	10%	20	4%	7	**203**	**5.14**
Increase Productivity in Environmental Friendly Manner	15%	31	19%	39	20%	41	9%	19	9%	19	18%	37	8%	17	**203**	**4.33**
Regulatory Compliance	16%	33	19%	39	14%	28	13%	27	14%	28	15%	30	9%	18	**203**	**4.31**
Increased Consumer and Supplier Demands	14%	28	12%	24	19%	37	16%	33	17%	35	9%	19	13%	27	**203**	**4.09**
Attract Employees	5%	9	9%	17	15%	30	23%	47	20%	41	17%	35	12%	24	**203**	**4.09**
Access to Finance	6%	12	12%	23	10%	20	13%	27	24%	49	20%	41	15%	31	**203**	**3.42**
Reduce Costs	16%	31	9%	19	10%	20	12%	25	8%	16	8%	17	36%	75	**203**	**3.41**

4.4.3 Financial implications

There is scant research on the financial implications of implementing ESR for SMEs. This study seeks to bridge that gap by asking SMPs to provide estimates based on their experience of working with their SME clients. There are a number of significant costs related to sustainability reporting (Johnson and Schaltegger, 2016; Qiu *et al.*, 2016; Bergmann and Posch, 2018), although assigning a precise monetary amount is challenging. This approach is twofold: firstly, by providing a table for the survey participants to complete to the best of their knowledge (Table 4.7), which includes costs relating to staff, technology/data capturing software, education, learning and development, and other costs. Secondly, asking SMPs to estimate the fee they would charge an SME client for completing the framework. Although specifying a monetary value regarding the cost of implementing ESR for SMEs is challenging, 65% of respondents provided an estimate for staffing requirements, 58% provided an estimate for training requirements, 51% provided an estimate for technology and 29% detailed other costs. There were notable differences in responses by respondent, with 85% of partners, directors and owners able to place a value on this template, while the majority of non-managers were unable to attribute a cost. Participants were also provided the opportunity to include further detail concerning the nature of the costings estimated.

Respondents estimate that an SME would incur an additional average staff cost of €25,000 to employ a dedicated staff member responsible for capturing sustainability reporting data. In providing further detail, 56% of respondents suggested that an SME would need 50% of a dedicated financially literate full-time staff member's time, or a part-time staff member whose primarily role would be to assist collating the data required by the framework. An additional cost falling between €20,000 and €25,000 would be a very substantial cost to an SME, particularly if the perceived benefits were minimal.

Consistent with the literature (Cho *et al*., 2020; Thoradeniya *et al*., 2015), SMEs are, in the most part, unaware of the information or knowledge required to implement sustainability reporting, and acknowledge that substantial training and education is required. Respondents estimate average training costs of €12,000 for staff members, which includes additional education, learning and development for staff. Respondents indicated that there are insufficient reporting capabilities in the accountancy software packages in this area at present, and additional software may be required in the future. Respondents estimate that, on average, SMEs will incur a €15,000 increase in their data capturing or software capabilities. In addition, 34% of respondents estimated that smart meters (measuring gas and electricity usage to become more energy-efficient) would be required to be installed by SMEs. Whilst this is not directly attributable to accountancy software, they consider it included under the heading of 'additional technological requirements'. In relation to other costs, 29% of respondents estimate an additional cost of €7,000 for each SME. These other costs include a once-off fee to set up templates and data capturing capabilities, fees associated with engaging an expert advisor to suggest the necessary data required for a particular company or industry, fees for external consultants or those who would provide workshops or additional guidance and resources from time to time. Overall, respondents estimate that SMEs will incur between €41,500 and €60,000 to implement an ESR system. This is a substantial cost to SMEs, although there will inevitably be variations depending on firm size, sector and sector-specific regulation.

As the study maintains, the ESR framework will most likely be completed by accounting practitioners- one of the SMEs most trusted advisors (Blackburn *et al*., 2010). Respondents provided estimates on their fee to complete the framework, and responses varied with reference to the size of the SME based on employee numbers or volumes of transactions. 67% of respondents provided an estimate of costs for an SMP. Of those respondents, 29% estimated an accounting fee of €1,500 - €2,000 for SMEs with up to 20 employees. This fee is for completion of the sustainability report assuming the data capturing capabilities were in place already by the company. Another 24% of respondents estimate that for SMEs with over 20 employees, they would charge approximately €3,500 - €5,000. 6% of respondents suggested that it would cost approximately €10,000 for a firm with over 50 employees. The magnitude of these costs for SMEs are not trivial, particularly as they are additional to usual accounting and auditing fees incurred. The remaining 41% of respondents did not provide any supporting breakdown of cost, and estimated an average additional accounting cost of €3,000. Based on the total responses, regardless of SME size, SMPs estimate an additional fee of approximately €2,500 to €3,500 to complete ESR, based on the framework presented.

Table 4.7 Financial implications for SMEs

	N	Mean (€)	Median (€)	SD (€)	Min (€)	Max (€)
Staff Cost	131	25,000	20,000	18,000	5,000	100,000
Training	117	12,000	8,000	9,000	4,000	35,000
Technology / Data Capturing	104	14,000	8,500	14,000	1,000	40,000
Other	59	9,000	5,000	2,600	1,000	25,000

** N being number of responses*

4.4.4 Resources and capabilities

SMPs will require additional resources and capabilities to assist SMEs in the implementation of ESR (ACCA, 2021). Interesting results were obtained when questioning the role of the SMP in promoting and delivering voluntary ESR. Conflicting opinions emerged on the role of the SMP, and the appropriate individual responsible for disclosing an SME's environmental impact. 39% of respondents believe that the role of the SMP should entail assisting the SME with disclosure requirements, and in capturing and managing the data on which disclosures are based. By contrast, 32% of respondents suggested that the SMP would more than likely be responsible for overseeing the disclosure requirements, as long as the SME was tracking the data over the financial year, and believed that this report should be included with their annual reports and financial filings. The findings thus indicate that SMPs are conflicted in their role, and their responsibilities for SMEs' environmental disclosures. This in itself is a challenge associated with ESR.

Another major issue referenced by respondents on the role of the SMP in delivering ESR was the role of the auditor. This is a major consideration for a number of SMPs, especially those who are also auditing SMEs. Independence is one of the fundamental concepts of auditing and if SMPs are disclosing this data on behalf of their SME clients, they are not in a position to audit those figures. This is another challenge which will be presented to SMPs and SMEs, and perhaps initially some discretion could be provided in order to encourage more environmental disclosures, although ultimately, auditing of these disclosures and metrics will be essential in order to ensure accuracy and completeness of these figures but also to avoid any greenwashing. Studies have also provided evidence to suggest that accountants may initially provide sustainability advice in an informal manner for SMEs before a formal audit requirement is introduced (Spence *et al*., 2012, 2013; IFAC, 2017; Diouf and Boiral, 2017; EFAA, 2018; Arnold, 2021).

In relation to capabilities and resources required for SMPs to support SMEs in implementing sustainability reporting, the responses find that there is a significant gap in awareness, education and

training. Over 63% of respondents reference a lack of awareness, knowledge and understanding of ESR, along with requirements for training. 54% of respondents stated that additional training, education or short-term specialised courses would be required to facilitate them in providing advice to SME clients. There is quite a significant knowledge gap in this area, although this findings suggest there is an appetite for additional training and education on sustainability reporting. In relation to the resources required by SMPs, 72% of respondents suggest that such resources are related to the initial implementation of ESR for SMEs and the financial cost of either hiring additional staff or utilising current staff time. Another 19% of respondents referenced training and education resources that would be required to train staff internally or contract experts to assist in educating staff.

4.5 Conclusion

Environmental responsibility is becoming increasingly important for firms, with attendant reporting and disclosure implications. Whilst large corporates have a statutory obligation to report environmental sustainability information (for example, in Europe under non-financial reporting directive (2014/95/EU) and the enhancement of this directive under the Corporate Sustainability Reporting Directive (CSRD) that is due to come into place in January 2024), SMEs do not have a similar regulatory requirement. However, EU level discussion suggests that it may be 2026 when the net is further widened to capture more firms, including that of SMEs under the CSRD. Nonetheless, SMEs are likely to engage progressively more with reporting non-financial sustainability information for economic and environmental reasons.

The study examines the perceived challenges, opportunities and costs of implementing sustainability reporting for SMEs by adopting an innovative research methodology. In the absence of formal regulatory guidance for SMEs, a reporting framework based upon the GRI is proposed, which is tailored to the requirements and reporting capabilities of SMEs. As established rapporteurs for SMEs, SMPs are uniquely well placed to evaluate the feasibility of implementing ESR by SMEs. Unsurprisingly, respondents to this study estimate an additional financial cost for SMEs. SMPs believe that the cost of implementing an integrated reporting system within an SME under the headings of staff cost, training, technology requirements and other relevant costs is approximately €41,500 to €60,000. Whilst this will vary with firm characteristics, the cost is likely prohibitive to the voluntary adoption of a sustainability reporting framework except for the most environmentally focused firms. In the present economic environment, SMEs are concerned with increased economic uncertainty due to the Covid-19 pandemic, increases in inflation and general increases in supply and material costs, and may therefore be unwilling to incur this additional cost. Aside from financial cost, the respondent's state that time and staff constraints are the most significant impediments to

implementing sustainability reporting by SMEs. Thus, the greatest challenge in implementing sustainability reporting by SMEs is not related to environmental issues *per se*, but the well-established lack of personnel and resources. SMPs believe they have an important role to play in the implementation of sustainability reporting, and this role can be more easily facilitated if their SME clients have reliable data capturing capabilities. Thus, while SME's adoption of ESR may be more efficiently accomplished were SMPs to complete the required disclosures on their behalf, the challenges associated with environmental data must first be overcome. That said, concerns remain where SMPs perform an auditing role for their SME clients. Moreover, whilst SMPs are well placed to evaluate the feasibility of sustainability reporting by SMEs, they highlight a lack of awareness, training, knowledge and understanding of ESR, for both their SME clients and accounting practitioners.

There are a number of perceived benefits for SMEs in implementing sustainability reporting. The principal benefit is an improved company image as a result of reporting environmental information. Perceived second order benefits include increasing productivity in an environmentally friendly manner, regulatory compliance and increased consumer and supplier demands. It may be surprising that environmental considerations are not the first order concern, but this finding suggests that respondents are attuned to prevailing market trends and are more concerned with practical commercial issues. This suggestion is supported by the finding that the younger cohort of respondents perceive additional benefits in attracting employees. It appears that whilst the financial cost of sustainability reporting may be significant, there are ancillary marketing and business benefits. Nonetheless, oversight may be required to ensure that the incentive to portray a 'green' public image does impair the reliability and accuracy of the measures reported.

One of the most pressing issues for policymakers is whether ESR is feasible. The respondents are affirmative on this question, stating that, with supports, it is feasible for SMEs to capture and report data relating to materials, waste, energy, water, and biodiversity, thereby facilitating the SMP in performing the reporting function in an accurate manner. Although access to data on carbon emissions may not be as easily accessible, this bodes well for the implementation of ESR by SMEs. Respondents are also of the view that the framework is appropriate and suitable for implementation by SMEs, suggesting that an abbreviated version of the reporting framework for large corporates is a suitable methodology. There is an eager willingness and reasonable capability to implement sustainability reporting, but the greatest perceived challenge is the paucity of personnel and resources in SMEs.

The SMP's reporting expertise is fundamental to the effective execution of ESR in the SME context. Couched within the framework of Lai and Stacchezzini (2021), the study has considered the challenges faced by the accountant in what is a transformative progression for SMEs and SMPs alike. The findings add to the literature in a number of respects. Firstly, while this study is not the first to consider the applicability of the GRI in the SME context (Arena and Azzone, 2012; Ortiz-Martínez and Marín-Hernández, 2022), it is the first to systematically reconstruct the environmental guidelines into a framework which may be operationalised for SMEs in a reasonably simplified and flexible manner. Secondly, this study responds to the noted dearth of empirical evidence regarding the accountant's ESR role (Humphrey *et al*., 2017; Rinaldi *et al*., 2018) in the analysis of the views of a substantial cross-section of the accounting profession. These views, while cautionary with respect to the costs involved, are encouraging to the extent that they strongly indicate a willingness to aid SMEs in ESR.

This study has a number of limitations. Firstly, it is based on a proposed framework on the GRI. For future research, it may be worthwhile incorporating other standards and frameworks. Secondly, the survey was collated from SMPs in Ireland. It would be valuable to examine other countries throughout Europe to assess cultural differences in environmental practices. Thirdly, as ESR is in its infancy, it is still very early to obtain detailed responses in some cases. A longitudinal survey or re-examination of this survey over a period of time could be beneficial to assess long-term benefits and costs of the implementation of ESR. Finally, it could be appropriate to survey SMEs to ascertain their views on sustainability reporting. This approach has challenges however, given incomplete data on the total SME population, and the potential lack of awareness of firm owners about environmental and sustainability reporting issues. One caveat with this approach is that smaller SMEs may not have a finance function and will request their SMP to complete the survey (Blackburn *et al*., 2010; Spence *et al*., 2012, ACCA, 2021, ACCA Ireland, 2022).

4.6 Practical and policy implications

This study makes a practical and policy-related contribution in several ways. Firstly, by developing a framework designed to assist SMPs and SMEs embarking on ESR. Secondly, details are provided on the financial implications for both SMEs and SMPs. In particular, the findings suggest additional resourcing is required to implement and engage in environmental sustainability reporting. Thirdly, this research confirms that there is a lack of knowledge from SMPs on this area but there is a strong appetite for education and training.

Specific to SMPs, the findings suggest that the accounting profession have a significant role to play in assisting SMEs in the implementation and delivery of ESR. This is one which has been greatly underestimated heretofore. Yet, to perform this role, the profession requires additional resources and supports. In response to survey items regarding delivery of education, training and learning, over 68% of participants cited professional accountancy bodies, higher education institutions, and government as being critical actors in developing and delivering education and training. Consistent with the theoretical framework employed herein, there is an arguement for co-operation and collaboration in devising a system of education, training and supports. There is a clear role for the professional accountancy bodies to act as leaders in this area, providing specialised training, aided by online tools such as webinars and virtual workshops. Inevitably, contemporary graduate recruits will have a great input in guiding this progresses. Accordingly, provision of the requisite tools and skillsets to enhance the knowledge and understanding of accounting students is a critical role of higher educational institutions. Universities have the capabilities to implement change through curriculum re-engineering and augmentation. This study submits that sustainability should be incorporated into all major business programmes, but in particular for sustainability reporting for accounting related programmes. Governments globally also have a considerable role to play. Recent debate and discussion at COP26 reflects a general global appetite to tackle climate change. Additional resources, both monetary and otherwise, are necessary. When asked to suggest specific incentives governments might provide in assisting SMPs in the delivery of ESR to SMEs, respondents offered some interesting views. A number of respondents suggested that financial and taxation incentives be provided to either the SMP or the SME. Moreover, the data reveals a distinct enthusiasm toward the provision of grants and business vouchers to SMPs to actively encourage their clients to engage with, and deliver, ESR. An example of a specific suggestion in this respect is a governmental grant or tax incentive of up to €500 for each SME client who provided evidence of submitting a report outlining their environmental impact. Many SMPs surveyed appear to believe that such measures would rapidly accelerate enthusiasm and willingness to engage. This research also finds suggestions for increased funding for accountancy software and technology associated with the capturing of ESR data. An optimal solution to the resourcing issues highlighted herein may be the creation of a state, or semi-state, sponsored organisation charged with assisting with the implementation of ESR, perhaps as part of a larger governmental environmental sustainability initiative. This would be very welcomed by all parties and certainly encourage the implementation of such.

A major consideration fundamental to the future of ESR is the role of auditors (Diouf and Boiral, 2017). SMEs that reach the threshold to submit fully audited financial statements, and outsource the preparation of their financial statements, including non-financial reporting disclosures

to their SMP, will encounter an audit requirement. Due to independence criteria and the risk of self-review, the SMP cannot audit any sustainability reporting component of their financial statements. As such, the role of the International Auditing and Assurance Standards Board (IAASB) is of critical importance when providing clear advice on the role of the auditor, in particular for SMEs when it comes to reviewing any sustainability reporting. In 2021, the IAASB issued guidance on the assurance of non-financial reporting. It has also launched *Sustainability Assurance*[19] which provides advice on ESG matters. The IAASB should engage in meaningful dialogue with standard-setters, such as International Sustainability Standards Boards (ISSB) or the GRI, for any future sustainability guidance so as to embed the role of the auditor in any future developments.

With appropriate interaction between policymakers, regulators, accountants and businesses, the future of sustainability reporting and standard-setting is positive. While there are a number of standards available to companies to engage with, the recent formation of the International Sustainability Standards Board (ISSB) amid the backdrop of COP26 may provide an impetus for a focus on ESR by smaller entities. This consolidation of a number of standards through the formation of the ISSB brings together a number of key players in the area with the aim of providing a global baseline of standards for businesses to implement. It is also very positive to note that there is even further collaboration between prospective standard-setters. In March 2022, the IFRS Foundation and GRI announced a collaborative agreement under which the ISSB and Global Sustainability Standards Board (GSSB), will seek to coordinate their work programmes and standard-setting activities, something which will encourage standardised reporting formats and perhaps a common framework for SMEs in the future.

[19] Sustainability Assurance https://www.iaasb.org/focus-areas/sustainability-assurance

Chapter 5: The implications of the implementation of the EU Taxonomy for Small to Medium Sized Enterprises

5.1 Introduction

Regulation (EU) 2020/852 establishes the basis for the EU Green Taxonomy (hereinafter, 'the Taxonomy') by setting conditions that an economic activity must meet in order to qualify as environmentally sustainable. The Taxonomy regulation was published in the Official Journal of the European Union in June 2020 and entered into force in July 2020 for certain larger entities. Prior to this, Directive 2014/95/EU set out rules of disclosures of non-financial and diversity information by certain large companies under the Non-Financial Reporting Directive (NFRD). The NFRD currently applies to large public-interest companies with more than 500 employees, covering approximately 11,700 large companies and groups across the EU, including listed companies, banks, insurance companies and other companies designated by national authorities as public-interest entities. In April 2021, the EU Commission adopted a proposal for a Corporate Sustainability Reporting Directive (CSRD), which amends the existing reporting requirements of the NFRD. The CSRD introduces a number of significant changes. Of particular importance, it widens the scope of the reporting obligations to apply to all non-SMEs and certain SMEs with securities listed on EU regulated markets, capturing an estimated capturing 49,000 companies. EU level discussion suggests that it may be 2026 before sustainability reporting requirements directly impact Small to Medium Sized Entities (SMEs). This lack of urgency notwithstanding, the capacity for SMEs to engage in sustainability reporting merits timely and focused consideration. Firstly, indirect pressures from larger companies in supply chains to provide basic measures of environmental impact are likely to amplify reporting demands on SMEs in the short term (Centobelli *et al*., 2021; Graafland, 2018; Johnson and Schaltegger, 2016; Sarkis *et al.*, 2011). Secondly, the environmental aspects of the European Central Bank (ECB) action plan may also serve to accelerate SMEs' propensity to measure their environmental impact, and the environmental risks facing them, before seeking bank financing (ECB, 2021; UN Environment Programme Finance Initiative and European Banking Federation 2022). On the back of the UN Environment Programme Finance Initiative and European Banking Federation report (2022), The French Economic, Social and Environmental Council (CESE)[20] warned that SME organisations would need sufficient time to raise awareness amongst their members on the new obligations, organise information sessions, train entrepreneurs and personnel and develop tools. They also stated that the development and the implementation of new software to deal with the new

[20] https://www.smeunited.eu/news/corporate-sustainability-directive-has-serious-shortcomings

obligations will require time and stressed that some big companies are already cancelling their contracts with SMEs as they are not able to report.

SMEs have typically relied on their Small and Medium Sized Accounting Practitioners (SMPs) for their reporting requirements (Collins *et al*., 2011; Nigri and Del Baldo, 2018) as well as for consultancy and advice, particularly on the implementation of new initiatives and processes (Blackburn and Jarvis, 2010; Jarvis and Rigby, 2011). A number of studies highlight the important role of SMPs, often referred to as the SMEs' 'most trusted advisor' (Spence *et al*., 2012: IFAC, 2016; World Bank, 2017; EFAA, 2018; Arnold, 2021). SMEs' reliance on SMPs increased throughout COVID-19, when many SMPs supported businesses in rebuilding and steering their way through the pandemic (ACCA, 2020). As SMEs face uncertainty, financial realities, and negative macroeconomic trends, business owners are increasingly turning to their most trusted advisors to ensure long-term viability, and SMPs are well-positioned to add value and ensure their clients can survive in a sustainable manner in the future (Arnold, 2021). SMPs are now experienced in the roles of advisor, confidant, analyst, facilitator, and educator to their clients (Alam and Nandan, 2010; Blackburn *et al*., 2010, 2014; Devi and Samujh, 2010).

The International Federation of Accountants (IFAC, 2012) called upon SMPs to play a role in 'greening' small business, viewing SMPs as being best positioned to encourage and advise their SME clients on sustainable practices and reporting. This advice has remained constant over the past decade, and in a more recent report, IFAC (2021) highlights the opportunities for SMPs in reporting sustainability information for their SME clients. It advises that SMPs' preparation of accessible, relevant and reliable sustainability information for SMEs will enable more informed business decision-making, enhance strategic planning and risk management, and therefore foster integrated thinking. It further maintains that the reporting of sustainability information to external stakeholders and business partners will naturally be influenced by SMPs. The findings of the European Federation of Accountants and Auditors' (EFAA) 2018 survey of the non-financial reporting requirements for European SMEs supports this view and also encourages SMPs to prepare for future implementation of sustainability reporting, suggesting their input will be essential for SMEs. Notwithstanding this commentary, the role performed by the accounting profession with respect to the introduction and practice of environmental sustainability reporting has been largely overlooked (Humphrey, O'Dwyer and Unerman, 2017; Rinaldi, Unerman, and De Villiers, 2018). SMEs represent 90% of businesses globally (World Bank, 2022) and Irish SMEs account for 99.8% of the total enterprise population (Central Statistics Office, 2020). Measurement of SMEs' environmental impact is a rational step

toward meeting the 2030 climate objectives, particularly with regard to those with sizeable operations.

Accordingly, this study focuses on the role of the SMP for SMEs in the implementation of the Taxonomy. This study employs a semi-structured survey to assess SMPs' opinions on (a) the feasibility to implement the Taxonomy for SMEs, (b) the supports required to minimise associated costs, and (c) the prospective benefits that may accrue from the provision of Taxonomy disclosures. This study adds to the sustainability reporting literature which, despite its growing focus on Taxonomy disclosures, has yet to truly examine the implications for SMEs. It also takes a unique methodological approach in that participants are acquainted with the issue of SME Taxonomy disclosures via an interactive case study approach. Finally, the study seeks to inform emerging policy on Taxonomy disclosures for SMEs by highlighting the financial and non-financial supports apt to be required in order to assure successful implementation.

5.2 Previously related literature

5.2.1 Theoretical framework: Legitimacy theory

The study adopts a legitimacy theory perspective. In a competitive business environment, increasingly concerned with environmental risks, SMEs face the task, not only of creating awareness of their existence (Ashforth and Gibbs, 1990) but also of achieving social acceptability among stakeholders (Suchman, 1995; Crossley *et al.*, 2020). Specifically, this entails conveying that their activities conform to societal norms of desirability and appropriateness. By virtue of their size and often vulnerable positions in supply chains, SMEs continuously aim to strengthen their legitimacy (Russo and Perrini 2010). This has been particularly apparent in financial reporting and relative narratives (Goncalves *et al*., 2022; Tang and Tang, 2016), for which SMEs typically contract SMPs (Collins *et al*., 2011; Nigri and Del Baldo, 2018). Voluntary provision of environmental disclosures presents opportunities to influence stakeholders' perceptions of SMEs' legitimacy and also lead to an advantage when such disclosures are mandated, for instance in a regulatory or supply chain context. SMPs have taken increasing responsibility for environmental reporting for SMEs (Humphrey *et al*., 2017; IFAC, 2021; Rinaldi *et al*., 2018). With this comes experience of working with a variety of firms with various levels of commitment to, and capabilities in, environmentally sustainable business practices.

Legitimacy theory suggests that such disclosures may have a substantive or symbolic basis (Deegan, 2002; 2014). In the case of the former, disclosures are based upon considered investment in environmentally sustainable business practices, whereas with latter, disclosures often serve merely

as window-dressing. Indeed, a dominant strand of the literature which considers disclosures through a legitimacy theoretical lens converges upon impression management, and greenwashing (Merkl-Davies and Brennan, 2007; Walker and Wan, 2012; Cho *et al*., 2015). As such, disclosures are made selectively as part of a strategy gain legitimacy by disproportionately revealing beneficial performance indicators, perhaps to obscure suboptimal overall performance (Marquis, 2016).

Crossley, Elmagrhi and Ntim (2020) note that a limitation of the applicability of legitimacy theory to SMEs in the environmental sustainability context is a lack of formalised or codified standards of conduct. Yet, so dynamic and rapid are developments in the area of environmental sustainability standards, that it would appear that stakeholder expectations are already relatively established (Centobelli *et al.*, 2021; Graafland, 2018; Machado *et al*., 2020), with regulatory requirements soon to follow. Legitimacy theory provides a suitable framework from which to consider the implementation of the EU Green Taxonomy by SMEs. The capacity of SMEs to engage with the Taxonomy varies along a spectrum of resource richness and levels of commitment to environmental sustainability. Accordingly, opportunities for both substantive practices (characterised by accurate and reliable disclosures) and symbolic practices (greenwashing) are predicted.

5.2.2 Feasibility

As SMEs represent a large proportion of global businesses, it is crucial to consider the feasibility of Taxonomy implementation for these businesses along the dimensions of cost and SMEs' willingness to engage. Furthermore, data availability, understandability, accuracy and reliability as well as firms' data capturing capabilities are fundamental issues which merit examination. Ultimately, the feasibility of providing the requisite Taxonomy disclosures for SMEs, and more pertinently, their reporting accountants presents a central issue which deserves urgent attention should there be an obligation or expectation for SMEs to align in the coming years.

At EU level, policymakers have been hesitant in mandating sustainability reporting for SMEs, largely due to opposition from member states who believe such a requirement imposes costs which smaller businesses cannot afford (Kinderman, 2020). The sources of such costs are manifold. Firstly, many of the SMPs contracted by SMEs lack formalised education and training in environmental sustainability measurement and reporting (Cho *et al.*, 2020; Lamberton, 2005; Thoradeniya *et al*., 2015). This introduces a challenge for the accounting profession which may impact the final cost incurred by the client. Coupled with the costs associated with the additional workload imposed on the SMP, adoption of the Taxonomy may simply not be financially feasible in the SME context.

The issue of SMEs' willingness to engage creates a challenge that extends beyond the accountant's remit. The quality of disclosures provided by SMPs is invariably contingent upon the co-operation of client entities. Time and skilled human resources are typically luxuries that SMEs cannot afford. The scarcity thereof serves as a significant barrier to the uptake of sustainability initiatives in smaller companies (Bergmann and Posch, 2018; Ismail *et al.*, 2011; Johnson and Schaltegger, 2016; Neto *et al.*, 2017). Specifically, SMEs lack the time and funding to educate existing staff, or to recruit sufficiently experienced and educated personnel. Since SMEs cannot achieve economies of scale on a level comparable to larger companies, many are reluctant to risk any investment, anticipating that the costs will likely outweigh the economic benefits derived (Arena and Azzone, 2012; Mourtzis *et al.*, 2016). This problem is exacerbated by inaccessibility to necessary capital (Bocken, 2015; Ismail *et al.*, 2011). Hence, a fundamental feasibility concern regarding the widescale implementation of the Taxonomy is disengagement by SMEs.

Since many SMEs have traditionally delegated financial reporting responsibility to the SMP, not only are they inexperienced in the area of reporting, but they also lack the expertise in recording and managing extensive data, financial or non-financial, and communicating it to their SMPs (Giovannoni and Maraghini, 2013; Gnan *et al.*, 2015). This raises a number of concerns for the SMP, including the existence of the data necessary to assess and report Taxonomy alignment, and the quality of such data with respect to understandability and reliability. The existence of data relies upon SMEs' data management systems. SMEs which implement environmental management systems appear to be in the minority with those companies who choose to adopt the ISO 14000 standard perhaps providing the best examples (Garengo and Biazzo, 2013; Heras and Arana, 2010). This problem is compounded by the fact that information systems tend to be tailored to the requirements of larger firms (Mbuyisa and Leonard, 2015). Central to both the accuracy of the KPIs reported under the Taxonomy, and to the accountants' professional obligation to provide a true and fair view of the firm's financial position, is the availability of environmental data relevant to financial performance (Dragomir, 2012; Unerman *et al.*, 2018). Due to the data aggregation and management limitations of many SMEs, SMPs may well be faced with inconsistent and inaccurate data with negative implications for the reliability of resulting measures. This significant threat to the feasibility of implementing the Taxonomy across SMEs ought to be addressed with urgency due to the potential consequences for the integrity of disclosures.

Current discussion surrounding the implementation of the Taxonomy in SMEs assumes an 'opt-in' approach such that the feasibility of accurately reporting the KPIs and assessment of the objectives on a contribution or do no significant harm basis for SMEs has yet to be truly interrogated.

Commentary suggests that the requirements may be refined for SMEs in the future (Hainz *et al.*, 2021). Nonetheless, KPIs related to turnover, operational expenditure and capital expenditure have long been applied in the SME context (Taylor and Taylor, 2014; Wouters and Wilderom, 2008). SMEs have also been found to commit to the circular economy (Mura *et al.*, 2020; Ormazabal *et al.*, 2018) and ecosystems (Bos-Brouwers, 2010) amongst others of the Taxonomy's objectives. Thus, Taxonomy disclosures may ultimately be feasible for many despite the concerns raised regarding the costs of implantation, willingness to engage and data integrity. A comprehensive and thorough assessment of feasibility requires consideration of the issues of costs, SMEs' willingness to engage and data integrity, alongside the specific disclosure requirements of the Taxonomy. It is pertinent to assess this from the perspective of the SMP as the primary rapporteur for the SME. Accordingly, presenting the first research question:

RQ 1: What is SMPs' feasibility assessment for implementation of the EU Green Taxonomy in SMEs?

5.2.3 Minimising costs

Having established that both SME management and the accounting profession are not yet fully technically literate in the area of environmental sustainability, it is perhaps not surprising that academics and professionals alike unequivocally call for enhanced education and training in sustainability reporting via higher education institutions and through continuous professional development (Cho *et al.*, 2020; Lamberton, 2005; Thoradeniya *et al.*, 2015). However, such instruction is costly. Moreover, given the data capturing issues faced by SMEs, coupled with the incapacity of many accounting software packages to accommodate environmental data (Shields and Shelleman, 2020), technological costs are also financially significant. These costs considered amid a small-medium sized business landscape in which many resource-poor firms are preoccupied with the struggle of meeting rising operational expenses, have very limited interest, economic or otherwise, to innovate with respect to sustainable business practices, and hence have little incentive or ability to engage in the disclosure process (O'Reilly, 2020).

These issues considered, there is little ambiguity surrounding the need to support SMEs in transitioning to the green economy and thus minimise the costs of aligning to the Taxonomy, thereby stimulating good quality disclosures. Governments have a clear role to play as part of their general mandates of promoting enterprise alongside environmental protection. Thus far, such support appears to have come indirectly through the banking sector vis-à-vis encouragement of green lending to SMEs

(European Commission, 2021b). Projects such as the Civitas Initiative[21] also serve an important role in supporting European SMEs. Yet, their reach to all European SMEs which constitute an estimated 99.8% of European businesses is questionable and there is an apparent need for harmonisation in the provision of supports across EU member states (Durst and Gerstlberger, 2021).

Pressures on SMEs from larger companies in supply chains to provide basic measures of environmental impact (Centobelli *et al*., 2021; Graafland, 2018; Johnson and Schaltegger, 2016; Sarkis *et al*., 2011) presents a further potential source of support for smaller firms. Emerging empirical evidence indicates collaboration in supply chains such that larger firms assist SMEs to develop their activities in an environmentally sustainable manner (Jo and Kwon, 2021; Machado, Vivaldini and Oliveira, 2020). While such support may often be of a non-financial nature, it may have intangible benefits which may greatly exceed any financial aid provided by banks or state bodies.

The opportunities to minimise the costs for SMEs' in aligning to the Taxonomy are meaningful, if fact it would appear that the fundamental issue is not as much the creation of supports, rather the development, utilisation and expansion of such. SMEs' financial and strategic advice has typically been provided by the SMP (Spence *et al*., 2012: IFAC, 2016; World Bank, 2017; EFAA, 2018; Arnold, 2021). Accordingly, SMPs are in a unique position to assess how supports can be most effectively employed to minimise the costs for SMEs. Hence, posing a second research question:

RQ2: What supports do SMPs consider necessary in order to minimise the costs of implementation?

5.2.4 Consequences

The potential multifaceted implications of the Taxonomy create intrigue across academic, policy and practitioner communities. While the intention behind the design of the Taxonomy is to urge climate change mitigation and adaption and to achieve additional environmental objectives, other potential outcomes may emerge from Taxonomy alignment. SMPs which report for SMEs that optimise their uses of natural resources may realise cost savings in the areas of energy (Meath *et al*., 2016; Tsalis *et al*., 2013), waste management (Mattila *et al*., 2020; Redmond *et al*., 2008) and materials (García-Arca *et al*., 2017; Oláh *et al*., 2019). More informed capital investment decisions which seek to 'future-proof' businesses can enhance returns (Thomson and Georgakopoulos, 2010). SMEs that monitor and report their environmental sustainability performance have also been found

[21] http://civitas.eu/about

to enjoy further benefits such as product innovation (Muñoz-Pascual *et al*., 2019) and participation in new business networks (Abbas *et al*., 2019). Having acknowledged the efforts of EU policymakers to promote environmental sustainability among SMEs via financial institutions, one pertinent benefit for those that align with the Taxonomy ought to be access to cheaper debt finance. While such an approach is endorsed within the literature (Cariola *et al*., 2020), there is evidence to suggest that environmental investment is perceived as risky by lenders (Cui *et al*., 2018). Commentary indicates that a primary rationale for contracting an SMP to report Taxonomy alignment for SMEs is supply chain related. As pressure to reduce Scope 3 greenhouse gas emissions grows (European Union Eco-Management and Audit Scheme, 2021), SMEs which provide verification of their environmental impact to larger suppliers (Centobelli *et al*., 2021; Graafland, 2018)) and customers (Machado *et al*., 2020) can achieve stronger positions within supply chains.

As societal support for environmental sustainability strengthens, firms aligned to the Taxonomy are apt to enjoy enhanced employee retention (Islam *et al*., 2021) and improved public recognition (Alon and Vidovic, 2015). Yet, this raises concerns regarding the incentives for SMEs to potentially pay large fees to their SMPs for providing Taxonomy disclosures. Legitimacy theory suggests that such disclosures create opportunities for symbolic action by firms (Liesen *et al*., 2015). Indeed, the limited technical solutions to counteract greenwashing have been acknowledged (Hoepner *et al*., 2017). Given the climate risks facing business and society into the future, aspirations among SMEs to engage in more environmentally sustainable business activities are likely genuine to a considerable extent. With this in mind, many SMEs will take substantive actions toward the Taxonomy's objectives. This is particularly true for those with high-growth potential, very much reliant upon legitimacy in the eyes of various stakeholders (Esau *et al*., 2021). Yet, well-established incentives to manage these stakeholders' impressions (Merkl-Davies and Brennan, 2007; Walker and Wan, 2012; Cho *et al*., 2015) cannot be overlooked in the context of Taxonomy disclosures. A critical perspective of even genuinely green firms might be that the most stringent of technical deterrents may be insufficient to preclude the inevitability of greenwashing. In effect, engagement in climate-related disclosures by SMPs on behalf of SME clients may well lead to positive outcomes within SMEs by creating a stimulus for more sustainable productivity. Disclosures ought also to aid SMEs in managing the risks they pose to, and face from, climate change. Yet, as SMEs compete to gain legitimacy among multiple stakeholder groups, an unintended, but predicable consequence may well be exaggerated claims regarding their environmental responsibility. The extent to which this will arise specifically within disclosures will be largely influenced by the reporting SMP. With this in mind, present a third research question:

RQ3: What consequences do SMPs envisage from implementation of the Taxonomy in SMEs?

5.3 Methodology

The dataset comprises survey responses from accounting professionals (SMPs), who, as discussed, work very closely with SMEs, perform the roles of advisor, confidant, analyst, facilitator, and educator to their clients (Alam and Nandan, 2010; Blackburn *et al*., 2010a, 2014; Devi and Samujh, 2010) and are likely better informed of the requirements of regulatory requirements and sustainability reporting for SMEs (IFAC, 2021). In addition, this means of data collection is more efficient, as each accounting professional may work with a number of SMEs. In selecting a research instrument to collect data, a self-administered questionnaire survey is deemed the most appropriate. In designing the research instrument, it would be considered more fruitful to present the SMPs with a case study and proposed framework on the potential practical implementation of the Taxonomy, rather than ask questions in the abstract about the feasibility, perceived challenges, methods of minimising costs and non-regulatory benefits. This approach has two advantages: (1) Proposing a framework which can be used (or form the basis) for SMEs to report their alignment to the Taxonomy, and (2) SMPs are providing information on a specific objective case study and proposed framework, rather than subjective views on the feasibility of the Taxonomy.

Two distinct case studies (Tables 5.1a and 5.1b) are developed. Firstly, an amended to the case study example on a cement company which forms part of the technical report on the Taxonomy by the EU technical expert group on sustainable finance and show the alignment to the Taxonomy under turnover and capital expenditure. Secondly, a case study based on the manufacture of low-carbon technologies is designed. This case study includes commentary and financial data on the alignment to turnover, operational and capital expenditure. These case studies provide participants with a basic overview of the practicalities of the Taxonomy and how SMEs may reporting their alignment. As part of the document, a basic framework is designed that covers the following: Taxonomy area, Activity, KPI, Alignment with the six Taxonomy Objectives (1. Climate change mitigation; 2. Climate change adaptation; 3. Water; 4. Circular Economy; 5. Pollution; 6. Ecosystems). The framework provides participants with an insight into how their business activities, turnover and expenditures can be reported under the Taxonomy. The required additional narrative disclosures is included to ensure firms have established the minimum social safeguards which are set out in the Taxonomy regulation. Additionally, narrative disclosures pertaining to ‘Do No Significant harm’ assessment is included, which is based on how activities comply with technical screening criteria established by the EU Commission through the delegated act.

Alongside the case study and proposed framework, a survey is developed which addressed the following research questions: (1) What is the SMPs' feasibility assessment for implementation of the EU Green Taxonomy in SMEs? (2) What supports do SMPs consider necessary in order to minimise the costs of implementation? (3) What consequences do SMPs envisage from implementation of the Taxonomy in SMEs?

As part of this study, focus groups are engaged as part of a collaboration with all major professional accountancy bodies in Ireland. The structure of the focus group involved providing participants with a high-level overview of the Taxonomy and trends in sustainability reporting. A walk-through of the case study and highlighting the practicalities of the implementation of the Taxonomy is undertaken, including explanations as to how to report KPI alignment, disclosing whether they are contributing or doing no significant harm under the key headings as well as discussing the additional narrative disclosures required. The professional accountancy bodies invited their SMP members to attend a virtual session to participate in this focus group and interactive case study. A pilot focus group and survey circulation with an ACCA Ireland SMP network group took place in March 2022. The first focus group in collaboration with ACCA Ireland took place on 8 April 2022 that led to 49 responses. A focus group in collaboration with Chartered Accountants Ireland took place on 11 April 2022 that led to 35 responses. CPA Ireland hosted a focus group on 25 April 2022 and led to 87 responses. Finally, a focus group in hosted by Chartered Institute of Management Accountants Ireland was held on 4 May and led to 28 responses.

There are approximately 1,700 small and medium accounting firms registered in Ireland which comprises of members across Chartered Accountants Ireland, the Association of Chartered Certified Accountants Ireland, Institute of Certified Public Accountants in Ireland and Chartered Institute of Management Accountants Ireland. The methodology employed resulted in 192 fully completed responses, excluding incomplete and partially completed surveys. This represents a response rate of approximately 11%.

Table 5.1a Case Study 1 (A cement company)

A cement company is renovating and adapting two plants (Turnover & capital expenditure as Taxonomy-aligned).

A cement company wants to renovate and adapt two of its biggest plants that contribute 50% to its turnover. The renovation of the cement facilities includes retrofitting to reach high energy-efficiency levels, increasing the use of blended materials to reduce the clinker-to-cement ratio to below 0.65, and the use of alternative clinkers and binders. The cement production facilities are expected to achieve a thermal energy intensity of approximately 3 GJ/t clinker, and carbon intensities in line with the Taxonomy. The company also commissions a climate risk assessment of the facilities. The assessment is based on climate data & indicates that facilities are vulnerable to flooding. The company decides to increase the capacity of drainage systems to make the facilities resilient to flooding. The overall renovation of the facilities amounts to €500,000, which represents 80% of the company's capital expenditure. Once the works related to climate change mitigation are finalised, the company can claim all turnover generated from those two facilities (50% of the company's turnover). The company will also be able to report that 80% of its capital expenditure is Taxonomy-aligned. The company has adopted all social safeguards outlined in the Taxonomy regulation. It has also implemented ISO 14001. It has obtained independent advice which has confirmed the activity has negligible impact on current weather variability, future climate change, other people, nature, assets or adaptation elsewhere. EU water legislation will be adhered to, and emissions to air and water are within the BAT-AEL ranges. An Environmental Impact Assessment (EIA) completed for the site and its ancillary facilities has confirmed negligible impact. Coincineration of waste is minimised by redirecting waste back into the production process where possible.

Taxonomy Area	Activity	KPI	Alignment	1. Climate change mitigation 3			2. Climate change adaptation4		3. Water		4. Circular Economy		5. Pollution		6. Ecosystems	
				Own Performance	Enabling Activities	Transitional Activities	C	D	C	D	C	D	C	D	C	D
One of the six Taxonomy objectives 1	NACE Activity	**Alignment with the Taxonomy** 2														
Climate change mitigation	Manufacturing of Cement	**% Turnover Aligned**	50%													
		% CapEx Aligned	80%	✓		✓		✓		✓		✓		✓		✓
		% OpEx Aligned	N/A													

Additional Narrative Disclosures	
How activity is conducted in compliance with minimum (social) safeguards set out in the Taxonomy Regulation 5,6	Firm has adopted OECD Guidelines for Multinational Enterprises, and adheres to UN Guiding Principles on Business and Human Rights, including all aspects of the ILO and the International Bill of Human Rights. It also observes the principle of 'do no significant harm' referred to in Regulation (EU) 2019/2088
How activity complies with technical screening criteria established by the European Commission through delegated act 7	DNSH Assessment: 2. Adaptation: Independent risk assessment, involving climate data and scenario analysis, indicates that activity will not hamper adaptation elsewhere over its expected lifetime. It has no significant negative impact on current weather variability or future climate change, or on other people, nature or assets. 3. Water: Following consultation with consultants, waste water will be treated such that there is no risk to quality, and measures will be taken to ensure no excess water consumption. It is the opinion of the consultants that EU water legislation will be adhered to. 4. Circular Economy: No hazardous wastes are used as alternative fuels. 5. Pollution: Independent advice sought has provided assurance that emissions to air and water are within the BAT-AEL ranges. ISO 14001 is implemented. Coincineration of waste is minimised by redirecting waste back into the production process where possible. 6. Ecosystems: An EIA completed for the site and its ancillary facilities has confirmed negligible impact. The plant is not located in, or near to, a biodiversity-sensitive area.

1: The six objectives set out under Article 9 are: (1) climate change mitigation, (2) climate change adaptation, (3) sustainable use & protection of water & marine resources, transition to a circular economy, (5) pollution prevention and control, and (6) protection and restoration of biodiversity and ecosystems.

2: Defined, under Article 8, as the extent to which the activity is associated with economic activities that qualify as environmentally sustainable under the Taxonomy Regulation.

3: The process of holding the increase in the global average temperature to well below 2 °C and pursuing efforts to limit it to 1.5 °C above pre-industrial levels, as laid down in the Paris Agreement (Article 2(5)). 'Own performance' refers to activities that make a substantial contribution independently. 'Enabling activities' refer to those that, by the provision of their products or services, enable a substantial contribution to be made in other activities. Transitional activities are those for which there is no technologically and economically feasible low-carbon alternative and which qualify under Article 10(2) as contributing substantially to climate change mitigation where it supports the transition to a climate-neutral economy.

4: The process of adjustment to actual and expected climate change and its impacts (Article 2(6)).

5: Alignment with (i) OECD Guidelines for Multinational Enterprises, (ii) UN Guiding Principles on Business and Human Rights, including the declaration on Fundamental Principles and Rights at Work of the International Labour Organisation (ILO), the eight fundamental conventions of the ILO and the International Bill of Human Rights and (iii) principle of 'do no significant harm' referred to in Regulation (EU) 2019/2088.

6: Disclosure should outline the extent to which the activity is conducted in a manner compliant with respect to safeguards, where relevant, for (i) Human rights, (ii) employment and industrial relations, (iii) combatting bribery, bribe solicitation and extortion, (iv) consumer interests, (v) science and technology, (vi) competition, (vii) taxation, (viii) any other matters addressed in the guidance referred to in note 5 deemed relevant.

7: Narrative on response to adaption/mitigation criteria and DNSH assessment.

Table 5.1b Case Study 2 (Manufacture of low-carbon technologies)

Manufacture of low carbon technologies (Turnover, operational & capital expenditure as Taxonomy-aligned).

Company A manufactures and installs building management systems, energy reduction solutions, and also produces LED lighting systems. During the most recent financial year, it had a turnover of €1,300,000. This can be 100% taxonomy-aligned due to the nature of its business which is considered an enabling activity which makes a substantial contribution to climate change mitigation. During the year, Company A spent €150,000 on installation and maintenance supports for its clients on their energy efficiency systems, which represents 25% of their operational expenditure (total expenditure €600,000). This expenditure can be taxonomy-aligned. More recently, Company A also embarked on the research and development of a new prototype software for its building management systems. It spent €400,000 on this, and under IAS38, has classified that €200,000 can be contributed to research expenditure and the other €200,000 can be capitalized under intangible assets. This €200,000 research expense represented 33% of their operational expenditure. Therefore, in the most recent year, Company A has a total of 58% (€150,000 + €200,000) of its operational expenditure which is taxonomy-aligned. It also purchased new specialized equipment to produce LED lighting systems in a more efficient and carbon neutral manner. The cost of the equipment was €350,000 and represents 100% of its capital expenditure in the year. Periodically, Company A contracts consultants to conduct an environmental impact assessment. Environmental consultants further evaluate climate and water risks, and the level of carbon emissions arising from its operations. EU regulatory compliance with respect to water and pollution is also assessed. The consultants also work with the company to develop policies on waste management and water conservation. The company is not located near to biodiversity-sensitive areas.

Taxonomy Area	Activity	KPI	Alignment	1. Climate change mitigation 3			2. Climate change adaptation4		3. Water		4. Circular Economy		5. Pollution		6. Ecosystems	
				Own Performance	Enabling Activities	Transitional Activities	C	D	C	D	C	D	C	D	C	D
One of the six Taxonomy objectives 1	NACE Activity	**Alignment with the Taxonomy** 2														
Climate change mitigation	Manufacture of low carbon technologies	**% Turnover Aligned**	100%		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		% CapEx Aligned	100%													
		% OpEx Aligned	58%													

Additional Narrative Disclosures	
How activity is conducted in compliance with minimum (social) safeguards set out in the Taxonomy Regulation 5,6	Firm has adopted OECD Guidelines for Multinational Enterprises, and adheres to UN Guiding Principles on Business and Human Rights, including all aspects of the ILO and the International Bill of Human Rights. It also observes the principle of 'do no significant harm' referred to in Regulation (EU) 2019/2088.
How activity complies with technical screening criteria established by the European Commission through delegated act 7	DNSH Assessment: 2. Adaption: An periodic professional climate risk assessment conducted for the company has consistently found no negative impact on current weather variability, future climate change, other people, nature or assets arising from its business activities. 3. Water: Risks related to water quality and consumption have been independently evaluated and are deemed negligible. The company operates under a water conservation policy developed by environmental consultants. The requirements of EU water legislation are adhered to. 4. Circular economy: An independent assessment has provided assurance that embodied carbon emissions represent less than 50% of the total carbon emissions saved by the use of the energy efficient equipment manufactured by the company. 5. Pollution: The company operates in compliance with the REACH Regulation and the RoHS Regulation. 6. Ecosystems: An Environmental Impact Assessment has been completed in accordance with the EU Directives on Environmental Impact Assessment and Strategic Environmental Assessment for the company's operations including its ancillary services. No threats to biodiversity or eco-systems have been identified. The company is not located near to biodiversity-sensitive areas.

1: The six objectives set out under Article 9 are: (1) climate change mitigation, (2) climate change adaptation, (3) sustainable use & protection of water & marine resources, transition to a circular economy, (5) pollution prevention and control, and (6) protection and restoration of biodiversity and ecosystems.

2: Defined, under Article 8, as the extent to which the activity is associated with economic activities that qualify as environmentally sustainable under the Taxonomy Regulation.

3: The process of holding the increase in the global average temperature to well below 2 °C and pursuing efforts to limit it to 1,5 °C above pre-industrial levels, as laid down in the Paris Agreement (Article 2(5)). Own performance refers to activities that make a substantial contribution independently. Enabling activities refer to those that, by the provision of their products or services, enable a substantial contribution to be made in other activities. Transitional activities are those for which there is no technologically and economically feasible low-carbon alternative and which qualify under Article 10(2) as contributing substantially to climate change mitigation where it supports the transition to a climate-neutral economy.

4: The process of adjustment to actual and expected climate change and its impacts (Article 2(6)).

5: Alignment with (i) OECD Guidelines for Multinational Enterprises, (ii) UN Guiding Principles on Business and Human Rights, including the declaration on Fundamental Principles and Rights at Work of the International Labour Organisation (ILO), the eight fundamental conventions of the ILO and the International Bill of Human Rights and (iii) principle of 'do no significant harm' referred to in Regulation (EU) 2019/2088.

6: Disclosure should outline the extent to which the activity is conducted in a manner compliant with respect to safeguards, where relevant, for (i) Human rights, (ii) employment and industrial relations (iii) combatting bribery, bribe solicitation and extortion, (iv) consumer interests, (v) science and technology, (vi) competition, (vii) taxation, (viii) any other matters addressed in the guidance referred to in note 5 deemed relevant.

7: Narrative on response to adaption/mitigation criteria and DNSH assessment.

5.4 Results and discussion

In Section 5.4, the results from descriptive statistical testing are presented. More specifically, the frequencies of responses and significant differences therein, examined using Mann-Whitney and analyses of variance (ANOVA) tests (Appendix D), are discussed.

5.4.1 Feasibility of EU Taxonomy implementation for SMEs

To address the first research question, what is SMPs' feasibility assessment for implementation of the EU Green Taxonomy in SMEs, three specific survey items are included concerning the feasibility of Taxonomy implementation for SMEs. The first deals with feasibility with respect to a number of overall considerations. On a ranking scale of 1 – 5 (with 1 being not feasible to 5 being highly feasible to implement), participants were required to indicate the feasibility of implementation along the dimensions of (i) cost, (ii) data availability, (iii) data understandability, (iv) data reliability and accuracy, (v) capacity of IT systems to capture data and (vi) clients willingness to engage in the disclosure process.

Cost of implementing the Taxonomy appears to be an issue of concern among the sample of SMPs surveyed, with over 57% indicating it is not financially feasible to implement for SMEs as presented in the case study. The suitability of existing systems to capture and manage the data required for Taxonomy disclosures is also considered problematic, with 60% of respondents suggesting it is not feasible. Since both issues are resource-related, almost six in every ten SMPs appear to believe that SMEs are not adequately resourced at present to implement the Taxonomy. When reviewing the other feasibility considerations, find that 71% of respondents consider the Taxonomy feasible from a data availability perspective and 58% consider it feasible to implement with regard to the reliability and accuracy of data (ranking either 3, 4 or 5). Just over one half (54%) of respondents indicate the Taxonomy is feasible, in that there is appetite from their clients to engage. On the whole, SMPs appear to be of the opinion that the data is available and may be accurately reported, but that resourcing is the major impediment to implementation for SMEs.

Table 5.2 Feasibility of EU Green Taxonomy (where 1 is not feasible to 5 being highly feasible)

	1		2		3		4		5		Total
	%	N	%	N	%	N	%	N	%	N	N
Cost of Implementation	26.24	50	30.50	59	30.50	59	7.80	15	4.96	10	**192**
Suitability of existing systems to capture and manage data	25.71	49	35.00	67	26.43	51	9.29	18	3.57	7	**192**
Clients' willingness to engage	15.22	29	31.16	60	27.54	53	21.01	40	5.07	10	**192**
Understandability of data	10.00	19	31.91	61	35.46	68	20.57	39	2.13	4	**192**
Availability of data	10.00	19	19.29	37	37.14	71	30.00	58	3.57	7	**192**
Reliability and accuracy of data	7.86	15	34.29	66	33.57	64	21.42	41	2.86	6	**192**

In relation to the specific Taxonomy KPI's (Table 5.3), the overwhelming majority (89%) of respondents believe reporting the percentage of Taxonomy aligned capital expenditure is feasible. Respondents commented that as some SMEs may not have much capital expenditure in a given financial period, alignment with the Taxonomy should be relatively straightforward to report on. 64% of respondents state that percentage of Taxonomy aligned operational expenditure is feasible to report, with 61% stating the percentage of Taxonomy aligned turnover is feasible. The lower perceived feasibility of the turnover and operational expenditure KPIs is to be expected as there are generally more transactions for these items and therefore, capturing this data may be more challenging and costly. This is particularly pertinent in light of the findings that the majority of SMPs deem cost and the suitability of IT systems to impair the viability of Taxonomy implementation in SMEs.

The feasibility of reporting a firm's contribution to, or doing no significant harm to, the six Taxonomy objectives is then assessed (Table 5.4). The study finds that for climate change mitigation (adaption), 77% (71%) of respondents believe it is feasible to report their clients' contribution to, and to confirm the principle of 'do no significant harm' has been adhered to. A considerable proportion of respondents also appear to deem disclosures regarding the objectives concerning water (68%) and pollution (57%) feasible to report on. However, fewer respondents believe it is feasible to provide disclosures concerning ecosystems (49%) and the circular economy (46%). Commentary from respondents suggest that they do not know enough about how to capture data on their ecosystem and

circular economy which highlights a need for knowledge and education on these specific metrics. SMPs appear to have considerable knowledge in more well-established areas such as pollution, however their responses to open-ended survey items are suggestive of incompatibility of software packages with data regarding pollution. Overall, research question 1 confirms that SMPs believe is it feasible for SMEs to implement the EU Green Taxonomy. A number of respondents also comment on the role of consultants, and their assistance with metrics such as pollution, ecosystems and circular economy, this issue is developed further in exploring the second research question regarding the minimisation of costs.

Table 5.3 KPI feasibility with the EU Green Taxonomy

	Yes		No		Total
	%	N	%	N	N
% of Turnover	61.43	118	38.57	74	**192**
% of Capital Expenditure	88.57	170	11.43	22	**192**
% of Operational Expenditure	64.03	123	35.97	69	**192**

Table 5.4 Doing no significant harm under the taxonomy regulations - feasibility assessment

	Yes		No		Total
	%	N	%	N	N
Climate change mitigation	77.14	148	22.86	44	**192**
Climate change adaptation	71.01	136	28.99	56	**192**
Water	67.63	130	32.37	62	**192**
Circular Economy	45.59	88	54.41	104	**192**
Pollution	56.62	109	43.38	83	**192**
Ecosystems	49.26	95	50.74	97	**192**

5.4.2 Minimising costs for SMEs

Research questions 2 aims to understand the supports SMPs consider necessary in order to minimise the costs of implementation. In order to assess how reporting and implementation costs can be minimised for SMEs, the study first examines the biggest resource- and reporting-related challenges for these firms. Table 5.5 presents comprehensive findings in this regard. Primarily, the study finds that the main challenges for SMEs are lack of knowledge or education, lack of resources and lack of data capturing capabilities. This elucidates the main resourcing requirements and therefore, provides greater clarity as to how the cost for reporting and implementation might be minimised. 31% of respondents indicated a lack of knowledge or education as the greatest impediment to implementing the Taxonomy for their SME clients. Lack of resources is the biggest challenge for 30% of SMPs in implementing the Taxonomy for their SME clients which places greater importance on the question as to how costs can be minimised. 17% of respondents ranked

lack of data capturing capabilities and technology as the greatest impediment which raises the question of the role of accountancy software packages and invoice generators in their ability to capture the data accurately. The lack of clients' incentives and lack of clients' interest are considered to be the greatest challenging by relatively fewer SMPs. This finding is encouraging in the context of EU-level commentary concerning voluntary disclosures for SMEs as a first step in wide-scale Taxonomy implementation.

Table 5.5 Biggest reporting challenges for SMEs (Ranking)

	1		2		3		4		5		6		Total	Average
	%	N	%	N	%	N	%	N	%	N	%	N	N	Score
Lack of Knowledge/Education	31.15	60	29.51	57	21.31	41	13.11	25	4.10	8	0.82	1	**192**	**4.68**
Lack of Resources	30.83	59	21.05	40	19.55	38	16.54	32	9.77	19	2.26	4	**192**	**4.40**
Lack of Data Capturing/Technology	17.32	33	24.41	47	24.41	47	18.90	36	12.60	24	2.36	5	**192**	**4.08**
Lack of Incentive	9.38	18	15.63	30	23.44	45	38.28	73	10.16	20	3.11	6	**192**	**3.66**
Lack of Interest	9.56	18	8.09	16	8.82	17	11.03	21	58.82	113	3.68	7	**192**	**2.88**
Other	5.49	11	3.30	6	3.30	6	3.30	6	0	0	84.61	162	**192**	**1.57**

Having assessed the challenges which SMPs observe in SMEs, the study then seeks to examine how SMPs' view on the feasibility of the Taxonomy vary with their perceptions of these challenges. Results of one-way ANOVA and Tukey post-hoc testing reveal that relative to SMPs who consider lack of resources as the greatest challenge, those who consider lack of knowledge as the greatest challenge are significantly more inclined to indicate that reporting the KPIs (F (4,179) = 8.76, p = 0.001; 0.89 ± 0.18, p = 0.001) and reporting alignment with the Taxonomy objectives (F (4,179) = 4.83, p = 0.001; 1.10 ± 0.34, p = 0.010) are feasible. They also are significantly more supportive of the view that implementation the Taxonomy is feasible from cost (F (4,179) = 8.01, p = 0.001; 0.94 ± 0.19, p = 0.001) and understandability (F (4,179) = 2.88, p = 0.020; 0.59 ± 0.18, p = 0.013) perspectives, relative to those who air resource concerns. This suggests that those SMPs who consider implementation of the Taxonomy in SMEs feasible believe that such this is contingent upon the provision of education and training, where resources allow for this. However, those SMPs whose views are reflective of resource-poor firms hold significantly less optimism for the implementation of the Taxonomy. Research question 2 is answered first by highlighting several key challenges and subsequently analysing the supports necessary.

5.4.3 Financial supports

Minimisation of costs, perhaps not surprisingly, rests heavily on the provision of non-financial supports for SMEs. Results are presented in Table 5.6. In assessing the potential financial supports, participants are invited to rank what they believe are the most appropriate and applicable financial supports for SMEs to implement the Taxonomy and ultimately reducing costs. An overwhelming majority (67%) of respondents indicate government/EU grants, tax incentives or carbon credits be the most beneficial and likely way of reducing costs for SMEs to implement the Taxonomy. There appears to be some concern within the commentary provided by participants that state-sponsored funding and grants would be consumed on engaging consultants, potentially on a one-off basis, that would effectively eliminate the benefit received. This provides the basis to argue for a structured approach to the provision of any related funding by governmental bodies.

Findings in Table 5.5 also denote that education is a priority for many SMPs, with respondents ranking subsidised private education as one of the main methods of minimising costs for SMEs. It is clear from previous studies (Cho *et al*., 2020; Lamberton, 2005; Thoradeniya *et al*., 2015), and from the findings discussed in Section 5.4.1, that lack of education is a primary concern and funding education appears to be expected from Higher Education Institutions and professional accountancy bodies. Among those SMPs that do not prioritise government funding or funded educational programmes, funding for or provision of open-sourced IT solutions to assist in the capturing of data is favored as mechanism for minimising costs for SMEs. As noted, accountancy software packages and technology are perhaps overlooked as crucial supports for SMEs. Somewhat surprisingly, financial supports from larger entities elsewhere in the supply chain, such as favorable credit terms by a financial institution or suppliers were prioritised by the lowest frequency of SMPs. Indeed, it would appear that there are two distinct schools of thought among SMPs, with one set of responses very much indicating an expectation from the government to play a role in providing financial support, while another is very suggestive of a need for investment in education to ensure successful implementation.

Analysis of variance in views on feasibility with respect to views on financial supports produces results consistent with the variance observed in SMPs' attitudes toward feasibility based on challenges they perceive. Relative to those who consider general government funding most important as a source of financial support, SMPs who place greater importance on specific educationally-related financial supports are significantly more likely to view implementation of the Taxonomy as feasible from financial ($F(3,180) = 5.60$, $p = 0.001$; 0.75 ± 0.22, $p = 0.005$) and understandability perspectives ($F(3,180) = 3.86$, $p = 0.010$; 0.58 ± 0.20, $p = 0.050$) and to indicate reporting the KPIs as feasible

($F(3,180) = 4.49$, $p = 0.005$; 0.57 ± 0.21, $p = 0.033$). It may be the case that government support is deemed necessary for those SMEs who lack resources as noted above. It would also appear that those SMPs which place value on the role of education and training are typically more sanguine regarding the feasibility of Taxonomy adoption by SMEs.

Table 5.6 Financial supports in reducing costs (Ranking)

	1		2		3		4		5		Total	Average
	%	N	%	N	%	N	%	N	%	N	N	Score
Government or EU Grants/Tax Incentives or Carbon Credits	67.18	129	19.85	38	8.40	16	3.05	6	1.52	3	**192**	**4.48**
Education (Subsidized)	14.29	27	26.98	52	35.1	69	23.02	44	0	0	**192**	**3.33**
Funded/Open-source IT solutions to aid data capture and management	13.08	25	31.54	61	29.23	56	24.62	47	1.53	3	**192**	**3.30**
Supports from larger entities elsewhere in the supply chain (Favourable credit terms)	5.93	11	20	38	27.41	53	42.22	81	4.44	9	**192**	**2.81**
Other	3.61	7	0	0	1.2	2	1.2	2	93.99	180	**192**	**1.18**

5.4.4 Non-financial supports

Alongside financial supports, supports of a non-financial nature have an important role in minimising the costs of Taxonomy implementation across SMEs. In assessing this, a survey item is included which requires participants to indicate what non-financial support they believe to be the most appropriate and applicable. Results are presented in Table 5.7. In line with the administrative challenges facing SMEs cited by the ECB (2021) and consistent with evidence indicating that the greatest challenge for SMEs is lack of personnel and time (European Commission, 2020b), SMPs seem to consider SMEs to be impeded by excessive administration in running their business. It is unsurprising that respondents believe that SMEs should be required to adhere to a simplified version of the Taxonomy. 39% of respondents ranked simplified disclosure requirements as the most appropriate and beneficial non-financial support that could minimise costs for SMEs. As reported previously, respondents generally express the view the Taxonomy is feasible to implement, there is a palpable lack of knowledge and resourcing for any form of sustainability reporting in SMEs, such that simplicity appears welcomed as an element of any measures to introduce the Taxonomy in

smaller firms. In particular, a number of respondents commented on the requirements on additional narrative disclosures being a real impediment to voluntarily engaging with the Taxonomy.

Again, the theme of an appetite for education is strongly apparent as 27% of respondents rank education, both in terms of Continuous Professional Development (CPD) programmes and the provision of suitably educated graduates from Higher Education Institutions (HEIs) as an appropriate aid in minimising costs. Just over one in five SMPs specify that the establishment of a governmental or non-governmental body could assist with the transition to reporting Taxonomy-alignment. Commentary on this item reflects a view that such a specialised agency could potentially assist in setting up the correct infrastructure for firms to engage with the Taxonomy as well as providing specialised training courses. A similar proportion (21%) regard supports from larger entities elsewhere in the supply chain, such as disclosure assistance from larger members, as a method of minimising costs. Some respondents had alluded to the possibility that certain suppliers will have their own reporting requirements and therefore, SMPs would need to adhere to multiple different templates and guidelines relating to various different aspects of their environmentally sustainability activities. These findings again reflect the presence of a dominant role for governmental regulators in phasing in Taxonomy disclosure requirements for SMEs, while a smaller, yet sizeable element of the sample strongly advocate that education and training are essential tools in implementing the Taxonomy in a means that would perhaps minimise the associated costs in the longer term.

Attitudes toward feasibility of the Taxonomy also vary along the dimensions of the non-financial supports required. Specifically respondents who consider non-financial support from HEIs as the greatest priority are more inclined to view implementation of the Taxonomy as feasible from a cost perspective than those who prioritise non-financial support in the form of regulatory action being taken to simplify disclosure requirements for SMEs ($F(4,179) = 3.17$, $p = 0.010$; 0.99 ± 0.29, $p = 0.008$). This finding coupled with those regarding the variations in attitudes toward feasibility in terms of challenges and financial supports are strongly indicative of a belief that the viability of implementing the Taxonomy rests upon education of the accounting profession. As such, there appears to be an appetite for the requisite training to enable technical disclosures to be provided, and assurance given with professionalism rather than merely providing surface-level indicators. It is important to note however, that these opinions appear to be aired to a much lesser degree by those SMPs who express concerns regarding the limited capacity of many SMEs to bear the cost of such professional services. Research question 2 surrounding the supports necessary to reduce costs is answered by providing both financial and non-financial supports SMP consider appropriate.

Table 5.7 Non-financial supports in reducing costs (Ranking)

	1		2		3		4		5		6		Total	Average
	%	N	%	N	%	N	%	N	%	N	%	N	N	Score
Simplified disclosure requirements (EU Green Taxonomy)	39.10	75	21.80	42	14.29	27	12.03	23	9.02	17	3.76	7	**192**	**4.59**
Establishment of government or NGO specialized agency to assist	21.80	42	24.06	46	15.04	29	15.04	29	19.5	38	4.51	9	**192**	**4.03**
Education (Availability of CPD programmes)	16.67	32	21.43	41	21.43	41	28.57	55	11.11	21	0.79	2	**192**	**4.00**
Education (Provision of suitably educated graduates from HEIs)	10.32	20	15.87	30	23.81	46	26.98	52	21.43	41	1.59	3	**192**	**3.62**
Supports from larger entities elsewhere in the supply chain (Disclosure assistance)	11.81	23	16.54	32	25.20	48	14.17	27	30.71	59	1.57	3	**192**	**3.60**
Other	2.63	5	0	0	0	0	1.32	3	7.89	15	88.16	169	**192**	**1.24**

5.4.5 The consequences of implementing the Taxonomy for SMEs

In addition to costs, there are further consequences, both intended and unintended, associated with implementing the Taxonomy for SMEs. Research question 3 aims to assess the consequences SMPs envisage from implementation of the Taxonomy in SMEs. One would hope that it would lead to a realisation of benefits by SMEs, Yet, as with any corporate reporting exercise, the potential for exaggerated claims to be made surrounding positive managerial actions must be assessed. In the present context, this will likely be manifest in the form of greenwashing. Results on the consequences of implementing the Taxonomy for SMEs are presented in Table 5.8.

5.4.6 Non-regulatory benefits for SMEs

The current Taxonomy will remain voluntary for SMEs until a possible extension of the proposed CSRD becoming effective for some SMEs in 2026. At which point, regulatory compliance will be a benefit for firms. Given that this at present cannot be realised and will in the future be a somewhat obvious benefit, focus is placed on the non-regulatory benefits arising from implementation of the Taxonomy. Similar to the previous survey items, SMPs, those who advise and provide financial management assistance to SMEs, were invited to rank the non-regulatory benefits for SMEs. It is unsurprising, given the macroeconomic environment at the time of writing that the standout benefit of implementing the Taxonomy is reduced costs (e.g. reduced energy bills, reduced

waste management costs, lower costs in replacing fixed assets). 43% of SMPs view Taxonomy disclosures a guide for better management of operational and capital expenditure and therefore reduce their costs. Enhancement of company image is also ranked as chief benefit by 32% of SMPs suggesting that SMEs. This, perhaps worryingly, indicates that whilst there may be considerable environmental and societal benefits in adopting the Taxonomy, SMPs perceive that managing stakeholders' impression of the company is of priority to SMEs. The potentially concerning implications for the integrity of the reports produced suggest that accounting for environmental sustainability may well need to accompanied by auditing of Taxonomy disclosures, in a phased approach at least.

It seems that external considerations such as access to finance (obtaining cheaper financing arrangements), increased demands from consumers and suppliers and the ability to attract and retain employees are of the least benefit to SMEs. Only a small percentage of respondents (16%) had selected any of the three as the primary benefit in implementing the Taxonomy. Just over 9% of SMPs consider Taxonomy disclosures would enable SMEs to gain competitive advantage and increase productivity in an environmentally friendly manner. While cost-related benefits appear to be most strongly anticipated by SMPs, many do express the view that disclosures will to some extent be an exercised aimed at strengthening SMEs' public profiles. Accordingly, greenwashing is a key potential consequence, albeit unintentional which must be explored.

Table 5.8 Non-regulatory benefits for SMEs in providing voluntary disclosures that are aligned to the EU Green Taxonomy (Ranking)

	1		2		3		4		5		6		7		Total	Average
	%	N	%	N	%	N	%	N	%	N	%	N	%	N	N	Score
Reduced costs (e.g. reduced energy bills, reduced waste management costs, lower costs in replacing fixed assets)	42.52	82	21.26	41	17.32	33	7.09	14	5.51	10	3.15	6	3.15	6	**192**	**5.66**
Enhancement of company image	31.50	60	23.62	45	14.96	29	5.51	11	10.24	20	4.72	9	9.45	18	**192**	**5.09**
Greater competitive advantage	3.91	8	15.63	30	21.88	42	24.22	47	18.75	36	10.94	21	4.67	9	**192**	**4.10**
Increased productivity in an environmental friendly manner	9.76	19	12.20	23	8.13	16	25.20	48	21.14	41	16.26	31	7.31	14	**192**	**3.86**
Access to finance	4.76	9	15.08	29	19.84	38	8.73	17	12.70	24	22.22	43	16.67	32	**192**	**3.57**
Increased demands from consumer and suppliers	8	15	6.40	12	14.40	28	20.80	40	11.20	22	12.80	25	26.40	51	**192**	**3.57**
Attraction and retention of employees	4.92	9	8.20	16	5.74	11	12.30	24	22.13	42	25.41	49	21.30	41	**192**	**3.00**

5.4.7 Greenwashing

The finding that SMPs foresee public image- related benefits suggests that respondents are attuned to prevailing market trends and are concerned with practical commercial and reputational issues. As such, there may be ancillary marketing and public relations benefits to implementing the Taxonomy. Reputation is a valuable and fragile company asset, and it is well recognised that businesses seek to preserve and enhance their status vis-à-vis the public. Thus, the finding in this respect is does not necessarily suggest any pernicious intent to mislead stakeholders. Nonetheless, oversight may be required to ensure that the incentive to portray a 'green' public image does impair the reliability and accuracy of the measures reported.

Ask participants to state their belief on whether the implementation of the Taxonomy could lead to greenwashing. The results are presented in Table 5.9. An overwhelming majority of SMPs (76%) believe that the Taxonomy disclosure requirements could lead to greenwashing. While relevant precautionary measures are a facet of the Taxonomy's design, limitations have been conceded (Hoepner *et al*., 2017). The capacity of the auditor to provide limited, and eventually reasonable, assurance must be given due consideration in this context so as to minimise potential greenwashing.

This study finds a significant difference in responses toward greenwashing. Specifically, those SMEs that indicate reporting alignment to the Taxonomy objectives as feasible are significantly more inclined to agree that disclosures will involve an element of greenwashing (Z = 1.979, p = 0.049). This implies that the substantive actions which may be taken to provide technical disclosures will nonetheless be accompanied by symbolic gestures aimed at exaggerating claims of positive environmental impact.

Curiously, those SMPs who view improvement of company image as a key benefit are significantly less inclined to view greenwashing as an outcome (Z = 3.503, p = 0.001). One interpretation is that SMPs regard the rigorous disclosure requirements remove the opportunity for greenwashing and thus enable companies to appear 'green' in a more authentic way. Another is that those concerned with image are more inclined to dismiss the concern of greenwashing.

It may also be the case, that greenwashing is only a concern for those SMEs that have the resources to engage in such behaviour as respondents who consider lack of resources as the greatest challenge are significantly less inclined to believe the Taxonomy will lead to greenwashing (Z = 1.979, p = 0.049). Research question 3 is answered by assessing the non-regulatory benefits and potential consequences. In this case greenwashing is considered a major potential consequence of

implementing the Taxonomy for SMEs. The greenwashing aspect of the consequences of implementing the Taxonomy ties in with other studies in legitimacy theory on undertaking symbolic practices (Merkl-Davies and Brennan, 2007; Walker and Wan, 2012; Cho *et al.*, 2015). As discussed in the literature above, a critical perspective of even genuinely green firms might be that the most stringent of technical deterrents may be insufficient to preclude the inevitability of greenwashing. This is confirmed in the opinions of SMPs who feel greenwashing is highly probably (76%).

Table 5.9 EU Green Taxonomy's disclosure requirements leading to greenwashing by SMEs

	Yes		No		Total
	%	N	%	N	N
Greenwashing	75.71%	145	24.29%	47	**192**

5.5 Conclusion

Environmental responsibility is becoming increasingly important for firms of all sizes, with attendant reporting and disclosure implications. While SMEs do not currently face regulatory reporting requirements akin to those expected of larger entities, EU level discussion suggests the requirements of the CSRD may be extended to capture more firms in 2026, including SMEs. Irrespective, SMEs are likely to engage progressively more with sustainability disclosures for economic and environmental reasons, not least due to supply chain and public pressures.

This study examines, from a SMPs' perspective, the feasibility of implementing the Taxonomy for SMEs. This study also further explores the supports they consider necessary in order to minimise the associated costs and the potential consequences envisaged. This is done by adopting an innovative methodological approach to engage focus groups using an interactive case study before completing a self-administered questionnaire survey.

This study produces a number of findings which are of consequence to future research, policy formation and practice in the area of sustainability reporting and, more specifically regarding the widespread adoption of the EU Green Taxonomy. Principally, the findings highlight the requirement for resourcing supports as the costs of implementation are significant, and current IT systems appear incapacitated to capture and manage the requisite data. This study uncovers very encouraging evidence to indicate viability of Taxonomy disclosures for SMEs; thus, overcoming the cost- and resource-related obstacles is central to broad adoption. Specifically, there is a finding that the accountancy profession deem the KPIs and criteria within the Taxonomy largely feasible to report, although this is contingent upon technological and financial support. Government grants and

incentives appear attractive to many SMPs as a means of assisting their SME clients with the implementation of the Taxonomy.

Discern for education and training to enhance accountants' environmental literacy and familiarity with the Taxonomy is desired and should not be treated with triviality. In fact, the observed divergence in opinions aired by SMPs forms the essence of the conclusion. This study is couched within legitimacy theory and find evidence to support its contentions. Specifically, there is a willingness, among a grouping of accountants at least, to develop the knowledge and skills necessary to work with SMEs in a substantive manner to provide Taxonomy disclosures. That said, the potential for symbolic actions with respect to greenwashing is omnipresent. Concurrently, the evidence also suggests a contrasting attitude which does not reflect such a strong appetite for development of the profession with regard to environmental sustainability. Rather, a view among a larger cohort of the sample suggests an air of expectation from government and regulators to take action with respect to provision of financial support and tailoring of guidelines.

This then brings into the question the role of the government and professional accountancy bodies who will have a big role to play in the development and implementation of environmental reporting going forward. An argument is for co-operation and collaboration in devising a system of education, training and supports. There is a clear role for the professional accountancy bodies to act as leaders in this area, providing specialised training, aided by online tools such as webinars and virtual workshops. Inevitably, contemporary graduate recruits will have a great input in guiding this progresses. Accordingly, provision of the requisite tools and skillsets to enhance the knowledge and understanding of accounting students is a critical role of higher educational institutions. Universities have the capabilities to implement change through curriculum re-engineering and augmentation.

It would of course be naive and ineffective to overlook the majority of SMEs which face resource constraints and appear in need of state-sponsorship in order to engage with the Taxonomy. On this point, this study draws upon the finding that a major non-regulatory benefit yielded by Taxonomy implementation may be the reduction in costs and the potential savings for businesses. As such, investment by governmental bodies in SMEs with respect to environmental sustainability and related disclosures may generate long-term returns with respect to operational and capital expenditure alongside the intended consequence of more environmentally responsible business practice.

Accordingly, this study concludes that SMPs seek to accommodate for a diverse range of SMEs. For some, there is rich potential for meaningful engagement with the Taxonomy, yet the audit profession, regulators and other users of reported disclosures should be attentive to the opportunities

which exist for greenwashing. For other SMEs, there is a distinct need for considered governmental support. The findings suggest that any aid provided, or guidelines issued, should aim to promote a realisation among SMEs as to the potential value which may be yielded by Taxonomy alignment and hence avoid it being considered a mere compliance exercise.

The study adds to the literature in a number of respects. Firstly, providing evidence to support legitimacy theory in the context of the EU Green Taxonomy. By doing so adding to prior work which has considered other means of sustainability reporting in SMEs through a legitimacy theoretical lens (Chelli *et al*., 2018; Crossley *et al*., 2020). Secondly, adopting a novel methodological approach has enabled exploring the research questions by engaging participants with the topic in a unique manner using case studies. Such an approach, to the best knowledge has heretofore not been adopted. Finally, this study uncovers evidence from an accounting perspective which may be used to inform the development of policy on Taxonomy disclosures for SMEs. The practical value of this perspective ought not to be underestimated amid an SME landscape where internal reporting and finance functions are limited to the largest of firms.

This study has a number of limitations. Firstly, the survey was distributed only to SMPs in Ireland. It would be valuable to examine other countries throughout Europe to assess cultural differences in environmental practices and their ability to implement the Taxonomy. Secondly, as sustainability reporting is in its infancy, and voluntary within SMEs, it is still very early to obtain detailed responses in some cases. A longitudinal survey or re-examination of this survey over a period of time could be beneficial to assess long-term benefits and costs of the implementation of the Taxonomy. Finally, it could be appropriate to survey SMEs to ascertain their views on sustainability reporting. This approach has challenges however, given incomplete data on the total SME population, and the potential lack of awareness of firm owners about environmental and sustainability reporting issues. One caveat with this approach is that smaller SMEs may not have a finance function and will request their SMP to complete the survey (Blackburn *et al*., 2010; Spence *et al*., 2012, ACCA, 2021, ACCA Ireland, 2022).

Chapter 6: Discussion and Conclusions

6.1 Overview of research and findings

Taking a two-strand approach, this thesis examines the impact of equity financing on Cleantech firms and the feasibility of implementing ESR for SMEs. Chapter 2 examines the financing of early stage Cleantech firms by analysing firms that sought equity crowdfunding across European platforms. This study examines pre- and post-crowdfunding financing, finding that firms with lower total assets and higher cash balances raise greater amounts of crowdfunding. In the pre-crowdfunding period, illiquid firms raise less finance and firms with greater assets raise more debt. In the post-crowdfunding period, crowdfunded firms raise significantly greater amounts of external equity, suggesting signalling effects. This study highlights the ameliorating liquidity effects of crowdfunding, which are especially important for early stage firms that develop new technologies.

In Chapter 3, the extent of equity financing is empirically tested using a unique database of UK Cleantech firms. Through the lens of the pecking order theory, evidence is provided as to the key financial and accounting influences in raising equity financing. This study also provides evidence that intangibility does not play an important role in raising equity finance and discusses the role of IAS38 in Cleantech firms. A distinct finding of this study is that while Cleantech firms are financed consistent with pecking order theory, firms with lower levels of intangible assets are financed by equity. This study provides evidence that software-led Cleantech firms raise greater amounts of financing than hardware-led firms. The study also provides further evidence of the potential equity gap for long horizon, capital-intensive and complex innovative hardware-led Cleantech firms. In addition, the study provides recommendations for governments and large corporations to provide long horizon, deep pocket investment to assist Cleantech firms to reach commercialisation.

In Chapter 4, an analysis of survey responses from SMP's on the GRI framework is undertaken as the basis of ESR for SMEs. This study finds that the greatest perceived benefit for firms adopting environmental sustainability reporting is an improved company image. Respondents detailed the financial and resource implications for SMEs, providing an estimate of additional costs. A significant perceived impediment in implementing sustainability reporting is the lack of knowledge and training, not only for SMEs but also for accounting professionals. The respondents validated the metrics used in the proposed framework. Although sustainability reporting is not yet mandatory for SMEs, this study suggests policy and practical implications for its adoption.

Finally, Chapter 5 examines the implementation of the EU Green Taxonomy and its implications for SMEs. This study suggests that SMPs believe that the requirements within the Taxonomy are feasible for SMEs to report on, but highlight the requirement for resourcing support as the costs of implementation are significant, and current IT systems appear incapacitated to capture and manage the requisite data. Overcoming cost- and resource-related obstacles is central to its broad adoption. Government grants and incentives appear to be attractive to many SMPs as a means of assisting SME clients in Taxonomy implementation. Evidence also suggests that education plays an important role in accelerating Taxonomy adoption. The study finds that a major non-regulatory benefit yielded by Taxonomy implementation may be the reduction in costs and potential savings for businesses. This study is positioned within legitimacy theory and finds evidence to support its contentions but air caution regarding the potential for greenwashing to skew the reliability of the Taxonomy disclosures.

6.2 Contribution

This thesis began with the primary aim of examining the financing of Cleantech firms and assessing the feasibility of ESR for SMEs. This requires comprehensive datasets, survey insights and analysis. This study makes several contributions to theory, literature, and practice.

6.2.1 Contribution to theory

Several theoretical frameworks underpin the studies presented in this thesis. First, specific to signalling theory (Spence, 1973), this study supports signalling theory by analysing equity crowdfunding in Cleantech firms and examining equity financing for UK Cleantech firms. This study provides new evidence to support signalling theory by identifying pre-campaign financing as a positive signal for crowdfunding campaign success. As such, firms that raise financing before the crowdfunding campaign will raise more money during the campaign itself. While extant findings exist to indicate the existence of types of information that acts as a signal for investors providing finance in a start-up context (Goldfarb *et al*., 2007; Nahata, 2008; Cosh *et al*., 2009; Agrawal *et al*., 2010; Connelly *et al*., 2011; Cole and Sokolyk, 2012; Robb and Robinson, 2014), and more recently, signals concerning crowdfunding (Ahlers et al., 2015; Hornuf *et al*., 2018), this study is the first to identify pre-existing equity financing as a signal which attracts further investment in the crowdfunding context. Specifically, results indicate that for each unit of finance raised during the equity crowdfunding campaign, firms raise X10 of equity post-crowdfunding. This indicates a positive signalling effect of crowdfunding on equity investors, providing them with validation from

the crowd who believe in the firm as to the potential for their business model, thus supporting the singnalling theory.

Chapter 3 provides further evidence to support signalling theory. While the primary analysis provides no evidence that suggests Cleantech firms with patents, granted or pending, are more likely to raise equity financing. The results of further tests suggest that equity investors are willing to invest at an early stage on the promise of success as indicated by the potential of a patent being granted. More precisely, analysis of the determinants of the amount of equity raised indicates that firms with patents pending prior to raising equity funding raise significantly more funds. Patents reduce information asymmetries in entrepreneurial finance (Conti *et al*., 2013a) and can act as a signal for start-up financing. A number of studies where multiple research suggest that patents attract external investment (Hoenen *et al*., 2014; Zahringer *et al*., 2017; Vo, 2019) and can be used for debt collateral from banks (Conti et al., 2013a: Conti *et al*., 2013b; Yang *et al*., 2021). For those firms that already have a patent granted, it may be the case that the patent will be used as collateral for debt financing (Conti *et al*., 2013a). Patents pending could also be a reason why firms with lower levels of intangibles raise greater amounts of equity finance as the future value of these patent applications cannot be capitalised. It is also perhaps a sign of the speculative nature of equity funding with investors willing to 'bet' more on the potential of success, and therefore, firms with patents pending.

Secondly, the research presented in Chapter 3 also supports pecking order theory (Myers, 1984; Myers and Majluf, 1984). Indeed, it is to the best of the researcher's knowledge, the first to examine the financing of Cleantech firms from this theoretical perspective. It finds that Cleantech firms generally source equity finance in a manner consistent with the pecking order theory, apart from one key area, intangible assets. Previous studies find that firms with intangible assets raise external equity financing (Gompers and Lerner, 2003; Thornhill and Gellatly, 2005; Mac an Bhaird and Lucey, 2010: Vanacker and Manigart, 2010: Walthoff-Borm *et al*., 2018). The evidence presented in Chapter 3 offers nuanced evidence in this regard. Specifically, firms with lower intangible assets are more likely to raise equity financing and in greater amounts. While this contradicts several extant studies in entrepreneurial finance, it is not overly surprising that this is the case. One potential reason is that the capitalisation of intangible assets, under IAS 38, is restrictive (Ahmed and Falk, 2006). Therefore, Cleantech firms, which are already considered more technologically innovative than other firms (Dangelico, 2017), struggle to capitalise on their R&D expenditures. Another potential reason is that equity investors are more concerned about the promise of success and want to invest at an early stage, especially in emerging and developing industries with great social and environmental benefits where intangible assets are possibly not a main priority. The

Cleantech industry has seen a significant increase in investment, both at public and private investment levels over the last number of years, suggesting that Cleantech firms obtain equity financing regardless of the development of intangible assets. Recent studies have also shown that venture capital firms are targeting investment in more *born-to-be-green* firms (Mrkajic *et al*., 2019) and that, identifiable intangible assets can be just as important for firms raising debt financing as tangible assets (Lim *et al*., 2020).

Chapters 4 and 5, employ different theoretical frameworks to examine ESR in SMEs, namely legitimacy theory and institutional theory. The findings presented in both Chapters 4 and 5 support legitimacy theory which suggests that, due to their size and often vulnerable positions in supply chains, SMEs continuously aim to strengthen their legitimacy which entails conveying that their activities conform to societal norms of desirability and appropriateness (Ashforth and Gibbs, 1990; Suchman, 1995; Deegan *et al*., 2000; Deegan, 2002). The findings derived in Chapters 4 and 5 suggest SMEs may engage in ESR to enhance their perceptions among relevant stakeholders as predicted by legitimacy theory. Specifically, the analysis presented reveals the existence of a cohort of SMPs who appear enthusiastic about both gaining skills in sustainability reporting and implementing Taxonomy. Legitimacy theory suggests that such accountants may take substantive actions to provide accurate and reliable disclosures for clients. These findings notwithstanding, the results presented in Chapter 5 also suggest that symbolic gestures may be manifest in the form greenwashing. These findings are consistent with observations and predictions made with regard to ESR. Primarily, while disclosures may be based up investment in environmentally sustainable business practices, they may also serve as window-dressing (Deegan, 2014), as firms seek to manage their impressions among stakeholders (Marquis, 2016).

The results presented in Chapter 5 also support institutional theory (DiMaggio and Powell, 1983; Mizruchi and Fein, 1999) which suggests that SMEs, as small resource-constrained entities, may believe that their provision of ESR disclosures is unnecessary and unfeasible (Bealing et al., 1996; Spiller, 2009; Baker et al., 2014; Greve and Argote, 2015; Nurunnabi, 2015; Reynolds et al., 2016 and Chiu, 2019). Therefore, they would wait until it became mandatory to conform to regulatory requirements, likely aided by government-sponsored grants, subsidies, etc. Chapter 5 which converges upon a potentially mandatory future reporting requirement reports that SMEs' adoption of the EU Taxonomy on an opt-in basis is likely be limited to those who face supply-chain pressures and those with environmentally sustainable business models and cultures. Institutional theory predicts that when mandated in 2026 or later, SMEs will merely comply with the necessary disclosure requirements due to the compulsory nature.

6.2.2 Contribution to literature

This study contributes to the literature in several ways. It provides a detailed and nuanced analysis of equity financing of Cleantech firms. Crowdfunding has emerged as a new source of external equity finance, playing an increasingly important role in the financing of young entrepreneurial firms (Ahlers *et al.*, 2015; Bruton *et al.*, 2015; Cumming and Vismara, 2017), and has a particular impact on growth opportunities (Eldridge *et al.*, 2019). Although access to finance is a common obstacle for start-up firms, Cleantech start-ups experience particular challenges in raising finance (Ghosh and Nanda, 2010; Mazzucato and Semieniuk, 2018) and assessing the role of equity crowdfunding in Cleantech firms has yet to be studied. There has been suggestions that while crowdfunding is viewed as an important financing method within both developed and developing countries' innovation and finance ecosystems (Hörisch, 2015; Lam and Law, 2016), its potential is not sufficiently used in the context of environmentally oriented ventures. This study is the first to investigate equity crowdfunding in European Cleantech firms. This is also one of the first studies to assess crowdfunding in the pre and post-crowdfunding financing phases. The crowdfunding market has increased dramatically over the last decade (Statista, 2020), second only to venture capital in the number of deals completed in 2020. Therefore, understanding the success of funding post-crowdfunding is important for investors and policymakers. This study provides evidence that for each unit of crowdfunding, there is a tenfold increase in equity post-crowdfunding which shows positive signalling effects. This study provides clear evidence that crowdfunding extends signalling theory in finance for Cleantech firms. Funding post-crowdfunding can assist policymakers in evaluating whether equity crowdfunding is an efficient and worthwhile form of financing for Cleantech firms. Through an examination of the determinants of the amount raised for Cleantech firms seeking equity crowdfunding, this study highlights the key areas business owners and investors should focus on for future success, such as the importance of correct business valuation and strong financial management.

Extant literature suggests a need for a clear research and policy agenda to assist early stage Cleantech financing, which has never been greater (Owen *et al*., 2020). An understanding of Cleantech firms resourcing requirements is essential to the development of new low-carbon business models and to increase investment in this sector (Criscuolo and Menon, 2015; Huhtala, 2003; Rizos *et al*., 2016). Studies have highlighted that the financing requirements of early stage firms developing innovations in the Cleantech sector have received little attention (Owen *et al*., 2018, McDaniels and Robins, 2017; Rowlands, 2009). Building upon the literature on Cleantech financing, Chapter 3 examines the role of equity financing in UK Cleantech firms. This study examines the financing of Cleantech firms through the lens of the pecking order theory, the first of its kind for Cleantech firms.

This study develops a number of hypotheses and finds that Cleantech firms raise external equity because of financial constraints and ameliorate illiquidity (as noted in Subsection 6.2.1). However, one distinct finding that is inconsistent the pecking order theory is that intangibility does not play an important role in raising equity financing. Another angle to this study also focuses on the type of technology financed by equity investors. There has been a large shift in the focus of venture capital firms away from hardware and towards software and service businesses (Lerner and Nanda, 2020). Technological changes over the past two decades have made it quicker and cheaper to learn about the demands of new software businesses. In contrast, many other sectors, including Cleantech and new materials, are less amenable (*Deeptech* firms) to such rapid learning. Software and service businesses, which are typically based on proven technologies, often have short development times and can benefit from quick market feedback, are amenable to this approach (Lerner and Nanda, 2020). These constraints imply that equity investors often exit their investments well before growth opportunities are fully realised (Farre-Mensa *et al*., 2020). This study provides evidence that software-led Cleantech firms raise greater amounts of finance than hardware-led firms and provides further evidence of the potential equity gap for long horizon, capital-intensive and complex innovative hardware-led Cleantech firms, thus adding to the literature on these types of firms (Rowlands, 2009; Lerner and Nanda, 2020; Owen *et al*., 2020).

In relation to ESR reporting, the majority of academic and policy discussions on sustainability reporting have converged on large firms and multinational enterprises. However, as stated previously, there have been suggestions that mandatory sustainability reporting requirements may be imposed upon SMEs within the next four years; therefore, the capacity of SMEs to engage in sustainability reporting merits further consideration. Futhermore, the role performed by the accounting profession with respect to the introduction and practice of ESR has been largely overlooked (Humphrey *et al*., 2017; Rinaldi *et al*., 2018). Thus, Chapters 4 and 5 add to the literature on ESR and SMP. Studies have highlighted that SMEs typically rely on their SMPs for reporting requirements (Collins *et al*., 2011; Nigri and Del Baldo, 2018) as well as for consultancy and advice, particularly regarding the implementation of new initiatives and processes (Blackburn and Jarvis, 2010; Jarvis and Rigby, 2011). SMPs are often referred to as the' 'most trusted advisor' (Spence *et al*., 2012). In spite of this, little empirical work has considered ESR for SMEs from an SMP perspective. Evidence garnered from SMPs indicates that greatest perceived benefit for firms adopting environmental sustainability reporting is improved company image. This finding provokes further research into the role of the audit profession in this area so as to shed further insight on the integrity of ESR by SMEs. While the research presented in Chapter 4 is not the first to consider the applicability of the GRI in the SME context (Arena and Azzone, 2012; Ortiz-Martínez and Marín-

Hernández, 2022), it is novel in that it reconstructs and develops environmental guidelines into a framework that can be operationalised for SMEs in a reasonably simplified and flexible manner. The study finds that the majority of respondents believe that the metrics presented as part of an amended GRI framework are suitable and feasible to implement. However, there are several financial and resource implications for SMEs. This study provides insight into the additional financial cost of implementing ESR with SMPs, stating that it would bear a financial cost of €41,500 to €60,000 on average as an initial cost to establish a fit for the purpose ESR system. Heretofore, no research study has successfully estimated the financial costs associated with ESR in the SME context. A major perceived obstacle in implementing ESR is the lack of knowledge and training, not only for SMEs but also for accounting professionals.

Finally, Chapter 5 focuses on the Taxonomy. Taxonomy is a new tool promoted by the EU to capture a firm's sustainable activities, and there has been scant academic literature on Taxonomy to date. Thus, this study adds to the ESR, SMP, and taxonomic literature. This study suggests that SMPs believe that the requirements within the Taxonomy are feasible for SMEs to report on, but highlight the requirement for resourcing support as the costs of implementation are significant. This ties into the findings in Chapter 4, and it is obvious that cost and resourcing are major impediments for SMEs in the roll-out of any ESR. IT systems are also inadequate for capturing and managing requisite data. It is obvious that future developments in technology and accountancy software packages to be in a position to capture this data will be of enormous importance. Overcoming cost- and resource-related obstacles is central to its broad adoption. As such, the study finds that government grants and incentives appear to be attractive to many SMPs as a means of assisting SME clients with Taxonomy implementation. The study finds that a major non-regulatory benefit yielded by Taxonomy implementation may be the reduction in costs and potential savings for businesses. Similar to Chapter 4, there is a high number of respondents suggesting that the enhancement of company image is another non-regulatory benefit of implementing the Taxonomy. This provides evidence to support legitimacy theory in the context of the Taxonomy, adding to other sustainability reporting in SMEs studies through a legitimacy theoretical lens (Chelli *et al.*, 2018; Crossley *et al.*, 2020). The views within this study also conform to institutional theory (Di Maggio and Powell, 1983; Mizruchi and Fein, 1999). Many SMEs may not turn to SMPs for reporting assistance until they are legislatively mandated. The best explanation for this that emerges from the evidence is the lack of resources to meet the costs associated with voluntary reporting. Despite its relatively smaller representation in the sample, this study focuses on the former view, which echoes the belief that education and training of the accounting profession may stimulate an early opt-in to the Taxonomy, albeit in a minority of better-resourced SMEs. Therefore, evidence suggests that education plays an

important role in accelerating Taxonomy adoption. The practical value of this perspective should not be underestimated in an SME landscape where internal reporting and finance functions are limited to the largest firms.

The studies in Chapters 4 and 5 have adopted a novel methodological approach that enables the exploration of research questions by engaging participants with the topic in a unique manner using case studies and a suggested framework. Based off extensive reviews and to the reseacher's best knowledge, this type of methodology has not yet been adopted with respect to ESR. Finally, this study uncovers evidence from an accounting perspective that may be used to inform the development of policies on Taxonomy disclosure for SMEs.

6.2.3 Contribution to methodology

This study presented an innovative methodological approach. Each study used distinct datasets and methodologies. OECD working papers (Dalle *et al.*, 2017) and specific to entrepreneurial finance research (Ferrati and Muffatto, 2020) call on researchers to incorporate Crunchbase with other data sources, which has been incorporated in this study in Chapters 2 and 3. The datasets were constructed using Crunchbase, Beauhurst, FAME, Orbis Europe, PATSTAT, Espacenet, and individual crowdfunding platforms. This represents an advancement in the construction of datasets used for analysing equity financing in Cleantech firms.

Chapters 4 and 5 incorporate various methodological approaches. The items used in the survey served to gather both qualitative and quantitative data but were primarily quantitative items. In both studies, unique frameworks and case studies were designed to focus on SMP groups. In designing the research instrument, it was considered more fruitful to present the SMPs with a proposed sustainability reporting framework, rather than asking questions in the abstract about the perceived challenges, opportunities, and costs of implementing sustainability reporting. The studies undertaken in Chapters 4 and 5 highlight the innovative approach taken to collect survey responses. A hybrid approach is undertaken where focus group participants are engaged in a practical workshop and their opinions are captured through surveys. It should be noted that the survey questions were informed by initial focus groups held with leading accounting practitioneers and professional accountancy bodies. There is no doubt that the design of the framework and case study contributes to the methodology. The case study development represents an innovative method within accounting research that contextualised the study very accurately. By providing participaints with a basic case study on the practical implementations of ESR, it really provided a clear insight of what is to be expected of them in their capacity as one of the leading advisors for their SME clients. Participants

were complementary of the workshops undertaken and believed that the framework and case study assisted greatly with their ability to answer as true, fair, and accurately as possible.

This study may encourage future researchers to engage in similar methodological approaches as it is accepted that online workshops and survey collection present a new and innovative method of survey collection (Dillman, 2022).

6.2.4 Contribution to practice

Contribution to practice focuses on the contribution and recommendations that can impact firms and investors. As this thesis takes a two-strand approach, the contribution to practice can be separated into two areas:

Cleantech firms

In relation to Cleantech firms considering equity crowdfunding as a method of financing, as stated in Chapter 2, it would be beneficial to ensure that they are at a developed stage and have sufficient assets, including intangible assets. It seems that investors are willing to invest more in Cleantech firms that have been established for a longer period of time and reach commercialisation. This study also assesses the use of funds in each campaign pitch. It is important to highlight in the campaign pitch that the exact use of funds and those requiring funds for expansion and R&D purposes will be more successful. As previously stated, the UK market is the leading crowdfunding market in Europe, and for Cleantech firms seeking to raise equity crowdfunding, it would also be beneficial to seek crowdfunding on UK-based platforms, as they are likely to raise significantly more. Specific to investors, this study provides practical contributions. Crowdfunding has emerged a new method of entrepreneurial finance for young innovative firms but the size of the crowdfunding market has grown dramatically in recent years, as stated in the study. For investors, based on their risk-taking profile, firms that have a steady financial position and have reached commercialisation are a good prospect regardless of liquidity ratios or liquidity positions in the short term. While not all campaigns have detailed past financial information, it is advisable to examine the financial statements in detail, be conscious of the pre-money valuation, and the forecasts set out in the campaign pitch itself. In some instances, firms may overstate their future potential, valuation, and forecasts that may never materialise. Thus, a detailed review of past financial performance is advisable.

When examining UK Cleantech firms seeking equity financing, there are additional contributions to practice. Evidence it provided that there is a potential equity gap for long-horizon *Deeptech* Cleantech firms. While Cleantech firms themselves are financed, consistent with pecking

order theory, there is a standout finding on the role of intangible assets. As stated in Chapter 3, a firm's ability to attract investment is not determined by its intangible assets. Therefore, one can assume or suggest that Cleantech firms do not necessarily need to focus on developing intellectual property and capitalising R&D expenditure to increase their intangible asset value.

Sustainability reporting

Chapters 4 and 5 highlight some significant contributions to practice, particulary to the accounting profession. First, the frameworks and case studies provided to survey participants can be used or form the basis of ESR for SMEs and SMPs, which is a significant contribution to practice. As the results show in Chapters 4 and 5, there is a consensus that the framework presented is highly feasible for SMPs to implement based on the criteria set aside in the specific frameworks. There is also the finding that the accountancy profession deems the KPIs and criteria within the Taxonomy largely feasible to report, although this is contingent upon technological and financial support. This suggests that if the costs of implementing ESR are reduced, either framework (GRI or Taxonomy) could be used in practice. This study also provides evidence on the suggested costs required for SMEs to implement ESR with SMPs, believing that the cost of implementing an ESR system within an SME could initially cost €41,500–€60,000. This provides first-time evidence on the specific monetary costs of implementing ESR but also sets realistic expectations for practitioners concerning the cost required. There is a clear acknowledgement for additional education and training to enhance accountants' environmental literacy and familiarity with the ESR frameworks available.

It is also evident across Chapters 4 and 5 that there is an appetite from SMPs to engage in ESR. The findings highlight the requirement for resourcing support as the implementation costs are significant, and current IT systems appear incapacitated to capture and manage the requisite data. Several respondents stated that many accounting software packages are not suited for capturing environmental data. This study highlights this as a significant area of focus for practitioners and innovators alike to ensure that technology is developed to capture and manage this data in a timely and accurate manner. A report by Deloitte[22] discussed the benefits that technology can play in ESR, but as of yet, there is no wide-ranging software in place, something that this study reemphasises. In their study of Norwegian firms, Klymenko *et al*. (2021) highlighted the role of technology as an enabling factor for ESR and called on large technology companies to develop suitable platforms and software that will accurately capture the required data.

[22] https://www2.deloitte.com/ie/en/pages/technology/articles/technology-enabler-for-sustainability.html

6.2.5 Key contributions

In sum, this research represents an advancement in the knowledge and literature on SME Cleantech financing and ESR for SMEs.

- This is the first empirical study to examine equity crowdfunding among Cleantech firms. From a data point of view, there is a contribution to the uniqueness of the dataset by obtaining information from all crowdfunded Cleantech firms in Europe and obtaining data from several sources, including firm-specific accounting variables.

- This is the first study to empirically investigate the potential determinants of equity and debt financing pre and post-crowdfunding.

- This research demonstrates that crowdfunded Cleantech firms raise significantly greater amounts of external equity (10x) in the post-crowdfunding period, suggesting signalling effects. The study also highlights the ameliorating liquidity effects of crowdfunding, which are particularly important for early stage firms that develop new technologies.

- This is the first study to examine and investigate the pecking order theory in Cleantech firms. The results show that Cleantech firms are financed consistent with the pecking order theory. However, there is a distinct finding on the role of intangible assets in the financing of Cleantech firms, which brings into question the role of intangible assets in these types of firms. Once again, the dataset is unique because several sources are incorporated.

- This is the first study empirically investigating the potential equity gap between hardware and software-led Cleantech firms. While several studies have suggested this, the testing in this study provides evidence that there is a potential equity gap for long-horizon, capital-intensive, hardware-led Cleantech firms. Software-led Cleantech firms are more likely to raise greater amounts of equity funding.

- This is the first study to adopt a unique methodological approach to survey SMPs. In designing the research instrument, it was considered more fruitful to present the SMPs with a case study and the proposed framework on the potential practical implementation of the GRI (Table 4.1) and the Taxonomy (Tables 5.1a and 5.1b). This was undertaken rather than asking questions in the abstract about the feasibility, perceived challenges, methods of minimising costs, and non-regulatory benefits. The advantages of this method have been stated throughout; however, by undertaking this method, greater objective insight has been obtained.

- This is the first study on SMPs and their views on the feasibility of ESR, including the benefits, costs, and consequences of implementation. This is also the first study to incorporate the views of all the major professional accountancy bodies.

- This is the first study to quantify the financial costs of implementing ESR for SMEs and SMPs. SMPs believe that the cost of implementing an ESR system within an SME under the headings of staff cost, training, technology requirements, and other relevant costs is approximately €41,500 to €60,000.

- Across both studies on ESR, there is an overwhelming majority that believe ESR is feasible to implement, and there is an appetite to engage from SMPs but additional support, both financial and non-financial, including additional education and training, is required.

- Several practical and policy implications are recommended as part of this study. The study produces several findings that are of consequence to future research, policy formation, and practice in the area of Cleantech financing and sustainability reporting and, more specifically, regarding the widespread adoption of the GRI and the EU Green Taxonomy.

6.3 Policy implications

As issues of environmental sustainability rise to the top of political, societal, and business agendas, the output of this thesis can help shape policy implications. Each study has clear policy implications and recommendations that can contribute to investors, governments, SMEs, and the accounting profession. The following are recommendations that governments and standard-setters can considering implementing.

To summarise, the key policy implications are:

- Specific to Chapter 2, governments should place greater emphasis on the immediate climate crisis by supporting innovative Cleantech firms by increasing crowdfunding co-financing programmes along with public-private principal venture capital co-financing (Owen *et al*., 2019). In some UK crowdfunding platforms, the opportunity to invest via Future Fund is available, which provides investors with further tax incentives. This study highlights the positive post-crowdfunding impact and therefore, is an appealing method of finance for policymakers to encourage.

- Specific to Chapter 3, the evidence shows that software-led Cleantech firms are more likely to raise equity financing and greater amounts. This further highlights the potential equity gap

for long-horizon *Deeptech* Cleantech firms, and greater focus and support are required for these types of firms through commercialisation (WEF, 2021). This study leads to the belief that with the increased focus on non-financial reporting and disclosures on ESG-related performance, an updated IAS 38 standard could perhaps focus on the capitalisation of *green* initiatives and *clean technologies* which will ultimately have a positive impact on climate change mitigation and adaptation. The restrictive nature of IAS 38 requires further examination of accounting standard-setters concerning Cleantech firms. There has been recent debate on the role of intangible assets among accountancy standards-setters (FASB, 2018; Mazzi *et al*., 2019), with recent calls for research on intangible assets from IFRS[23]. It is also clear that one of the key policy recommendations for investing in Cleantech firms is patient capital. Studies have repeatedly explored and indicated the need for a better-funded early stage *Deeptech* public-private finance escalator (Owen *et al*., 2019, 2020; Owen and Vedanthachari, 2022). Wilson *et al*. (2018) also highlight the need for patient capital in knowledge-intensive firms. This study echoes these indications and recommends that large corporations and venture capital firms increase their spending on hardware-led Cleantech (WEF, 2021).

- Specific to Chapters 2 and 3, one method that could be reviewed to stimulate further equity investment in Cleantech firms is that of R&D credits. Policymakers could review R&D tax credits to supplement this tax credit for early stage Cleantech firms. As previously stated, Ireland is regarded as a European leader in R&D tax credits, providing 25% of R&D expenditure in addition to the 12.5% corporate tax deduction at the standard rate. The UK operates a patent box initiative that allows companies to apply for a lower corporate tax of 10%. Perhaps these examples could be increased much further, specifically for Cleantech firms in their early stages of development. The UK has introudcued a number of tax incentives for investors, along with suggestions for *Green Tax Breaks* (Rankin, 2020). In relation to crowdfunding, the UK is one of the most advanced countries in the world (Vulkan *et al*., 2016), primarily because of the tax incentive for investors by providing two tax reliefs for investors. Both the enterprise and seed enterprise investment schemes offer tax relief of up to 30% and 50%, respectively. Other European countries could follow to improve investment efficiency, interest from prospective investors, and individual investor incentives,

[23] https://www.ifrs.org/content/dam/ifrs/news/2021/2023-iasb-research-forum-call-for-papers.pdf

and additional support to firms will undoubtedly stimulate further investment in the Cleantech sector.

- Specific to Chapters 4 and 5, these studies have several contributions. First, the findings suggest that the accounting profession plays a significant role in assisting SMEs in implementing and delivering ESR, which has been underestimated. Professional accountancy bodies play a clear role in acting as leaders in this area, providing specialised training aided by online tools such as webinars and virtual workshops. Universities have the capability to implement changes through curriculum reengineering and expansion. This study suggests that sustainability should be incorporated into all major business programmes, particularly sustainability reporting for accounting-related programmes. This study also notes that a significant consideration fundamental to the future of ESR is the role of the auditors. In 2021, the IAASB issued guidance on the assurance of non-financial reporting. The IAASB should engage in meaningful dialogue with standard-setters for any future sustainability guidance to embed the auditor's role in any future development.

- Specific to Chapters 4 and 5, the study finds that the government plays an increasingly important role in ensuring that firms are encouraged to adhere to ESR. Across both studies, interesting policy-related implications are suggested by the respondents. It becomes clear that respondents believe that the provision of financial grants is the most appropriate financial support to assist SMEs in implementing ESR. As presented in Chapter 4, an example of a specific suggestion in this respect is a governmental grant or tax incentive for each SME client who provided evidence of submitting a report outlining their environmental impact. Several SMPs believe measures would rapidly accelerate enthusiasm and willingness to engage. However, there appears to be some concern from participants that engaging consultants would consume state-sponsored funding and grants, potentially on a one-off basis, which would effectively eliminate the benefit received. This highlights the need to argue for a structured approach to providing of any related funding by governmental bodies. As highlighted previously, a potential optimal solution to the resourcing issues highlighted in this study may be the creation of a state or semi-state-sponsored organisation charged with assisting with implementing ESR. This could also involve professional accountancy bodies, and perhaps as part of a larger governmental environmental sustainability initiative. With appropriate interaction between policymakers, regulators, accountants, and businesses, the future of sustainability reporting and standard-setting is positive.

6.4 Limitations and avenues for future research

Despite the scope and contributions of this study, avenues for future research exist. The European Green Deal is in its infancy, half of the technologies required to achieve net zero emissions have not yet been developed (IEA, 2021), and their financing requirements need further examination. There has been a sharp increase in funding for Cleantech firms, but more is required over the next decade if the threat of climate change is to be taken seriously (WEF, 2021). Enabling reporting frameworks are currently being implemented, but wide-scale implementation is not due to being enforced until 2026 across the EU at the earliest, with 2030 a more likely target. There is constant evolution in reporting requirements and standard-settings. Therefore, future research avenues must be investigated.

As highlighted in each chapter of this thesis, there are significant additions to research based on the studies undertaken. However, the research also highlights certain limitations and avenues for further research that are significantly warranted in this growing and important research field.

To summarise, the limitations of this research are:

- Chapter 2 examines firms that obtained crowdfunding from 2014 to 2019, with some firms yet to be in a position to raise financing post-crowdfunding, and examines the years before and after the campaign.
- Chapter 3 examines firms that obtained equity financing based on equity deals from 2011 to Q1 2020. Perhaps there are some spillover effects from Brexit and COVID-19, which could not be incorporated into this study. The Beauhurst database does not provide insights into firms that sought equity financing and were unsuccessful in doing so. As such, the sample is split between Cleantech firms that raised equity finance and those that did not.
- Chapters 4 and 5 examine the feasibility of different ESR frameworks, the GRI, and Taxonomy. There are other frameworks available, and this study covers two of them. As ESR is in its infancy, it is still very early to obtain detailed responses in some cases. The survey responses were from SMPs only, and did not include insights from SME owners or managers.

To summarise, future avenues of research are:

- Specific to Chapter 2, a dataset with a longer timeframe and a re-examination of those firms in the future would be beneficial to examine financial patterns and decision making over a longer period and assess whether many of these firms have had any major changes, such as

acquisitions or liquidation. Further studies may add to this by using a dataset with a longer period, investigating firms that also raised outside European platforms, and comparing Cleantech firms to those of other firms in different industries. An examination took place of Cleantech firms that obtained crowdfunding from 2014 to 2019 with some of those firms yet to be in a position to raise financing post-crowdfunding, this ties in with analysing over a greater time period. While the sample in study covers 177 Cleantech firms across Europe, at the end of 2021 there was a total of 242 (65 additional Cleantech firms, according to Crunchbase) that raised equity crowdfunding across European platforms. Further analysis could be undertaken on these additional firms, especially as investors seek to invest more in *born-to-be-green* firms (Mrkajic *et al*., 2019).

- Specific to Chapter 3, it would be beneficial to distinguish the UK market from other European countries. Examining the sequencing and timing of external equity investment is another fruitful area of research. This could indicate the amount of equity required during the early stage development of Cleantech firms and identify areas bridging the equity gap and second equity gap (Sadler, 2016; Wilson *et al*., 2018) for knowledge-intensive firms. Studies have provided evidence that the time horizon for cleantech firms is different from other types of technology start-ups (Lehner and Nicholls, 2014; Quélin *et al*., 2017; Lehner *et al*., 2018; Lehner *et al.*, 2019). Wilson *et al.* (2018) show estimated coefficients in their study, which state that knowledge-intensive firms will achieve stability after 11 years. Therefore, examining the post-equity funding performance of these firms and their funding cycles over a long period is important for policymakers, but a detailed longitudinal dataset is essential.

- Specific to Chapters 4 and 5, the survey was collated with SMPs in Ireland. It would be valuable to examine other European countries to assess the cultural differences in environmental practices. A longitudinal survey or re-examination of this survey over a period could be beneficial for assessing ESR implementations long-term benefits and costs. It would be appropriate to survey SMEs to ascertain their views on sustainability reporting. However, this approach has challenges, given incomplete data on the total SME population and the potential lack of awareness of firm owners about environmental and sustainability reporting issues. An obvious avenue for future research would be to follow up with SMPs in the future, especially those whose clients have implemented ESR or are mandated under the Taxonomy to report. This would provide additional insight into the fundamental challenges, costs, and benefits of implementing ESR. In June 2022, new rules surrounding the CSRD were announced (highlighted in Chapter 1), including that reporting must be certified by an

independent auditor. As stated in Chapters 4 and 5, the role of auditors and the quality assurance of these reports are vital. Obtaining the insight of auditors and examining the quality of the assurance provided is another potential avenue for future research. Another fruitful research avenue could be to partner with some SMPs on the rollout of ESR for some SME clients. This would provide in-depth and practical insights into the challenges and implications of implementing ESR for these firms, which could assist accountants, SMEs, and policymakers in several ways. It is evident across both these studies that there are data capturing issues faced by SMEs, along with the incapacity of many accounting software packages to accommodate environmental data, which coincides with previous studies (Shields and Shelleman, 2020). Assessing the role of technology in sustainability and implementation of ESR would have important practical implications.

6.5 Current trends and future landscape

Academia has increasingly focused on environmental and sustainability-related matters that cover all disciplines. There has been a substantial increase in ESG-focused studies, calls for papers, and special issues regarding these pressing issues in the accounting and finance academic landscape. Several highly ranked accounting journals have sought studies on the role of sustainability reporting covering a wide variety of topics including, the impact of mandatory disclosures, the role of the auditors and the assessment of reporting on SMEs, to name a few. It is clear that, through several governmental agencies, there is a significant push for research related to sustainability. Horizon Europe[24] is the EU's research and innovation programme for 2021-2027 with a budget of €95.5 billion. The main goal of this programme is to tackle climate change, help achieve the UN's Sustainable Development Goals, and boost the EU's competitiveness and growth, which effectively ties into the European Green Deal. The Irish government launched a new €100m programme to recruit high-level researchers by increasing annual research stipends to €28,000, which is a substantial increase on current funding levels. The initial phase of the initiative will seek up to 400 high-calibre PhD students to undertake research into national and global challenges, such as global warming, climate adaptation, and sustainability (Carswell, 2022). Additional funding will likely be provided across several agencies, both nationally and internationally, which will stimulate further research and collaboration in sustainability-related topics. Editors of some of the world's leading journals will continue to encourage publication opportunities in ESG and sustainability.

[24] Horizon Europe - https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en

The Cleantech industry has had its ups and downs in recent times. Venture capital firms spent over $25 billion funding Cleantech start-ups from 2006 to 2011 and lost over half their investment. As a result, funding dried up in the Cleantech sector. Gaddy *et al*. (2017) concluded that based on investment in the Cleantech sector from 2006 – 2014, the VC model was broken for the Cleantech sector due to a shortage of large corporations willing to invest in innovation. However, after the 2015 Paris Climate Change Summit, new public and private capital became interested again. If new and more diverse actors avoid the mistakes of the Cleantech VC boom and bust cycle (as set out by Gaddy *et al*., 2017), then they may be able to support a new generation of Cleantech companies, but will it be different this time around? The answer is yes.

Action on climate change is now the top priority of governments globally. This is evident due to the level of funding being provided and climate-related measures being implemented. The European Green Deal will seek over €1 trillion of sustainable investments over the next decade. The UK plans to provide over £12bn in green investment by 2030. This level of funding provides evidence of the commitment toward investment in sustainability-related activities from European governments. Equally and just as crucial for early stage Cleantech firms is that equity funding for Cleantech firms has soared in recent years, with venture capital funding for Cleantech hitting £40bn in 2020 and 2021, which exceeds the total for the previous two years by 37 per cent (Pitchbook, 2021). While investment in early stage Cleantech firms can be complex, investors see this as a significant opportunity rather than a boom-bust cycle that was evident from 2006 to 2011. This is primarily due to the regulation and measures undertaken by world governments on climate change. A prime example of this is EU states agreeing on a deal to push for stricter climate measures in June 2022 (Hancock, 2022). Investors realise that the severe commitment made to funding and regulation is an opportunity for them. Recent studies have shown that venture capital firms are targeting investment in more *born-to-be-green* firms (Mrkajic *et al.*, 2019). Berkowitz (2022) highlights that Cleantech is at an inflection point and that the state of the industry for 2022 is looking very bright. Venture capital financing in Cleantech is expected to rise even further over the coming years (Statista, 2021), but on this occasion, it is more advanced with prominent successful venture capitalists seeking considerable opportunities in this area and committing significant funding to this sector (Berkowitz, 2022). An example of this is Lowercarbon Capital[25], led by vastly experienced technology venture capitalists who recently raised $1.2bn for their Cleantech fund. Leading venture capitalist, Chris Sacca, states that ‘there has never been a better time to start a company focused on emissions

[25] https://lowercarboncapital.com/

reduction or actively removing carbon already in the atmosphere' (Sacca, 2021, p. 1). Sacca is one of those involved in Lowercarbon Capital seeking to invest further into the Cleantech sector.

Another example highlighting investor's attraction to Cleantech firms is the increasing number of 'Unicorn' firms in the Cleantech sector that has grown exponentially in the last few years (Liubinskas, 2021). It is anticipated that the number of Cleantech firms reaching 'Unicorn' status could double by 2030 (Liubinskas, 2021; Jessop, 2022). Studies have repeatedly explored and indicated the need for a better-funded early stage public-private finance escalator for Cleantech (Owen *et al*., 2019, 2020; Owen and Vedanthachari, 2022). An excellent example of this in practice was the latest announcement (as of June 2022) of a 'Unicorn' Cleantech, U.S.-based Turntide Technologies. Initially, funding included state grants and government supports, Turntide Technologies have obtained funding from British investor SDCL Energy Efficiency Income Trust, Fifth Wall and Meson Capital's Captain Planet LP fund for $80m, taking their valuation to more than $1bn. Their previous investors include Amazon Climate Pledge Fund, WIND Ventures and BMW iVentures, showcasing the importance of public-private financing and the role of large corporations in financing innovation, which was missing from the previous Cleantech boom-bust cycle (Gaddy *et al*., 2017). There has also been recognition from some of the leading companies in the world, such as Amazon and Google to do more for climate innovation. This has been achieved through the Amazon Climate Pledge Fund[26] and Google's Impact Challenge on Climate Innovation Fund. Amazon launched The Climate Pledge Fund in 2020 to support the development of sustainable and decarbonising technologies and services. This dedicated investment programme commenced with an initial $2 billion in funding specific for Cleantech ventures. Half of the technologies required to achieve net zero emissions have not yet been invented (IEA, 2021), and the World Economic Forum calls on large corporations and venture capital firms to increase their spending on Cleantech firms as a matter of urgency (WEF, 2021). As highlighted, there is a need for increased patient capital to finance early stage Cleantech firms. This study highlights the potential equity gap and difficulties in raising equity financing for hardware-led Cleantech firms. As leading agencies (IEA and WEF) have called for increased patient capital funding specifically for these types of firms, it could be beneficial for the Green Deal to place more emphasis and their funding efforts on these types of firms. It is also likely that large corporations will become essential to this and will see more investment from those with sufficient resources to supply patient capital with additional focus on these hardware-led firms in the near future. In relation to crowdfunding, the global market is expected to reach $40 billion by

[26] Amazon Climate Pledge Fund - https://sustainability.aboutamazon.com/about/the-climate-pledge/the-climate-pledge-fund

2026 (Statista, 2020). This alternative method of financing is becoming a stable source of finance for innovative SMEs. While angel investors and VC's invest in crowdfunding platforms, there may be concerns surrounding unsophisticated investors on crowdfunding platforms (Stemler, 2013; Hildebrand *et al*., 2017; Barbi and Mattioli, 2019). Several economic reports have suggested that the global economy will enter recession in late 2022 or early 2023 (Aldrick, *et al*., 2022), with significant losses already witnessed on major stock exchanges. As the Federal Reserve and ECB increase interest rates, this could be a deterrent for unsophisticated investors getting involved in crowdfunding, which could harm several SMEs seeking equity investment from crowdfunding platforms, but this is yet to be seen.

Sustainability reporting is an ever-changing landscape. The Taxonomy is the first step in mandating ESR disclosure across the EU. From January 1, 2024, larger firms will be required to disclose several KPIs concerning their sustainability activities under the Taxonomy classification system. The EU is also implementing the CSRD that will provide further disclosures and is currently being designed by ERFAG, with the first set of these standards adopted by October 2022. The ISSB proposes issuing two IFRS sustainability disclosure standards. The first would require a company to disclose information that enables investors to assess the effects of significant sustainability-related risks and opportunities on its enterprise value. The second is to establish disclosure requirements specific to climate-related risks and opportunities. The ISSB will consider the comments (until July 29, 2022) it receives on the exposure drafts in developing its final requirements. It plans to consider the comments in the second half of 2022 and aims to finalise the requirements by the end of 2022. A concern that could be raised is the number of different standard-setters involved in the process at the minute; the EU is rolling out the Taxonomy and CSRD, and the professional accountancy body standard-setters are developing standards at the same time as ERFAG in the form of the ISSB. This does not consider the standards currently available, namely the TCFD and GRI. It is positive to note that the GRI have agreed to collaborate and work closely with the ISSB. However, this may be necessary across all standard-setters, and further harmonisation and collaboration is required for this to be successfully implemented. What will these standards achieve in the race to net zero? Only time will tell.

Several leading studies on sustainability reporting have questioned the effectiveness of ESR (Cho *et al*., 2020) and also stated that the actions of larger firms do not replicate the words in the annual reports (Cho *et al*., 2012) while also suggesting that sustainability reporting is 'organized hypocrisy' that serves little purpose in the quest to improve sustainability matters (Cho *et al*., 2015) suggesting it is merely a marketing or public relations tool. Liesen *et al*. (2015), Hoepner *et al*. (2017),

and Hoepner and Schneider (2022) discuss the greenwashing of large corporations and find that there may be disclosures without solutions in several cases. This has been observed in two high-profile cases in recent months. Deutsche Bank's funds arm DWS[27], has allegedly misled investors about its 'green' investments over how it used sustainable investing criteria to manage its assets. Goldman Sachs[28] is facing a SEC probe for ESG funds in their asset management department. Similar to the Deutsche Bank scenario, the SEC is looking into whether some investments for the funds are in breach of the ESG metrics promised in marketing materials to investors. Whether these allegations are true or not, it does not bode well that two of the worlds leading investment banks are potentially misleading investors, claiming to hit specific ESG metrics. If larger firms engage in this level of greenwashing, it would be challenging to expect a widescale rollout of accurate reporting. Thus, an increased level of accountability associated with the disclosure of sustainability activities is required. Initiatives such as *Sustainability Assurance*, launched by the IAASB, are warmly welcomed to ensure that the audit profession is engaged in dialogue with standard-setters.

As stated throughout this thesis, SMEs are vital in the race to net zero as evidently highlighted in the "No net zero without SMEs" report (OECD, 2021c). While SMEs are unlikely to be involved in mandatory disclosure requirements until 2026, at the earliest, several SMEs are already experiencing a 'trickle-down effect' from large suppliers. A recent example of this is the requirements set by Tesco (Hegarty, 2021), highlighting the growing pressure on SMEs to engage with their environmental responsibilities as a matter of urgency. More than 90% of the SME associations report that SMEs experience strong or very strong external pressure to achieve climate neutrality (European Commissions, 2022). Therefore, it is important for SMEs to increasingly invest in sustainable technologies and acquire the skills and knowledge to transform their businesses into more sustainable ones, including the reporting of such sustainability activities. (European Commission, 2021a; 2022; OECD, 2021b). In a recent report by Aldermore (George, 2022), who surveyed 997 senior decision-makers at SMEs across the UK, 53% of the survey respondents said their company had invested in environmental sustainability within the past 12 months. They also reveal that most businesses plan to either maintain or increase spending on environmental sustainability in the upcoming financial year, despite the potential cost increases for utilities, raw materials, and products. It is clear from this survey that SMEs are aware of the importance of sustainability during the next phase of their

[27] https://www.reuters.com/business/finance/deutsche-banks-dws-allegations-greenwashing-2022-06-09/
[28] https://www.bloomberg.com/news/articles/2022-06-10/goldman-sachs-facing-sec-probe-of-esg-funds-in-asset-management

development. It is also interesting to note that under the remit of DEFRA[29], the UK government has provided practical guidance for SMEs to measure and report their greenhouse gas emissions. This again demonstrates the ever-changing nature of sustainability reporting and the attention it is receiving from policymakers, and now being geared towards SMEs.

Companies' increased regulatory requirements and focus on sustainability-related activities brings opportunities for job creation and, in particular, a growth area for professional services firms. There has been an increase in the top four accountancy firms developing and expanding sustainability teams, with several prominent graduate recruiters putting this at the forefront of their recruitment campaigns (Edgecliffe-Johnson and O'Dwyer, 2021). One example is PwC, aiming to hire up to 100,000 staff globally over a five-year period by investing up to $12bn, with specific departments targeting ESG advice are established in all jurisdictions. With this level of commitment to ESG advice and support, it is clear that education providers and universities will need to implement changes through curriculum re-engineering and augmentation. This study submits that sustainability should be incorporated into all major business programmes, particularly sustainability reporting for accounting-related programmes. This brings into question the role of professional accounting bodies. Specific to Ireland, all major professional accountancy bodies have incorporated some level of sustainability into their professional examinations. A prime example is Chartered Accountants Ireland and the Final Admittance Exams process. Risk Management and Sustainability have been included as a core topic in these exams, testing students on their knowledge of sustainability through a case study-based exam. While several education providers will see this as an opportunity, sustainability-related modules and materials should be implemented with the involvement of policymakers, including standard-setters and professional accountancy bodies. There is no doubt that future research will examine the post-implementation phase of ESR and assess the opportunities, challenges, and benefits of such reporting. Specific to SMPs, their role in reporting for SMEs should not be underestimated, as discussed in previous chapters. SMPs need further education and training to assist in the delivery and reporting of ESR. A method to ensure the success of ESR is to provide simplified disclosure requirements and encourage SMEs as much as possible.

Another crucial area of focus is the role of technology in sustainability and ESR. At the most recent WEF 2022 annual meeting, several business leaders called for common standards on 'onerous ESG frameworks'. A key highlight of the ESG reporting track is the lack of available technology to

29 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69494/pb13310-ghg-small-business-guide.pdf

capture the requisite data for several ESG/ESR metrics. Alan Jope, CEO of Unilever, stated that despite Unilever having a large team dedicated to sustainability reporting that, "we (Unilever) are struggling with the most basic ability to measure these difficult-to-measure areas, and we've been at this for a while."[30] Although this might be viewed as a negative comment, especially considering that large entities are struggling to capture this data, it was concluded at the ESG reporting track that technology and technological advancements in capturing key metrics will be one of the cornerstones of the success of ESR. There is no doubt that several additional actors will enter this market to try and bridge the gap between the lack of available technological platforms and the role of accurate ESR. Klymenko *et al.* (2021) highlight the need for digital technologies in ESR and believe that large technology firms will be in the driving seat to implement their technologies to ensure correct reporting and eliminate greenwashing. There is no doubt that ESG reporting will play a huge role in investment, business, and society for decades to come.

6.6 Conclusions

The European Green Deal focuses on investment which will initiate at least €1 trillion of sustainable investments and the development of an 'enabling framework' which will facilitate and stimulate the transition to a climate-neutral, green and inclusive economy. At the same time ensuring companies report their sustainable activities. SMEs represent 90% of global businesses (World Bank, 2022) and understanding their needs from a financing and reporting perspective is crucial. This study examines the financing of Cleantech firms and ESR reporting for SMEs. This is captured in four different studies that provide first-time evidence of some of the key issues within the sustainable finance component of the European Green Deal, with a focus on SMEs.

There are several key practical and policy implications as part of this study that is certain to gather more focus from all political, societal and business agendas for many years to come. It is hoped that this study will further stimulate researchers, practitioners, and industry experts to continue investigating Cleantech firms' financing and the development of ESR for SMEs. Only history will judge the success of the European Green Deal in the race to climate neutrality. Whether increased investment in new technologies and mandating reporting requirements will contribute to ambitious net zero targets remains to be seen. However, actions speak louder than words (and disclosures) (Cho *et al*., 2015), and the EU's actions are very loud.

[30] https://www.weforum.org/press/2022/05/business-leaders-call-for-a-common-standard-on-onerous-esg-frameworks/

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Appendix A. Crowdfunding Platforms and Countries (Chapter 2)

Crowdfunding Platforms	Countries
Spreds	Belgium
FundWise	Estonia
Funderbeam	Estonia
Invesdor	Finland
SoWeFund	France
WiSeed	France
Companisto	Germany
Seedmatch	Germany
Spark Crowdfunding	Ireland
BacktoWork	Italy
MamaCrowd	Italy
OnePlanetCrowd	Netherlands
Symbid	Netherlands
The Angel Crowd	Spain
FundedByMe	Sweden
Crowdcube	United Kingdom
Seedrs	United Kingdom
Syndicate Room	United Kingdom
Crowd for Angels	United Kingdom

Appendix B. Correlation Coefficient Matrix (Chapter 2)

	Amount Raised	Firm Age	Investors	Equity Given	Pre-Valuation	Post-Valuation	Directors	Equity Pre-CF	Debt Pre-CF	Equity Post-CF	Debt Post-CF	Intangibles	Gearing	Liquidity	Illiquid <0.75	Illiquid <0.50	Total Assets	Cash	SH Funds	Capital
Amount Raised	1.0000																			
Firm Age	0.1470	1.0000																		
Investors	0.6342	0.1233	1.0000																	
Equity Given	0.2338	-0.0526	0.1011	1.0000																
Pre-Money Valuation	0.6208	0.2163	0.5810	-0.2610	1.0000															
Post-Money Valuation	0.5381	0.2428	0.6594	-0.2228	0.9336	1.0000														
Number of Directors	0.4785	0.5074	0.2461	0.0675	0.2480	0.4012	1.0000													
Equity Funding Pre-CF	0.0866	0.3844	0.1601	-0.1204	0.3209	0.2466	0.3703	1.0000												
Debt Funding Pre-CF	0.1462	0.3185	0.1813	-0.1580	0.1169	0.2888	0.2571	0.5735	1.0000											
Equity Funding Post-CF	0.3143	-0.0973	0.1301	0.0113	0.2521	0.1712	0.1860	0.0338	-0.1041	1.0000										
Debt Funding Post-CF	0.2109	0.2015	0.3472	-0.1171	0.4490	0.4532	0.3046	0.2324	0.6379	-0.0234	1.0000									
Intangibles	0.1731	0.1400	0.0885	-0.0476	0.2492	0.2246	0.1375	0.3037	0.6883	-0.0063	0.5537	1.0000								
Gearing	-0.0627	0.0140	-0.0550	-0.0283	0.0748	-0.0269	-0.0236	-0.0200	0.1151	-0.1631	0.3848	0.0136	1.0000							
Liquidity	-0.0324	-0.0458	0.0678	-0.0792	-0.0061	-0.0042	-0.0771	-0.0068	-0.0347	-0.0370	0.1953	-0.0248	-0.0330	1.0000						
Illiquid <0.75	-0.1444	-0.0330	-0.1784	0.1109	-0.2294	-0.2624	-0.0930	-0.1221	0.0011	0.1287	-0.0130	0.0551	-0.1016	-0.1851	1.0000					
Illiquid <0.50	-0.0346	-0.0295	-0.0712	0.0833	-0.1509	-0.1134	-0.0361	-0.0490	0.0684	0.1294	-0.1140	0.1055	-0.1178	-0.0303	0.5007	1.0000				
Total Assets	0.3728	0.2914	0.3610	-0.1260	0.4863	0.4870	0.4583	0.4410	0.7543	0.0023	-0.0899	0.6476	0.0101	-0.0206	-0.1092	-0.0239	1.0000			
Cash	0.3289	0.1257	0.2755	-0.0039	0.2194	0.2239	0.4237	0.0535	0.0386	0.1256	0.0848	0.1928	-0.0149	-0.0126	-0.0618	0.0201	0.3710	1.0000		
Shareholder Funds	0.3709	0.2475	0.4534	-0.0334	0.4592	0.4940	0.4088	0.4211	0.6634	0.0579	0.4295	0.6423	-0.0693	0.0917	-0.1685	-0.0898	0.9009	0.2470	1.0000	
Capital	0.1028	0.3156	0.1484	0.1393	0.1530	0.1939	0.2579	0.4405	0.0599	-0.0850	0.0341	-0.0114	0.0003	0.0075	-0.1744	-0.1583	0.1974	0.0908	0.2860	1.0000

Appendix C. Variance Inflation Factor (Chapter 2)

Model 1		
Variable	**VIF**	**1/VIF**
Shareholder Funds	6.29	0.1206
Total Assets	5.98	0.1253
Intangibles	2.18	0.4581
Investors	1.88	0.4219
Pre-Money Valuation	1.79	0.4558
Raised Debt Pre-CF	1.43	0.6972
Cash	1.39	0.7171
Gearing	1.38	0.7239
Capital	1.31	0.7621
Firm Age	1.27	0.7882
Illiquid <0.75	1.19	0.8426
Liquidity	1.06	0.9406
Mean VIF	**2.26**	

Model 2		
Variable	**VIF**	**1/VIF**
Shareholder Funds	6.74	0.1292
Total Assets	6.35	0.1359
Intangibles	2.24	0.4455
Illiquid <0.75	2.06	0.4892
Illiquid <0.50	1.99	0.5037
Number of Directors	1.82	0.5509
Firm Age	1.50	0.6642
Cash	1.50	0.6687
Investors	1.46	0.6872
Capital	1.31	0.7683
Raised Equity Pre-CF	1.18	0.8492
Liquidity	1.05	0.9500
Mean VIF	**2.43**	

Model 3		
Variable	**VIF**	**1/VIF**
Total Assets	10.42	0.0489
Post-Money Valuation	9.74	0.0721
Sharholders Funds	8.88	0.0918
Debt Funding Post-CF	6.26	0.1082
Pre-Money Valuation	5.86	0.1112
Amount Raised	4.47	0.1729
Intangibles	3.97	0.2518
Investors	2.82	0.3544
Cash	2.76	0.3619
Number of Directors	2.39	0.4185
Equity Given	1.83	0.5455
Firm Age	1.67	0.5971
Capital	1.67	0.6002
Raised Debt Pre-CF	1.32	0.7556
Raised Equity Post-CF	1.30	0.7682
Liquidity	1.03	0.9714
Equity Funding Post-CF	1.01	0.9801
Mean VIF	**3.96**	

Appendix D. Correlation Coefficient Matrix (Chapter 3)

	Amount Raised	Firm Age	Employees	Revenue	Rtd. Earnings	EBITDA	Tangibles	Intangibles	Bank	ST Loans	Overdraft	C. Assets	C. Liabilities	Capital	Ord. Shares	Reserves	S Premium
Amount Raised	1.0000																
Firm Age	0.0489	1.0000															
Employees	0.0141	-0.0209	1.0000														
Revenue	0.0062	-0.0374	0.6096	1.0000													
Retained Earnings	-0.0044	-0.0160	-0.0288	-0.0142	1.0000												
EBITDA	-0.0311	-0.0171	0.2729	0.0273	0.3182	1.0000											
Tangible Assets	-0.0202	-0.0569	0.4377	0.3285	-0.0262	0.2712	1.0000										
Intangible Assets	-0.0226	-0.0693	0.5890	0.3309	-0.0199	0.1890	0.1601	1.0000									
Bank	-0.0169	-0.0569	0.3690	0.1444	0.4609	-0.0510	0.1439	0.2505	1.0000								
Short-Term Loans	-0.0068	-0.0170	0.2586	0.2150	0.0743	0.2102	0.1177	0.0635	0.0698	1.0000							
Overdraft	-0.0124	0.1279	0.4713	0.4110	-0.0087	0.1921	0.3183	0.1301	0.0348	0.2149	1.0000						
Current Assets	-0.0075	-0.0259	0.0137	0.0051	0.9927	-0.0920	0.0037	0.0071	0.5251	0.0977	0.0012	1.0000					
Current Liabilities	-0.0082	-0.0291	0.0557	0.0501	0.9883	0.3382	0.0267	0.0381	0.5283	0.1476	0.0291	0.9975	1.0000				
Issued Capital	-0.0112	-0.0388	0.0308	0.0189	-0.0805	0.0082	0.1061	0.0120	0.0395	0.1058	-0.0060	0.0087	0.0125	1.0000			
Ordinary Shares	-0.0101	-0.0347	0.0115	0.0169	-0.0778	0.0972	0.1024	0.0021	0.0038	0.1078	-0.0049	0.0078	0.0116	0.9901	1.0000		
Total Reserves	-0.0067	-0.0232	0.0103	-0.0013	0.9956	0.3710	0.0018	0.0055	0.5300	0.0833	-0.0026	0.9981	0.9945	-0.0480	-0.0482	1.0000	
Share Premium	-0.0240	-0.0739	0.4341	0.1469	-0.0613	0.1193	0.3483	0.2690	0.7357	0.0655	0.0767	0.0194	0.0275	0.0457	0.0119	0.0272	1.0000

Appendix E. Variance Inflation Factor (Chapter 3)

Model 2		
Variable	**VIF**	**1/VIF**
Short-Term Loans	3.51	0.2587
Debt Pre-Equity Funding	3.50	0.2858
Bank	2.48	0.4031
Patent Pending	2.36	0.4232
Tangible Assets	2.33	0.4303
Patents Granted	2.20	0.4559
Overdraft	1.62	0.6178
Intangible Assets	1.40	0.7132
Retained Earnings	1.19	0.8398
Firm Age	1.16	0.8641
Software	1.03	0.9676
Mean VIF	2.07	

Model 3		
Variable	**VIF**	**1/VIF**
Patent Pending	4.12	0.2183
Bank	3.31	0.2618
Retained Earnings	2.55	0.3981
Tangible Assets	2.48	0.4139
Patents Granted	2.12	0.4284
Employees	1.78	0.5983
Intangible Assets	1.64	0.6082
Overdraft	1.52	0.6892
Software	1.44	0.7280
Liquidity Ratio	1.29	0.7826
Short-Term Loans	1.11	0.8836
Firm Age	1.08	0.9518
Mean VIF	2.03	

Appendix F. Survey Questions (Chapter 4)

SMPs and Sustainability Reporting for SMEs

1. If you would like a copy of our final report please include your business email address

2. What is your role within your organisation
   A. Principal owner / partner / director
   B. Manager
   C. Non-manager
   D. Other (please specify)

3. Please select your age category
   A. 18 – 30
   B. 31 – 49
   C. 50 – 60
   D. 60 +
   E. Prefer not to say

4. Based on the attached framework, do you consider the key headings feasible for SMEs to report? (Yes or No)
   - Materials
   - Energy
   - Water
   - Biodiversity
   - Emissions
   - Waste
   - Other

5. Do you believe the framework attached to this survey is feasible in terms of the following dimensions? (please rank 1-5, 1 being the most feasible)
   - Cost
   - Willingness to provide data
   - Availability of data
   - Reliability of data
   - Suitability of metrics

6. Based on your above answer, what is the biggest change in implementing this framework for SMEs?

7. What are the benefits to your clients (SMEs) in implementing sustainability reporting? (please rank 1-7, 1 being the most beneficial)
   - Reduce costs
   - Improve company image and competitive advantage
   - Increase productivity in environmentally friendly manner
   - Regulatory compliance
   - Attract employees
   - Access to finance
   - Increased consumer and supplier demands

8. Based on your above answer, can you provide more specific detail in relation to the benefits for your clients in implementing a sustainability reporting framework? (Ex: Recruitment of better staff / improved distribution channels)

9. Aside from cost, what is the biggest challenge in implementing sustainability reporting for SMEs?
   A. Time
   B. Lack of knowledge
   C. Lack of incentive or willingness to engage
   D. All of the above
   E. Other (please specify)

10. If possible, please provide more specific detail regarding the current challenges for your clients in implementing a sustainability reporting framework.

11. Can you provide a reasonable estimate of the financial cost (for your SME clients) of implementing sustainability reporting? (Please include numerical data where possible)
    - Staff costs (Ex: 50% of dedicated staff member at €X per annum)
    - Technology / Data capturing Software (Ex: updating technology or software to capture data / new meters)
    - Education, learning & development (Ex: additional education, learning and development for staff including opportunity cost of staff while learning)
    - Other potential costs (Please specify)
    - Other potential costs (Monetary amount €X)

12. Providing a reasonable estimate, how much would it cost an SMP to fill in the attached suggested framework on behalf of an SME client? (Ex: % of a dedicated staff member at €X per annum / Suggested fixed fee at €X)

13. What elements of education, learning and development do you consider necessary for SMPs in order to delivery appropriate sustainability reporting for clients?

14. With respect to the previous question please list the key players you believe have a role to play in education, learning and development of sustainability reporting.

15. Have you provided sustainability reporting advice to any of your SME clients to date?
    A. Yes
    B. No

16. If you have answered yes to the above, what is the nature of the advice you have provided to your clients on sustainability reporting?

17. What do you believe is the role of your firm in promoting and delivering voluntary sustainability reporting for SMEs?

18. What capabilities do SMPs need to support SMEs in implementing sustainability reporting?

19. What resources are/would be drawn upon by SMPs in the provision of sustainability reporting advice?

20. What role and incentives do you believe the government can play in assisting SMPs in delivering sustainability reporting for SMEs?

21. Please any other comments or recommendations

Appendix G. Survey Questions (Chapter 5)

EU Green Taxonomy for SMEs

1. If you would like a copy of our final report please include your business email address

2. Based on the case study illustration and framework attached, do you believe the EU Green Taxonomy is feasible in terms of the following dimensions? (where 1 is not feasible to 5 being highly feasible)

- Cost of implementation
- Availability of data
- Understandability of data
- Reliability and accuracy of data
- Suitability of existing systems to capture and manage data
- Clients' willingness to engage

3. Based on the case study illustration and framework attached, do you believe it is feasible for you to report the following KPIs required within the EU Green Taxonomy? (Yes or No)

- % of turnover
- % of capital expenditure
- % of operational expenditure

4. Based on the case study illustration and framework attached, do you believe the EU Green Taxonomy is feasible in terms assessing a firm's contribution to, or doing no significant harm to, the following? (Yes or No)

- Climate change mitigation
- Climate change adaption
- Water
- Circular economy
- Pollution
- Ecosystems

5. Having considered the application of the EU Green Taxonomy to SMEs, what in your opinion are the biggest reporting challenges for SMEs? (Please rank 1-6, 1 being the most challenging)

- Lack of knowledge / education
- Lack of data capturing capabilities/technology
- Lack of incentive
- Lack of resources
- Lack of interest
- Other (please specify in question 6 below)

6. If you believe there are other reporting challenges, please provide more detail

7. Please rank the following financial supports to SMEs in reducing the costs of implementing the EU Green Taxonomy? (Please rank 1-5, 1 being the most likely to reduce costs)

- Government or EU Grants/Tax incentives or carbon credits
- Education (subsidized or funded in-house training supported by accountancy bodies and other relevant specialists)

- Funded/open-source IT solutions to aid data capture and management
- Supports from larger entities elsewhere in the supply chain (favourable credit terms)
- Other (please specify in question 8 below)

8. If you selected 'other' in question 7 above, please provide more details

9. Please rank the following non-financial supports to SMEs in reducing the costs of implementing the EU Green Taxonomy? (Please rank 1-6, 1 being the most likely to reduce costs)

- Education (availability of CPD programmes)
- Education (provision of suitably educated graduates from HEIs)
- Support from larger entities elsewhere in the supply chain (disclosure assistance)
- Simplified disclosure requirements (EU Green Taxonomy)
- Established of government or NGO specialised agency to assist
- Other (please specify in question 10 below)

10. If you selected 'other' in question 9 above, please provide more details

11. How do you think the additional reporting cost and administrative burden can be reduced for SMEs?

12. What are the non-regulatory benefits for SMEs in providing voluntary disclosures that are aligned to the EU Green Taxonomy? (Please rank 1-7, 1 being the most beneficial)

- Reduced costs (e.g. reduced energy bills, reduced waste management costs, lower costs in replacing fixed assets)
- Enhancement of company image
- Greater competitive advantage
- Increased productivity in an environmental friendly manner
- Attraction and retention of employees
- Access to finance
- Increased demands from customer and suppliers

13. Please comment on any additional non-regulatory benefits to SMEs in providing voluntary disclosures that are aligned to the EU Green Taxonomy?

14. Do you consider the EU Green Taxonomy's disclosure requirements will lead to greenwashing by SMEs?

A. Yes
B. No

15. Aside from reporting alignment with the EU Green Taxonomy, do you believe there is a more effective means of encouraging SMEs to behave in a more environmentally sustainable manner?

16. Please include any other comments or recommendations on the EU Green Taxonomy for SMEs

Appendix H. ANOVA (Chapter 5)

Table 1. Variance in perceived feasibility between respondents with resource education concerns and respondents with resource concerns.

	ANOVA	Tukey Post-hoc
Feasibility of:	F (4,179)	Mean difference
KPI Reporting	8.76***	0.896***
Taxonomy Objective Reporting	4.83***	1.100*
Taxonomy Implementation (Cost)	8.01***	0.942***
Taxonomy Implementation (Data Availability)	1.14	-
Taxonomy Implementation (Reliability and Accuracy)	2.75*	0.108
Taxonomy Implementation (Understandability)	2.88*	0.591*
Taxonomy Implementation (Suitability of Systems)	2.74*	0.370
Taxonomy Implementation (Client Willingness)	0.88	-

Table 2. Variance in perceived feasibility between respondents seeking general governmental financial support and respondents seeing educational financial support.

	ANOVA	Tukey Post-hoc
Feasibility of:	F (3,180)	Mean difference
KPI Reporting	4.49**	0.570*
Taxonomy Objective Reporting	1.54	-
Taxonomy Implementation (Cost)	5.60***	0.754**
Taxonomy Implementation (Data Availability)	1.54	-
Taxonomy Implementation (Reliability and Accuracy)	0.89	-
Taxonomy Implementation (Understandability)	3.86*	0.578*
Taxonomy Implementation (Suitability of Systems)	1.35	-
Taxonomy Implementation (Client Willingness)	1.99	-

Table 3. Variance in perceived feasibility between respondents seeking simplified disclosure requirements and respondents seeing education as non-financial supports.

	ANOVA	Tukey Post-hoc
Feasibility of:	F (4,179)	Mean difference
KPI Reporting	3.98**	0.595
Taxonomy Objective Reporting	1.84	-
Taxonomy Implementation (Cost)	3.17*	0.846*
Taxonomy Implementation (Data Availability)	2.59*	0.270
Taxonomy Implementation (Reliability and Accuracy)	2.18	-
Taxonomy Implementation (Understandability)	1.99	-
Taxonomy Implementation (Suitability of Systems)	0.88	-
Taxonomy Implementation (Client Willingness)	0.53	-

Appendix I. Statistical Tests (Chapter 5)

Tests for differences between those who predict greenwashing and those who do not predict greenwashing

Table 1. Feasibility

	Mann Whitney Z	Significance
Cost of implementation	1.941	0.052
Availability of data	-1.030	0.303
Understandability of data	0.409	0.683
Reliability and accuracy of data	-1.000	0.317
Suitability of existing systems to capture and manage data	0.917	0.359
Clients' willingness to engage	0.951	0.341
Feasibility of reporting Taxonomy KPIs	1.149	0.251
Feasibility of reporting Taxonomy objectives	1.979	0.049*

Table 2. Challenges

	Mann Whitney Z	Significance
Lack of knowledge or education	0.203	0.839
Lack of data capturing capabilities/technologies	0.063	0.950
Lack of incentives	-0.816	0.414
Lack of resources	1.979	0.048*
Lack of interest	0.173	0.863

Table 3. Financial Supports

	Mann Whitney Z	Significance
Government/EU grants, tax incentives, or carbon credits	1.194	0.233
Subsidised education	1.647	0.099
Funded/open-source IT solutions for data capture and management	-0.206	0.837
Supports from larger entities elsewhere in the supply chain	-1.239	0.215

Table 4. Non-Financial Supports

	Mann Whitney Z	Significance
Education-CPD	1.416	0.157
Education-Suitably educated graduates from HEIs	1.869	0.062
Supports from larger entities elsewhere in the supply chain	-0.612	0.541
Simplified disclosure requirements	0.256	0.798
Establishment of an agency to assist	-1.135	0.256

Table 5. Benefits

	Mann Whitney Z	Significance
Reduced costs	1.628	0.104
Enhanced company image	3.503	0.001***
Competitive advantage	0.186	0.853
Increased productivity in an environmentally friendly manner	0.728	0.468
Attraction and retention of employees	-1.142	0.255
Access to finance	-0.425	0.671
Increased demands from customers and suppliers	-4.025	0.001***

Table 6. Summary

	Mann Whitney Z	Significance
Feasibility of the Taxonomy objectives	1.979*	
SMPs who do not predict greenwashing:		
Tend to view improvement of company image as a key benefit	3.503***	
Tend to consider lack of resources as the greatest challenge	1.979*	