ACCELERATING CLIMATE TRANSITION THROUGH FINANCE: TOWARDS AN IMPROVED METHODOLOGY FOR CARBON ACCOUNTING IN THE FINANCIAL SECTOR

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PREFACE

This report is the final product of my studying career at the Delft University of Technology and the last step in completing my master program of Complex System Engineering and Management. The research was in combination with an internship at Guidehouse in the Netherlands, Utrecht.

I would like to take a few words to thank my graduation committee consisting of Kornelis Blok, Enno Schröder and Aad Correljé for their feedback and input during my thesis process. Also, I want to thank Giel Linthorst and Caspar Noach for the opportunity to combine my graduation with an internship at Guidehouse. You both helped me through the rough start with working from home and were always available for discussions and feedback.

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"De omgeving van de mens is de medemens" - J.A. Deelder

ABSTRACT

Carbon accounting in the financial sector has experienced a rapid growth over the last years. Both private and public institutions have focused their attention on the role the financial sector can play in accelerating the transition to a low carbon economy. More than 80% of the financial institutions worldwide acknowledge the importance of GHG accounting for their loans and investment. However, less than 20% of these institutions actually measure and report on their climate impact. An often heard argument for this lacking carbon disclosure is data quality and the need for estimation models to improve this data. Less attention in academic research has been focused on the basics of carbon accounting methodologies. The larger part of capital in the world finds itself in the financial sector in public and private institutions. Accelerating the transition to a low carbon economy will require a shift of this capital to a more sustainable focus. In order to identify carbon intensive investments and to track the decarbonisation of loans and investments as a financial institution, carbon accounting plays an important role. This research aims to improve the approach that forms the basis for carbon accounting used in financial institutions. More attention in this field can possibly trigger a line of events with more attention to the climate impact of the investing world. Ideally this can lead to more sustainable investments and carbon reduction on a global scale. The question aimed to answer in this research is the following: *What is the most adequate approach for financial institutions to measure financed emissions?*

This study goes into the existing carbon accounting methodologies and metrics. The current approaches are analysed and the four most common metrics selected. The major accounting issue following from this overview and related interviews is that there is no approach combining investments in equity and debt when allocating emissions. Based on this observation three alternative accounting approaches are proposed and assessed on their contribution and sensitivity in order to come to an improved practice for carbon accounting. The three discussed approaches are the use of Enterprise Value Including Cash, Balance Sheet Total and separate allocation for equity and debt. The alternatives of using Enterprise Value Including Cash and Balance Sheet Total together with four of the existing carbon accounting metrics are evaluated on a set of 7 qualitative criteria. This evaluation brings the use of Enterprise Value Including Cash forward as the preferred metric. The second evaluation of the metrics is done through a quantitative approach using a sample investment portfolio to test the metrics in a practical situation. Here, the four remaining metrics are compared in their performance over a time-span of 5 years. With the use of experiments this performance is evaluated, where the use of Enterprise Value Including Cash and Balance Sheet Total show the most potential.

The research concludes that the use of Enterprise Value Including Cash is the preferred approach. This approach enables the financial institution to assess the carbon footprint of their investment portfolio for both equity and bonds investments in listed companies. The advantage of this method is that it avoids double counting and the emissions are allocated to the actual invested values. A downside of the Enterprise Value Including Cash is the dependency on market development and therefore market volatility. This can cause issues when analysing the trend of decarbonisation of an investment portfolio. This research recognises this problem and proposes research into corrections to mitigate the issue. This improved practice should enable the financial sector to harmonise their approach in carbon accounting to ensure higher comparability, transparency and consistency in the landscape of carbon accounting. The next step would be piloting the improved methodology in a real investment environment on real-time data.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

Abbreviation	Explanation
BST	Balance Sheet Total
CDP	Carbon Disclosure Project
CFP	Carbon Footprint
CI	Carbon Intensity
CO_2-eq	CO_2-equivalent
EU TEG	European Union Technical Expert Group for sustainable finance
EV(IC)	Enterprise Value (Including Cash)
FI	Financial institution
GHG	Greenhouse gas
GHGP	Greenhouse gas Protocol
IIGCC	The Institutional Investors Group on Climate Change
IPCC	The Intergovernmental Panel on Climate Change
NGFS	Network for Greening the Financial System
PCAF	Partnership for Carbon Accounting Financials
PRI	Principles for Responsible Investment
TCE	Total Carbon Emissions
TCFD	Task Force for Climate related Financial Disclosure
UNEP FI	United Nations Environmental Program Financial Initiative
WACI	Weighted Average Carbon Intensity

Table 0.1: List of abbreviations

1 INTRODUCTION

In the world we live in today, climate change is a central topic in all industries. New initiatives and technologies are brought into place to reduce greenhouse gas (GHG) emissions. To limit the threats of climate change substantially this transition to a low carbon society needs to move much faster in order to reach net-zero emissions by 2050. Businesses are key in both national and international climate policies since they are seen as the main source of the problem as well as the main option for solutions (Sundin & Ranganathan, 2002). Financial institutions represent most of the available capital in the world and are therefore a key player in the operations of most large businesses all over the world. The financial sector is connected to every part of the economy through their investments and loans and therefore play a crucial role in financing the transition to a low-carbon economy (Louche, Busch, Crifo, & Marcus, 2019; Shrivastava et al., 2019; WRI, 2018). Since the Paris Agreement, financial institutions have invested $2 trillion dollars into the fossil fuel sector (PCAF Netherlands, 2019). This indicates the lack of movement towards sustainable investments. The financial industry can play a key role in facilitating the acceleration of this transition in the short and medium-term. In order for the financial industry to make an impact, it is crucial to understand the climate impact and risk of their own investment portfolio. Knowing this will help to steer investments in order to reduce GHG emissions. To do so effectively, the financial industry needs a global carbon accounting standard (PCAF, 2018), which harmonises the way financial institutions measure and disclose their GHG emissions. This need is recognised and supported by the United Nations Environmental Program (UNEP FI, 2019) and the European Commission Technical Environmental Group (EU TEG, 2019a). To facilitate this movement, the Partnership for Carbon Accounting Financials (PCAF) was introduced. Their mission is to create a widely accepted approach to measure and disclose the GHG emissions associated with loans and investments for the financial industry (PCAF Netherlands, 2019). This provides financial institutions with a starting point to align their investment portfolio with the Paris Agreement. A global carbon accounting standard as described, will help to reduce GHG emissions and to reach climate goals for 2050. PCAF identified three conditions for this to be successful:

1. A global carbon accounting standard is developed and broadly accepted by banks and investors.
2. Various stakeholders back the global accounting standard, the number of financial institutions that measure and disclose financed emissions grows globally and reaches critical mass.
3. Financial regulators encourage and eventually require financial institutions to adopt carbon accounting at a portfolio level.

This research will focus on the first condition and is aimed at improving and solving methodological issues of the current accounting standard related to measuring GHG emissions from listed equity and bonds. And more in detail focuses on the attribution of emissions from the businesses in the portfolio to the financial institution. The main objective of this research is to define an improved practice metric as the denominator for attributing GHG emissions of a company to a financial product. The most general formula is presented in formula 1.1 and will be discussed in more detail during this thesis:

$$Portfolio\ emissions = \sum_{Portfolio} \left(\frac{Contribution\ to\ the\ financial\ metric}{Financial\ metric} * Company\ emissions\right) \tag{1.1}$$

Formula 1.1 considers a given portfolio managed by a financial institution. The financial metric defining the denominator in this formula can represent a set of different variables. This will be one of the main focus points throughout this report.

1.1 RESEARCH CONTEXT

The environmental, social and economic challenges the world's society is facing are substantial and broadly addressed by several initiatives like the United Nations Paris agreement and the 2030 Agenda for Sustainable development. Effective climate mitigation will not be achieved if individual entities seek after their own interests independently. Only when the response to mitigate GHG emissions is cooperative, and with an international focus, the required level can be reached. Without mitigation, the IPCC assessment report states that 'warming is more likely than not to exceed 4°C above pre-industrial levels by 2100' (IPCC, 2014, p. 5). The risks expected to follow from a temperature rise above 4°C are significant. To help and accelerate the progress in order to fight these challenges, financial institutions can play an essential role (European Commission, 2015; UN, 2019; Wiek & Weber, 2014). Incorporating environmental factors in the investment decision making gets increased attention and is known as the Environmental, Social, and Governance (ESG) investment approach (Ziolo, Filipiak, Bak, & Cheba, 2019). This approach is integrated through the Principles of Responsible Investment (PRI) in more than 2200 asset owners representing over 80 trillion US dollars in assets under management (PRI, 2020b). This can be seen as a strong indicator of the willingness around the world to integrate ESG principles into investment decisions. A certain self-regulative steering mechanism arising from corporations working together is a relative new phenomenon. More standard mitigating measures are market mechanisms, price incentives and governmental regulation.

1.2 RESEARCH PROBLEM

The failing of previous climate policies combined with the lack of knowledge and standards has led to a 'finance gap' for sustainable low carbon investments (2° Investing Initiative, 2013). According to the IEA (2019), there is a need for a capital increase of 50% on an average annual basis until 2030 for investments towards a low carbon economy. To contribute to mitigating climate change an increasing number of banks has committed to net zero emissions in their investment portfolio by 2050. The awareness of the financial sector is very clear according to the Global Investor Survey On Climate Change from 2013, where 83% of asset owners and 77% of asset managers considers climate change to be of material risk to their investments across the entire portfolio (IIGCC, 2013). The climate snapshot of the Principles for Responsible Investment shows a similar result of 74% of their 410 investor signatories being aware of the issues climate change brings to their investment portfolio (PRI, 2020a). However, only 2% has already incorporated climate factors on a strategic level and less than 20% reports on their financed emissions as indicated in figure 1.1. But how can the world know if financial institutions really live up to their commitment and that it is not a deceptive marketing strategy to appear green to the public, also called 'greenwashing'? It will require measurement of the carbon footprint of investment portfolios to keep track of the progress towards the goals of net zero emissions by 2050. The financial sector will therefore need a well understood and transparent methodology.

One of the reasons mentioned by many publications for the conflict between willingness and desired progress is the lack of knowledge in financial institutions on how to measure the GHG emissions in their investment portfolio (Friede, 2019; Kareiva, McNally, McCormick, Miller, & Ruckelshaus, 2015; Quarles, 2019; C. Weber et al., 2018). 2° Investing Initiative (2013) conclude that the development of

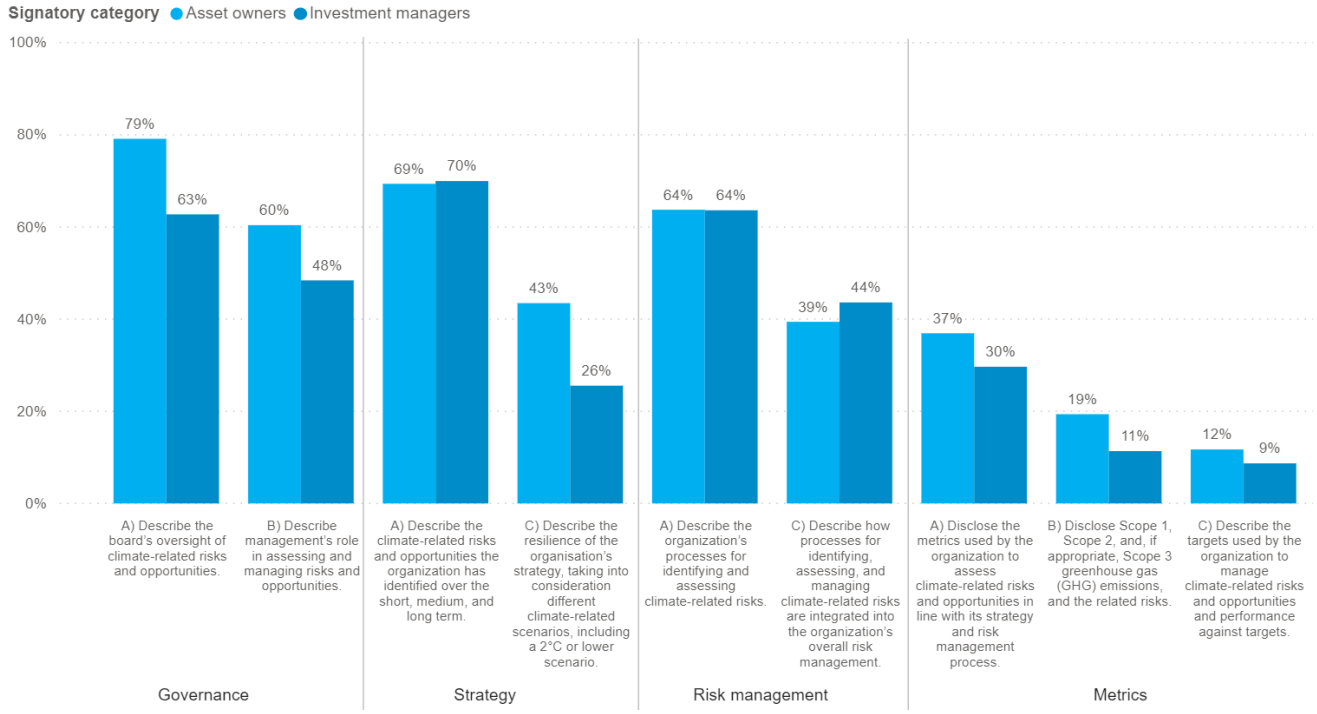


Figure 1.1: PRI signatories reporting against TCFD recommendations (PRI, 2020a)

a standard focusing on carbon performance indicators will be most likely to get comprehensive support from the financial institutions based on their showed willingness. A standardised method could help investors and policymakers to assess the carbon footprint of their investments. This knowledge allows investors to identify their most carbon intensive investments. Followed by a strategy of engagement with investees or divesting money to less carbon intensive investments the financial investor can start re-allocating capital towards financing investments that support a low carbon economy. For these strategies and targets to be of meaning, there should be a globally standardized measurement methodology (PCAF, 2020b).

1.2.1 Financed emissions

The climate impact caused by activities from companies can be expressed in a wide range of factors, such as water use, land use, deforestation and GHG emissions. For this research, we only focus on the GHG emissions from these companies and focus on who should be responsible for these emissions. Financed emissions are the GHG emissions from the real economy associated with loans and investment from the financial institution. Financed emissions give insight in the link between loans and investments and climate change exposure. Measuring financed emissions enables the investor to disclose and to assess the performance related to certain values within the banks strategy or the amount of risk climate impact has on the investment. Climate change impact on investment portfolios is defined as a transition risk. Emissions related to investments can devalue the market value of an investment due to climate policy, market changes or technological developments. Therefore the emissions flowing from an investment within a company considering historical and future data can be defined as financed emissions. The way this can be measured in the most adequate way will be point of discussion in this thesis. The next step after measuring will be reporting the relevant information and communicate this to stakeholders and the outside world.

1.3 RESEARCH OBJECTIVE

In this research, the focus will be to analyse the shortcomings of the current methodologies to measure a portfolio carbon footprint. There has not been any sufficient research into this topic up until this point. There have been presented overviews of certain methodologies by organisations within the field. But all with a more practical approach and a lack of complete independence from bias. This research looks into different accounting approaches and aims to assess these by using a set of criteria. To overcome the current problems three alternative approaches are proposed and assessed based on the same criteria. A best approach to measure an investment portfolio carbon footprint is proposed. This will help to measure the real impact on the economy.

The **objective** of the research is proposing a best GHG accounting methodology for financial institutions to measure the GHG emissions of their investment portfolio. The main research question this report aims to answer is:

"What is the most adequate approach for financial institutions to measure financed emissions?"

To be able to answer the main research question, several sub questions are drafted up to break down the main question. The sub questions are formulated as followed:

1. Which approaches are currently in place to define the climate impact of an investment portfolio?
2. What are the most commonly used metrics for carbon accounting and what are their advantages and disadvantages?
3. How can the identified metrics be used to fairly attribute financed emissions from the investee to the investor portfolio?
4. How robust are the identified metrics when tested in a real life investment portfolio??

It is important to notice that research questions 1 and 2 speak about the concepts approaches and metrics. Approaches include all broader concepts related to approaching climate impact assessment for (financial) institutions. Metrics include the specification about how the chosen approach should take form in practice when analysing an investment portfolio. To answer the main research question, it is essential to define what is considered to be best. Best is defined based on the hand of seven criteria used in this research. These accounting criteria are practicability, consistency, accuracy, comparability, transparency, robustness, and context. These principles are derived from literature research in chapter 3 and further analysed in chapter 5.

This report is focused on finding the best approach for GHG emissions measurement for loans and investments in listed companies. These investments represent over 60% of total global investor capital and can be divided in equity investments and bond investments.

1.4 READING GUIDE

This section provides an overview of the contents of this research. The research can roughly be divided in four stages, first the knowledge base is laid out, than the analysis is presented in two parts and finally the contribution and conclusions of this research are presented.

This thesis starts with the methodology and research questions in chapter 2. Chapter 3 provides the background knowledge of literature study and desk research and concludes with the mechanisms surrounding the field of carbon accounting. A more detailed follow up of the existing knowledge base into the focus of this research is presented in chapter 4. Chapter 4 provides the answers for research

question 1 and 2. These two chapters provide the current state of emissions accounting in the financial sector and identify the current shortcomings.

Chapter 5, 6 and 7 present the analysis part of this research. First, in chapter 5 method alternatives are proposed and assessed in a qualitative research approach. These methods aim to harmonise carbon accounting for the financial sector and aim to answer research question 3. In chapter 6 these alternatives are tested on a sample portfolio case and the results of this application are presented in chapter 7. Based on these results final recommendation are proposed and research question 4 is answered.

Chapter 8 and 9 present the final stage of this research and go into the remaining limitations, recommendations, future research and the contribution and conclusions of the research.

2 METHODOLOGY

An exploratory approach, in combination with a quantitative Excel study, will be used in this research. The first two questions and parts of question 3 will be answered with more literature and desk research. The exploratory approach is there because of a lack of uniform theory. There are different proposed methods and metrics for financial institutions. The wish is there to have one uniform method that can be applied for all financial institutions representing a high coverage rate. This coverage mostly depends on data availability from the businesses in their investment portfolio. The result will be a clear definition of scope 1, 2 and 3 emissions for this research. This will be combined with a set of criteria to measure the different scopes and a best method to attribute the emissions. Assessing different alternatives for this methodology will be done based on stakeholder needs. To construct these needs and assess the alternatives the systems engineering approach developed by Sage and Armstrong (2000) will be used. They define the function of systems engineering as "an appropriate combination of the methods and tools of systems engineering, made possible through use of suitable methodology and systems management procedures, in a useful process-oriented setting that is appropriate for the resolution of real-world problems, often or large scale and scope." Sage and Armstrong (2000, p. 60). In this research, their approach is used and translated in three basic steps and two phases of system definition considering the formulation of the problem, analysis and interpretation, secondly the system development and lastly system deployment.

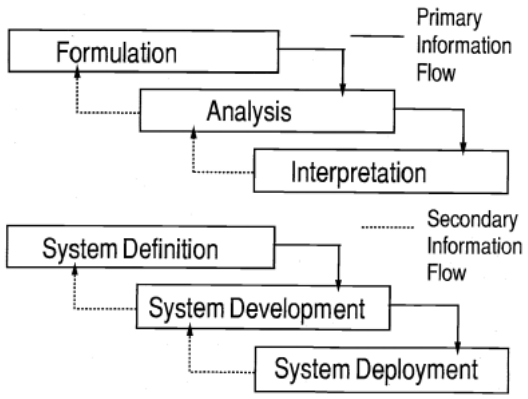


Figure 2.1: The three basic steps and phases of systems engineering (Sage & Armstrong, 2000)

In the formulation phase, a problem definition and system design values need to be defined to round up this phase with a system synthesis. Problem definition requires isolating, quantifying and clarifying the need that creates the problem to be able to identify a set of needs to foresee in this overarching need. Next is the selection of objectives or goals that guide the search for alternatives. This involves identifying criteria to select the most appropriate system. The last step in the formulation phase is describing and creating alternatives.

First, a system is defined as a group of components that work together for a specified purpose, this is a straightforward but correct definition. Purposeful action is a primary characteristic of a system. A number of functions must be implemented in order to achieve these purposes (Sage & Armstrong, 2000).

Systems Engineering is the application of scientific and engineering efforts to:

- transform an operational need into a description of system performance parameters and a system configuration through the use of an iterative process of definition, synthesis, analysis, design, test, and evaluation;
- integrate related technical parameters and ensure compatibility of all physical, functional, and program interfaces in a manner that optimises the total system definition and design;
- integrate reliability, maintainability, safety, survivability, human engineering, and other factors into the total engineering effort to meet cost, schedule, supportability, and technical performance objectives.

One of the core sources for identifying these needs are literature and desk research into market studies and reports looking into climate accounting. Relevant stakeholders here are data providers, consultancy firms and financial institutions themselves. This will also lead to an overview of carbon accounting principles as applied in the current market. These needs will be translated into criteria to assess current methods and identify shortcomings. Using these shortcomings, alternative approaches are introduced to improve the link with the needs identified as most important.

To investigate how these alternative approaches can be applied in real life, the exploratory research will be combined with a third source to test technical application. With the use of Excel and sample carbon emission and financial data, a test investment portfolio with real data is set up. This sample is used for the purpose of illustration and testing existing, and new carbon accounting approaches. The conceptual model and set-up of this sample portfolio is shown in figure 2.2.

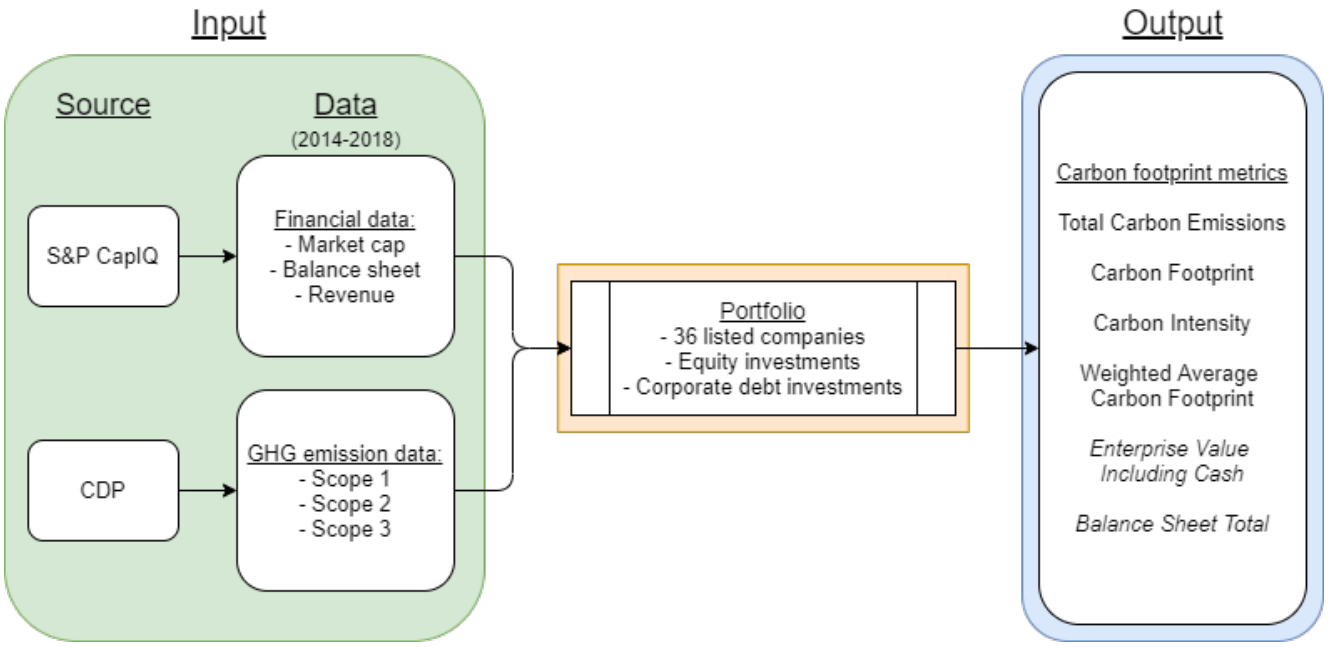


Figure 2.2: Conceptual model for the sample portfolio

The full list of companies in the sample portfolio can be found in Appendix B. First a selection of sectors was made to ensure a diversity of companies. This list of sectors was chosen to have both high emitting companies and low emitting companies in the sample portfolio as well as sectors with a relative high and low scope 3. The exact companies within sectors were than selected on the requirement of good available data for both financial and GHG emissions.

The financial data relies on the data provider S&P Capital IQ (S&P Global, 2020), where access is provided by Guidehouse Research Services. The data is verified with annual reports and open source data from Yahoo Finance by a random sample.

Carbon emission data relies on the reports published through the Carbon Disclosure Project and is verified with annual sustainability reports by a random sample. The result is a test of the applicability of the created method and helps to test different metrics on desired outcome and volatility.

The end result will be the best applicable metric. This metric will be used in the measurement and attribution of GHG emission to an investment portfolio of equity and bonds. Based on this method and metric recommendations are made. New investment strategies can be based on the outcome of the climate impact assessment in order for financial institutions to reduce carbon emissions within organisations focusing on their scope 3 emissions related to equity investments and corporate bonds.

2.1 SUB QUESTIONS AND THEIR RESEARCH METHODS

To be able to answer the drafted sub questions, an approach and method per sub question are described in the following section. The sub questions are also elaborated on how they relate to each other.

2.1.1 Sub question 1: Which approaches are currently in place to define the climate impact of an investment portfolio?

This first sub question investigates the broad issue of how to gather information on financed emissions. This considers the climate impact for an investor from multiple perspectives and require literature and desk research on relevant documentation for reporting financed emissions (PCAF reports, EU benchmark on carbon accounting, GHG protocol, Task Force on Climate-Related Financial Disclosures). Also, interviews have been done with different financial institutions about their experience and use of current approaches.

2.1.2 Sub question 2: What are the most commonly used metrics for carbon accounting and what are their advantages and disadvantages?

The second research question considers the main approach for defining financed emissions, namely carbon accounting. The field of carbon accounting combines financial and GHG emission data to define a portfolios carbon intensity and the allocated emissions to a portfolio. To find out what metrics are used to practice carbon accounting, a search is carried out through different data providers. Moreover, financial institutions are interviewed about the current used metrics and calculations. Also, interviews have been conducted with current PCAF members and the working group within PCAF to define the current view on calculating GHG emissions related to equity and bonds. This provides a clear definition of existing carbon accounting principles.

2.1.3 Sub question 3: How can the identified metrics be used to attribute financed emissions from the investee to the investor portfolio?

The third question is in place to evaluate the identified metrics based on a set of criteria in order to answer how to use the metrics and if they will be suited for portfolio emission allocation. This required a set of criteria to test the performance of the different metrics. To gather the criteria literature and desk research are used as well as multiple expert talks in the field of carbon accounting and data.

2.1.4 Sub question 4: How robust are the identified metrics when tested in a real life investment portfolio?

The last sub question evaluates the performance of the metrics when put into practice in a real life investment portfolio. To do so, data is collected to perform a quantitative analysis in Excel on the volatility of the identified metrics and the effect on attributed GHG emissions. Effects that will be included are market fluctuations, divestment strategies and engagement. Since the data quality of scope 3 is highly variable, this will be done considering effects on scope 1 and 2 emissions from the investee.

3 THEORETICAL BACKGROUND

This chapter brings together the very limited literature on the topic of this thesis, carbon accounting. The purpose of this chapter is to learn from previous work and to get a basic understanding of the field where carbon accounting plays a role and the positive impact it can provide. First some background on sustainable banking is presented, second the principles of financed emissions are discussed and third an overview of existing literature is presented.

Speth (1992) recognises five transformations that need to happen in order to achieve a transition towards environmental sustainability. This includes (1) a demographic transition, managing our world population to avoid over-population, (2) a technology transition in order to reach 'green' electricity and transport, (3) an economic transition, (4) a transition in social equity and (5) an institutional transition. Focusing on the economic (3) and institutional (5) aspect Speth (1992) argues that non of the transitions will happen without prices, including environmental costs. In the current market, making the environmentally friendly decision is often more expensive. When incorporating environmental costs the decision making will more often shift towards the environmentally friendly decision. Together with incorporating environmental costs in our society, also an institutional transition is needed to bring the enormous potential of the private sector into play. Academic literature widely discusses the potential and importance of the financial sector to play a role in reaching the 2030 and 2050 goals of reaching a net-zero carbon economy and society (Kareiva et al., 2015; Wiek & Weber, 2014; Ziolo et al., 2019).

Initiatives like the Global Alliance for Banking on Values (GABV) and The Network of Central Banks and Supervisors for Greening the Financial System (NGFS) support the goal to change the financial system to make it more transparent and make it more sustainable (GABV, 2012; NGFS, 2019). More initiatives like the Net-Zero Asset Owner Alliance (UNEP FI, 2020) and the Partnership for Carbon Accounting Financials (PCAF Netherlands, 2019) support the same goal and try to enable and activate financial institutions to take action in order to limit global warming to 1.5 °C above pre-industrial levels.

3.1 SUSTAINABLE BANKING

The United Nations Environmental Program Inquiry put out a Design of a Financial System that takes into account not only economic growth but sustainable development as well. Here the critical distinction is made between the two ways a financial institution can impact sustainable development (UNEP, 2015). Firstly, financial institutions can directly impact sustainable development by reducing emissions from their offices. Secondly, a financial institution can impact sustainable development indirectly through its investments in equity or debt from their clients. In the world today, most of these investments are used to maximise financial return. This situation is now changing with the awareness of the risks and opportunities created by the environmental impact of their clients (Mendez & Houghton, 2020). When the financial sector becomes responsible for the impact of their investments, this will create significant risks for financial institutions. On the other hand, it will also bring new opportunities for banks, especially for the banks associated with the Global Alliance for Banking on Values (GABV). Their members already turned around their business principles in order to contribute to sustainable development (GABV, 2012). For other banks, the first step in taking these indirect

emissions into account will be mitigating the risk it will bring. Taking into account the role of the financial sector in almost every other sector with the capital they represent, it becomes clear that their potential to contribute to sustainable development is enormous. In this thesis, the focus will be on the indirect impact the financial sector can make through their investments. Indirect impact does not mean this impact is a side effect of business as usual. The financial sector directly finances companies, but in the end, the company itself decides what to do with this capital. Therefore it can be interpreted in multiple ways, but in this research, the indirect emission interpretation will be used since the focus from the field considers this as indirect emissions. In this research these emissions are called financed emissions from loans and investments. Section 3.4 further defines what is considered to be financed emissions.

3.2 BUSINESS CASE OF SUSTAINABLE FINANCE

The first reason for financial institutions to integrate sustainability into their operations is the most obvious one: in some cases, it directly pays off (Eshet, 2017; Margolis & Walsh, 2003). The capital needs for the transition to a low carbon economy are enormous and financial institutions are becoming more aware of the opportunity this brings (WRI, 2018). Other arguments for the integration of sustainability are identified by Jeucken and Bouma (1999). They distinguish the driving forces behind sustainability in internal and external drivers. Internal drivers relate to employees, shareholders and the board, while external drivers relate to governments, clients, media, NGO's, and the rest of society. This concept of sustainability drivers is highlighted in more detail by O. Weber and Feltmate (2016), who identified 12 sustainability drivers: (1) customer attraction, (2) employee satisfaction, (3) evolving securities commission reporting requirements, (4) operational efficiency, (5) media pressure, (6) industry self-regulation, (7) inclusion in sustainability indexes, (8) access to markets, (9) legal due diligence, (10) due diligence regarding partnerships, (11) discounted loan rates, and (12) facilitation of divestitures.

These drivers can move a financial institution towards the integration of sustainable investments and operations. For this research, there is an interest to know which drivers can be supported by a carbon accounting method. High-quality reporting of climate impact from an investor will directly play a role in (3) evolving securities of commission reporting requirements and (12) facilitation of divestitures. Also, it can indirectly support drivers (1) customer attraction (2) employee satisfaction and (5) media pressure by showing the outside world and (future) employees the progress a financial institution is making in responsible investments.

3.3 NEED FOR A HARMONISED CARBON ACCOUNTING METHOD IN THE FINANCIAL SECTOR

3.3.1 What is carbon accounting?

In literature, several terms are used interchangeably to address GHG reporting. The three most common ones are carbon disclosure, carbon accounting and carbon reporting. However, when taking a closer look, the definition of these terms slightly differs. After analyzing 129 publications Stechemesser and Guenther (2012, p. 25) defined carbon accounting as the 'measuring, collation, assessment and communication of GHG emissions emitted by a source or sequestered in a sink and monetary valuation of GHG emissions (as assets and liabilities) to provide this information to internal and external audiences'. This definition covers a broad range of activities in the landscape of calculating emissions

in order to report or disclose. Carbon reporting is a term used for a more concrete purpose and focuses on the reporting of carbon emissions by companies, both mandatory and voluntary (Haigh & Shapiro, 2012). Finally, carbon disclosure is defined as the idea to 'translate corporate carbon profiles into an assessment of risks and market opportunities with clear financial implications for firms and investors. Indeed this constitutes the central logic behind carbon disclosure movement' (Kolk, Levy, & Pinkse, 2008, p. 228-229). This first definition linked to carbon accounting is the basis for high-quality reporting and disclosure. Carbon accounting uses the methods and frameworks to increase transparency and accountability in order to engage with stakeholders to improve reporting, set targets and reduce climate impact by taking action. This definition coincides best with the purpose of this thesis, and therefore carbon accounting will be the main term used throughout this research. Carbon accounting is often heard in the field alongside with 'measuring financed emissions'.

3.3.2 Measuring financed emissions

All reporting schemes for financed emissions are consistent on one thing, and that is they all use the classification from the Greenhouse Gas Protocol (GHGP) dividing GHG emissions into three scopes. The GHGP was a first effort to measure GHG emissions from private and public sector operations created by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) (WBCSD & WRI, 2012). The GHGP identifies three different scopes of emissions that define the difference between direct (scope 1) and indirect emissions (scope 1 and 2). Scope 1 emissions originate from sources that are owned by the organisation (Liu et al., 2012). Scope 2 emissions define the emissions from electricity, heat or steam that is purchased by the organisation (Brander, Gillenwater, & Ascui, 2018). And scope 3 emissions are defined as the emissions from all indirect sources and take into account all other emissions originating from the organisation divided into 15 categories, as seen in figure 3.1 (Jewel & Tamhane, 2011). The fifteenth category of scope 3 emissions defines investments and is particularly interesting for this research and financial institutions.

Upstream or downstream	*Scope 3 category*
Upstream scope 3 emissions	**1.** Purchased goods and services **2.** Capital goods **3.** Fuel- and energy-related activities (not included in scope 1 or scope 2) **4.** Upstream transportation and distribution **5.** Waste generated in operations **6.** Business travel **7.** Employee commuting **8.** Upstream leased assets
Downstream scope 3 emissions	**9.** Downstream transportation and distribution **10.** Processing of sold products **11.** Use of sold products **12.** End-of-life treatment of sold products **13.** Downstream leased assets **14.** Franchises **15.** Investments

Figure 3.1: List of scope 3 categories (Callahan et al., 2013)

3.3.3 Scope 3 category 15: investments

Scope 3 emissions are divided into 15 categories by the GHGP as shown in figure 3.1 (WBCSD & WRI, 2012). The first 8 categories focus on the upstream scope 3 emissions and the other 7 focus on downstream scope 3 emissions. Category 15 represents investments and is often referred to as financed emissions. This category brings focus on measuring the climate impact of investments from a financial institution. The GHGP describes on a high level which investments should be considered and how emissions should be allocated to a certain investment. A more detailed description of this method and other methods in the field will be discussed in chapter 4.

3.3.4 Scope 3 emissions of the investor vs. scope 3 emissions of the investee

To avoid confusion, a clear distinction has to made between two different definitions of scope 3 that can occur in this thesis. In this research, the focus lies on defining a method to measure scope 3 category 15: investments for a financial investor. This is called 'scope 3 emissions of the investor' and will be referred to as financed emissions in this thesis. For the financial institution (investor), we do not consider the other fourteen categories in this research, which all have their own calculation methodologies. The climate impact from greenhouse gasses of these investments is based on scope 1, scope 2 and scope 3 emissions from the organisation invested in. This scope 3 is called 'scope 3 emissions of the investee' and contains all 15 categories defined by the GHGP. The sum of these scope 1, scope 2 and scope 3 emissions forms the basis for calculating financed emissions.

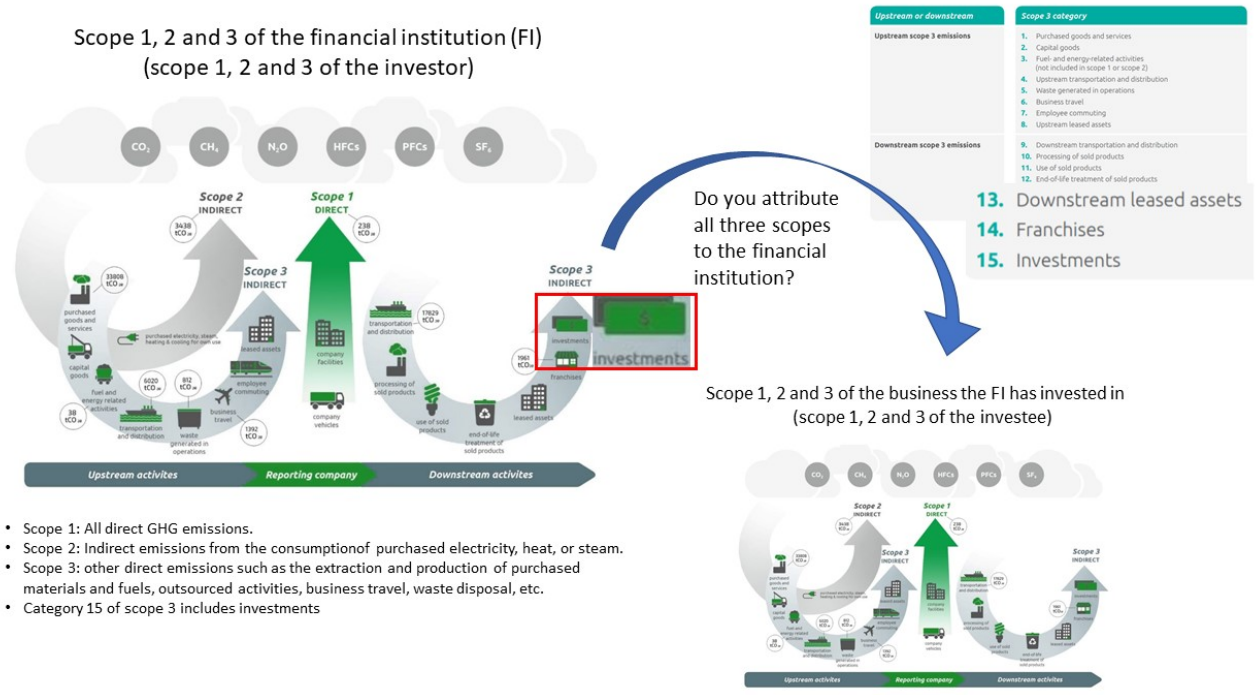


Figure 3.2: Investment from scope 3 translated to investee

3.3.5 Current landscape of carbon accounting and carbon disclosure

Carbon accounting has become a topic of high interest during the last decade (Stechemesser & Guenther, 2012; Tang & Demeritt, 2018). This is also shown in the number of companies reporting their

GHG emissions to the Carbon Disclosure Project (CDP). CDP published 2043 companies reporting in 2009 and 8446 companies reporting in 2019 (CDP, 2020b). However, only 182 of these companies made the 'A-list' of CDP, indicating that the organisation has the leadership level of climate reporting. This indicates the willingness and attention for carbon accounting but the inability of achieving complete and high-quality reporting again. Next to the CDP, several other public and private initiatives are focusing more on financed emissions. At the moment, there are about 25 GHG reporting frameworks worldwide to assess GHG emissions related to investments. Most frameworks are requiring emission data on scope 1 and 2 and in some cases also scope 3. The most important and leading initiatives are discussed in 4 and a full review can be found in Appendix A. These initiatives aim to assist in dealing with climate-related solutions for the financial sector. One of the key issues, as described in this thesis, is the development of a uniform and harmonised carbon accounting method and framework (PCAF, 2019; TCFD, 2020). The field where initiatives are working on the development of such a framework is rapidly evolving (Pattberg, 2017; Siew, 2015). However, no widely accepted approach for accounting carbon emissions for financial institutions has been established yet (Buchner et al., 2019).

Measurement of financed emissions and carbon disclosure is still voluntary when looking at the international context. This is one of the main reasons for the lack of harmonisation, which leads to incomparable disclosure on carbon-related performance and information (Velte, Stawinoga, & Lueg, 2020). Another barrier lies within the fast arising initiatives working on a carbon accounting standard. Despite the best efforts and intentions, these initiatives are also striving to become the leader in the carbon accounting landscape. This causes fragmentation in the carbon accounting world and could have the undesired outcome of multiple GHG accounting frameworks that get supported. The risk in this development is 'wait-and-see behaviour' from the financial sector for one globally accepted standard to measure financed emissions. Waiting for the ultimate outcome and having one excellent globally accepted standard could lead to more years of waiting, where the need to take action to mitigate climate impact is now.

3.4 LITERATURE ON FINANCED EMISSIONS

When searching for literature in the Scopus database with a focus on 'financed emissions', the result is only 2 articles. When broadening the search to only the mentioning of 'financed emissions' in the full text, the result is still only 13 articles. Broadening this further with search terms 'carbon reporting' 'emission accounting' or 'GHG accounting' does extend the amount of articles, but ends up with the same amount of relevant articles that form an interest for this research. This indicates the lack of attention for financed emissions in the field of carbon disclosure from an academic perspective. Analysing these 13 articles shows that only 7 are relevant to contribute to this research.

O. Weber (2014) discusses three fundamental ways the financial sector influences sustainable development. First, the financial sector can influence the environmental impact of their clients through investing in specific projects of their investees. This is called the indirect influence the financial sector can make. This is seen as the most impactful influence. Second, environmental regulations influence the financial sector. The only issue here is the more reactive approach from the financial sector than proactive concerning sustainability. Third, stakeholder pressure focuses on the sustainable efforts a financial institution makes. This influences their reputation and employee performance. Coulson (2009) emphasises the problem of measuring sustainability performance in the sector because of the indirect impact on sustainable development that is mainly caused by lending and investment processes and not by the direct impact of operations (O. Weber, 2012).

(Thomä, Dupré, & Hayne, 2018) conclude that non-consistent approach is used for portfolio analysis, and no consensus is reached on what approach works best in practice. Some of the more accounting related challenges may have been neglected because of the questions and challenges associated with

underlying data quality. Also, the time intensiveness of good reporting, especially for scope 3 emissions, hinders improvement of data quality (Morel & Cochran, 2015). There is not one principle that can be applied for all use cases when using carbon performance data. Dependent on the use case, one principle can be most appropriate. Crucial to recognise is that the decision for a principle can significantly impact the end results of the portfolio analyses.

Coeslier, Louche, and Hétet (2016) argue that harmonisation of carbon accounting is crucial when several companies are put together or compared. This is the case for investors holding an investment portfolio. These portfolios consist of many companies in different sectors. The most important questions for investors, as stated in this research are *"How much carbon emissions am I responsible for?"* and *"What is my exposure to carbon risks?"*.

Mitigating climate change is a key challenge in this legislative period. Otto et al. (2020); Schiemann, Busch, Bassen, and Reimsbach (n.d.) recommend introducing mandatory reporting of direct and indirect GHG emissions as an addition to the Non-financial Reporting Directive. The reason behind is the minimal effect of voluntary reporting shown in recent research. An essential first step in making carbon reporting mandatory is a transparent and harmonised approach for the measuring of financed emissions.

Hunt and Weber (2019); Thomä et al. (2018) are the only articles that go into the use of denominators and the importance of choosing the right denominator for the right use case. They start the discussion between using portfolio weight or balance sheet based approaches and the use of a flow or stock variable (sales vs market capitalisation).

3.5 CONCLUSION LITERATURE REVIEW

Previous research has indicated the dominating influence the financial institutions have on the economy, society and sustainable development (Helleiner, 2011; Mezher, Jamali, & Zreik, 2002; Scholtens, 2009, 2011). They have a position to channel capital to different markets, regions and sectors. According to Otto et al. (2020) the financial market is at a tipping point in playing an essential role for the world stabilising and mitigating climate change and reach global emission reduction goals by 2050. Researchers agree that one of the critical steps for the financial sector to be able to play such a role is a harmonised approach for carbon accounting. Much attention within carbon accounting goes to improving underlying data, where an often heard measure is making carbon reporting mandatory. A subject maybe evenly important, but with much less attention is the measurement of financed emissions. *"You can't manage what you can't measure."* For financial institutions to be able to contribute to mitigating climate change and to channel capital to climate solutions and more sustainable businesses, they need a straightforward approach for measuring the emissions from their loans and investments.

It is essential to measure, report and verify GHG emissions in order to set targets and develop strategies to reach those targets. Measuring emissions is not the solution that leads to worldwide emission reduction on itself. Portfolio carbon footprinting is the entry point for investors into the landscape of carbon accounting. Having a good understanding of the basics is essential in the next steps to utilise carbon accounting and associated metrics. These next steps are disclosure to stakeholders, target setting, strategy development, and finally taking action to reduce emissions. Performance on these targets will then again be evaluated using financed emissions measurement. This process is indicated in figure 3.3.

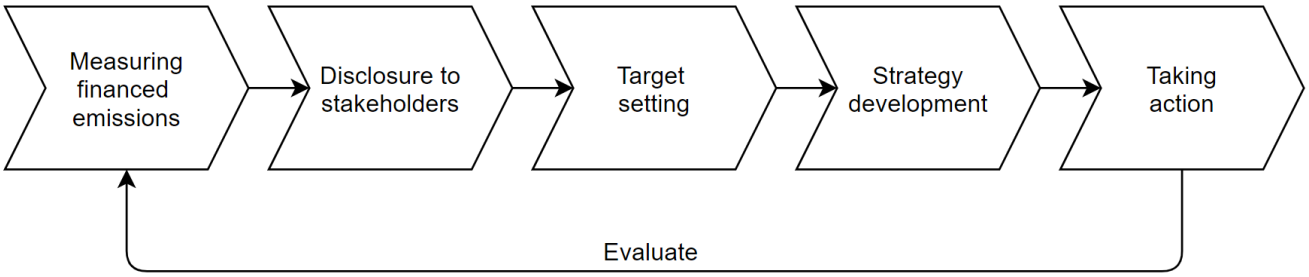


Figure 3.3: Role of carbon accounting and financed emissions in climate portfolio alignment landscape, derived from (PCAF, 2020b)

4 SYSTEM IDENTIFICATION

This chapter tries to condense the existing methods and metrics within the field of carbon accounting. The purpose of different approaches will be discussed to show which method or and metric suits best in a specific use case. New methods and metrics are being developed by data providers, investors, and public and private initiatives in the financial sector. Current academic interest has mostly focused on climate data quality and decisions for estimation models to fill data gaps. In this thesis, the focus lies on the basics and tries to condense the existing methods and metrics.

4.1 ACTORS INVOLVED IN THE CARBON ACCOUNTING FIELD

In order to get a clear overview on how all parties relate to each other a stakeholder analysis was conducted. Carbon footprinting of portfolio's started with equity investments in 2005/2006 and had pioneers in the field of data providers like Trucost, South Pole Group, Ecofys and MSCI (2° Investing Initiative, 2013). In 2014 the UN PRI came around with the pledge for responsible investment. In 2015 the first signs of policymaker interest paid off with the French Energy Transition Law, which included a regulatory obligation for investment managers and asset owners above a specific size to report on their ESG factors. Policymakers are essential in the overall process through legislation around standards and in taking steps towards mandatory reporting on GHG emissions. The Financial Stability Board (FSB) initiated the Task Force on Climate-Related Financial Disclosures (TCFD), which came out with a report in 2017 and a revision in 2019. The TCFD is the leading authority in the field of carbon accounting at this moment. In the current market, the most important stakeholders for carbon accounting methodology development are data providers and several public and private initiatives. These stakeholders play an essential role in the field of carbon accounting, as shown in figure 4.1.

Most of the frameworks developed collect different data points, which they bring together, calculate and report in different ways. This makes the comparison between reporting schemes difficult (Tang & Demeritt, 2018) and hampers the comparability of carbon performance by companies (Andrew & Cortese, 2011). Also, there is no specific framework for the financial sector yet available. The leading initiatives are discussed shortly in this section, and a more comprehensive list can be found in Appendix A. This is used in order to derive the common carbon accounting principles.

4.1.1 The Greenhouse Gas Protocol (GHGP)

The GHGP provides guidelines, reporting and accounting standards, sector guidance and calculation tools for companies, organisations, countries and cities to calculate their GHG emissions and measure the positive effects of emission-reducing projects (WRI & WBCSD, 2013). The GHGP is set up by the World Resource Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). In 2001 they published the first Corporate Standard and this GHGP is nowadays widely used and incorporated globally to measure and manage GHG emissions. The GHGP is not specifically developed for the financial sector; however, their efforts form the basis for most carbon accounting methodologies and are therefore essential to understand.

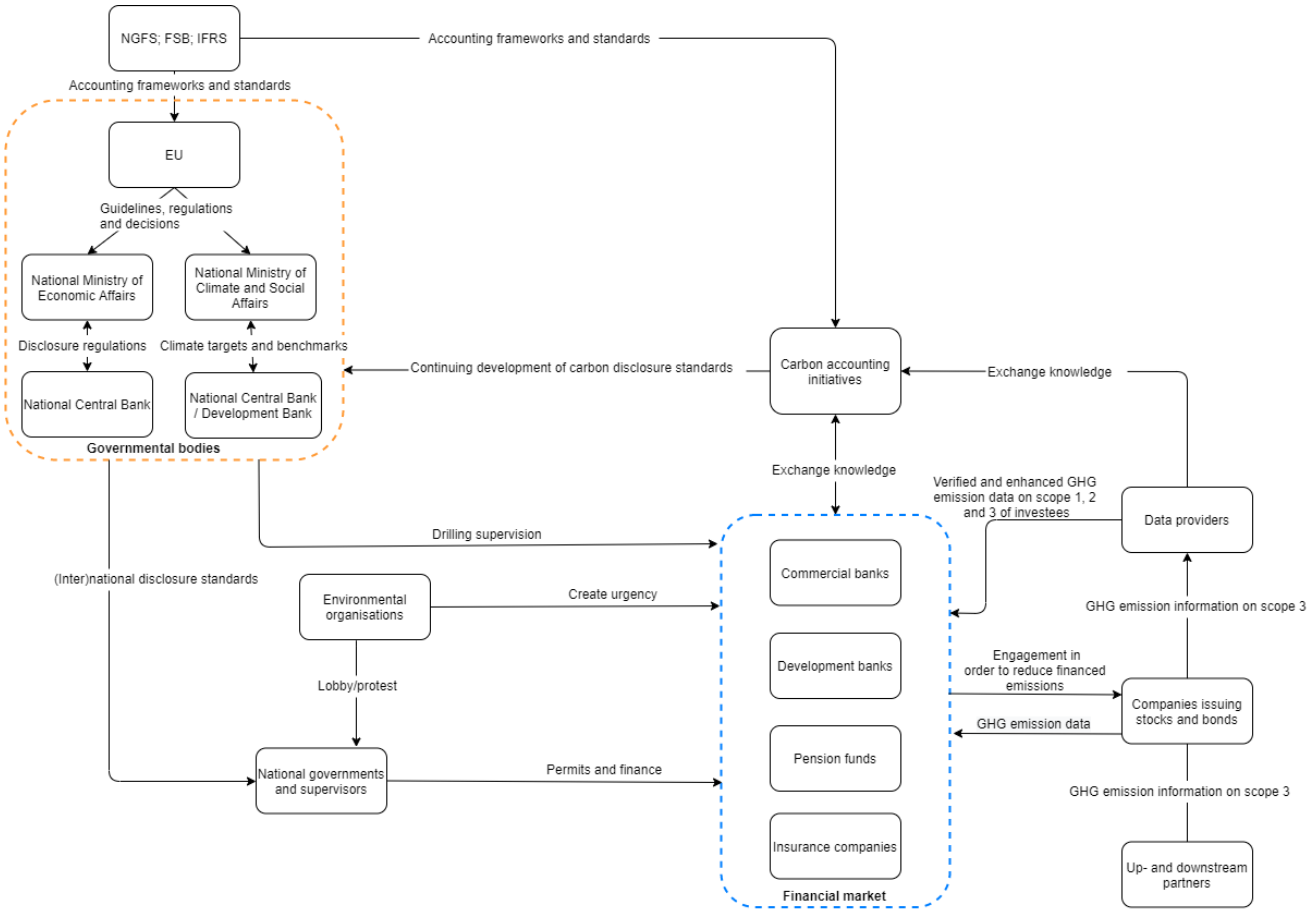


Figure 4.1: Stakeholder diagram

4.1.2 Task Force on Climate-related Financial Disclosures (TCFD)

The TCFD developed a voluntary climate-related financial risk disclosure to enable companies to provide information to financial institutions. The goal is to educate companies in their carbon disclosure and to align their disclosure with investor needs (Quarles, 2019). In June 2017 the TCFD published their final report with recommendations for climate-related financial disclosure. The TCFD recognises the issue of a lacking coherent framework to disclose material information causing missing or incomplete information to make financial decisions as an investor. Moreover, they present recommendations which are based on four thematic areas. In the centre of these areas, as shown in figure 4.2, lie the metrics and targets to assess and manage climate-related risks and opportunities. In order for organisations to disclose in line with TCFD recommendations, they must be able to quantify or qualify the risks and opportunities facing them, linked to climate-related issues, and be able to describe policies, procedures and systems in place to monitor and address climate-related issues on an ongoing basis (Quarles, 2019).

4.1.3 EU Technical Expert Group on sustainable finance (EU TEG)

The European Commission initiated the EU TEG after the completion of the European Green Deal. This expert group developed the Taxonomy, which is a tool to help investors, companies, issuers and project promoters navigate the transition to a low-carbon, resilient and resource-efficient economy (EU TEG, 2019c). The EU Taxonomy is a significant development in sustainable finance and has the ambition to trigger wide-ranging implications for investors working in the EU, and beyond (MSCI,

Figure 4.2: Thematic areas that show and summarize organisations operations (TCFD, 2017)

2019b). The Taxonomy suggests an approach for the coming years, together with the recommendations of the TCFD this forms the basis for the identified metrics discussed in 4.4. The EU TEG presented a legislative plan that is seen as one of the most ambitious plans globally to shift capital into sustainable investments. Their mission is to create a low-carbon, climate-resilient and circular economy. With this aim, their goal is to meet Paris agreement targets in 2030 and to achieve a climate-neutral economy by 2050 in the EU (MSCI, 2019b). This initiative is focused on the EU, but will also influence jurisdictions of outside the EU since these investors need to report for all investments they do, so also organisations outside of the EU. By this means, the expectation is that the aimed effect will spiral down to other regions and sectors. The EU TEG recognises that limiting GHG emissions is the most crucial challenge in the short term to mitigate climate change and contain the rise in temperature to well below 2 degrees (UNFCCC, 2015).

4.1.4 Partnership for Carbon Accounting Financials (PCAF)

The Partnership of Carbon Accounting Financials (PCAF) is a unique collaboration of financial institutions, mostly from the Netherlands and North America but growing into other regions worldwide. This initiative is working on a harmonised carbon accounting methodology divided per asset class. The goal is to develop a method to quantify and assess the emissions the financial institution should account for. The developed methods include nearly all financial products, such as equity investments, bonds, mortgages and project finance (PCAF, 2020b). This group helps financial institutions to assess and disclose GHG emissions. The aim of this initiative is to enable financial institution, with the help of carbon accounting, to disclose emissions at a fixed point in time. This helps the financial sector to provide stakeholders with the understanding of how their investments are contributing to the transition to a low carbon economy. A low carbon economy is seen as an essential step in reaching the Goals of the Paris Agreement (PCAF, 2020a).

4.2 METHODOLOGY BOUNDARIES

From the stakeholder diagram, we can identify three key groups: users of a carbon accounting method, parties that deliver data needed for a particular method and parties setting guidelines and regulations implementing a certain method. The focus here will be on the user to select a most suitable method and improve this according to the identified needs. Therefore the focus will be on methods that are developed for and with the financial sector. Other standards providing guidance on reporting include

the Financial Accounting Standards Board (FASB), Sustainability Accounting Standards Board (SASB), Climate Disclosure Standards Board (CDSB) and Global Reporting Initiative (GRI).

4.2.1 Financial scope

The financial sector is rather complicated and parted in multiple asset classes where ways of financing are categorised. Commonly seen asset classes are project finance, listed equity, corporate bonds and private equity. In this research the focus will be on the two asset classes for listed equity and corporate bonds for two reasons. The first is that these two asset classes combined represent over 60% of total global investor capital. Therefore, it makes sense to start with developing a method to assess GHG emissions associated with these two asset classes in order to make a big impact. The second reason is that data availability for listed companies is much better than in other asset classes. Listed companies are required to publish financial data and since recent legislation and development most of these companies also report on their ESG data and therefore their GHG emissions on a yearly basis. In classical accounting practices these two asset classes stand on their own. However, from a carbon accounting perspective taking these two asset classes makes perfect sense (2° Investing Initiative, 2013). Corporate bonds and equity investments are both represented on a listed company's balance sheet. When allocating emissions both asset classes need to be considered at the same time to avoid double counting and over allocation of emissions. This asset class defines the following investments:

- Common equity, representing the invested value of shares bought on a stock exchange market from a publicly traded company.
- Preferred Equity, representing the invested value of preferred shares. These shares have the advantage of having first claim on dividends and their assets in case of company liquidation. The disadvantage of preferred shares is that they represent a limited voting right within the company.
- Minority interest, representing the invested value by the investors which is less than 50% of the existing shares or the voting rights in the company. Furthermore, they do not have control over the company through their voting rights thereby having very little role in taking the decisions for the company.
- Corporate bonds without known use of proceeds, representing the invested value of loans put out by an investor in a certain company. Loans are a means to raise capital in return for a certain interest rate issued by a company and sold to an investor.

4.3 METHODOLOGY PRINCIPLES

The reviewed methodologies used by the initiatives discussed in appendix A and used by data providers who are discussed in appendix C can be categorised on two different levels. These categorisations are made to identify the methodologies suitable for attribution of GHG emissions to an investment portfolio.

- Historical performance vs. forward looking
- Principle for attribution
  - Balance sheet principle
  - Ownership vs. financier approach

- Stock vs. flow variable
- Absolute vs. normalised outcome

4.3.1 Historical performance vs. forward looking

The first categorisation in methods can be made between backward or forward-looking metrics and indicators. There are roughly three options, where historical trends and point-in-time relate to backwards-looking data, and forward-looking methods rely on some sort of company preparedness analysis to assess their future performance (Transition Pathway Initiative, 2020). Most financed emissions frameworks that currently exist are based on point-in-time data. However, there is a rising interest in forward-looking performance frameworks to make arguable predictions on a companies alignment with global goals to limit the world's temperature rise. Forward-looking indicators are often linked with scenario analysis as seen in practice with the 2 degrees investment initiative, PACTA and TPI. In this research, forward-looking methodologies are seen as most appropriate for target setting and strategy development, as shown in figure 3.3. When it comes to measuring impact and responsibility for a particular climate impact, historical data is most appropriate to use in the step considered as measuring financed emissions (Thomä et al., 2018).

4.3.2 Attribution principles

After defining the focus on backwards-looking accounting data, the allocation of economic activity represented in emissions to financial instruments is the next challenge. This is probably the most complex step since it has no groundwork in traditional accounting frameworks. Two common approaches are identified from reviewed methodologies as the 'portfolio-weight' and the 'balance sheet' approach. The common equation used to account for emissions can be defined as follows:

$$u_f = \sum_{i=1}^{n} \left(\frac{p_i}{a_i} \times u_i\right) \tag{4.1}$$

where u_f is the emission unit allocated to the investment portfolio, p_i is the value of the investment or financial product of company i in the investment portfolio, a_i is the financial metric or allocation factor and determines the weight factor for the allocation, and u_i is the absolute emission unit of the company i. The main challenge is to define a_i, where the other variables are basically represented as total emissions from a company u_i and the invested value in the investor portfolio p_i. The fraction $\frac{p_i}{a_i}$ determines the amount of the total emission unit is allocated to the portfolio.

Balance sheet approach

The balance sheet approach has two options. These options are based on perspective of responsibility. The first option takes the perspective of the owner and the second option takes the perspective of the financier. The main difference can be found in how a_i is defined in formula 4.1.

The first option allocates all economic activities to the equity part of the balance sheet of a company. This approach is used to back-calculate the related emissions to an equity investment. Allocating only to equity is considered the 'shareholder method'. On the balance sheet the value of equity held by the shareholders is represented as the book value. However, when calculating the attributed emissions, a_i is defined as the current value of the shares as market capitalisation. Market capitalisation refers to the total US dollar market value of a company's outstanding shares. Commonly referred to as "market cap," it is calculated by multiplying the total number of a company's outstanding shares by the current market price of one share.

The second method is called the 'financier method'; this considers creditors and shareholders to have equal responsibility for the emissions of a company they invest in. In this method a_i is defined as a sum of the market capitalisation and the debt of a listed company. When allocating emissions to equity and creditors separately, the biggest issue that arises is double counting (allocating the same unit of emissions from economic activity to two different financial instruments). This happens because in practice financial institutions do these calculations separately for equity and debt and therefore allocate emissions twice. The upside of this separately considered allocation is that this allocation approach is not influenced by market prices, since the equity-based ownership can be defined in a percentage of the total available shares. Since the aim of this research is to improve the methodology for allocating emissions to both equity and bonds from listed companies, the financier approach is of most interest.

Stock vs. flow variable

The balance sheet approach is based on market capitalisation, which is considered a stock variable. In literature there is an ongoing discussion about using a stock variable such as market cap or a flow variable such as revenue. Stock variables rely on a single moment in time, where flow variables represent a period of time. A disadvantage of using a stock variable is the volatility on a short time period due to possible day-to-day changes on the stock market. However, with the use of a flow variable, companies with a higher revenue stream in the same sector appear to be more sustainable than their peers purely based on differences in their retail price instead of their exposure to climate-related impact. As will be shown in 4.4 this distinction is of key importance for the differences between two of the most applied metrics in the current field.

4.3.3 Normalisation principle

Normalisation plays an important role in creating performance benchmarks for carbon accounting and normalisation allows to compare investor portfolios. Equation 4.1 represents the emissions unit allocated in absolute value. Bigger portfolios are expected to have a higher emissions output than smaller portfolios since they invest more capital and have therefore bigger responsibility over emissions from the companies they invest in. In order normalise the footprint to allow for comparison between investment portfolios the following accounting principle is used.

$$cl_f = \frac{\sum_{i=1}^{n} (\frac{p_i}{a_i} \times u_i)}{\sum_{i=1}^{n} g_i} \tag{4.2}$$

In equation 4.2 cl_f represents the normalised climate impact of the portfolio and g_i is the normalisation factor. Applying this principle results in a relative carbon footprint. The first normalisation factor that can be applied is based on company activity and economic units such as barrels of oil or tonnes of steel produced. This normalisation principle based on units is the more common way of normalisation. However, this approach does not allow for portfolio-level aggregation where comparison over multiple sectors is required as is the case when analysing financial institutions. Therefore, only the second approach is considered in this research. This approach uses portfolio size to define emissions per million dollar invested. This approach takes into account the investor's portfolio size and allows for comparison between portfolios. The normalisation factor in this case will be the total invested value of the portfolio in million of dollars.

4.4 CURRENT CARBON DISCLOSURE METRICS

To select a set of metrics to investigate further, there is a need to scope down the methods into asset classes. Asset classes are a classification system for financial products to divide a portfolio into different categories. The most common asset classes are equity, bonds, cash and cash equivalents, real estate and project finance. In this research, the focus is on listed equity and corporate debt (bonds); therefore only metrics will be considered covering one or both of these asset classes focusing on the balance sheet approach. Another distinction that is made is between absolute and normalised measurement of portfolio GHG emissions. Absolute emissions are measured in tonnes CO2 equivalent and normalised metrics are divided by a monetary value such as revenue or portfolio size as explained in 4.3.3.

4.4.1 Absolute metrics

The first effort to measure financed emissions was made by the World Research Institute and the World Business Council for Sustainable Development. In their technical guidance, known as the Greenhouse Gas Protocol, an emission attribution calculation for equity investments is presented (WRI & WBCSD, 2013).

$$\begin{aligned} &Emissions\ from\ equity\ investment\ = \\ &\sum_{i=1}^{n}(Scope\ 1\ and\ scope\ 2\ emissions\ of\ equity\ investment_i * \ Share\ of\ equity\ (\%)) \end{aligned} \tag{4.3}$$

In this equation, a financial institution gets a percentage of the total emissions from the investee attributed based on their ownership. The ownership is defined by the amount of shares that are owned of the total shares outstanding. Building on this idea presented by the GHGP, the TCFD expands this with a set of four main metrics to assess climate impact from an investment portfolio (TCFD, 2017). All these metrics consider a financial part and an GHG emission part recovered from the investee. The emission part is always referred to as $issuer's\ GHG\ emissions_i$. This can contain the emissions from scope 1, scope 2 and/or scope 3. In this thesis only scope 1 and scope 2 are considered in the $issuer's\ GHG\ emissions_i$, when not mentioned otherwise. The first metric of the TCFD is the absolute metric and is discussed in this section. The other 3 are normalised metrics and will be discussed in 4.4.2. The first metric forms the basis of all other metrics and represents the portion of GHG emissions linked to an investment as a total amount. This metric is based on the same idea as equation 4.3, only presented differently. The TCFD defines this as Total Carbon Emissions (TCE) associated with a portfolio, and is expressed in tons [CO_2-equivalents] CO_2e. The TCE is calculated according to the following formula:

$$\sum_{i=1}^{n}\left(\frac{Current\ value\ of\ investment_i}{issuer's\ market\ capitalisation_i} * (issuer's\ GHG\ emissions)_i\right) \tag{4.4}$$

The i refers to each individual investment in an investors portfolio. Therefore it can be seen as a calculation of all separate investments that are added together. This metric is relatively easy to compute and is specifically useful to align a portfolio to the GHG protocol and follow efforts in absolute carbon reduction over time. The fraction in equation 4.4 can be interpreted as a weight to divide the GHG emissions of the investee. This is in line with the attribution principle described in equation 4.1. In the TCE metric, the weight is computed by dividing the total equity investment of the investor and the total market capitalisation of the investee. This metric can be used to narrow down the emissions gap and to assess the absolute portfolio performance. Absolute, in this context, means that the emissions are expressed in tonnes of CO_2-eq without any further computation. The downside of this is that portfolio growth is not taken into account. The second issue is that in this form, the metric uses ownership

perspective and can, therefore, only be used to assess equity portfolios. The main advantage of this metric is that it represents the most literal carbon footprint from GHG accounting perspective, and the absolute number can be used for carbon offsetting.

4.4.2 Normalised metrics

The other three metrics presented by the TCFD are all normalised metrics. The metrics that will be discussed in the section below are the Carbon footprint (CFP), Carbon Intensity (CI), and weighted average carbon intensity (WACI).

Carbon footprint (CFP)

The CFP metric can be seen as an addition or extension to the TCE metric, which means that formula 4.5 is an operationalisation of formula 4.2. It normalises the TCE by the total portfolio value (commonly expressed per 1M dollars). This results in the unit [tonnes CO_2e/$M invested] and is defined by the following equation:

$$\frac{\sum_{i=1}^{n}\left(\frac{Current\ value\ of\ investment}{issuer's\ market\ capitalisation} * issuer's\ GHG\ emissions\right)}{Current\ Value\ of\ portfolio\ \$M} \tag{4.5}$$

In equation 4.5 it can be seen that the numerator has the same expression as the TCE metric. The main advantage of normalising the TCE by portfolio value is that the CFP becomes a metric that makes portfolio comparison between different investors possible. Also, the normalisation by portfolio value is commonly applied by investors in the financial sector. Moreover, this metric allows for portfolio decomposition and attribution analysis. However, this metric also has its limitations. It does not take into account the size of companies invested in by the financial institution. This is a limitation because in general lager companies produce and therefore emit more than smaller companies. Since this metric also takes into account only market capitalisation, it is only applicable to equity portfolios. The CFP is normalised by the portfolio value, which can fluctuate with market changes and is therefore sensitive for other influences than emission changes.

Carbon intensity (CI)

Carbon intensity (CI) is a metric used to express the carbon efficiency of an investment portfolio. This metric allows financial institutions to measure the amount of GHG emissions per revenue of the companies in the portfolio over time. Efficiency at a company level is normally best expressed by using sector-specific measures like tons of steel, distance travelled or generated power. In this case sales are seen as the best available measure since comparison happens across industries. The CI metric is expressed in [tonnes CO_2e/$M] and is computed as follows:

$$\frac{\sum_{i=1}^{n}\left(\frac{Current\ value\ of\ investment}{issuer's\ market\ capitalisation} * issuer's\ GHG\ emissions\right)}{\sum_{i}^{n}\left(\frac{Current\ value\ of\ investment}{issuer's\ market\ capitalisation} * issuer's\ \$M\ revenue\right)} \tag{4.6}$$

As shown in equation 4.6, the CI metric is slightly different from the Carbon Footprint metric. Where the carbon footprint uses the portfolio value of the investor the Carbon intensity metric uses the share of revenue the investor owns. The share of revenue is defined in the same way as the share of emissions is defined and leads to an emission intensity of GHG emissions per dollar revenue theoretically owned by the investor based on the equity share. The main advantage of this metric

compared to the previous ones is that this statistic takes into account the size of the companies the financial institution has invested in. Therefore 4.6 can be used to compare portfolios against each other, regardless of the portfolio size. It can be used to assess how carbon-intensive the companies are the financial institution invested in. This is different from formula 4.5 where only the portfolio itself is taken into account. The downside of this metric is that it is a more complex calculation and harder to communicate to and understand by stakeholders. Also, this metric has the same disadvantage of using the ownership perspective and therefore, only applies to equity portfolios.

Weighted average carbon intensity (WACI)

The fourth metric the TCFD describes is the weighted average carbon intensity (WACI). The WACI is the most meaningful metric according to the TCFD and represents the "portfolio exposure to carbon intensive companies". The WACI is recommended to use when expressing the financial carbon intensity. The WACI is computed by the following expression:

$$\sum_{i=1}^{n}\left(\frac{Current\ value\ of\ investment}{Current\ Value\ of\ portfolio} * \frac{issuer's\ GHG\ emissions}{issuer's\ \$M\ revenue}\right) \tag{4.7}$$

The WACI differs from the Carbon footprint and Carbon Intensity metric since it is not based on any ownership within the invested company. In this metric the carbon intensity of a company is defined by the emissions per million dollar revenue. The left fraction of equation 4.7 determines the weight that is used to calculate the portion of emissions the investor should be accounted for. The right fraction expresses the carbon intensity of the company determined by CO_2e per \$M revenue. The weight used to allocate the GHG emissions is based on portfolio weight instead of ownership, like in the other carbon footprinting exposure metrics. For this reason, the metric is also more easily applicable across asset classes. The calculation is straightforward and it enables attribution analysis and portfolio decomposition. The main disadvantage of this metric is that it does not show any measurement of investor responsibility for an amount of GHG emissions making it less suitable for allocation purposes. Another important note to make is that this metric is the essence is very similar to the CFP. When rewriting the WACI equation it shows that it can be expressed in the same way as the CFP:

$$\frac{\sum_{i=1}^{n}\left(\frac{Current\ value\ of\ investment}{issuer's\ revenue} * issuer's\ GHG\ emissions\right)}{Current\ Value\ of\ portfolio\ \$M} \tag{4.8}$$

From this perspective it can be argued that this metric only differs by using revenue as the financial unit for emission allocation and portfolio value is used for normalisation. From this perspective using revenue as an allocation principle will lead to incomplete allocation since invested value and revenue do not do not add up.

4.5 SYNTHESIS OF CHAPTER 4

This chapter started with the scope and boundaries for the researched methodologies and metrics to assess climate impact of investment portfolios. The focus on the asset class for listed equity and bonds was defined together with the components associated with this asset class. To address the first research question *"Which approaches are currently in place to define the climate impact of an investment portfolio?"* it can be concluded that there are many approaches leading to very different outcomes. The most important in this varying set of approaches is to constantly focus on the use case of a specific situation. In this thesis the focus is on the allocation of emissions to loans and investments and

therefore only historical based approaches are relevant. Forward looking approaches are relevant in the case of assessing a chosen strategy to predict if the strategy is enabling the financial institution to reach the targets they committed to. This is relevant in step 4 and 5 of the climate portfolio alignment as explained in figure 3.3.

When using an approach based on historical data there are several ways to allocate emissions. When analysing these attribution principles it becomes clear that using a balance sheet approach is the most appropriate when the use case is emission allocation. In order to allocate emissions to both equity and bond investment the financier method is chosen, where the amount of investment has an equal responsibility for both equity investments and bond investments.

Metric	Financial product p_i	Financial metric a_i	Normalisation factor g_i
CFP	Invested equity	Market capitalisation	Total portfolio size in equity
WACI	Invested equity	Revenue	Total portfolio size in equity
CI	Invested equity	Market capitalisation and revenue	
EVIC	Invested equity and bonds	Enterprise value including cash	Total portfolio size in equity and bonds
BST	Invested equity and bonds	Balance sheet total	Total portfolio size in equity and bonds

Table 4.1: Differentiation in the metrics based on the financial metric used to attribute emissions and the input value of the investment

The second part of this chapter is focused around the actual metrics that are found in practice. The metrics are divided into absolute metrics with an outcome in absolute GHG emissions and metrics based on the normalisation principle. The discussed metrics address research question 2 *"What are the most commonly used metrics for carbon accounting and what are their advantages and disadvantages?"* and are seen as the most used metrics in practice. The total carbon emissions (TCE) metric represents the actual total emissions and carbon footprint of an investment portfolio. This gives the most literal representation of the impact a portfolio has and allows the financial institution to align their portfolio according with the guidance in the GHG protocol. The limitations are the inability to use this metric for portfolio comparison, since the portfolio size is not taken into account. The 3 normalisation metrics discussed do have the ability to compare portfolios amongst each other. All three serve different purposes and have their own pro's and con's as presented in table 4.2. The takeaway of this table is not to put one metric above another, but to address shortcomings and highlight the advantages of certain metric. This should enable the user to judge which metric is most suitable for the use case at hand. A more detailed discussion on metrics linked to the appropriate use case is part of the discussion section in chapter 8.

	Carbon footprint (tons CO_{2e} / $M invested)	**Carbon intensity** (tons CO_{2e} / $M revenue)	**Weighted average carbon intensity** (tons CO_{2e} / $M revenue)
Purpose	Presents the normalised carbon footprint per invested dollar	Presents the portfolio efficiency in terms of GHG emission per sales	Presents the exposure to carbon intensive investees
Pro's	- Portfolio comparison possible - Commonly applied by investors - Allows for portfolio decomposition and attribution analysis	- Takes into account the company size of the investee - Portfolio comparison possible - Allows for portfolio decomposition	- Applicable across asset classes - Relatively easy data availability - Allows for portfolio decomposition and attribution analysis
Con's	- Ownership perspective, thus can only be used to assess equity portfolios - Fluctuate with market changes - Does not take into account company size of investees	- Ownership perspective, thus can only be used to assess equity portfolios - More complex calculation and harder to communicate	- Does not show any measurement of investor responsibility - Sensitivity to extreme cases

Table 4.2: Carbon footprint exposure metric overview

5 SYSTEM ALTERNATIVES

This research aims to compute a carbon footprint metric that can include both equity investments and debt investments to circumvent the issue of most metrics that can only be applied to equity portfolios. Also, this metric needs to be robust for market fluctuations and should still be able to give a good representation of emissions attribution. In order to do so, it is important to get a view on the requirements in order to create and assess alternative metrics.

5.1 SYSTEM REQUIREMENTS

To construct these criteria and to guide the first part of this research, the approach from Sage and Armstrong (2000) is applied using the systems engineering perspective. They define systems engineering as follows: systems engineering is the management technology that controls a total system life-cycle process, which involves the definition, development, and deployment of a system that is of high quality, trustworthy, and cost-effective in meeting user needs (Sage & Armstrong, 2000).

As Sage and Armstrong describe in their view on system development: "*A successful design and development must be broadly responsive to client needs and requirements.*" Sage and Armstrong (2000, p. 47). The main stakeholders are described in chapter 4 in figure 4.1. Here the conclusion was drawn to focus on the main user of the system, namely the financial institutions. To identify the needs, a combination of desk research, literature study and interviews has been used. From this analysis, 19 needs were identified. Naturally, these needs have much overlap and were condensed into the seven most representative criteria. These seven criteria are explained below. The full list of needs can be found in appendix D and the full list of interviews with financial institutions and data providers can be found in appendix **??**.

1. Practicability
    - The method and underlying data should be understandable for all parties and practical to implement.
2. Consistency
    - The method should have an output of results that are timely and give a current understanding of the situation. Users of the information output want to track emissions over time. A consist system enables the user to identify trends and make a **meaningful** assessment of the performance of a company over time. Consistency is an essential need for the user when it comes to **comparability** over time.
3. Accuracy
    - The method should aim for allocation of 100% of the investee emissions. When 100% of the GHG emission are allocated, also all emissions are accounted for in terms of responsibility. When the allocation becomes to fragmented and detailed this can negatively influence the accuracy of allocation. This enhances the **credibility** of the decisions. Note that this will always be dependent on quality of the data. Secondly, it is important to emphasize that accuracy relates to the attribution itself and not the accuracy of the attribution factor.

4. Comparability
    - The method should produce results that allow comparison between asset classes for listed equity and corporate bonds. Also, the method should allow for comparability between financial institution portfolios.
5. Transparency
    - Information should be provided on the key assumptions and methodologies used to assess climate progress, so the reader knows how to use the information and its limitations. Third parties should be able to verify the reported information and come to the same outcome.
6. Robustness
    - The method should produce results that are not clouded by external effects. Impact of these external effects, such as market cap fluctuations or exchange rate changes, should be minimal. This also include adaptability of the **methodology** and **timeliness**.
7. Context
    - Where possible, metrics should be compared to values outside the bank's portfolio, such as ratios in the regional economy and required financing to meet global policy goals. The method should also align with the upcoming policy frameworks.

Using these criteria, the current identified metrics from chapter 4 are assessed using the priority check-mark method described by Dym, Little, and Orwin (2002). This selection method ranks the criteria as high, medium or low in priority. When a criterion is met, the method will receive 1, 2 or 3 check-marks based on the priority. The advantage of this method is the ease to use and the high level of understanding from users. The following metrics are considered during the assessment. Note that the emission attribution based on market capitalisation from the GHGP expressed in equation 4.3 is not in the list since this metric is computed in the exact same way as the total carbon emissions metric from the TCFD expressed in 4.4.

- Total carbon emissions as described by the TCFD (TCE).
- Carbon footprint metric as described by the TCFD (CFP).
- Carbon intensity metric as described by the TCFD (CI).
- Weighted average carbon intensity metric as described by the TCFD (WACI).

5.2 CURRENT SHORTCOMINGS

From table 5.1 and the detailed review of the metrics in chapter 4, it becomes clear that there are some evident shortcomings in the existing metrics.

- **Practicability** is not an issue for any of the metrics. All methods have good availability of underlying data. Also the computation of these metrics is easy and practical to implement.
- **Consistency** is not an issue in current metrics. As long as the user consistently applies one metric, there is no issue. However, it could be the case a user decides to switch to another metric. In this case the switch for previous years also has to be made for the new approach.

- **Accuracy** Using a metric based on market capitalisation will result in over allocation as described in chapter 4. However, the representation of ownership in this method is accurate. Using the CI and WACI method result in lower accuracy due to the use of revenue, which can fluctuate year-on-year and does not accurately result in an emission allocation.
- **Comparability** is a major issue for metrics that are based on attribution by market capitalisation, which is the case for the TCE and CFP. Using revenue instead of market capitalisation allows for comparison but has issues on its own. Revenue does not ensure 100% emission attribution and therefore less suited to use for answering the responsibility question financial investors have. Also, there is a bias towards companies producing luxury goods.
- **Transparency** is only an issue when using the Carbon Intensity metric, where this metric is harder to communicate and understand for third parties.
- **Robustness** is not an issue when the metric is based on market capitalisation. In this approach the allocation is purely based on ownership percentage in the equity of the company and is therefore not sensitive to market influences.
- **Context** wise there is a lot of attention for the WACI and developments for the use of enterprise value. Allocating emissions only to equity is not considered to be a sustainable approach for the coming years. However, the Carbon Footprint metric can still be considered only with incorporation a new approach for combined listed equity and bonds.
- Majority of the metrics are only applicable to equity portfolios. When emissions are also allocated to debt investments double counting occurs. This causes an over-allocation in total emissions from the companies invested in.
- Investors are dependent on investees in terms of underlying data. The reliability of emissions data is in some cases questionable. Especially quality on scope 3 data is lacking. This issue is not being solved by methodology improvement. However, this is a big issue in the field of carbon accounting and will therefore be discussed in chapter 6. This issue is addressed using interviews with data providers with a focus on improving and expanding data on GHG emissions from organisations.

Criteria	TCE	CFP	CI	WACI
Practicability	✓	✓	✓	✓
Consistency	✓	✓	✓	✓
Accuracy	✓	✓	×	×
Comparability	×	×	×	✓
Transparency	✓	✓	×	✓
Robustness	✓	✓	×	×
Context	×	✓	✓	×

Table 5.1: Metric assessment against system criteria

Table 5.1 emphasises there is no ideal metric to match all the seven criteria. The assessment of the criteria is done in a more qualitative manner and without putting weights on the separate criteria. This is considered the right approach because weights per criteria will change depending on the purpose of the user. Even though the impression might be created, this assessment is not absolute. The general approach of the check mark method is applied because a more detailed scoring is rather impossible with the available data. The takeaway from this table is that depending on what a user finds the most important criteria. The most appropriate metric for that user can be identified.

5.3 ALTERNATIVE METHODS

In the currently used methods, 100% of emissions are attributed to equity. However, financial institutions also provide loans, which are not taken into account in the existing metrics. In case a method is prescribed for debt separately, it will cause the effect of over-allocation (double-counting). On the other hand, it is proposed and often applied to attribute over revenue (carbon intensity) instead of market cap, but in this case, you can not make sure 100% of emissions are allocated as discussed in 4.4.2. Three alternatives are proposed for emission attribution for a combined asset class of listed equity and corporate bonds. These three alternatives originate from different sources. The first alternative bases itself on a new attribution factor, Enterprise Value, and finds its origin in work from the European expert group on sustainable finance (EU TEG, n.d.). The second approach is based on a well known factor in finance used for a variety of metrics, balance sheet total. This factor was not used for emission attribution metrics, but is now proposed as an option by Thomä et al. (2018). The third alternative originates from practice and has been elaborated in discussion with thesis internship supervisors and interviewee organisations. The alternatives are listed below and further explained throughout this chapter, including their advantages and disadvantages. At the end of the chapter, the alternative metrics are added to the assessment matrix for the 7 selected criteria.

- Allocation by enterprise value (including cash)
- Allocation by balance sheet total
- Separate allocation for equity and debt with a weighting afterwards

5.3.1 Enterprise value (including cash)

Enterprise value is an indicator commonly used in the accounting world for assessing a company in case of a merger or takeover. It gives a comprehensive indication of the company's value including the equity market value, current short-term and long-term debts and cash and cash equivalents on the balance sheet. The EU technical expert group on sustainable finance defines the enterprise value in general as the sum of the market cap at fiscal year-end plus the book values of all debts minus the cash and cash equivalents (EU TEG, 2019c).

$$Enterprise\,value = Market\,cap + Total\,debt - Cash\,(and\,cash\,equivalents)$$

However, the classic approach of enterprise value where cash is subtracted does not work from a carbon accounting perspective. Normally cash is subtracted to artificially pay off debts when assessing a company's value. In the case of allocating emissions, cash subtraction leads to imperfect allocation as shown in table 5.2 and could even lead to negative enterprise value. Therefore, enterprise value including cash (EVIC) was introduced to solve this issue and to be able to strive for 100% allocation of emissions.

The computation into EVIC is also supported by the PCAF group, and the EU TEG advises this as well in their handbook of climate transition benchmarks (EU TEG, 2019b). The EVIC can be defined as the sum of the market capitalisation of ordinary shares at fiscal year-end, the market capitalisation of preferred shares at fiscal year-end, and the book values of total debt and minorities' interests.

$$\begin{aligned} Enterprise\,value = {} & Market\,cap + Market\,value\,of\,preferred\,shares\,outstanding \\ & + Book\,value\,of\,debt + Book\,value\,of\,minority\,interest \end{aligned}$$

Enterprise value including cash is a financial metric that is not used in financial accounting and is a term only introduced in carbon accounting since the last year. No literature exists on enterprise

Approaches	Enterprise value	Attribution to Equity investment	Attribution to debt investment	Total attribution
Standard EV (subtracting cash)	50 + 50 − 10 = 90$M	50/90 = 56%	50/90 =56%	>100%
EVIC as defined in this thesis	50 + 50 = 100$M	50/100 = 50%	50/100 = 50%	100%
EV variant with adding cash	50 + 50 + 10 = 110$M	50/110 = 45%	50/110 = 45%	<100%

Table 5.2: Example calculation for company X with Equity = 50$M, Debt = 50$M, Cash = 10$M

value including cash. This asks for the need to accurately describe the components of EVIC and the associated balance sheet items. The equation for EVIC can be broken down into four parts:

1. **The market capitalisation** is the sum of ordinary shares outstanding multiplied with the ordinary share price at fiscal year-end on the stock exchange. Outstanding shares can be found on the balance sheet, and typically the share price for fiscal year-end is reported in the balance sheet too. When the fiscal year-end share price is not reported in the balance sheet, it can be found by using Yahoo Finance, or similar open-source databases.

2. **Market value of preferred shares outstanding** is the sum of preferred shares outstanding multiplied with the preferred share price at the moment in time. Normally the value of preferred shares can be found on the balance sheet between liabilities and equity and is often called preferred equity. When the fiscal year-end preferred share price is not reported in the balance sheet, this can be found using Yahoo Finance, or similar open-source databases.

3. **Book value of debt** can be calculated as follows:

$$\begin{aligned} \textit{Book value of debt} = \textit{Notes payable} + \textit{Current portion of Longtermdebt debt} \\ + \textit{Long term debt} + \textit{Current portion of leases} + \textit{Long term leases} \end{aligned}$$

   The following items are found on the current liabilities section of the balance sheet:

   - Notes payable, any short term interest-bearing debt reported under the current liability section of the balance sheet. Other terms that may appear on the balance sheet that should be included under notes payable are promissory notes, loan contracts, short-term borrowings, amongst others.
   - Current portion of long term debt and debt
   - Current portion of leases

   The following items are found on the long-term liabilities section of the balance sheet:

   - Long-term debt
   - Long term leases

4. **Book value of minority interests** (sometimes called Non-Controlling interest), which represents ownership of less than 50% in a company. Minority interest is classified as a non-current liability and shows up on the balance sheet of the company that owns a majority interest in the company.

Possible differences in EVIC based on accounting standard

Carbon disclosure requires a global standard, and financial institutions may use different accounting standards. The two commonly used standards are US GAAP, typically used in the United States, and IFRS, which is typically used in the rest of the world. The two standards have been converging over time; however, there are still differences that can cause differences in EVIC based on whether it's calculated per US GAAP or IFRS.

1. **Leases**
   Historically companies could classify leases into capital leases and operating leases. All capital leases are included on company balance sheets and are included in the calculation for the book value of debt. There were provisions for companies to keep a part (or all) of their operating leases off-balance sheet (Damodaran, 2011). However, in 2018, global accounting including the FASB and the IASB, which lay out the accounting rules for GAAP accounting and IFRS accounting, tightened and aligned requirements for operating leases reporting on the balance sheet. Currently, all leases (capital and operating) must be reported on the balance sheet, unless the lease is shorter than 12 months (FASB, 2016; IFRS, 2019). In the definition of this thesis, all leases shown on the balance sheet are included in calculating book value of debt. No adjustments to book value of debt have to be made for companies that report according to IFRS or GAAP.

2. **Reporting sections**
   Table 5.3 includes reporting differences between IFRS and U.S. GAAP for certain components used to calculate EVIC.

	IFRS	US GAAP
Preferred shares	Typically classified as a liability	Typically classified as equity
Minority interest	Reported as equity	Reported either as a non-current liability or as equity
Leases (both long-term leases as current portion of long-term leases)	Leases may be reported separately on the balance sheet or as part of the long-term debt and current portion of long-term debt.	

Table 5.3: Reporting differences between IFRS and U.S. GAAP

Enterprise value including cash (EVIC) solves the issue of double-counting and enables allocation of emissions to both debt and equity. Discussion with this enterprise value is that now the weight on equity investment and debt investment is the same. For 1 million dollars invested debt, investors get the same emission return as from 1 million dollars invested in equity. Criticism on this definition is that equity and debt do not have the same weight in terms of responsibility and therefore accountability. Some would argue that equity holders have more influence in a company and should therefore be responsible for a more significant emission share. However, one could also argue that a financial institution providing a debt could do the same consideration when buying stock in a particular company. The initial decision is made with the same knowledge about a particular company. Also, it is easier to reclaim an outstanding debt than to sell all the stock investors have invested within a company. In this perspective, financial institutions holding debt in a particular company can still pressure the business to improve their efforts for sustainability. However, it should be noted that by the use of market capitalisation the weight on the equity investment is generally larger than in the case of using equity book value.

The second point of criticism on using the enterprise value is the influence of market fluctuation. This issue occurs now debt and equity are summed in the denominator of the equation. When the

stock value of a company increases or decreases, the debt value remains the same. This causes the emissions attributed to equity and debt to change. When the stock value increases the denominator increases, but the invested value from a debt stays the same. Meaning the attributed emissions to debt will decrease when equity increases and the emissions increase when equity decreases. The same goes for invested equity but then the inverse effect. This phenomenon is criticised because emissions change due to market fluctuations instead of actual emission reduction. Mitigating these external effects will be investigated in chapter 6 where the alternative metrics will be tested on a real data sample portfolio.

5.3.2 Balance sheet total

Balance sheet total is a commonly used indicator in the financial sector. Balance sheet total represents the total liabilities and total equity on a balance sheet. It is also often referred to as 'Total Assets'. This is calculated as follows:

$$Balance\ Sheet\ Total = Total\ Liabilities + Total\ Equity$$

Total liabilities include both current liabilities and long-term liabilities. Total equity includes all forms of equity like common stock, preferred stock and minority interest's. The balance sheet total can be found on the balance sheet as 'Total Assets' or can be computed with the underlying components as described above.

Balance sheet total allows for allocating emissions to both equity and debt investment without double counting. The main advantages of using the balance sheet total are (1) the accessibility of the required data and (2) is the relatively low market volatility due to the use of book value from equity. The book value of a share is much less volatile compared to the market value of a share. Moreover, the market value is often of greater value. This value difference is expressed in the price-to-book-ratio. This ratio was 3.53 end of year 2019 according to the S&P 500 index. On the downside this ratio already indicates that the weight on debt investors when allocating emissions is much higher than in case the market value of equity is used. This strengthens the criticism in the discussion about appreciating equity in contrast to debt investments. The second downside of using balance sheet total is that in this approach also short term debt is included. The biggest issue here related to the balance sheet item 'accounts payable'. This represents the short term creditors a company still has to pay money to. This can fluctuate heavily depending on the date of the portfolio assessment. Also, this part of the balance sheet complicates the allocation of emissions. In theory this will mean that every creditor of a company gets attributed a portion of the emissions in order to achieve 100% attribution. For most organisation this is will be an impossible process when bringing into practice.

5.3.3 Separate allocation and weighting

A third alternative approach is to use a separated allocation for both debt and equity investments and make a weighting afterwards to avoid double counting of emissions when allocated to the investor. Equity investments will be allocated by using market capitalisation and debt investments will be allocated to the total debt position of a company. With this approach allocation is based on an ownership percentage, where no side effect from market fluctuations play a role. The only influence comes from a changing amount of total debt by attracting more capital or paying off a debt and for equity the influence is seen in total shares outstanding. Both these effects are considered desired since it changes the responsibility of the investor in the company, which should be reflected in the footprint of the investor. After this process 200% of the investees GHG emissions are allocated and a weight process should be applied to quantify the actual emissions an investor gets allocated for the portfolio carbon footprint. This weighting process is the most challenging of this alternative and has the need for an

extra discussion into the responsibility question for an equity or debt investment. From an accounting perspective the most straightforward approach is to use an weight factor based on the ratio of equity and debt within the investee. When 80% of the company is financed with equity and 20% with debt the wight factor for equity holders will be 0.8. It is important to recognise that the results will be the same as in the BST approach, when using equity book value and total liabilities. And the same when using the EVIC approach, when using market value for equity and total debt. Only in this process an extra step is added in the allocation process.

However, the decision can be made to exploit this alternative further and develop a new weighting process based on a deep-dive into responsibility factors between equity and debt. This can include levels of voting right, ease of retraction from the invested amount and many more factors. This direction is considered out of the scope of this research. Since the results are the same when the calculation is made as with the BST and EVIC approach this alternative is considered irrelevant to uphold for the remaining of this research.

5.4 ALTERNATIVES SCORING

First a short recap on the three considered alternatives is presented. From the discussion above it can be concluded that only the first two alternatives will be considered for the remaining of this research. The differences between both approaches are mainly in the balance sheet items the alternatives use to compute a level of responsibility and financier ownership. These choices lead to a significantly different output when allocating emissions. Table 5.4 shows a simplified but accurate example of the difference in outcome when using either enterprise value including cash or balance sheet total. It becomes clear that EVIC puts more weight on equity holders compared to the BST principle. The assessment of the two remaining alternatives is done by using the same criteria and is presented below.

EVIC	Market cap	Book value of debt (interest-bearing debt)	EVIC	Invested Value (owned shares = 100)	Allocated emissions
Equity	10000	4000	14000	1000	**71.4**
Debt	10000	4000	14000	400	**28.6**
BST	Book value equity	Total liabilities	BST	Invested Value (owned shares = 100)	Allocated emissions
Equity	5000	5000	10000	500	**50**
Debt	5000	5000	10000	400	**40**

Table 5.4: Simple calculation example using EVIC and BST for investee with shares out=1000, share value book=5, share value market=10, emissions=1000

- **Practicability** is not an issue for the alternative metrics. However, it should be acknowledged that in the case of using EVIC several components need to be extracted from a companies balance sheet in order to compute EVIC. When this metric becomes a more general approach this issue will probably be resolved on its own. Just like metrics as balance sheet total, market capitalisation, etc. the EVIC will then be provided by investees or data providers. The availability of data is for both metrics not an issue. However, when considering other asset classes besides listed equity this availability can change. Also the computation of these metrics is easy and practical to implement.

- **Consistency** can be found in both alternatives. As long as the user consistently applies one and the same metric consistency will be safeguarded. In the case of using EVIC consistency in application of the underlying components is a point of attention, however not specifically challenging. It could be the case a user decides to switch to another metric. In this case the switch for previous years also has to be made for the new approach.
- **Accuracy** of the GHG allocation will be most complete when using the EVIC metric. All relevant financiers (meaning financiers that are considered to finance the operational capital) are held responsible for their portion of GHG emissions from the investee. Using this metric brings the allocation closest to 100% in theory. When using BST the allocation is less accurate and because of the inexhaustible list of debt holders an investee can hold the practical side of allocating emission is a challenge.
- **Comparability** between investors is relatively improved when using EVIC or BST. The alternatives enable investors to compare both equity, debt and mixed portfolios for listed equity and bonds investments. This improves the representation of the emissions an investor finances compared to the conventional metrics.
- **Transparency** is no issue for both alternatives. The application is straightforward and easy to communicate to and understand for clients and other stakeholders.
- **Robustness** of the alternatives needs further investigation. In chapter 7 the alternatives are applied on a sample investment portfolio in order to test robustness.
- **Context** considered both alternatives are in line with new frameworks that are being developed. Especially EVIC is getting lot of attention from several groups including the EU Technical Expert Group for Sustainable Finance. This metric is considered to have potential so solve the issue for double counting in the conventional methods. Balance sheet total is often mentioned as a back-up when EVIC cannot be calculated. This limitations is mostly associated with other asset classes, such as private equity.

Criteria	TCE	CFP	CI	WACI	EVIC	BST
Practicability	✓	✓	✓	✓	✓	✓
Consistency	✓	✓	✓	✓	✓	✓
Accuracy	✓	✓	×	×	✓	×
Comparability	×	×	✓	✓	✓	✓
Transparency	✓	✓	✓	✓	✓	✓
Robustness	✓	✓	×	×	?	?
Context	×	✓	✓	✓	✓	×

Table 5.5: Metric assessment weighted against system criteria

5.5 REMAINING ISSUES

An important limitation of EVIC that should be recognized is the possibility of high year-on-year variations caused by a changing debt-to-equity ratio. This ratio can fluctuate by attracting more debt or equity investments, which will lead to a wider spread of the allocation of emissions over investors. This does not cause any problem, since the allocation follows the ownership trend and still accurately

reflects the emissions an investor is responsible for. However, it does cloud the assessment of the portfolio performance on GHG emission reduction. A second cause for this ratio to change is due to market value fluctuation on the equity side of the ratio, and therefore, emission allocation between equity and debt changes. This effect results in a change in footprint from the investor without any real-world emission change with the company invested in. To mitigate this issue chapter 6 and 7 will discuss several options to control for these market fluctuations and improve robustness of the metric. Investors are dependent on investees in terms of underlying data. The reliability of emissions data is in some cases questionable. Especially quality on scope 3 data is lacking. This issue is not being solved by methodology improvement. However, this is a big issue in the field of carbon accounting and will therefore be discussed in chapter 8. This issue is addressed using interviews with data providers with a focus on improving and expanding data on GHG emissions from organisations.

6 APPLICATION OF ALTERNATIVE METRICS

Throughout this thesis the focus has so far been on existing and alternative approaches to measure climate impact for an investment portfolio. Within these approaches the first step is identified as measuring financed emissions. In theory these measurements look straightforward and easy to compute. However, from practice it has become clear that multiple (economic) side effects can play a role in the results provided by the different measurement approaches. Chapter 5 concluded that there are remaining issues seen in practice, which could not be assessed in the qualitative research approach from chapter 4 and 5. Chapter 6 discusses the criteria to determine the quality of the metric, the set-up of this portfolio, and the characteristics of the portfolio. The actual analysis of the existing and alternatives metrics are tested on a sample portfolio with real world data in chapter 7.

6.1 MODEL CRITERIA

Before the data gathering and model construction it is of key importance to define a set of criteria in order to assess the performance of different metrics brought into practice. With these criteria and several experiments it will be possible to translate the results in chapter 7 into a conclusion and answering of sub question 4: *How robust are the identified metrics when tested in a real life investment portfolio?* The following criteria are considered when analysing the results in the next chapter:

1. **Emission reductions are reflected in the indicator.** When a company within the investment portfolio reduces its emission this should be reflected in the emission impact indicator for the whole investment portfolio. Emission reduction can also be caused by activities from the investor itself. In case an asset of shares is sold, this should be reflected in the indicator.

2. **A decline in the indicator can be backtracked to emission reductions.** When the indicator of the metric shows an increase of decrease this should be caused by changes in emissions within the portfolio. Again, this can be caused by reductions within companies, selling shares or buying shares.

3. **A minimum of large fluctuations over time**. The indicator should not fluctuate to heavily throughout the chosen time-frame. Big fluctuations make it hard to set clear goals and to use the indicator as a tool for company strategies into the future.

6.2 MODEL DESCRIPTION

In order to set up a good sample portfolio a conceptual model of the portfolio was created as shown in figure 6.1. The required information includes the time-frame from 2014-2018. The 2014-2018 time-frame was chosen based on the available GHG emission data in company disclosures. The most recent and widely available data is for the reported year of 2018. The set of data points for all companies in the test portfolio follow from the conceptual model, the criteria and the previously discussed metrics.

The variables in the metrics from chapter 4 form the basis for the required data in order to test the different metrics on the criteria. The overall integration of the required data is listed below:

1. A diverse company selection
2. Financial data
   - Value of investment in a company by the financial institution
   - Total value of FI investment portfolio
   - Market capitalisation components of company issuing the stocks/bonds
   - All relevant balance sheet components of company issuing the stocks/bonds
   - Revenue data of company issuing the stocks/bonds
3. GHG emission data in a carbon-dioxide-equivalent on company level
   - GHG emissions scope 1
   - GHG emissions scope 2
   - GHG emissions scope 3

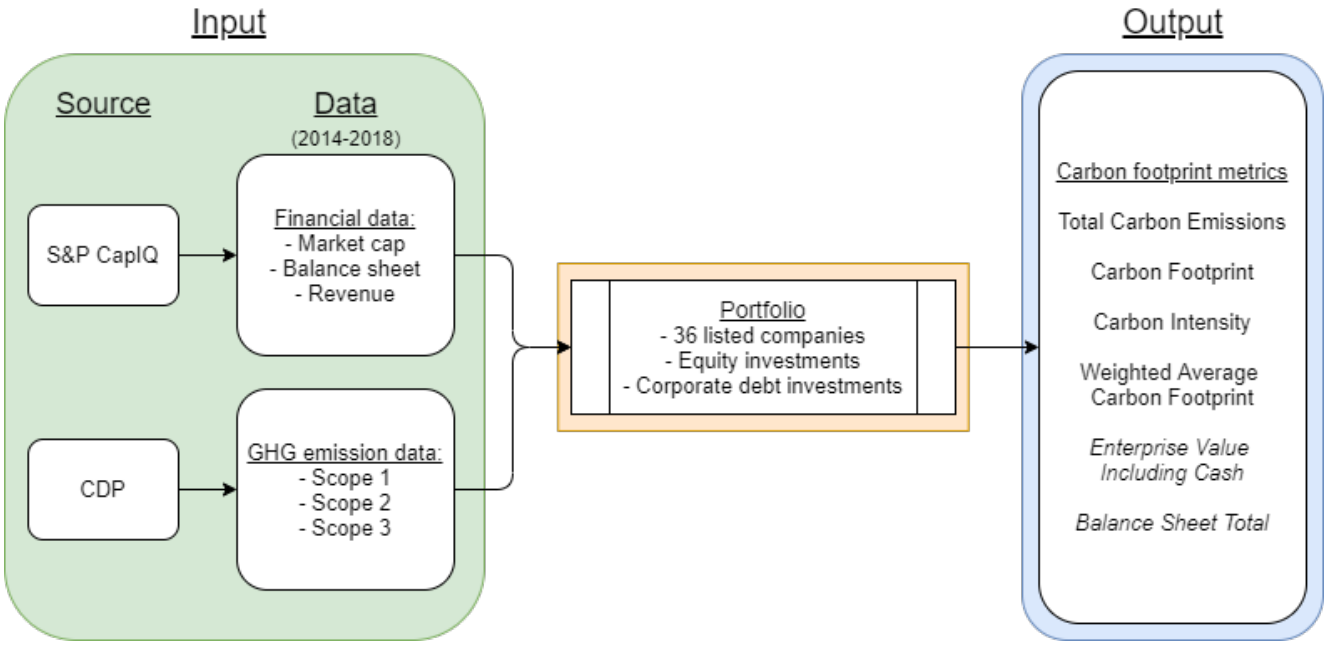


Figure 6.1: Conceptual model for the sample portfolio

6.3 COMPANY SELECTION

To obtain a representative company portfolio a selection of 10 different sectors was made. This sector list is discussed with the PCAF group and presents a good understanding of all relevant sectors. Therefore, the 10 sectors are used to select 3 to 5 companies within this sector representing different markets and regions. The exact companies within sectors were selected on the requirement of good available data for both financial data and GHG emissions data. This last requirement resulted in a noticeable bias towards western companies. In these markets companies are in front when considering GHG emission reporting. The chosen sectors and companies are listed in table 6.1.

Sector	
Financials	Bank of America, Barclays, Deutsche Bank, Goldman Sachs, ING
Food (Agriculture)	Archer-Daniels, Tyson Foods
Food (FMCG)	Coca-Cola, Kraft Heinz, Nestle, Unilever
IT	Apple, Microsoft, Samsung, Sony
Materials	BHP, CEMEX, Glencore, Heidelberg Cement
Oil & Gas	BP, Exxon Mobil, Shell, Total
Pharmaceutical	Pfizer, Merck, Novartis
Steel production	China Steel, POSCO, Tata Steel, Tokyo Steel
Transport	Deutsche Post, FedEx, United Parcel Service
Utilities	Enel, Engie, National Grid

Table 6.1: Sample portfolio selection

6.4 SOURCES OF FINANCIAL DATA

In order to test the alternatives, financial data on all companies was required. To extract this information two options were considered. First the option was explored to extract the data from a public accessible database. The most comprehensive database selected for this option was Yahoo Finance. All listed companies are registered in this database and a large part of their financial information is openly accessible through this platform. However, for certain specific balance sheet data and especially historical data a license is required. The second option was to explore the options to access financial data through the collaborating organisation in this thesis, Guidehouse. Guidehouse Information Services department has access to the S&P Capital IQ Platform (CapIQ). CapIQ is a market intelligence platform hosted by the data provider Standard & Poor's (S&P). This Platform is widely used in the corporate finance sector and provides data on both public and private companies. Through the Guidehouse Information Service department financial data on all 36 companies was extracted for the time period of 2014 - 2018 on a quarterly basis. The information was extracted using Excel exports and provided balance sheet data, market capitalisation and revenue data.

6.5 SOURCES OF GHG EMISSION DATA

The third source of data are GHG emissions data on a company level. To gather this data an extensive research in the field of data providers was conducted. This research showed that the world for carbon data is growing rapidly, but only a few organisations are leading in the market. One thing that became very clear is that there are very few public data providers. The Carbon Disclosure Project is by far

the largest organisation publicly providing GHG emission data. Companies provide their emissions through the CDP questionnaire, which asks for specified data for scope 1, scope 2 and every category in scope 3. Besides CDP there is one other public provider focusing more on forward-looking carbon performance data, the Transition Pathway Initiative. This organisation has an interesting approach of providing carbon data, but since the focus in this research is on backward-looking carbon data this organisation is not further investigated. On the private data provider side there are many parties and the field is dominated by the bigger financial data providers who have incorporated smaller carbon data providers over the years. Since these data providers normally use CDP data as a starting point and because they all require a licence this research uses public CDP data. The emissions data provided through CDP is used in the data model specified for scope 1, scope 2 and all 15 categories of scope 3. This information was extracted from the CDP website per company per year. An example of this data source can be found in Appendix B. A full overview of researched data providers, both public and private, can be found in Appendix C.1.

6.6 DATA AVAILABILITY AND VALIDATION

For all companies in the data set a comprehensive financial report could be extracted. All needed data was available in the right time-frame. However, in some cases financial reports did only present financial data every 6 months instead of the preferred time frequency of 3 months. In order to be able to use a value the average of data point from one time-step before and one time-step ahead was used to compute the missing value. Another issue that occurred in the data is that companies do not all report their financial performance at the end of the calendar year. For most companies the fiscal year matches the standard calendar year. For some companies it is the case that they report halfway through the year in June, July or even March. In case a company reports their emissions and revenue at another point in the year a shift in data had to be made. Companies reporting their data for the time period between July 2016 and June 2017 where considered to report in December 2017 in order to match the data among all companies. By using this approach the assumptions had to be made that there are no seasonal effects that have a significant impact on the analysis. Therefore it is assumed that the results would be the same when a company would report at the end of the calendar year.

After aligning the data to the right time-frame both the financial and emission data where validated by using random sampling. In a random sample emission data was checked using annual reports or sustainability reports in order to verify the data reported through the CDP questionnaire. In total 3060 data points are used in the emission data set of which 50 data points are verified through a secondary source. This resulted in a 94% confidentiality level while taking into account a margin of 5% for the validated data points. The financial data consists of 1080 data points and is verified using a combination of annual reports and a secondary data provider Yahoo Finance. This random sample consisted of 50 data points and resulted in a 98% confidentiality taken into account a margin of 5%.

After collecting all the data, validating the data and solving data issues the different sources of company data were merged. This was done using Excel matching companies by their company name to merge the financial and emission data.

6.7 CHARACTERISTICS COMPANY PORTFOLIO

In order to familiarise with the chosen company portfolio this section will discuss the more important observations regarding the differences within the portfolio to take into account when analysing and concluding on the results in chapter 7. The table is ordered per section as earlier presented in table 6.1. All the companies vary in size and revenue, therefore the last two columns of table 6.2 are scaled to

emissions per million dollar. It is important to note that the relative carbon footprint and the carbon intensity numbers are in the same order of magnitude within the same sector. However, when looking across sectors the difference can be a factor of 1000 times bigger. Lower emitting sectors are the financial, IT, pharmaceutical and FMCG sector. The mid-range emitting sectors are the transport and agriculture sector. And the higher emitting sectors are the materials, oil and gas, steel production and utilities sector. The large differences across sectors will play a role in the emission attribution process for an investment portfolio. When analysing the results it is important to be aware of the high and low emitters within your portfolio. Also, when analysing the results in chapter 7 these observations are important when the next step is made into making a strategy towards emission reduction.

Company	Rev. '18	MC '18	Emissions*	CFP	CI	**Company**	Rev. '18	MC '18	Emissions*	CFP	CI
Financials						HeidelbergCement	20,768	14,609	83,268,629	5699.8	4009.5
Bank of America	88,467	282,905	876,311	3.1	9.9	**Oil & Gas**					
Barclays	25,195	35,958	222,898	6.2	8.8	BP	297,220	146,734	56,310,000	383.8	189.5
Deutsche Bank	28,431	16,978	329,937	19.4	11.6	Exxon Mobil	279,332	336,540	128,000,000	380.3	458.2
Goldman Sachs	35,942	73,249	196,291	2.7	5.5	Shell	388,379	256,132	82,000,000	320.1	211.1
ING Groep	20,229	45,866	106,070	2.3	5.2	TOTAL	184,106	148,919	44,218,026	296.9	240.2
Agriculture						**Pharmaceutical**					
Archer-Daniels	64,341	23,440	17,363,000	740.7	269.9	Pfizer	53,647	240,671	1,676,750	7	31.3
Tyson Foods	40,052	21,960	6,223,579	283.4	155.4	Merck	42,294	208,098	1,208,100	5.8	28.6
FMCG						Novartis	46,099	197,998	1,447,436	7.3	31.4
Coca-Cola	34,300	195,730	1,508,070	7.7	44	**Steel production**					
Kraft Heinz	26,268	35,038	1,466,610	41.9	55.8	China Steel	13,089	12,024	21,305,492	1771.9	1627.7
Nestle	93,246	260,118	6,599,611	25.4	70.8	POSCO	58,368	17,627	72,489,000	4112.4	1241.9
Unilever	58,372	141,227	2,183,463	15.5	37.4	Tata Steel	19,072	9,397	60,230,582	6409.6	3158.1
IT						Tokyo Steel	1,545	1,142	1,261,748	1104.9	816.7
Apple	265,595	779,200	63,320	0.1	0.2	**Transport**					
Microsoft	110,360	816,170	3,091,246	3.8	28	Deutsche Post	70,722	37,985	7,100,000	186.9	100.4
Samsung	218,973	272,318	15,173,000	55.7	69.3	FedEx	65,450	48,296	16,202,370	335.5	247.6
Sony	80,360	63,769	1,376,631	21.6	17.1	UPS	71,861	96,139	14,635,000	152.2	203.7
Materials						**Utilities**					
BHP	43,386	133,776	16,600,000	124.1	382.6	Enel	83,624	64,152	95,884,305	1494.6	1146.6
CEMEX	13,531	7,341	47,025,887	6405.9	3475.4	Engie	65,224	36,798	69,202,011	1880.6	1061
Glencore	220,524	55,471	35,561,181	641.1	161.3	National Grid	21,405	37,419	7,012,642	187.4	327.6

Table 6.2: Company portfolio characteristics (1. M$ revenue in 2018, 2. M$ market capitalization end of 2018, 3. total scope 1 and 2 emissions in tonne CO_2, 4. Carbon Footprint [Ton CO_2/million dollar company value], 5. Carbon intensity [Ton CO_2/million dollar revenue])

7 RESULTS

This chapter will present the main findings from the quantitative analysis in this research. This part of the thesis will present an analysis of the practical use of the discussed metrics including the existing and alternative metrics. The first section of this chapter will include a general analysis where the metrics are applied on an investment portfolio. The investment portfolio and its characteristics were discussed in chapter 6. The second section of chapter 7 will discuss several experiments done with the data sample to test the robustness of the metrics. There will be 3 experiments and an analysis on the criteria drafted in chapter 6.

7.1 GENERAL ANALYSIS

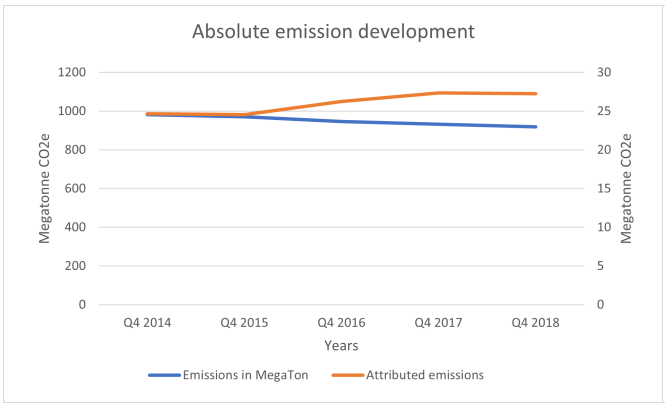
During the analysis there are a few supportive graphs that will be used to present the results. These are the total emissions and the development of market capitalisation and the development of total revenue over the time-span of 5 years.

The emissions are presented in megatons produced by all the companies in the portfolio per year as displayed in figure 7.1a. The blue line indicates the cumulative of all scope 1 and 2 emissions of the companies within the portfolio. The orange line indicates the cumulative of all attributed emissions to the portfolio using market capitalisation as the financial metric. It becomes clear that in total the emissions are decreasing and are reduced by 6.8% over a time-span of 5 years. However, the orange line shows that the emissions attributed are increasing over the years. This is caused by the increase in portfolio size as seen in figure 7.1b, meaning more ownership within the invested companies resulting into more owns emissions. This increase results from rising market shares following up to a growing portfolio size. There are no shares added or removed over time.

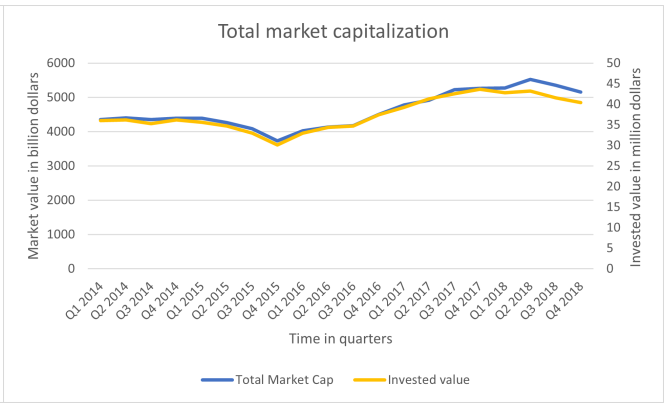
The graph in figure 7.1b shows the development of the market capitalisation cumulative over all companies. This line shows a dip in the fourth quarter of 2015, which can be explained by a flash crash on the U.S. stock exchange market in August 2015 as shown in the Dow Jones index which can be found in Appendix B. From there the market rose up until the end of 2018 with a small dip in the last two quarters. This market development influences the invested value in the investment portfolio, which strongly follows the line of the general market development. The market rise leads to a portfolio increase of 12% over the period from January 2014 up until December 2018.

The development in revenue is presented in figure 7.1c and shows the total revenue of the companies in the portfolio took a great hit in 2015 and 2016. This recovered almost in full in the 2 years after. Based on the shares in a company the part of revenue for the investor can be defined. This line is shown in orange and moves along together with the main line.

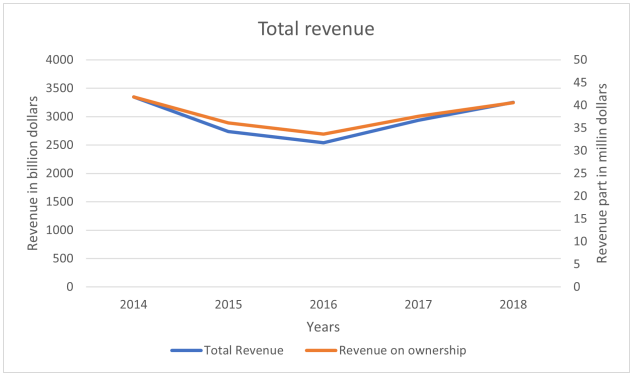
The development of the market, the revenue and the emissions over time are important factors to take into account when analysing the results and to understand the outcome of these results. Together these two variables decide how many tonnes of CO_2 are to be attributed per million dollar company value. This statistic is shown in figure 7.1d and shows an almost inverse relation with the market capitalisation development. This is an expected effect since the value of a company decides the amount of emissions per million dollar that are produced. In this way the size of a company is taken into account when attributing emissions. In case the market value drops, the amount of emissions per



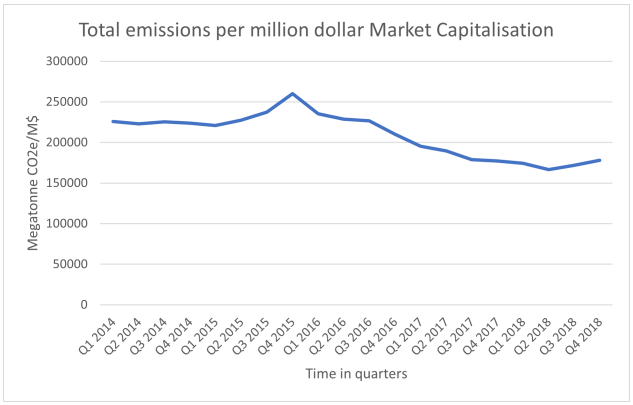
(a) Total emissions of companies in the portfolio and the absolute attributed emissions by market cap



(b) Cumulative market capitalisation of companies within the portfolio and invested value of the portfolio



(c) Cumulative revenue of companies within the portfolio and owned revenue based on investment ownership



(d) The emissions per million dollar market capitalisation

Figure 7.1: Supportive data information

million dollar will rise and vice versa. This will also have an effect on the trend of the carbon footprint, especially when using the market capitalisation as the main financial metric.

7.2 METRIC COMPARISON

In this thesis 5 metrics have been discussed. All these metrics are analysed on theory and judged by qualitative criteria in chapter 4 and 5. In this section these metrics will be analysed based on their performance when put into practice. The way these metrics differ based on the financial metric to put a weight on the attribution is shown in an overview in table 7.1 The first part will look at the trend of the different metrics and compare this with the theoretical expectations from the quantitative analysis. The next section will discuss some experiments to judge the metrics on the three drafted criteria from chapter 6: 1) Emission reductions are reflected in the indicator, 2) a decline in the indicator can be backtracked to emission reductions, 3) a minimum of large fluctuations over time caused by anything other than emission influences.

Metric	Financial product p_i	Financial metric a_i	Normalisation factor g_i
CFP	Invested equity	Market capitalisation	Total portfolio size in equity
WACI	Invested equity	Revenue	Total portfolio size in equity
CI	Invested equity	Market capitalisation and revenue	
EVIC	Invested equity and bonds	Enterprise value including cash	Total portfolio size in equity and bonds
BST	Invested equity and bonds	Balance sheet total	Total portfolio size in equity and bonds

Table 7.1: Differentiation in the metrics based on the financial metric used to attribute emissions and the input value of the investment

The first metric to discuss is the weighted average carbon intensity (WACI). The WACI is based on revenue as a financial metric and the invested value based on the market value of a company. This means that this metric uses both a stock and a flow variable. This has the effect that the denominator and the numerator don't add up and the attribution will never reach 100%. The only exception on this is when the total market capitalisation on the date of calculation is exactly the same as the revenue over a whole year. The metric flow behaves as a combination of the revenue flow of a company and the market stock development together with emission in- or decreases.

The second metric is based on the market capitalisation and divides the invested value by the company value to define the portion of emissions that should be attributed to the financial institution. This orange line in figure 7.2 follows the same line as figure 7.1d, which means that the relative carbon footprint based on market capitalisation follows the relation between emissions and market development. The outcome of this metric is one of the highest footprints in absolute terms since only market capitalisation is taken into account as a denominator.

The third metric is based on enterprise value including cash and represents an important alternative to the conventional option of using market capitalisation. The main difference being that also debt is taken into account in the EVIC which leads to a higher denominator of the invested value. In practice this leads to a lower carbon footprint per million dollar invested and a more stable trend over the years since the effect of the market is mitigated by adding the debt investors to the equation.

The fourth metric is presented by the yellow line and shows the carbon footprint when using the balance sheet total. This metric has the same order of magnitude as the EVIC, which is a logical outcome since both these metrics take into account the debt part of the companies invested in. However, the balance sheet total uses the book value of the company instead of the market value. The share price of the market is on average higher than the book value leading to a lower denominator when using balance sheet total in comparison to the EVIC. This logically leads to a higher footprint per million dollar invested.

The last metric to discuss is the carbon intensity represented by the green line. This is an indicator for emission exposure in your investment portfolio. This indicator takes the portion of revenue and the portion of emission within a company based on ownership. This indicator works well to indicate

which companies in the portfolio have a very high emission in comparison to the revenue of that company. The metric on itself is not usable to attribute emissions. This conclusion can be based on the qualitative part in chapter 5 and the flow in graph 7.2 where the footprint value varies from 600 to almost 800 tonnes per million dollar revenue.

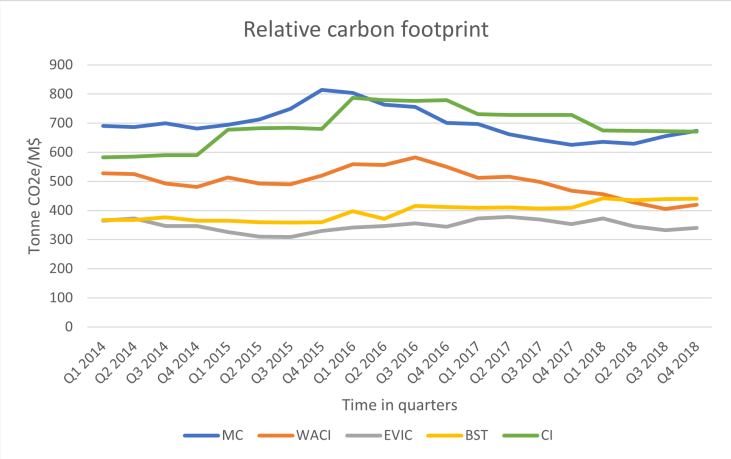


Figure 7.2: The emissions per million dollar of the financial metric with revenue, market capitalisation, enterprise value including cash, balance sheet total and carbon intensity

In short, the conclusion that can be drawn is that 4 of the 5 metrics can serve as an indicator for financed emissions. Carbon intensity has too many drawbacks to serve as a metric for emission attribution, mainly because of the significant year on year fluctuations. The other four metrics differ on being market share or revenue based and including or excluding the debt investments. Revenue and market share can both fluctuate quite significantly over the years. This is seen in the relative high differences between the maximum and minimum in the orange and blue lines representing the revenue and market based metrics. When including debt into the equation the indicators of EVIC en BST are much more stable as seen in the graph with the yellow and grey line. Based on this general analysis these two metrics show the most potential based on the criteria of little fluctuations caused by side effects. This confirms the first conclusions from chapter 5. In the next section all four remaining metrics will be tested on three different experiments to evaluate the remaining criteria.

7.3 EXPERIMENTS AND CRITERIA SCORING

After analysing how the different metrics behave in the current portfolio set up this chapter introduces some experiments to test the behaviour when some extreme changes occur. First the base case is presented and then the experiments will be discussed from 1 to 3.

The experiments are based on the three main strategies a financial institution can follow to reduce the portfolio carbon footprint. The first option is to sell stock or bonds in a heavy emitting company. This decision can be based by looking at the same statistics on a sector or company level. This will show the companies that have the highest emissions per share or per million dollar revenue. Selling the stake in a company will lead to a lower portfolio value and a lower total footprint. In the experiment displayed in figure 7.3b the total stock in TATA Steel is sold in the first quarter of 2015.

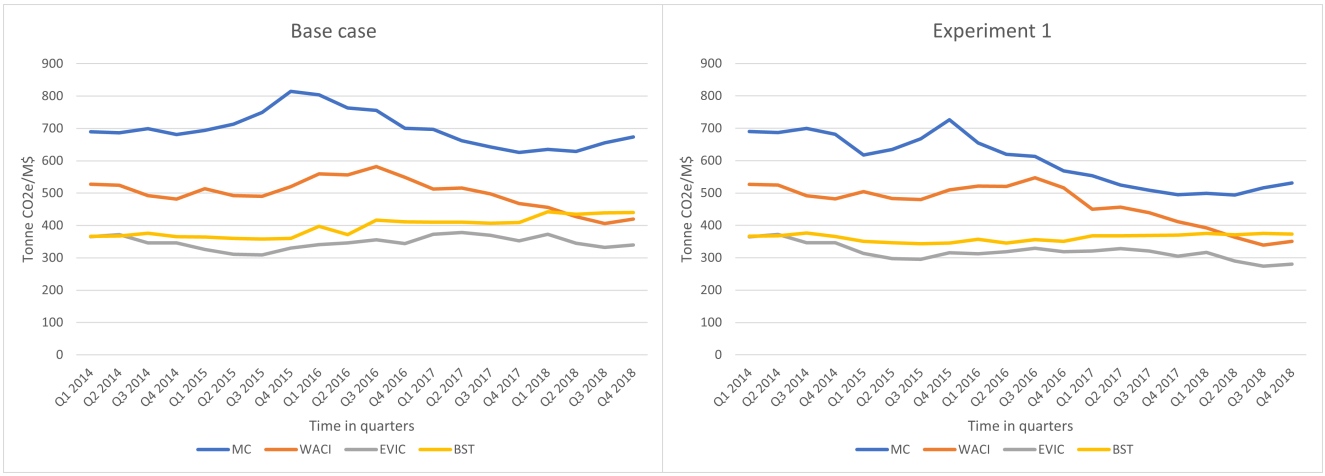
The second strategy option is to engage with the companies invested in to realise emission reduction within those companies. This will lead to a lower emission number within the company while keeping on to the same stake in a company. The positive or negative effects of this engagement are not taken into account in this experiment. Only the emission reduction that is realised will be used as a change

to test the behaviour of the metric. In the actual experiments all companies in the portfolio reduce their emissions with 10% in the first quarter of 2016. The results are shown in figure 7.4a.

The third strategy discussed in this section is to attract more stock of bonds within companies with a very low relative footprint. This will bring the relative value of the portfolio footprint down but it will increase the total emission value in absolute numbers. In this experiment an extra investment of 10 million dollar is made divided over the 10 lowest emitting companies per million dollar market capitalisation as presented in figure **??**. This investment takes place in the third quarter of 2015.

7.3.1 Base case

The four metrics discussed in this chapter can be divided in two common metrics currently used in the field and two alternative methods presented during this thesis. The two approaches most commonly used in the current field are based on market capitalisation or on revenue to determine an allocation factor. When using the metric based on revenue the carbon footprint has a smaller order of magnitude than with market capitalisation. This means that the revenue numbers are higher than the market capitalisation on average in the analysed investment portfolio. The alternative approaches both use a debt including financial factor to determine the attribution factor of an investee. This metric is computed by using the market capitalisation and debt of a company. The second alternative differs from the EVIC approach by using book value of a company instead of the market value. This approach uses balance sheet total as the financial metric. The performance of the four metrics in the base case is presented in figure 7.3a and is discussed in detail already in section 7.2.



(a) Base case results

(b) Experiment 1

Figure 7.3: Results for all metrics representing the base case as presented in figure 7.2 and experiment 1 selling stock

7.3.2 Experiment 1, 2 and 3

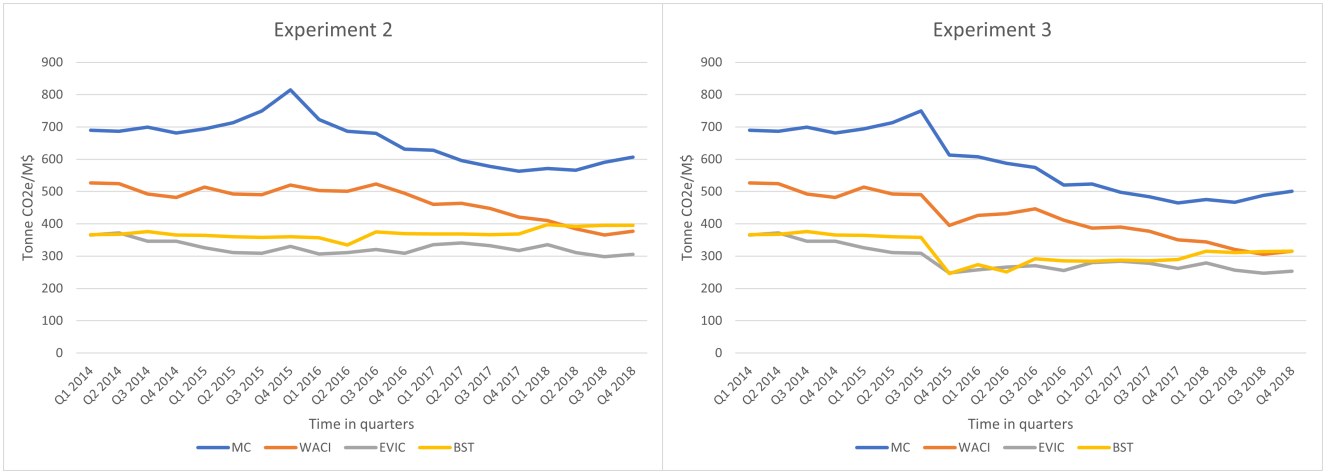
Experiment 1 tests the metrics on their behaviour in the scenario where stock in a heavy emitting companies is sold in a certain moment in time. In this experiment it stands out that only the market capitalisation metric responds immediately to the selling of TATA Steel stock. In the other three metrics this effect is of a lower impact on the moment of selling, but increases from the year 2016. This can be explained by looking at the emission profile of TATA Steel and the revenue numbers in comparison to the market value of the company. The emissions in 2015 are much lower compared to the year

2016 and combined with a high revenue the attributed emissions when using revenue are around the 600 tonnes of CO2 in 2015, this is a major differences compared to the calculation with market cap where the attributed emissions for TATA Steel are around the 3000 tonnes CO2 in 2015. After 2015 the impact in revenue increases because of a recovering market value but a decrease in revenue leading to attributions of 3000 and 5000 tonnes CO2 in 2017 for respectively the WACI and MC. When considering the EVIC and BST metric a second reason for this mitigated effect is the inclusion of debt in these metrics. Changes on the market are of lower impact with the use of EVIC and BST.

The second experiment of lowering the emissions with 10% after 2015 results in the expected drop in the indicator of 10%. Looking at the formulas this is a logical effect where the emissions have a proportional relationship with the carbon footprint. This effect is seen in all four indicators.

The third experiment has a significant impact on the footprint development and follows the strategy of buying extra stock in low emitting companies. Figure 7.4b indicates the attraction of extra stock in the 10 companies with the lowest carbon intensity. For the EVIC metric this causes almost a difference of 100 tonne CO2e/M$ with the base and in the case of MC, WACI and BST this drop is over 100 tonne CO2e/M$.

When looking at the graphs in figures 7.3 and 7.4 it becomes clear that all three strategies have the desired effect of lowering the carbon footprint of the investment portfolio. However, the impact of the experiments varies within the different metrics.



(a) Experiment 2

(b) Experiment 3

Figure 7.4: Results for all metrics on experiment 2, realising emission reduction, and experiment 3, divesting into low emitting companies

7.4 SYNTHESIS OF THE RESULTS

Based on the first part of this analysis it became clear that the Carbon Intensity metric does not perform well enough to be used in practice for financed emission attribution. This metric failed on the third criteria of keeping fluctuations to a minimum caused by anything other than emission changes. Looking at this criteria there are also concerns of the fluctuations in the metrics based on market capitalisation and revenue. However, these fluctuations are not of an extreme nature to disregard these two metrics on the first part of the analysis. Another concern is with the balance sheet total metric, being the only metric which is rising in footprint when the start and end year are compared. This is caused by the greater influence of debt in this metric. With a descending debt the weight on share holders will increase leading op to a higher footprint. This is a drawback of the use of BST as

also recognised in chapter 5. Moving forward to the second part of the analysis in this chapter with the remaining four metrics showed the behaviour when tested on several experiments. In experiment 1 only the market capitalisation metric responded in the desired manner, where the other 3 experienced a certain delay on the effect of selling stock. Experiment 2 led to the expected effect of a 10% reduction in the indicator performance for all four metrics and showed that the first criteria of emission reduction being reflected in the indicator is valid for all metrics. The 3 experiment showed in all cases a strong descending effect in the indicator. In the case of using balance sheet total this effect was the most extreme. Based on these findings there remain to be concerns with both conventional metrics and with the balance sheet total metric. The metrics using revenue and market capitalisation show undesired behaviour on criteria 3, because of their fluctuations over time. The the balance sheet total metric lacks on the performance in experiment 1 and 3 and being the only metric to have a rising carbon footprint over the years. The metric using enterprise value including cash also has a lacking performance in experiment 1, however in all other aspects this metric shows the most potential to implement as a financial metric for financed emission attribution.

8 DISCUSSION AND RECOMMENDATIONS

This chapter aims to reflect on the conducted research and identify limitations in order to provide recommendations for improvement and future research as well as recommendations for the practical field of carbon accounting in the financial sector. GHG emission accounting is still a rapidly growing profession and this research sheds light on the different approaches in the current landscape and their limitations. This resulted in identified alternatives to add to the current practice.

This research has highlighted the range of options in approaches for carbon accounting. The range of choices and other findings show that the financial system is getting closer to defining a standard, but a global harmonised and widely used standard will still need some time. Many of the carbon accounting issues can be solved by learning from financial accounting by simply replacing money with GHG emissions. Nonetheless, some accounting issues require new approaches. For example, in financial accounting it is common to separate bonds and equity, but in carbon accounting it has become clear this leads to allocation issues and double counting. Also, in financial accounting data is collected on a daily basis and in some cases even in hours, minutes or seconds. With GHG emissions it will take time to improve the data collection. In the current situation the data is always a year behind or more. For that reason it can be a valuable addition to consider future looking data as well when considering investment portfolio footprints. This will add an extra perspective to the concept of how to look at an investor. In this thesis an investor is considered to take into account the numbers and data from a historical view to make sure the input is correct and verified. However, when making an investment decision the future business plan for reducing GHG emissions is equally important to assess the future performance of a company and therefore the investment. This work in future data will play an important role not only for the company valuation for an investor, but also for the societal evaluation. The outside world and media pay attention to data and numbers, but even more to promises on business plans for the coming years. The call in society becomes stronger every year to push companies to reduce GHG emissions and to push governments to enforce and accelerate this process. In the end, the data and numbers are needed again to evaluate the business plans and the expected future performance in order to learn from best practices. A harmony between these two perspectives on data based performance and future performance evaluation could be the key for the field of carbon accounting and the contribution to a shift of capital towards more sustainable investments.

Another important aspect of achieving a harmonised standard is to let go of seeking for one single metric to assess portfolio climate performance. The discussion should move to find the best selection of metrics to cover the variety of use cases. In many cases not one accounting principle rules over all the others, but the most appropriate one to use depends on the purpose. An investor making a decision should be aware of the differences, challenges and benefits from using a specific metric. A decision for a certain approach can influence the outcome and therefore the decision making process significantly. This research focused mainly on the allocation principle and what metric suits best to do so. Recognising there is no 'one size fits all' solution for climate aligned investment is crucial in the upcoming process of developing a harmonised carbon accounting standard. Several initiatives working on such a standard have to be open to other approaches and identify opportunities to be complementary instead of defending their approach as the one-and-only right direction.

8.1 POSITIONING OF RESEARCH FINDINGS

In this research Enterprise Value Including Cash (EVIC) comes forward as the most adequate metric to use in an approach to measure and report financed emissions. This conclusion is a combination between the quantitative and qualitative evaluation of the metrics selected in this report. In recent history no scientific article has done a certain evaluation of metrics for the carbon accounting field. However, there are some reports from invested organisations who have done an analysis of their own. The 2019 sustainability report of Allianz supports the use of Enterprise Value in the form it is proposed in this research, combining market capitalisation and the book value of total debt (Allianz group, 2019). Also the Task Force on Climate Related Financial Disclosure and the Partnership for Carbon Accounting Financials share the vision for the use of Enterprise Value in their reports (PCAF, 2020c; TCFD, 2021). However, other reports are more critical on the use of Enterprise Value. Institut Louis Bachelier et al. (2020) argues that enterprise value has a bias towards companies with high intangible value (e.g. technology sector) and companies with high amounts of cash on their balance sheet. The problem with a bias towards cash is taken care of in this research with the configuration of the definition of enterprise value towards enterprise value including cash as discussed in chapter 5. A second argument is the possible introduction of extra noise when using this metric for portfolio carbon footprint assessment. This second argument is a suggestive argument by Institut Louis Bachelier et al. (2020) and the added noise experienced in this research is not extra compared to the other metrics. Although, this research recognises in their future research that complication complication in practice resulting from the use of EVIC should be investigated further. The report published by 2 Degrees Investing Initiative (n.d.) argue that use of Enterprise Value is pushed to avoid double counting, which is also one of the main reasons it comes forward in this research. However, their considered downside is the high year-on-year fluctuations caused by market influences and changes to the debt-to-equity ratio. These two arguments are acknowledged in this research. High year-on-year fluctuations are not more significant in practice compared to other metrics as seen in the experiments in chapter 7. The debt-to-equity ratio changes are indeed a new problem when bringing these two types of asset classes together and should be a point of attention when bringing the theory into practice. Considering different view points and the criteria used in this report the conclusion remains to argue for the use of enterprise value as presented in chapter 9.

8.2 RESEARCH LIMITATIONS

An important part of this research is based on several sources of data, scoping decisions and selected criteria. Choices that have been made result into several limitations or exclusions. An important part of research is critically reflecting the shortcomings throughout the research process. This section aims to explain what limitations are identified and what the associated consequences of these limitations are.

- The used sample portfolio is a small and simplified representation of a real-life situation. Investment portfolios from pension funds, banks and other investors will have thousands of observations in outstanding loans and investments. In this research a sample portfolio with 36 different investment companies is considered. Data gathering per company is very time consuming and therefore expanding this portfolio was not possible in this time-frame. However, the smaller size of the portfolio is no reason to doubt the results. For example, the AEX Index also bases their output on the 25 biggest companies on the market. And based on the Law of Diminishing Returns it is believed that from an amount of 32 stock positions the risk aversion is already at 96% (Zundert, 2019). Another simplification that can be considered a limitation of

this investment portfolio is the invested value. In real economic activity investors are constantly re-allocating and re-investing their money. In this sample the invested value stays constant in order to analyse the trends associated with emissions in the best possible way without secondary effects. The effect of attracting and retracting extra shares in the observed trend is important to consider. This will influence the ownership within the investee and therefore the portfolio carbon footprint. Leaving out this effect is a limitation and opens up an opportunity to develop the practical application further. Looking at the results this limitation will not change the final conclusions, but it could bring more fluctuations during the year within the investors' carbon footprint.

- The company selection of the sample portfolio was based on data availability. This automatically resulted in a database with efficient data availability to compute EVIC and calculate the portfolio emissions. The issue of missing data or other forms of data gaps in terms of extreme outliers are not addressed in this research. Mitigating the challenge of data gaps and estimating missing observations could be a serious problem in practice for a financial institution. This has to be noted when bringing the recommendations in practice, but will not change the outcome of this research.
- The assessment of methods in this research is performed using qualitative criteria. The assessment criteria are based on expert input, literature and desk research. This entails that the results allow for a bias based on the used groundwork for these criteria. Furthermore, the complete list of identified criteria consisted of 19 criteria where a selection of 7 is used in this research. Using a different criteria selection could lead to other results in the qualitative part of this research.
- This research focused on listed equity and bonds investments. However, there are multiple other asset classes out there of which many have no standardised accounting approach yet. This can be considered a limitation of the proposed approach, since this does not take into account the needs for other asset classes and therefore does not provide a method for measuring financed emissions for all investment positions.
- Last, the method used to assess the discussed metrics has been limited to a set of the identified criteria. This improves the understandability and makes the results easier to communicate. However, a more detailed assessment (using more criteria) could lead to other insights.

8.3 RECOMMENDATIONS

- A first and vital recommendation is aimed at the industry and links to the limitation of data quality. All methods, excellent or poor, will always be dependent on the underlying data. Financial data is a well-known practice, widely available and for most markets and sectors of good quality. However, GHG emission data is not. Measuring emissions related to scope 1 and scope 2 are a practice which is quite well developed but still needs major improvements. The biggest issue in the data is currently on the emissions upstream and downstream in the value chain, known as scope 3 emissions. While the method in this thesis contributes to improvement of scope 3 measurement within the financial sector, this is only 1 of the 15 categories defined by the Greenhouse Gas Protocol. Further improvement and standardisation is needed in order to improve scope 3 emission data. This will provide the world with better understanding of the emissions produced in order to target and mitigate these emission sources.
- Another next step that could be recommended is to find the best way to incorporate this new carbon accounting approach into existing frameworks, keeping in mind that there is not one

perfect metric, but multiple metrics should be used to cover the variety of use cases. The best combination of metrics and approaches should be standardised in one framework to guide investors in using carbon accounting and carbon exposure metrics. This should be the first step towards achieving a harmonised accounting standard for the global financial sector.

- This research showed several options and approaches within carbon accounting. An improved option is proposed to measure financed emissions. Financial institutions can use this to communicate a portfolio footprint in their public reports and show the trend of their investments. It can also be used in the decision making process to set future targets. In this process it is recommended to not only use the view of the total portfolio footprint, but also look at individual investment footprints. This research shows that the carbon footprint trend can be overshadowed by the heavy emitters in the portfolio. It will be important to look into the underlying investments in order to get a full picture of the financial institution's performance. As earlier stated, the 'best' approach and accounting principle will depend on the use case.
- The findings in this research show that carbon accounting can be sensitive due to the snapshot aspect. The information is always based on a moment in time combined with a certain frequency. This aspect of carbon accounting makes it sensitive to 'greenwashing', where investors sell their heavy emitters before the check point and invest again after the footprint assessment. Another simple solution when looking at the results, seems to divest from heavy emitters in order to reduce the portfolio emissions. However, this simplistic divestment policy is not recommended as a primary strategy, because bringing these companies in financial discomfort can bring negative consequences to the whole sector. The industry will need investment capital to make the transition. Therefore, the recommended primary strategy is to engage with investees and encourage them (with investments) to reduce their emissions and make a transition in their way of doing business. A second option will be to divest and re-allocate the money when there is no perspective or willingness with the investee to reduce emissions.
- This research has a focus on backward looking data to calculate financed emissions. The major issue with this approach is the lack of knowledge and insight on the current measures that an investee is taking to reduce carbon emissions. Therefore, the proposed method in this thesis will always benefit from a combined approach with forward looking data. Forward looking data will always be more subjective and based on expectations, while the backward-looking approach complements this with a quantitative based performance with an objective perspective.

8.4 FUTURE RESEARCH

The main findings and discussions left some open gaps that can be filled through future research. Some interesting directions are identified to follow up in further research related to methodology development for carbon accounting in the financial sector.

- One of the addressed limitations in the discussion section addressed the imperfection of the link between the quantitative and qualitative assessment of the metrics in this research. Research into quantification of the assessment criteria could provide a solution to have a stronger link between both assessments. In this way the arguments from the quantitative analysis can be linked better to the qualitative research.
- A second suggestion for further research relates to the limitation of the used sample data. A research with a more quantitative focus using a real case study within a financial institution is considered a valuable addition. In this way real-time changes within investment portfolios can

be taken into account and the performance of the EVIC metric can be considered. In addition, the portfolio will be much larger in terms of invested value and investment observations. It will be interesting to investigate if this will lead to more or to less side effects from market fluctuations on EVIC.

- A third suggestion for further research would be an investigation into the combination of forward looking based and backward looking based accounting principles. In the end carbon accounting presents the user with a snapshot in time and provides a trend of performance to assess certain decisions and targets. However, it says nothing about the current state or current measures an investee is taking in order to reduce emissions. These current measures should also be a factor within an investment decision making process. Nonetheless it will be crucial as well to use trends in order to evaluate the investment strategy over time. A research into best practices from both approaches and how to combine this in the investment decision making process could be of great value.
- A fourth option for further research is to investigate the incorporation of green investments into the current carbon accounting methodology. The current market of green investments and especially green bonds is growing. Green bonds have the aim of realising a project or activity that contributes to the targets of limiting global warming. In itself these investments can emit a large amount of GHG emissions, but in the long run these green bonds have a positive effect.
- A fifth option for further research could be an investigation into secondary influences from the financial market. Since investors invest in companies on a global scale their investments are translated into one currency. This means exchange rates are used to convert all investments into one currency. These currencies have their own fluctuating exchange rates and appreciation of depreciation of these exchange rates will influence the footprint. Another secondary effect that could be researched is the influence of inflation. This can be combined with the exchange rate research.
- • A final and crucial recommendation for further research is about data quality. As addressed in this research there is already lots of research going into improving data quality and estimation models. A key aspect in this field is the delay in reporting. A research into the pace of GHG emissions reporting could contribute to a more flexible way of practising carbon accounting. When emission streams become more general practice and get real time updates in the same frequency as monetary streams, the data will improve rapidly. How this higher frequency of reporting can contribute to the decision making process for loans and investment will be a valuable addition to this field.

To conclude, the carbon accounting principles in the financial sector and incorporation of this practice is still a rather new field of research. This rapidly evolving landscape will take form in the coming years and numerous of new interesting and challenging topics will arise in this process.

8.5 SCIENTIFIC CONTRIBUTION

Carbon accounting is a rapidly growing field within the financial sector. Lots of methods and metrics are being presented by several initiatives, but there is no widely accepted and harmonized approach yet. Also, most of the suggestions being made have no detailed substantiation. The contribution of this thesis is to compare existing methods and metrics that are being used to propose a more robust methodology for emission allocation to financial institutions considering listed equity and bonds investments. The key criteria that are identified can help in future and continuing improvements of

this methodology. Carbon accounting is the first step in a process of high quality reporting, target setting and taking climate action. It is an essential process in empowering the financial sector to be the accelerator of the global transition to a low-carbon economy.

8.6 SOCIETAL CONTRIBUTION

Measuring the emissions financed by a financial institution is the foundation for several areas within the financial institution to take climate actions. There are several initiatives currently active to support and facilitate financial institutions in taking climate action. All these initiatives flow out from the goal of limiting global warming below 1.5°C, as stated in the Paris Agreement. These initiatives create the awareness of the need for carbon accounting in the financial sector. This is supported by policies and regulation that are being developed. The EU Green Finance Agenda leads this development with their Action Plan on Sustainable finance, and they provide a European benchmark for GHG disclosure. It is expected that policies will be brought into place making carbon accounting mandatory for the financial sector. This thesis contributes to the process of realising a clear and uniform GHG measuring and disclosing method. This enables the financial institution to act and set targets to reduce GHG emission.

9 CONCLUSION

The objective of this research has been to develop an improved methodology for carbon accounting in the financial sector. This will contribute to the current efforts being made in developing a harmonised global carbon accounting standard in order to improve comparability, consistency and transparency in the financial sector. To reach this objective a research has been conducted and is presented in this thesis. The final conclusions are drawn from both the quantitative and qualitative analysis and build upon 4 sub research questions. First, these 4 sub questions are discussed in short before discussing the main research question.

"1. Which approaches are currently in place to define the climate impact of an investment portfolio?"

In chapter 4 several methods are discussed and two main differences came to the fore. The first is whether a method is based on forward or backward looking data. Forward looking data takes into account the future actions a company is promising to take. On the other hand, backward looking data uses historical data on emissions and finances of companies to make an assessment of their carbon footprint. In the latter there is always a one or two year delay, while with forward looking data current day decisions can be taken into account. The second important difference is within the backward looking methods. Here the footprint assessment can be done based on a stock or a flow variable. A stock variable has a certain point in time such as the market capitalisation of a company. A flow variable considers a whole year such as the yearly revenue of a company.

"2. What are the most commonly used metrics for carbon accounting and what are their advantages and disadvantages?"

The four most common metrics are discussed in chapter 4 and evaluated in chapter 5. Chapter 5 also adds two alternative methods into the mix. The most commonly used metrics at the moment are the Weighted Average Carbon Intensity (WACI), based on the investee revenue, and the Relative Carbon Footprint (CFP), based on the investee market capitalisation. Together with the two alternatives, which take into account the debt side of an investee, these are the four most promising metrics in this research. The alternatives are based on Enterprise Value Including Cash (EVIC) and the other on Balance Sheet Total (BST). In the qualitative analysis of these metrics the CFP and EVIC perform the best.

"3. How can the identified metrics be used to attribute financed emissions from the investee to the investor portfolio?"

In chapter 6 a conceptual model is presented, which shows how to construct an investment portfolio where the carbon footprint is calculated. Bringing the current metrics and alternatives into practice provides an insight in what data and information is needed to make a fair assessment of the portfolio footprint. The most important inputs are well disclosed emission data on the investees and basic financial data such as market capitalisation, revenue and debt. What matters most is consistency, independent of the metric chosen, because when analysing a portfolio over multiple years the financial institution needs to be consistent in their methods in order to provide sensible conclusions and set up the right strategy towards financed emission reduction.a conceptual model is presented, which shows

how to construct an investment portfolio where the carbon footprint is calculated. Bringing the current metrics and alternatives into practice provides an insight in what data and information is needed to make a fair assessment of the portfolio footprint. The most important inputs are well disclosed emission data on the investees and basic financial data such as market capitalisation, revenue and debt. Most important of this all independent of the metric chosen is consistency. When analysing a portfolio over multiple years the financial institution need to be consistent on their methods in order to provide sensible conclusions and set up the right strategy towards financed emission reduction.

"4. How robust are the identified metrics when tested in a real life investment portfolio?"

All four considered metrics in the analysis of chapter 7 are implementable on a real world investment portfolio. However, the analysis shows great dependency on the input variable for the WACI and CFP metrics. These metrics are highly dependent on changes in the financial landscape such as the market value of the stock exchange market. The BST and EVIC show a more consistent performance on this quantitative analysis and are therefore more suitable for the use on a real world investment portfolio when calculating the carbon footprint based on allocated emissions.

With all sub questions answered there is now a basis for the main conclusion and answering of the main research question.

"What is the most adequate approach for financial institutions to measure financed emissions?"

Financed emissions are defined as the GHG emissions from the real economy associated with loans and investment from the financial institution. To measure the impact of the financed emissions several principles and metrics have been discussed. This researched concludes that measuring financed emissions is the basis for all other carbon accounting and should focus on the allocation of emissions from a responsibility perspective. This responsibility can be expressed by measuring emissions from the financier perspective and allocate emissions to both equity and debt investments. The preferred approach following from this research is the use of Enterprise Value Including Cash (EVIC) in order to allocate emissions to a financial institution using equation 9.1. This conclusion is drawn from both the quantitative and qualitative analysis where together the metric based on EVIC shows the best performance for allocating financed emissions [Tonnes CO2/M$ invested].

$$\sum_{i}^{n}\left(\frac{Current\ value\ of\ investment_i}{issuer's\ enterprise\ value\ including\ cash_i} * (issuer's\ GHG\ emissions)_i\right) \tag{9.1}$$

In conclusion, this research provides an overview of several accounting principles and current metrics being used to address climate impact of investment portfolios. Based on an analysis of the challenges and shortcomings of the main metrics, the use of EVIC is proposed to use for measuring financed emissions. Still, it is believed that a carbon accounting methodology should include multiple metrics for a specified use case. For example, the Weighted Average Carbon Intensity metric that is discussed could be the most useful indicator when comparing investors in terms of GHG investment intensity. This metric suits best to get insight in how carbon intensive companies in the investment portfolio really are. A carbon accounting standard with the right selection of metrics will eventually provide the tools for the financial sector to make steps towards target setting, tracking their performance and actual emission reduction. A widely accepted and harmonised standard is what the financial sector needs in order to shift capital towards climate friendly solutions and accelerate the global climate transition.

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A IN DEPTH REVIEW OF THE MOST LEADING INITIATIVES IN THE CARBON ACCOUNTING LANDSCAPE

A.1 EUROPEAN COMMISSION AND EUROPEAN GREEN DEAL

Sustainable finance is a pillar of the European Commission supporting the European Green Deal by allocating capital and private investments to the transition to a low-carbon economy. In this pillar the EU is examining how to integrate sustainability into the European financial policy. This financial policy has the aim to mobilise finance for sustainable growth in the whole European region (European Commission, 2019). This Green Deal provides an action plan requiring cooperation of all sectors and industries. In this way the EU wants to achieve net-zero GHG emissions by 2050. One of the focus points is 'Pursuing Green finance and investment ensuring a just transition'. This includes using EU capital to invest in fighting climate change and supporting the industry to make the transition by investing in environmentally-friendly technologies and working with international partners to improve global environmental standards. To turn this political commitment into a legal obligation they also proposed a European Climate Law where one of the steps lead to the establishment of the EU TEG. Another step the EC has taken is the adoption and revision of the Non-Financial Reporting Directive. The European law requires companies with more than 500 employees to disclose non-financial information on the social and environmental impact of the company. This improves the data availability for investors and other relevant parties to strengthen the basis for sustainable investments (European Commission, 2020).

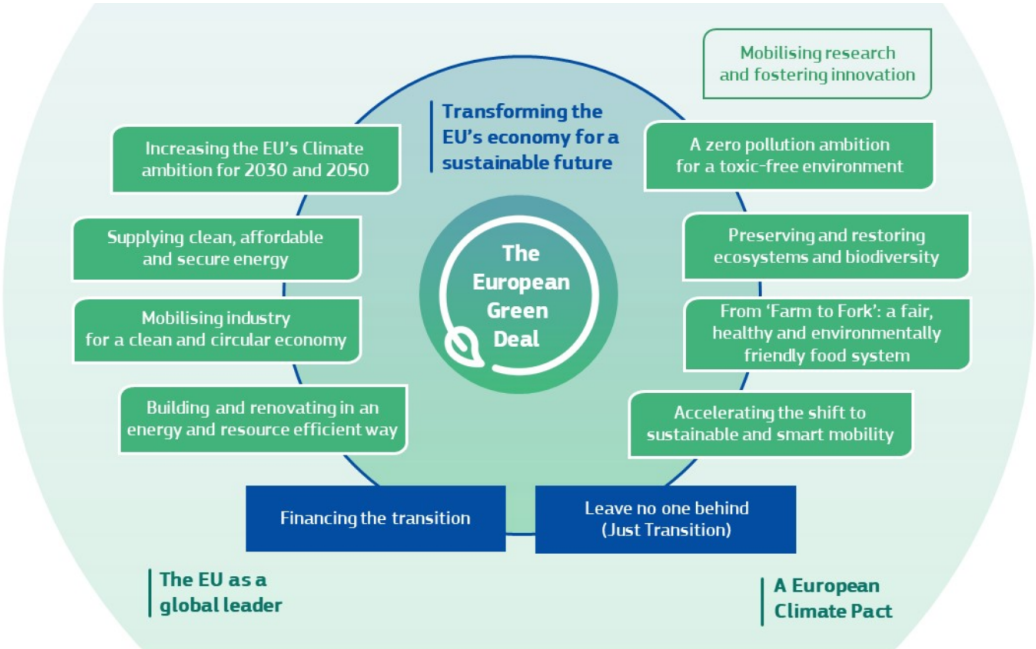

Figure A.1: The focus pillars of the European Green Deal (European Commission, 2019)

A.2 SCIENCE BASED TARGETS INITIATIVE (SBTI)

The Science Based Targets initiative's (SBTi) aims to have a critical mass of companies to set emission reduction targets. The initiative is a collaboration between CDP, the UN Global Compact, the WRI and WWF. SBTi encourages companies to set science based targets with the help of the Sectoral Decarbonisation Approach (SDA). The SDA is a scientifically driven method to help organisation set targets to align with the Paris Agreement and stay well below 2°C temperature rise (SBTi, 2015). The SBTi provides guidance and resources to help companies across all sectors set emission reduction targets for all three scopes SBTI (2019).

A.3 UNITED NATIONS ENVIRONMENTAL PROGRAM FINANCE INITIATIVE (UNEP FI)

United Nations Environment Programme Finance Initiative (UNEP FI) is a partnership between the UNEP collaboration and the global financial system to move capital from the private financial system into climate finance. More than 300 members are associated with the UNEP FI ranging from national Banks, insurers and investors. Together their goal is to restructure the financial system with a focus on people and planet combined with making positive impact. The initiative wants to set the tone and inspire others to follow and enable financial institutions to make efforts in financing the global climate transition. By leveraging the UN's role, UNEP FI accelerates sustainable finance (UNEP FI, 2019).

A.4 PRINCIPLES FOR RESPONSIBLE INVESTMENT (PRI)

The PRI is a leading initiative focusing on the global financial system with the aim to bring focus on responsible investment. Their main principles are based on incorporating environmental, social and governance (ESG) factors into the investment decision making process. The PRI acts in the long-term interests of its signatories, of the financial markets and economies in which they operate and ultimately of the environment and society as a whole (PRI, 2020b).

The PRI claims to be truly independent. It encourages investors to use responsible investment to enhance returns and better manage risks, but does not operate for its own profit. PRI beliefs climate impact reporting should be mandatory and made this step public for their signatories in February 2019. The strategy and governance indicators of PRI's climate risk indicators are to become mandatory for signatories to report from 2020 (PRI & UNEP FI, 2019).

A.5 CARBON DISCLOSURE PROJECT (CDP)

One of the most prominent and well known reporting frameworks is the Carbon Disclosure Project (CDP). The CDP was founded in 2003 and was the first platform to link environmental integrity and fiduciary duty (CDP, 2019). The mission of CDP is to collect information from as many companies and cities worldwide on their climate related impact, risks and opportunities and also about their actual GHG emissions (Matisoff, Noonan, & O'Brien, 2013). The insights that CDP provides enables investors, companies, cities and governments to make better choices concerning GHG emissions targets for the long term.

A.6 NET ZERO ASSET OWNER ALLIANCE

The Net Zerro Asset Owner Alliance is a collaboration initiated by the UNEP FI to bring asset owners together. The initiative represents over 4.6 trillion US dollars in assets under management. The committed investors have pledged to transition their investment portfolios to net-zero GHG emissions by 2050. The initiative demonstrates united investor action to align portfolios with a 1.5°C scenario, addressing Article 2.1c of the Paris Agreement (UNEP FI, 2020).

A.7 CLIMATE ACTION 100+

Climate Action 100+ is an investor initiative launched in 2017 to put pressure on the most heavy GHG emitters in the world. This alliance want these companies to take action on climate change. Collectively the aligned investors have over 40 trillion US dollars in asset under management. They encourage companies to reduce emissions, improve climate governance and strengthen disclosure on climate related exposure. The companies include 100 'systemically important emitters', accounting for two-thirds of annual global industrial emissions, alongside more than 60 others with significant opportunity to drive the clean energy transition (Climate Action 100+, 2020).

A.8 GLOBAL REPORTING INITIATIVE (GRI)

The GRI was established in 1997 and has the mission to develop a globally applicable reporting framework for sustainability (Global Reporting Inititiave, 2019). The GRI has developed several reporting standards for organisations and companies in all sectors.

A.9 CENTRAL BANK AND SUPERVISORS NETWORK FOR GREENING THE FINANCIAL SYSTEM (NGFS)

The NGFS is an unique initiative composed of both supervisors and central banks. Their goal is to better understand and manage financial risks and opportunities caused by climate change. The network was created in 2017 and consists of 36 participating members as of June 2019 (NGFS, 2019). This network defined their purpose as promoting and defining best practices to implement in the financial sector and to conduct analytical work on green finance.

B COMPANY INVESTMENT PORTFOLIO

In order to set up a good sample portfolio a conceptual model. Figure 6.1 shows the conceptual representation of the sample investor portfolio. The following requirements for the sample portfolio that came out of this process are listed below. The information is required for the time-frame from 2014-2018 and when possible the data should be extracted on a quarterly basis. The 2014-2018 time-frame was chosen based on the available GHG emission data in company disclosures. The most recent available data is for the reported year of 2018.

1. A diverse company selection
2. Financial data
3. GHG emission data in a carbon-dioxide-equivalent on company level

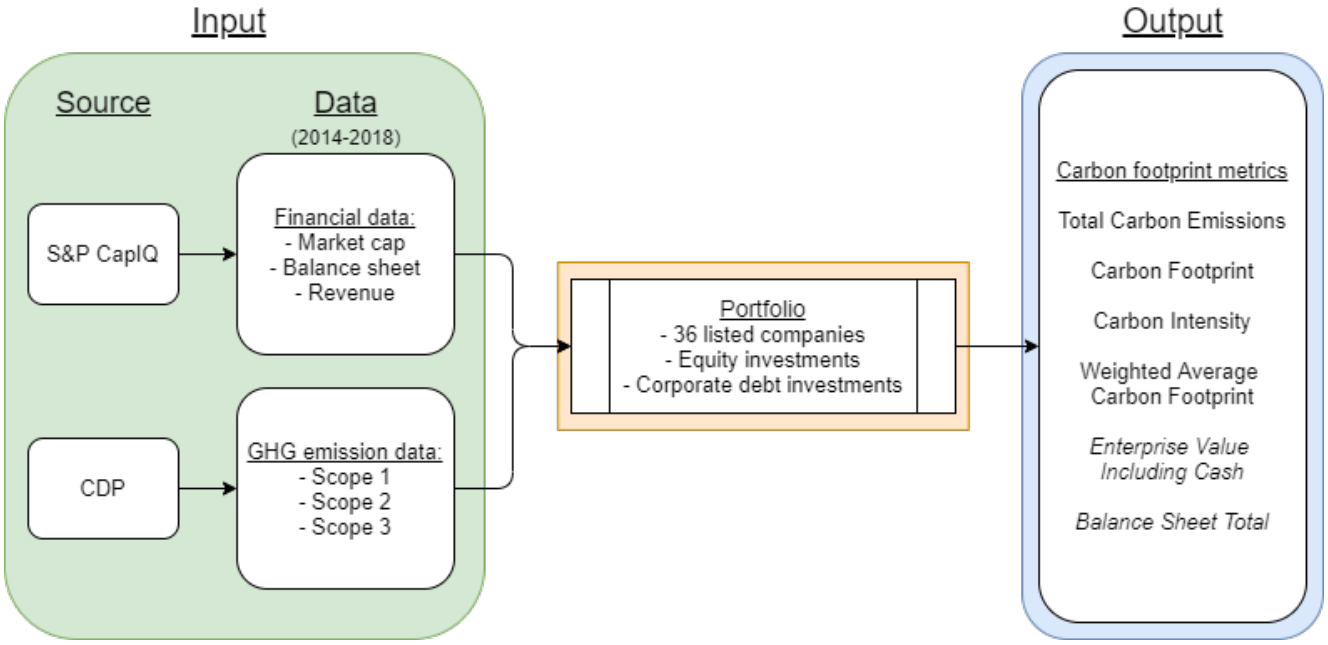

Figure B.1: Conceptual model for the sample portfolio

In table B.1 you will find the company portfolio for the test and data analysis.

Company	ISIN number	Country name	Sector
ING Groep N.V.	NL0011821202	Netherlands	Financials
Deutsche Bank Aktiengesellschaft	DE0005140008	Germany	Financials
Barclays PLC	GB0031348658	United Kingdom	Financials
Bank of America Corporation	US0605051046	United States	Financials
The Goldman Sachs Group, Inc.	US38141G1040	United States	Financials
Tyson Foods	US9024941034	United States	Food (Agriculture)
Archer-Daniels-Midland Company	US0394831020	United States	Food (Agriculture)
The Unilever Group	NL0000388619	Netherlands	Food (FMCG)
The Coca-Cola Company	US1912161007	United States	Food (FMCG)
The Kraft Heinz Company	US5007541064	United States	Food (FMCG)
Nestle S.A.	CH0038863350	Switzerland	Food (FMCG)
Microsoft Corporation	US5949181045	United States	IT
Samsung Electronics Co., Ltd.	KR7005930003	South Korea	IT
Apple Inc.	US0378331005	United States	IT
Sony Corporation	JP3435000009	Japan	IT
HeidelbergCement AG	DE0006047004	Germany	Materials
CEMEX	MXP225611567	Mexico	Materials
BHP Group	GB0000566504	Australia	Materials
Glencore Plc	JE00B4T3BW64	Switzerland	Materials
Royal Dutch Shell plc	GB00B03MLX29	Netherlands	Oil&Gas
Exxon Mobil Corporation	US30231G1022	United States	Oil&Gas
Total S.A.	FR0000120271	France	Oil&Gas
BP p.l.c.	GB0007980591	United Kingdom	Oil&Gas
Novartis AG	CH0012005267	Switzerland	Pharmaceutical
Merck & Co., Inc.	US58933Y1055	United States	Pharmaceutical
Pfizer Inc.	US7170811035	United States	Pharmaceutical
Tokyo steel manufacturing	JP3579800008	Japan	Steel production
China Steel Corporation	USY150411251	Taiwan	Steel production
Tata Steel Limited	INE081A01012	India	Steel production
POSCO	KR7005490008	South Korea	Steel production
FedEx Corporation	US31428X1063	United States	Transport
Deutsche Post AG	DE0005552004	Germany	Transport
United Parcel Service, Inc.	US9113121068	United States	Transport
ENGIE SA	FR0010208488	France	Utilities
Enel SPA	IT0003128367	Italy	Utilities
National Grid plc	GB00BDR05C01	United Kingdom	Utilities

Table B.1: Selected companies for the test portfolio sorted per sector

C6.5

(C6.5) Account for your organization's Scope 3 emissions, disclosing and explaining any exclusions.

Purchased goods and services

Evaluation status
Relevant, calculated

Metric tonnes CO2e
6812253

Emissions calculation methodology
These emissions have been calculated with the scope 3 screening tool developed by the GHG protocol in collaboration with Quantis.

Percentage of emissions calculated using data obtained from suppliers or value chain partners
0

Explanation
These emissions are becoming relevant as the Group is reducing its scope 1 emissions as fuel-energy related activities. The Group has through its purchase and supply policy already actions to engage with our major suppliers.

Capital goods

Evaluation status
Not relevant, calculated

Metric tonnes CO2e
3350358

Figure B.2: Example data from CDP report of Engie 2019, reporting data for 2018 (CDP, 2019)

C DATA PROVIDERS RESEARCH

Table C.1: Data providers for GHG emissions

2dii	Non-profit international research initiative to promote the integration of climate risks in investment strategies and financial regulations.	PACTA, EC High Level Expert Group on Sustainable Finance	Non-profit	(The 2 degrees Investing Initiative, 2020)
427	Four Twenty Seven's provides comprehensive insights into the forward-looking physical climate risk exposure of investment portfolios via an intuitive, browser-based interface.	Home developed on-demand risk analytics, Integrating climate science into business and policy decisions	Corporate	(Four Twenty Seven, 2019)
Acclimatise	Acclimatise is committed to achieving the greatest impact in driving action on climate change adaptation. Acclimatise provides climate impact advisory and analyses investment portfolios to help identify new investment strategies in more than 80 countries worldwide.	Provide advisory and analytics services for their clients.	Corporate	(Acclimatise, 2019)
Arabesque	A global group of financial technology companies. Established in 2013 following a management buyout from Barclays Bank. Our story is one of partnership between leaders in finance, mathematics, AI, and sustainability working together to deliver a new approach to capital markets.	Offering sustainable investment, advisory, and data services. Investment forecast through AI.	Corporate	(Arabesque, 2020)
Asset Owner Disclosure Project, ShareAction	We have developed an assessment framework that is fully aligned with the Task Force for Climate-related Financial Disclosures (TCFD) recommendations and applied it successfully in evaluating investors' responsible investment practices in the light of a changing climate.	Report ranking 75 of the world's largest asset managers on their approaches to responsible investment	Non-profit project, part of ShareAction (Charity)	(Asset Owners Disclosure Project, 2018)
Baringa	Management consulting focusing on Energy/Utilities sector and investment management. Helping financial institutions respond to climate change risk.	Climate Change Scenario Model is enabling the financial services industry to understand its risk from climate change and to reallocate trillions of dollars of capital to accelerate transition.	Corporate	(Baringa Partners, 2020)
Beyond Ratings	Beyond Ratings offers new financial analysis standards that systematically and transparently incorporate Environmental, Social and Governance (ESG) criteria.	Follow the Principles for Responsible Investment (PRI)	Corporate	(Beyond Ratings, 2020)

	Main company activity	Proposed or developed method/service	Interest	Source
Bloomberg ESG Data	Bloomberg is known for their reputation on providing financial data to investors. This practice is now extended with information on ESG data and specific climate carbon data. Bloomberg users consult their database for investment decisions every day.	Provide data in order to compare ESG and financial performance across companies.	Corporate	(Bloomberg L.P., 2019)
Carbone 4	Carbone 4 is an independent consulting firm specialized in low carbon strategy and climate change adaptation.	Low carbon strategies, carbon impact analytics	Corporate	(Carbone4, 2015)
Carbon Delta (MSCI)	Carbon Delta strives to make the Climate Value-at-Risk assessment the industry standard for analyzing the climate change risk exposure of companies, thereby factoring climate change into investment decisions by default.	MSCI Climate Value-At-Risk provides forward looking and return-based assessments to measure potential impact of climate change on company valuations. MSCI as data provider	Corporate	(MSCI, 2019a)
Carbon Tracker	Carbon Tracker is an independent financial think tank that carries out in-depth analysis on the impact of the energy transition on capital markets and the potential investment in high-cost, carbon-intensive fossil fuels.	Research on reforming the financial regulatory system and scenario analysis to understand changes to supply and demand and their impact on fossil-fuel exposed companies.	Non-profit think tank	(Carbon Tracker Initiative, 2019)
CDP	CDP Global is an international non-profit organization comprising of CDP Worldwide Group and CDP North America, Inc. It is directed by a board of trustees and board of directors respectively. As an international organization, CDP receives funding support from a wide range of sources. We focus investors, companies and cities on taking action to build a truly sustainable economy by measuring and understanding their environmental impact.	Collecting and providing data and comparing organisations in terms of performance with the help of a benchmark report.	Non-profit	(CDP, 2019)
Climetrics	Climetrics provides the transparency needed to move capital towards more climate-resilient funds. This can motivate companies around the world to improve how they manage material environmental risks and opportunities.	At the portfolio holdings level, Climetrics uses methodology to score companies' performance. This is done across three interrelated themes: reducing GHG emissions, managing water resources and tackling deforestation.	Initiative from CDP and ISS ESG	(CDP, 2020a)
EcoAct	EcoAct is an international consultancy and project developer, helping businesses and organisations succeed in their climate ambitions. Simplifying the challenges and complexities involved, we help you deliver sustainable business solutions for a low carbon world.	A to Zero is EcoAct's Net Zero programme, designed for sustainable business leaders taking thier organisations on a path to Net Zero and beyond.	Corporate	(EcoAct, 2019)

	Main company activity	Proposed or developed method/service	Interest	Source
Engaged Tracking	Founded in 2016, Urgentem (formerly Engaged Tracking) is the leading independent provider of transparent carbon emission data and climate risk analytics to the finance industry.	Aligned with the latest IPCC reports, EU Taxonomy and TCFD (Task Force on Climate-related Financial Disclosures) frameworks.	Corporate	(Urgentem, 2018)
ERM	ERM is a leading global provider of environmental, health, safety, risk, social consulting services and sustainability related services. We work with the world's leading organizations, delivering innovative solutions and helping them to understand and manage their sustainability challenges.	Help organisations to effectively disclose and report to initiatives like CDP and TCFD. Furthermore help in assessing strategic direction to integrate sustainability.	Corporate	(ERM, 2019)
Investor Agenda Founding Partners	The Investor Agenda is a collaborative initiative (funded and set up by CDP, IIGCC, PRI, Ceres and more) to accelerate and scale up the investor actions that are critical to tackling climate change and achieving the goals of the Paris Agreement with the aim of keeping average global temperature rise to no more than 1.5-degrees Celsius.	The Investor Agenda provides investors with a set of actions they can take in four key focus areas: 1. Investment, 2. Corporate Engagement, 3. Investor Disclosure, 4. Policy Advocacy	Non-profit initiative	(The Investor Agenda, 2020)
ISS	ISS ESG brings globally recognized expertise across the full range of sustainable and responsible investment issues, including climate change, SDG-linked impact, human rights, labor standards, corruption, controversial weapons, and many more.	ISS ESG enables investors to integrate responsible investing policies and practices. Provides climate data, analytics, and advisory to help FI's understand measure and act on climate related risk.	Corporate	(ISS, 2020)
OS-Climate	OS-C is establishing an Open Source collaboration community to build a software platform that will dramatically boost global capital flows into climate change mitigation and resilience.Through a non-profit, non-competitive organization, OS-C will aggregate the best available data, modelling, and computing and data science worldwide into an AI-enhanced physical-economic model that functions like an operating system, enabling powerful applications for climate-integrated investing in a world where the future will be very different from the past.	The OS-C technology platform will accelerate development of scenario-based predictive analytic tools and investment products that manage climate-related risk and finance climate solutions across every geography, sector, and asset class.	Non-profit open source platform	(OS-Climate, 2019)
PWC	Professional services firm and Big Four accounting firm. At the strategic and organisational levels, we advise companies on how to improve the social relevance and impact of their business activities. By measuring the total impact, it becomes possible to compare strategies and effective (investment) decisions based on quantitative data.	the three following pathways: 1. Reporting & Assurance, 2. Sustainability Strategy and 3. Responsible Governance.	Corporate	()

	Main company activity	Proposed or developed method/service	Interest	Source
Quantis	We guide top organizations to define, shape and implement intelligent environmental sustainability solutions. We deliver resilient strategies, robust metrics, useful tools, and credible communications.	Provide LCA to measure environmental impact and strategies according to SBTi.	Corporate	(Quantis, 2020)
Right.XDC	The software of the Frankfurt-based climate change startup, right. based on science, makes it possible to calculate the contributions of a company or portfolio to climate change. Results are expressed in a tangible °C number.	Calculates the impact of an investment portfolio expressed in degrees the earth would warm up.	Start-up	(Right - based on science, 2019)
SBTi FI	The initiative's overall aim is that by 2020, science-based target setting will become standard business practice and corporations will play a major role in driving down global greenhouse gas emissions. Embedding science-based targets as a fundamental component of sustainability management practices is crucial in achieving this.	SBTi target setting method: www.sciencebasedtargets.org/institutions/	Initiative from CDP, United Nations (UNGC), WRI and WWF	(SBTI, 2019)
SENSES	The use of scenario analysis in disclosure of climate-related risks and opportunities has moved into focus since the start of the TCFD (Task Force on Climate-related Financial Disclosures 2017) initiative. The Climate Change Scenario Toolkit created in the SENSES project supports the understanding of the new generation of climate change scenarios.	Scenarios include 1. Climate change projections, 2. Climate impact scenarios, 3. Mitigation scenarios	Funded project by EU a.o.	(SENSES, 2020)
Southpole	We help realise deep decarbonisation pathways across industries, based on a thorough understanding of climate risks and opportunities in specific sectors, as well as the highest emission reduction standards.		Corporate	(South Pole, 2020)
Sustainalytics	Sustainalytics is a global leader in ESG and Corporate Governance research and ratings. Sustainalytics supports hundreds of the world's foremost investors who incorporate ESG and corporate governance insights into their investment processes.	Data provider and risk analysis.	Corporate	(Sustainalytics, 2020)
TPI	The Transition Pathway Initiative (TPI) is a global initiative led by asset owners and supported by asset managers. Aimed at investors and free to use, it assesses companies' preparedness for the transition to a low-carbon economy, supporting efforts to address climate change. Launched in 2017, it is rapidly becoming the 'go-to' corporate climate action benchmark.	Open acces online tool to compare emission data over several sectors and several (listed) companies in these sectors. Data used comes from public information provided by FTSE Russell. Being in line with TCFD.	Open access tool	(TPI, 2020)

	Main company activity	Proposed or developed method/service	Interest	Source
Trucost (S&P)	Trucost, part of S&P Global, assesses risks relating to climate change, natural resource constraints, and broader environmental, social, and governance factors.	Providing data and risk of analysis of investment portfolio.	Corporate and academic research	(Trucost, 2018)
Vigeo Eiris (Moody's)	As a rating and research agency, Vigeo Eiris evaluates organisations' integration of social, environmental and governance factors into their strategies, operations and management – with a focus on promoting economic performance, responsible investment and sustainable value creation.		Corporate	(Vigeo Eiris, 2019)
Vivid Economics	A strategic economics consultancy, providing help to public and commercial parties in their decision making and strategies to a net zero transition.		Corporate	(Vivid Economics, 2020)

D FULL OVERVIEW OF STAKEHOLDER NEEDS

Based on literature, research, interviews and stakeholder analysis the following needs displayed in table D.1 are identified.

	Criteria	Retrieved from
1)	Efficiency	Interviews
2)	Practicability	Interviews (IFRS, 2015)
3)	Credibility	(WBCSD & WRI, 2012)
4)	Comparability	Interviews (EU TEG, 2019c; Hahn, Reimsbach, & Schiemann, 2015; IFRS, 2015; Sullivan & Gouldson, 2012)
5)	Simplicity/Understandable	Interviews (IFRS, 2015; Sullivan & Gouldson, 2012)
6)	Consistency	(EU TEG, 2019c; NGFS, 2019; WBCSD & WRI, 2012; O. Weber & Feltmate, 2016)
7)	Relevance	(Hahn et al., 2015; IFRS, 2015; Sullivan & Gouldson, 2012; WBCSD & WRI, 2012)
8)	Objectivity	Fair share, faithfully represented
9)	Transparency	Interviews (Clark & Hebb, 2005; WBCSD & WRI, 2012; C. Weber et al., 2018)
10)	Adaptability	Interviews
11)	Materiality	(NGFS, 2019)
12)	Faithfully represented	(IFRS, 2015; Sullivan & Gouldson, 2012)
13)	Timeliness	(IFRS, 2015; Sullivan & Gouldson, 2012)
14)	Verifiable	(IFRS, 2015; Sullivan & Gouldson, 2012)
15)	Meaningfulness	Interviews (NGFS, 2019)
16)	Data availability/Completeness	(EU TEG, 2019c; NGFS, 2019; WBCSD & WRI, 2012; C. Weber et al., 2018)
17)	Context	(NGFS, 2019; C. Weber et al., 2018)
18)	Fair share	(IFRS, 2015; C. Weber et al., 2018)
19)	Accuracy	(WBCSD & WRI, 2012)

Table D.1: Identified criteria

These criteria can be merged into overarching criteria based on overlap and comparability into 7 main needs for the eventual method to allocate emissions.

1. Efficiency
    - The need for a system that does not require excessive resources. On the other hand the input for the system needs to be detailed enough to be meaningful. Finding balance between these needs is what is defined as efficiency. This balance between required resources in time and money and quality of the output is influenced by other criteria from the list such as **Simplicity**, **Practicability** and **Relevance**.
2. Practicability
    - The method and underlying data should be understandable for all parties and practical to implement.
3. Relevance
    - For financed emissions measurement to be relevant the output needs to be relevant for the users in order to use for the associated decision making process. The relevance is decided by the system boundaries, which depend on the purpose of the information to the users. This criteria ensures the GHG inventory appropriately reflects the GHG emissions of the company.
4. Consistency

- The method should have an output of results that are timely and give a current understanding of the situation. Users of the information output want to track emissions over time. A consist system enables the user to identify trends and make a **meaningful** assessment of the performance of a company over time. Consistency is an essential need for the user when it comes to **comparability** over time.

5. Accuracy
    - Ensure that the quantification of GHG emissions is systematically neither over nor under actual emissions, as far as can be judged, and that uncertainties are reduced as far as practicable. Achieve sufficient accuracy to enable users to make decisions with reasonable assurance as to the integrity of the reported information. This enhances the **credibility** of the decisions. Note that this will always be dependent on quality of the data.
6. Transparency
    - Information should be provided on the key assumptions and methodologies used to assess climate progress, so the reader knows how to use the information and its limitations. Third parties should be able to verify the reported information and come to the same outcome.
7. Completeness
    - Reporting should include all material parts of the bank's business, notably including all parts of the bank financing climate-relevant activities and the financing of both climate "problems" (e.g., coal-fired power plants) and "solutions" (e.g., renewable energy). Current reporting practices often focus much more, sometimes exclusively, on "green" activities with little disclosure of high-carbon financing as specifically desired by many stakeholders.
8. Fair share
    - Fair share: When banking activities occur in syndicates, reporting should be based on "fair share" of the activity, for both climate problems (banks should not be saddled with lifetime emissions of a coal plant if they were only part of an underwriting syndicate) and solutions. (Don't claim $10 million of "green" if you represent 20 percent of a $10 million syndicated loan.)
9. Comparability
    - The method should produce results that allow comparison between asset classes for listed equity and corporate bonds. Also, the method should allow for comparability between financial institution portfolios.
10. Context
    - Where possible, metrics should be compared to values outside the bank's portfolio, such as ratios in the regional economy and required financing to meet global policy goals. The method should also align with the upcoming policy frameworks.
11. Robustness
    - The method should produce results that are not clouded by external effects. Impact of these external effects, such as market cap fluctuations or exchange rate changes, should be minimal. This also include adaptability of the **methodology** and **timeliness**.

E INTERVIEWS DATA PROVIDERS

E.1 INTERVIEW PROTOCOL AND INTERVIEW QUESTIONS

E.2 INTERVIEW MSCI

Interviewed organisation: MSCI
Name interviewee: David Bokern - Head scope 3 estimation model development and Bruno Rauis - Climate risk centre

Date and interview duration: 27-7-2020; 58:00 minutes

Section 1: Introduction

How would you describe your role within the company?
Bruno Rauis is based in London and part of the climate risk centre, part of MSCI ESG research. Bruno works on model development and mostly with clients on climate risk and climate disclosure. Besides these activities also involved in research activities writing papers. (Mr. Rauis his answers will be indicated with a (R).)

David Bokern works for the climate risk centre as well and is based in Zurich as most of the team. He works mostly on model development and was main responsible for scope 3 estimation model. Also takes part in research and client talks but focus on model development. (Mr. Bokern his answers will be indicated with a (B).)

Would you say that there is a changing approach towards sustainability in the financial sector?

In your opinion, do you think financial institutions should be held responsible for their financed emissions?

Section 2: General questions

Can you tell us more about your company and your data services?
Bruno and David are part of MSCI ESG research, and this department focusses on compiling and creating ESG data. Here in climate change and GHG emissions are just one part. MSCI uses this data to license it to financial institutions, mostly asset owners and asset managers. This data is also used to create indexes. (R)

What clients do you focus on?
See 1.

Please explain what data you provide to clients. Financial data and/or ESG data? MSCI ESG provides the ESG data, MSCI inc. provides also portfolio analytics. This could be considered as financial data, but

MSCI ESG only focusses on ESG data. (R)

What do you see as the most important role for data providers in the emerging carbon reporting/disclosure landscape?
Scope 3 data quality is generally quite bad. MSCI provides modelling on scope 3 data as addition to what is already reported. Also, MSCI has experts on dealing with data every day and provide a sort of consultancy in this field. Thirdly, putting a risk perspective on climate data for clients. (B)

One of the main difficulties is that emissions are often not well comparable. Depending on method (equity share, operation control, financial control) the outcome can differ significantly. Only 2000 companies worldwide report well at this moment, as MSCI we provide climate data for 10,000 companies. This data provision, consistency and quality management are main roles of us as a data provider. Also educating the landscape and sharing what we know about carbon disclosure. MSCI was also involved in the EU Technical Expert Group developing the EU Taxonomy. (R)

Are you familiar with the PCAF method and approach?
Not super familiar but interested in the methodology approach. Would like to see a document summarising the standard to learn more. (R)

Section 3: Data specific questions

What kind of ESG data do you provide? Is the focus on environmental data?
Provide GHG emissions for sure, also water use and water intensity (per revenue). This is also used in the rating models for industries where water use is relevant. There is a broad range of data points, for climate risk centre the focus is on emission information. (B)

What data on GHG emissions do you provide?
For which asset classes?
Emissions are provided on the level of entities (individual company level) and this includes equity as well as bonds. (R)
Or for which sectors?
Provide data on around 10,000 companies across all sectors.(R)
Is this global or regional?
Globally and in development markets as well as emerging markets. (R)
Yearly or quarterly
Yearly. (R)

Do you provide data in scope 1, 2 and 3? Yes for scope 1 and 2 and thanks to new scope 3 estimation model where David worked on scope 3 data as well. (R)

When covering scope 3, can you share your method for including/estimating Scope 3 emissions? Do you separate this into all 15 categories?
Scope 3 is separated into all categories, but 1 & 2 and 4 & 9 are merged. (R) This can also be divided into upstream and downstream where separate intensity can be linked to. (B)

We normalize emissions by revenue (emissions/revenue) and we normalize by EVIC. This is also done for upstream, downstream and total. In a portfolio export we use this to show emissions per company. (B)

For a portfolio we provide a WACI for scope 1/2/3, you have to know what it means to consider double counting. Climate risk measures are broken down in equity and bonds numbers. (R)

How do you gather all the needed data for your clients?
Use disclosed data from companies directly and from CDP. Manage the quality of this data as well and clean this up (R). Clients also have the choice to export their portfolio in reported data or modelled data. (B)

Section 4: Emissions, data availability and data quality

What approach do you have/use to improve data availability and quality?
Climate risk centre develops models. The people gathering the data could answer this question best. (R)

How do you model existing data gaps on Scope 1, 2 and 3?
Scope 1, 2 and 3 all require their own approach to model the data. For scope 1 we use revenue streams broken down within the company based on industries, sectors or countries. Scope 2 you can use location based or market based approach. (R)

For scope 3 we use revenue intensity as well for some categories. Revenues are there broken down per sector and country. For other categories (for example use of sold products) bottom up data is used, where you use production numbers (the amount of sold cars) and model the emissions. This approach is preferred over top-down approach where you use revenue intensities. (B)

Can you share any information on your model and methodology for estimating these data gaps?
Methodology will get published soon but is still in the pipeline. So, no sharing is possible yet. (B)

What do you see as the biggest issue/barrier in making scope 3 reporting mandatory? Or would you see it as an opportunity?
Biggest barrier I foresee from a financial industry perspective is disclosing scope 3 data is very time intensive and what you get back is minimal. Mostly critics on inaccuracy. An opportunity for parties as MSCI would be to have more available data to have more data to work with to verify own modelled data. Another opportunity would be from a strategic risk perspective. For example, as a car manufacturer it is valuable to know what your emission intensities are and what your impact on climate is as a company. Knowing this yourself is an advantage, before third parties sort it out and publish to the world what your impact as a company is. Also be prepared for the transition that is now seen is all markets. (B)

Disclosing is very difficult for a company. Secondly, there is not much willingness especially in sectors where emissions are high. Having said this, the car industry is one of the best disclosing companies out there. Also, the relevancy per category can differ a lot per company (like franchises, investments, business travel). (R)

EU TEG and PCAF approach is a phase-in of scope 3 based on sectors to make scope 3 incorporation mandatory. Would you agree with this approach?
Is helps to break it up and give some extra time to companies, but no strong opinion on this question.

Do you use scoring methods to assess data quality and availability? (explain PCAF methods on this scoring)
Bottom up data can be more trustworthy then using sector averages, but at the moment we don't use

a scoring system incorporated in the database. (B)

Section 5: Methodological questions

Do you use an approach to attribute emissions for clients or do you only provide the requested data? If yes, do you use the PCAF attribution approach (using EVIC and/or balance sheet Equity + Debt for not listed companies) to attribute emissions from companies? (*further questions only relevant when answered yes)*
Yes, as described further. (R)

Can you share your definition of Enterprise Value? What is included? If possible, please share detailed formulas and the underlying elements from financial reports/balance sheet that are included within the main elements of EVIC (e.g. what are the elements included for calculating 'book value of debt').
Basically it is debt plus equity, but could look up the exact specification of debt side. We definitely use EVIC. (R)

What climate impact metrics do you use for financial institutions? (Absolute carbon footprint, intensity, WACI, others)
We calculate different things, first we provide portfolio emissions per equity/debt position from a financial institutions. You can use here market capitalisation approach, where only equity gets emissions attributed. Or you use debt plus equity, but this can be argued as not fair either because equity and debt have the same weight in this approach. Then we also use WACI, also provides emissions/million revenue, but uses another calculation. First is portfolio emissions/revenue my portfolio is earning and WACI is average emissions of a company in my portfolio and the corresponding carbon intensity. Both are interesting but cover different things. (R)

Which intensity metrics do you calculate, and which do you feel is most appropriate? How do you calculate them and on what level (portfolio or individual company level)? Please share any discovered pros/cons for each?
See before.

Do you make any corrections to your (intensity) calculations to be able to compare portfolio carbon performance over time? And if so, how do you correct for market changes, inflation, currency changes, etc. Please share the detailed correction formulas.
There are no corrections made. For scope 3 we just calculated for the first time, so could change in the future. For scope 1 and 2 we use data for intensity using emission in that time and revenue or EVIC in that time. (R)

Section 6: Questions PCAF method specific

Considering the PCAF method, would your provider be able to apply this method in calculating your clients carbon footprint? (Like a PCAF data package.)
Would be able to provide this, but could not say if we are willing to or not. (R)

Are you already actively recommending your clients to apply PCAF or willing to do this when the Global standard is launched?
Not at this moment. (R)

Can you share your main comments or issues with the PCAF method if any? No main comments, since not familiar enough with PCAF method. (R)

Section 7: Providers and their differences

Do you experience (big) differences in data provided by other data providers? What is your viewpoint on the cause of these differences?
Mainly different model assumptions. Also bottom-up approach and information can be different. (B)

What do you think is needed to improve comparability between data providers?
Need companies to disclose more and in a more comparable way. Global industries classification standard is an example from a corporation of joined forces. (R)

Please share any remaining comments, issues or solutions you experience with the asset classes listed equity / listed corporate debt?

E.3 INTERVIEW ISS ESG

Interviewed organisation: The Institutional Shareholder Services group of companies (ISS)
Name interviewee: Maximilian Horster - Head of Climate Solutions at ISS ESG
Date and interview duration: 21-7-2020; 52:00 minutes

Section 1: Introduction

How would you describe your role within the company?
Maximilian Horster runs the climate team at ISS. I started the company 10 years ago under the name The South Pole Group and this company was bought by ISS in 2017. So now we are part of ISS where we form the climate team within the ESG unit of the company. Here we are with 20 people and 400 people in total with the ESG unit. We draw from data across the organization

Would you say that there is a changing approach towards sustainability in the financial sector?

In your opinion, do you think financial institutions should be held responsible for their financed emissions?

Section 2: General questions

Can you tell us more about your company and your data services?
ISS ESG provides to hundreds of asset managers and asset owners throughout the world with ESG reports solutions. This includes ESG ratings, raw data, analysis and so on.

What clients do you focus on?
We focus mostly on asset managers and asset owners. We don't work for corporates, because of the conflict of interest, since these companies are also rated by the company.

Please explain what data you provide to clients. Financial data and/or ESG data?

- ESG and raw data
- Little financial data, no raw financial data, but more valuation of a company to decide to buy or sell.
- Also more comprehensive reports to help investors bring up their stock.

What do you see as the most important role for data providers in the emerging carbon reporting/disclosure landscape?
Data providers in the first place provide data. We also invented high volume investment carbon reporting basically. We educated the market on carbon foot printing during the last 10 years. How to read and interpreted data and what can you learn from certain data. Now also helping regulators and policy makers to provide expertise. Our role is not only to gather the data and provide it to investors, but also to cut through the data and validate it and disregard what is not trustworthy and to complement the data with data from other sources, which might tell another story. This to overcome any type of erroneous reporting the company is doing. So, sometimes an investor is not using a data point, not because they did not find it but because the information is marked as not valid. With emission data from self-reporting we still disregard 10% of all data on emissions where we advise the investor not to use that data.

Are you familiar with the PCAF method and approach?
Yes, very much so and we have aligned our reporting stats. We create climate impact reports and these reports are designed to comply with all (+/-) 20 reporting initiatives that are out there including PCAF. PCAF we see mainly in the Netherlands, so this local role was expected. Since recent we also see it being picked up in the US, but outside those regions not that much. It's an interesting method and approach, but it will still have to scale globally to remain of relevance going forward.

Section 3: Data specific questions

What kind of ESG data do you provide? Is the focus on environmental data?
We provide data across all E, S and G areas. ISS climate provides over 700 data point per company on climate- related issues alone, there GHG emissions is 3 data points (scope 1, scope 2 and scope 3). For land use and water use we have many more data points that can be used online, in ready-made reports or be downloaded into spreadsheets leading to ESG reports.

What data on GHG emissions do you provide?
For which asset classes?
Try to cover all asset classes. We cover 25000 companies. Mostly on equity and bonds and sovereigns. Other classes are not automatically available, but are being generated on clients wishes.
Or for which sectors?
All sectors.
Is this global or regional?
Global.
Yearly or quarterly
GHG information is yearly, due to the fact they are reported on annual base. Other climate linked data gets updated in real time.

Do you provide data in scope 1, 2 and 3? Yes, scope 2 in market based and location based. We also use here the emission budget based on 2 degree, 4 degree, 6 degree scenarios and going forward also SDS, STEPS and CPS.

When covering scope 3, can you share your method for including/estimating Scope 3 emissions? Do you separate this into all 15 categories?
Not yet, currently we look at scope 3 in the following way. We first check the reporting quality on scope 3 every two years, and this quality is bad. Very poor quality, so you cannot use self-reported scope emissions. Two exceptions (in more developed markets) are the automotive and utilities sector

where scope 3 emissions reporting show increasing qualities.

How do you gather all the needed data for your clients?
Buy from CDP and collect a lot of data ourselves through CSR reports. Here we also see contradicting data quality, so it is also a way to validate and improve the available data.

Section 4: Emissions, data availability and data quality

What approach do you have/use to improve data availability and quality?
To improve availability, we try to use all available sources. Company websites, CSR reports, CDP data, and more. To improve quality, we use two steps. One is an algorithmic approach where we basically use our own trust metric (score 1-100) to show clients the data quality. This algorithm looks at emissions from peers, consistency over time, differenced between year on year reports. Step 2 is an analyst check.

How do you model existing data gaps on Scope 1, 2 and 3?
For scope 1 and 2 we build our own sector classification based on their carbon profile. Then we look at companies that report well and we disregard the outliers. Then we have 800 subsector specific models where we model the GHG emissions of those companies. This is based on best financial indicators to model within this industry. For instance revenue, revenue is not a good proxy for industries that have different pricings for the same product. For example the case with luxury goods. Take the example of watches, you can buy one for 50,000 and a cheap watch can cost 10 euro. In the end emission wise they emit the same amount of GHG gasses.

- We model scope 3 emissions upstream based on an economic input-output model. We basically model how different industries are interacting with each other, already converted into CO2 as we get it from the modeler.
- Then we model downstream emissions. We look at it from the life-cycle perspective (the use phase) where we look at a product. We model out this typical product from a company and use that as the downstream scope 3 emissions. The scope 3 data we have is not company specific but is kind of based on industry/sector averages. This means you cannot use it to differentiate between individual companies. This would mean that Tesla and Mercedes are getting the same output for use phase. Please don't quote the text in brackets
- No scope 3 emissions modelling at the moment, looking at competitors, has solved these quality issues. They all use industry averages and the ones using self-reported data you fall into the trap of poor reporting.
- Sector averages are based on input-output logic for upstream and for downstream it is based on life-cycle assessment approach. Take a product apart and assess the climate impact for its lifetime in the use phase.

Can you share any information on your model and methodology for estimating these data gaps?
See 12.

What do you see as the biggest issue/barrier in making scope 3 reporting mandatory? Or would you see it as an opportunity?
I think there are two hurdles. One is that is can be very painful to report scope 3 emissions. And two is that in my opinion scope 3 is not the holy grail to all the question that we have. A lot of people think that when we have scope 3 we get to answer all the question that we have when assessing a portfolio,

but this is not true. Scope 3 is not solving the issue that scope 3 is always backward looking. It is also not solving for efficiencies in the supply chain, it also does not tell you that much about the efficiency of the product. Our belief is that we can answer all the questions people have for scope 3 data with our qualitative research. We look at whether a company has climate targets in place, whether they are on route to achieve this target and if there is an incentive. We look at the product itself within these companies. Our analysts know the whole company from bottom-up and understand the product and its supply chain. Having better scope 3 data is a lot of work with very little improvement of incremental understanding in my opinion. In my view qualitative information can get you more further there to focus more on forecasting instead of back casting.

EU TEG and PCAF approach is a phase-in of scope 3 based on sectors to make scope 3 incorporation mandatory. Would you agree with this approach?
Yes, I think that is a good approach. We should always strive for more transparency. Only we should not expect a world where scope 3 data is high quality and widely available.

Do you use scoring methods to assess data quality and availability? (explain PCAF methods on this scoring)
See part about the trust metric.
We also use another metric when we model the data. Not all models are of the same strength and quality, so we also use a score for our own models to score the outcomes.

Section 5: Methodological questions

Do you use an approach to attribute emissions for clients or do you only provide the requested data? If yes, do you use the PCAF attribution approach (using EVIC and/or balance sheet Equity + Debt for not listed companies) to attribute emissions from companies? (*further questions only relevant when answered yes)*
Yes, as discussed.

Can you share your definition of Enterprise Value? What is included? If possible, please share detailed formulas and the underlying elements from financial reports/balance sheet that are included within the main elements of EVIC (e.g. what are the elements included for calculating 'book value of debt').
We use the Enterprise Value and leave the cash out. We call this adjusted Enterprise Value, so in practice the same as PCAF.

What climate impact metrics do you use for financial institutions? (Absolute carbon footprint, intensity, WACI, others)
We provide several metrics in our assessment reports to be aligned with several frameworks and guidelines out there. We provide WACI from TCFD, one is emissions to Market Capitalisation, basically the ownership approach where you get 1 % of emissions when you own 1% of the company. One is linked to revenue. We try to fit all needs with this one report.

Which intensity metrics do you calculate, and which do you feel is most appropriate? How do you calculate them and on what level (portfolio or individual company level)? Please share any discovered pros/cons for each?
As mentioned we use several metrics (see also example report that is send to see how this is implemented in an actual report). Which one is most appropriate depends on the use case. When you want to do an analysis throughout all asset classes WACI makes more sense. When you go for carbon footprint (absolute numbers) and you want to know the amount of CO_2 you are responsible for you want one that is linked to ownership (for example market cap approach). And when you want to compare your numbers to competitors you should use the same number as they use. To make sure to compare apples to apples. All metrics have their pro's and con's. Mostly the con is related to the denominator

about what to include and what not. Fluctuating market caps can influence your emissions ownership.

Do you make any corrections to your (intensity) calculations to be able to compare portfolio carbon performance over time? And if so, how do you correct for market changes, inflation, currency changes, etc. Please share the detailed correction formulas.
We can do it, but only manual when clients request it. It is not automatically in the system.

Section 6: Questions PCAF method specific

Considering the PCAF method, would your provider be able to apply this method in calculating your clients carbon footprint? (Like a PCAF data package.)
Yes, as discussed we already do this in some way.

Are you already actively recommending your clients to apply PCAF or willing to do this when the Global standard is launched?
We discussed the pro's and con's internally. We don't actively promote PCAF, but when clients ask for PCAF we do the assessment in that way.

Can you share your main comments or issues with the PCAF method if any? I wonder if there is a value in creating a standard on a regional level and than scale it globally while there are other organisations doing this the other way around. You also have initiatives on a global level, but I think on it's focus on GHG emissions is quite unique. The way PCAF goes deep into the knowledge of carbon footprinting and trying to implement this into many different asset classes. That is a standard that is as detailed as hardly any other out there.

I would also put a question mark at the point to ask yourself if this is good enough for the world? Because I do think that carbon footprinting is well understood, but the cons of being it backward looking. Therefore I don't think it is a good instrument to structure a portfolio. But it is a good instrument to, from my point of view, to over time measure the temperature of your portfolio and to see if your temperature is going down. Therefore, it is well to use as a control instrument to make sure that what you are doing is bearing fruit. If you try to steer the emissions down, don't use GHG emissions (carbon footprinting), but rather commitment (more qualitative measures). And than use a carbon footprint to test every two years to if your commitments drive the portfolio emissions down. In the focus of carbon accounting it works well, but this should be combined with something more foreword looking. Also the use of sector averages don't work when singling out individual investments.

For example in real estate asset class you want to see that building A is doing better than building B, ben when using sector averages this is not possible.

Section 7: Providers and their differences

Do you experience (big) differences in data provided by other data providers? What is your viewpoint on the cause of these differences?
Yes there are differences when it comes to GHG emissions numbers. An important issue is providers that use data without validating it and then use data what they should not use. Also we use an approach much more granular when modelling than anybody else out there. Hopefully this pays off and then it is logic that the outcome is different from others using only sector averages.

What do you think is needed to improve comparability between data providers?
We are being compared already by our clients and the competitive side of the market. We as providers needs this competition to be able to innovate and improve rather then having governmental bodies tell what data to use and eventually ending up with the same numbers throughout all data providers. Clients decide by market quality.

I think there is a trade-off to be made between standardisation and innovation. In some way standardization can kill innovation. When standardization is done to early, you lose the incentive to innovate. We need certain standard, but should also safeguard space for innovations.

Please share any remaining comments, issues or solutions you experience with the asset classes listed equity / listed corporate debt?
Important issue is the mapping, when you issue a bond this gets a new identifier. The buying institutions gets this number popping up in their portfolio and it is super hard to track these numbers through portfolios and to reconcile this to the underlying company.

Also the topic of double counting is an issue. PCAF solves this by using Enterprise Value, but there can also be reasons where it is good to double count. The reason you don't want to double count is that you don't want to inflate GHG emissions. The problem of inflating GHG emissions is only there when you link this to a carbon budget, where in the budget it is only counted once. For example; when I own the stock and bond of Unilever and Unilever gets hit by climate regulations. Then I, as an investor, get hit twice. I get hit on the bond and on the equity side. When I did not double count I kind of deflated my exposure to the same amount of CO2. Also this again depends on the use case. Whether you want to avoid double accounting or want to work with double counting.

In general I would say carbon accounting is developed for companies. Moving this to the equity space was already a bit of a stretch to say the company is not responsible but the ones who own the company should be held responsible. Now moving this from equity to other asset classes it gets really messy. Constantly more contradictions appear where you see carbon accounting was not created for that application. The original thought is "I see a ton of CO2 here, who owns it?". Then try to attribute it to those who can change the emissions. And for a debt holder it is really hard to make the case the debt holder can influence the way the companies make decisions. For equity holders you can say they have a vote in the company to influence policy. But when a bonds is acquired you only lend money and you can't say where the money should be put in the company. Only you can complain about not being paid back.

E.4 INTERVIEW CDP

Interviewed organisation: Carbon Disclosure Project
Name interviewee: Eoin White, Pierre Badiuzzaman and Luke Maxfield
Date and interview duration: 4-9-2020; 52:00 minutes

Section 1: Introduction

How would you describe your role within the company?
Pierre works in the capital market team of CDP in Europe. Within this team his focus is on product development and senior developer on climatrics. The last few years his work focused on climatric

fund ratings and the CDP temperature ratings. Temperature scores rating report came out last July and was up for consultation the last two months including a webinar for interested stakeholders.

Eoin works in the science-based target team within the Europe business of CDP. His role has a focus on reviewing and auditing the submissions from companies regarding their science-based targets. As a second focus point Eoin works on the temperature scoring report together with Pierre. Also involved in a project with SBTi FI to align science-based targets with the FI pathway.

Luke works at CDP for about 1,5 years and is part of the data analytics team. Their work supports the various other departments within CDP by enhancing the reported data CDP receives. This ranges from cleaning data sets to estimating data gaps. CDP can't control the underlying methods reporting companies use to report on their environmental data. Luke's department analyses this data to identify companies that might have mis reported their data due to human errors for instance. Furthermore, the incoming data is used to set up estimation models to estimate emission data for companies that do not report on their carbon emissions. Main focus of Luke's work is on assessment for city data to validate responses from cities.

Would you say that there is a changing approach towards sustainability in the financial sector?

In your opinion, do you think financial institutions should be held responsible for their financed emissions?
Eoin: I don't think they should carry all the responsibility, but investors doe share a large portion of responsibility since they finance new activities. Furthermore, they have a major role in terms of influencing through stocks they decide to buy and flow of capital within companies. Holding them to account for scope 3 emissions from their investment is really important in order to drive change.

Pierre: Adding to that, it is increasingly seen as something investors need to consider as part of their responsibility to their clients. Also, this responsibility for investor is a strong part of the EU financial plans and has a centered role within the legislation, which need to be especially strengthened in its implementation.

What would you say that are the most important aspects of a harmonized carbon accounting methodology?
Eoin: I would say consistency is crucial and also the ease of adoption. There is a need for methodologies that eventually all financial institutions can easily adopt.

Luke: Data is very scarce and that makes it very difficult to compare companies amongst each other. The data shows that highest emitting companies are simply those that put the most effort in their reporting. This creates a bias that companies having the best handle on what their impact is are appearing to be the companies to have the highest impact. This bias is important to acknowledge and is a good example of a consequence from not having a large scale adoption of the same reporting approach.

Section 2: General questions

Can you tell us more about your company and your data services?
CDP has been around for about 20 years and was the first organisation that requested environmental data from companies. With this action CDP pioneered the field for carbon disclosure. Initially CDP worked with a paper questionnaire, which they send around to companies. This process was initiated through financial investors as a result of the growing interest from investors in companies' environmental performance. The questionnaire was used to also rise attention with companies to start disclosing on this data part of their business. Since then CDP has grown to over 500 investor signatories, over a 100$ trillion assets under management and over 8000 companies reporting. These 8000 are divided over the investor program (2,500) and the supply chain program where companies ask organisations in their supply chain to disclose (5,500). In the supply chain program, the data is not always publicly available but only available to this particular company requesting their reports. From there we offer

this data to our investor signatories and sell data to third parties and non-signatory investors. The environmental data is accompanied with scores on the reporting quality ranging from A to F. Lastly, we estimate data gaps on scope 1, 2 and 3 which we provide to clients besides the reported data.

What clients do you focus on?
A broad spectrum of institutional investors.

Please explain what data you provide to clients. Financial data and/or ESG data? Focus is only on environmental data. CDP does not provide financial related data. The environmental data focuses on GHG emissions and also water use and deforestation.

What do you see as the most important role for data providers in the emerging carbon reporting/disclosure landscape?
The most important role is to provide data, which is as accurate and as comprehensive as possible. However, the role of a data provider is also to let users know about the limitations of the data and underlying biases. This is crucial to avoid decisions being made that are based on wrong conclusions. The goal of CDP is to highlight that these limitations and gaps exist to activate clients and reporting companies to improve the data and solve part of these issues.

Are you familiar with the PCAF method and approach?
Yes.

Section 3: Data specific questions

What kind of ESG data do you provide? Is the focus on environmental data?
We now have three questionnaires with focus on emissions, water and forestry. CDP aims to go beyond information on GHG emissions into management and carbon processes to also provide forward looking metrics. This gives an understanding how companies prepare to adjust and improve themselves in the future.

What data on GHG emissions do you provide?
For which asset classes?
We don't have it yet, but questions on this are introduced in the latest questionnaire from 2020 so from October on CDP should also have data specified per asset class.
Or for which sectors?
Data is on company level. Meaning we have data across all sectors. CDP does not provide data on sectorial level, but there is interest around emission intensities across different sectors, so work to develop this is being done.
Is this global or regional?
Global.
Yearly or quarterly
GHG information is yearly, due to the fact they are reported on annual base. Other climate linked data gets updated in real time.

Do you provide data in scope 1, 2 and 3?

When covering scope 3, can you share your method for including/estimating Scope 3 emissions? Do you separate this into all 15 categories?

How do you gather all the needed data for your clients?
CDP also does data collection. Collecting asset level data from high intensity sectors such as oil and gas, cement, steel etc. Collecting data for these sectors is relatively simple because they are quite homogenous in terms of unit of production (barrel of oil, tonnes of steel). This data feeds into the bottom-up models and on their turn these models feed into the full emissions estimation data set. They are also used for some different outputs for example in the science-based targets activities within CDP to provide a sector specific assessment. This helps to assess reported data from companies in a particular sector.

Section 4: Emissions, data availability and data quality

What approach do you have/use to improve data availability and quality?
There are two main methods. CDP uses a regression method and the bottom-up method. The bottom-up method is explained on question 10. Sectors with a clear unit of output are estimated from a bottom up approach using 'amount of coal plants – produced coal – emission factor per unit output of coal' to get an emission value for the company. Only the unit of production is in the majority of sectors much harder to define. Therefore, it is very difficult to obtain an emission value through this approach. The method used in those cases is a regression method where CDP takes the cleaned emission data and try to remove outliers and misreported data. Then use company revenue, this works well since companies with higher revenue usually make more stuff and therefore have higher emissions. However, in some sectors such as the service industry this relation between revenue and emissions is very vague and so this approach is not perfect to use across all sectors. Generally speaking, the use of revenue as a proxy is a decent way to model data gaps. The reported dataset is than used as some sort of training set for the regression model in order to estimate the emissions of companies not reporting or improving data which is assumed to be misreported.

How do you model existing data gaps on Scope 1, 2 and 3?
Using sector averages and revenue streams

Can you share any information on your model and methodology for estimating these data gaps?

What do you see as the biggest issue/barrier in making scope 3 reporting mandatory? Or would you see it as an opportunity?
Two main barriers are there. The first would be time limitations on the company side. Reporting on scope 3 is a major task and companies are hesitant to go down that path and dedicate themselves and put resources into the reporting on scope 3 emissions. Also companies are unfamiliar with LCA data and inventory databases that could help them estimating their scope 3.

Another barrier could be rigor and quality control throughout the value chain. Companies in Europe have relatively good reporting, but looking at emerging markets emission reporting is already less common and the quality is also a bit lower. Moving into scope 3 reporting there needs to be more attention for emerging markets and smaller companies. Quality control for the information from these markets would become an important part in order to be able to use this data.

EU TEG and PCAF approach is a phase-in of scope 3 based on sectors to make scope 3 incorporation mandatory. Would you agree with this approach?

Do you use scoring methods to assess data quality and availability? (explain PCAF methods on this scoring)

Section 5: Methodological questions

Do you use an approach to attribute emissions for clients or do you only provide the requested data? If yes, do you use the PCAF attribution approach (using EVIC and/or balance sheet Equity + Debt for not listed companies) to attribute emissions from companies? (*further questions only relevant when answered yes)*
On request we can do portfolio footprinting. We also do portfolio assessment through our company climatric scores. GHG footprinting is not something we regularly do. Focus is mostly on equity exposure. CDP has looked at five different approaches to aggregate information on a portfolio level and assign contribution. Here we also did a public consultation and the outcome in general was that there are many different approaches. For us it did not became clear one approach was really superior to one other. The eventual favoured approach came down to use enterprise value to decide the ownership on portfolio level. This is also in alignment with PCAF.

We as CDP try to be more flexible and favour the approach based on the asset class and purpose of the approach. Whether it is for target setting or responsibility allocation. The favour at the moment tends to go to EV for target setting and for aggregating at portfolio level, but are also open for other approached dependent on the purpose. This would support the discussion to go more into what approach to use for what purpose/use case instead of chasing for one perfect and widely used approach. When considering attribution it is also important to see if it can be done on public available data. You will need information on market cap, EV so transparency behind these approaches is very important to have it all from public databases.

Can you share your definition of Enterprise Value? What is included? If possible, please share detailed formulas and the underlying elements from financial reports/balance sheet that are included within the main elements of EVIC (e.g. what are the elements included for calculating 'book value of debt').

What climate impact metrics do you use for financial institutions? (Absolute carbon footprint, intensity, WACI, others)

Which intensity metrics do you calculate, and which do you feel is most appropriate? How do you calculate them and on what level (portfolio or individual company level)? Please share any discovered pros/cons for each?

Do you make any corrections to your (intensity) calculations to be able to compare portfolio carbon performance over time? And if so, how do you correct for market changes, inflation, currency changes, etc. Please share the detailed correction formulas.
No

Section 6: Providers and their differences

Do you experience (big) differences in data provided by other data providers? What is your viewpoint on the cause of these differences?
CDP asks for more detailed data than companies would report themselves in annual sustainability reports. This can cause differences, but hopefully improved the quality of the data coming in through CDP. On the emissions data side we see also differences because of the reporting approach chosen. For example, companies with multiple subsidiaries can report for the whole group in their annual report, but with the responses through CDP they could give responses per subsidiary. Another example which can cause differences in data is whether a reporting organisation uses operational control of financial control as an approach to calculate their emissions. This kind of decisions need to be understood to take into account possible differences in reported data through different channels. As long as these

different approaches exist the differences will exist until there is one uniform accepted approach for emission reporting.

Part of the problem lies within the GHGP, which is purposely vague on some of these points. Much of all the work is based on this GHGP, which intended to bring flexibility. A disadvantage of this flexibility is causing the problem of consistency. Boundaries and approaches companies use can also change over time through this inconsistency making comparing emission performance from companies over time nearly impossible.

What do you think is needed to improve comparability between data providers?

Please share any remaining comments, issues or solutions you experience with the asset classes listed equity / listed corporate debt?

E.5 INTERVIEW TRUCOST S&P

Interviewed organisation: S&P ESG (formerly Trucost)
Name interviewee: Anja Rundquist - Senior business development manager
Date and interview duration: 05-8-2020; 55:03 minutes

Trucost is a global data provider focusing on environmental data. Trucost was acquired by S&P Global in 2016, but still operates as Trucost since the strong reputation and brand the name carries. S&P Global is from origin a financial data provider. Anja Rundquist works with Trucost since May 2020 in the Stockholm office. Before Anja worked with FactSet for 8 years focusing more on financial data. Now the focus is all on ESG within Trucost where S&P comes in for the financial data.

Section 1: Introduction

How would you describe your role within the company?
Working as a senior business development manager. Covering Nordics and Netherlands. Within the business we have a product development team, an innovation team, a research team, and a data analyst team.

Would you say that there is a changing approach towards sustainability in the financial sector?

Definitely, I used to sell Trucost data in my early time with FactSet. This was 10 years ago. In that time this sustainability was a 'nice to have' extra for certain investors and to benchmark your carbon footprint of your portfolio. Nowadays, you see this massive shift with regulation such as the EU Taxonomy and initiatives such as PCAF and TCFD coming into place and stimulating the whole incorporation of sustainability into the financial sector. The financial materiality has also changed. There is now an understanding that not managing your ESG can be very costly and it is also incorporated in investment decisions. It changed from 'nice to have' to really important to use when assessing and deciding on new investments. Investors also see it as opportunity to assess investments. This is strengthened by the new generations where there is a shift in choosing more and more the sustainable option making sustainable focused businesses to grow and an increase return on investment.

In your opinion, do you think financial institutions should be held responsible for their financed emissions?

Yes, I think so. For the large of society this is the place to make impact. As individuals we can recycle and such, but with these investors is where the impact is made. As an investment fund, you can conduct an investment analysis to decide your investment strategy. Then you can also think about the impact you make with your investment and thus be held responsible for this impact. As an investor you can start shareholder engagement and steering to mitigate the impact.

Section 2: General questions

Can you tell us more about your company and your data services?
Trucost is part of S&P Global. A leader in carbon and environmental data and risk analysis, Trucost assesses risks relating to climate change, natural resource constraints, and broader environmental, social, and governance factors. Companies and financial institutions use Trucost intelligence to understand their ESG exposure to these factors, inform resilience and identify transformative solutions for a more sustainable global economy.

What clients do you focus on?
Trucost branch of S&P Global focuses mainly on financial clients, covering asset owners, asset managers, insurance companies, pension funds, banks etc.

Also, we have corporate company clients where we help them with ESG scoring and TCFD reporting and helping them in improving. The ESG rating is strictly kept apart to avoid conflicts in scoring and ratings.

Please explain what data you provide to clients. Financial data and/or ESG data?
Trucost, prior to acquisition, did focus mainly on environmental data. GHG emissions, air pollution, water use, and data deep coverage on environmental part. In 2016 acquired by S&P and since than the combined company does provide also financial data and ESG ratings. Also, the Trucost focus on Environmental was extended to Social and Governance data about SDG's and social impact investment.

What do you see as the most important role for data providers in the emerging carbon reporting/disclosure landscape?
Quality data providing. Initially it was hard to get access to financial data, then the issue moved to getting clean data when data in general was available. Now the issue is mostly on getting clean and high-quality data, especially on environmental data. Trucost does clean and correct the data and checks the trustworthiness of the data.

Secondly, we can advise financial institutions on incorporating ESG in their business and be in an educational role.

Are you familiar with the PCAF method and approach?
Personally, I don't know it in detail but our data analysts know the PCAF method and already apply the method for clients requesting this approach. We provide data to our clients in different ways. First is providing them with data figures, which they can incorporate in their own system and calculations. Than we also have our platform were clients can access both financial and ESG data. Lastly, we have a team doing portfolio analysis. Portfolio benchmarking or footprinting for example. This part we already do in the PCAF method when clients require this.

Section 3: Data specific questions

What kind of ESG data do you provide? Is the focus on environmental data?
Focus is on Environmental data. We also provide data on land-use, water-use, air pollution, waste and

biodiversity besides GHG emissions. Besides this we also do ESG scoring and consider also social and governance values.

What data on GHG emissions do you provide?
For which asset classes?
Fixed income, equity, sovereigns, broad based. Less on private companies, they require some other methodology since data availability lacks in private companies.
Or for which sectors?
All sectors.
Is this global or regional?
Global (15.000 companies).
Yearly or quarterly
emissions yearly and financial data based on reporting of the company this is annually, semi-annually, quarterly. Emission data is marked in the year the company releases the data

Do you provide data in scope 1, 2 and 3? Yes.

When covering scope 3, can you share your method for including/estimating Scope 3 emissions? Do you separate this into all 15 categories?
Yes, scope 3 emissions are divided in all 15 categories. These 15 categories are then divided into upstream and downstream emissions as prescribed by the GHGP.

Upstream emissions are provided in 'reported data' and 'modelled data'. The reported data comes from corporates directly and from CDP and goes through an additional validation of the Trucost analyst team. The modelled data is calculated using environmentally extended input-output models. Trycost is able to estimate emissions from all tiers of the upstream value chain of a company by using this model. This covers emissions associated with the company's purchased or acquired goods and services.

Downstream emissions are also divided into 'reported data' and 'modelled data'. The reported data goes through the same process as the upstream emissions. The modelled data is calculated using a combination of a 'top down' approach and 'bottom-up' approach. The top-down approach is used to model scope 3 category specific emissions intensities (tonnes/$M revenue) at a sub-industry level (GICS). This approach is utilised when a company: (1) does not report any scope 3 data, (2) if a third party has not verified reported data or (3) has not calculated all relevant categories. The bottom-up approach is used for key sectors, such as oil & gas, coal extraction and automotive. The modelled data utilises production data disclosed by each company in the sector.

How do you gather all the needed data for your clients?
Using CDP verified data and data directly disclosed by companies.

Section 4: Emissions, data availability and data quality

What approach do you have/use to improve data availability and quality?
Spend 3 months exploring companies, before adding their data in the model and putting it out. This is a thorough process conducted by the analyst team to explore the company and feed good estimates to the modelling processes explained above.

How do you model existing data gaps on Scope 1, 2 and 3?
See question 9. More detailed info can be found in the additional documents from Trucost on scope 3

data.

Can you share any information on your model and methodology for estimating these data gaps?
See question 9.

What do you see as the biggest issue/barrier in making scope 3 reporting mandatory? Or would you see it as an opportunity?
People can be hesitant on putting responsibility on scope 3. For scope 1 and scope 2 it is quite clear and boundaries are well defined, but when entering the space of scope 3 this is harder to define. What should you account for in reporting scope 3 data and what not. Where do the boundaries lie of your responsibility as an investor?

Example of employee commuting, how do you tell and monitor how people come to work and how often they choose for alternatives etc. and than you can also start the discussion on impact percentage of certain categories. It would make more sense to focus on the categories with the higher numbers in order to have a clear picture of the order of magnitude to start and take measures in the areas where most impact can be achieved.

EU TEG and PCAF approach is a phase-in of scope 3 based on sectors to make scope 3 incorporation mandatory. Would you agree with this approach?
Yes, but personally I would support combining this with focusing on specific categories where most impact can be made. When heavy emitting companies start reporting and take on 12/15 categories saying they are doing well, but actually their emissions from the remaining 3 categories make up 90% of their emissions. Can you than say they are doing well? Off course you should be held responsible for all, but starting with phasing in on specific categories defined by sector would be more convenient.

Do you use scoring methods to assess data quality and availability? (explain PCAF methods on this scoring)
We don't use actual scoring methods, however we do show the level of data which is disclosed and where the estimated amounts are based on. Providing coverage and defining difference in disclosed and modelled data.

Also, Trucost recognises the bias that can occur in reporting data. The top-down modelling is based on reported scope 3 data from companies. Trucost expects companies that do well in their GHG emission numbers will report more often. Meaning that averages derived from reporting companies are expected to be lower than the actual sector average. This is considered due to the expectation that reporting companies with a relatively lower scope emissions intensities have a greater incentive to disclose this data versus companies with higher downstream impacts that would prefer to not make this information publicly known. To solve this problem sample sizes need to increase over time.

Section 5: Methodological questions

Do you use an approach to attribute emissions for clients or do you only provide the requested data? If yes, do you use the PCAF attribution approach (using EVIC and/or balance sheet Equity + Debt for not listed companies) to attribute emissions from companies? (*further questions only relevant when answered yes)*
Attribution we do on carbon performance and relative to benchmarks. That is how we base our attribution analysis. The attribution through market cap we use for full equity portfolios and EV is used for fixed income and portfolio's where bonds and equity are combined. We can use both in our analysis based on the client preferences.

Can you share your definition of Enterprise Value? What is included? If possible, please share detailed formulas and the underlying elements from financial reports/balance sheet that are included within the main elements

of EVIC (e.g. what are the elements included for calculating 'book value of debt').
We use Enterprise value data from S&P Cap IQ, see Cap IQ glossary with definition and underlying components defined there.

What climate impact metrics do you use for financial institutions? (Absolute carbon footprint, intensity, WACI, others)
In reports we show absolute, relative, intensity and WACI. We provide a wide range to comply with all client needs. We believe the WACI is a very good methodology, because you can also use it on private equities where EV is often lacking.

Which intensity metrics do you calculate, and which do you feel is most appropriate? How do you calculate them and on what level (portfolio or individual company level)? Please share any discovered pros/cons for each?

Do you make any corrections to your (intensity) calculations to be able to compare portfolio carbon performance over time? And if so, how do you correct for market changes, inflation, currency changes, etc. Please share the detailed correction formulas.
In the case market fluctuations are polluting the performance and results of carbon metrics, clients often ask for absolute emissions to see if the companies they invest in actually go down or not and how their absolute portfolio emissions are developing. This helps to recognise any change caused solely by market fluctuations instead of actual emission reduction.

Section 6: Questions PCAF method specific

Considering the PCAF method, would your provider be able to apply this method in calculating your clients carbon footprint? (Like a PCAF data package.)
Yes and we are already doing so, however no active promoting.

Are you already actively recommending your clients to apply PCAF or willing to do this when the Global standard is launched?

Can you share your main comments or issues with the PCAF method if any? No specific issues.

Section 7: Providers and their differences

Do you experience (big) differences in data provided by other data providers? What is your viewpoint on the cause of these differences?
Personally, I think there is a broad variety between data providers. There are also vendors focusing only on reported data and also the quality of data and cleaning data varies across the data providers.

What do you think is needed to improve comparability between data providers?
At the moment data does not require external audit, but in the future I expect this to change. This will improve data quality from companies and more reliable reported data will also lead to more comparable data between data providers, since the underlying uncertainties are reduced. Also consider the bias of companies doing good report more. Also see the additional document on this. Same for SDG's, report on the ones you know your organisation is doing well.

Please share any remaining comments, issues or solutions you experience with the asset classes listed equity / listed corporate debt?

E.6 INTERVIEW SUSTAINALYTICS

Interviewed organisation: Sustainalytics (a Morningstar company)
Name interviewee: Emma Gordon - Carbon product manager
Date and interview duration: 05-8-2020; 57:00 minutes

Section 1: Introduction

How would you describe your role within the company?
Joined Sustainalytics 2,5 year ago and now carbon product manager. Responsible for different carbon products, such as emissions and carbon risk products. Develop and maintain products based on client feedback. Talk with clients about data quality and level of reporting and how their opinion is in this aspect. Before Sustainalytics I worked in country risk and worked a lot with oil and gas companies. I don't work on the actual research but focus on emissions data quality checking and as said product development including competitor and market analysis. Most of the time goes into client advisory work, both existing as new clients. And helping clients in expanding use cases for their emission data.

Would you say that there is a changing approach towards sustainability in the financial sector?

Yes, I really think so and I see this as a very positive message. I noticed a shift about 2,5 years ago where data on emissions was very much impact focused. This shifted toward more risk focused data. Not only the negative impact of the investment on the climate but also how the emissions can have a negative impact on the investment value itself. This discussion moved the discussion more towards integration of ESG values into the financial sector. Now also institutions that don't see themselves as an impact investor now also see the importance of incorporating ESG in their investment strategy. This is also encouraged by initiatives like the TCFD to help investors think more about the long term of climate impact risk.

In your opinion, do you think financial institutions should be held responsible for their financed emissions?

I think that the idea of it being a shared responsibility should be central. The idea that everyone in the value chain needs to think about their impact and risk. It does not have to be about being more responsible than another entity in the value chain. There is pressure encouraging this thought from two sides. On the one side it's the regulatory initiatives and on the other side the consumers that want to see their money being invested in a responsible and sustainable way. Or building their pension with a fund with a positive impact. I would say this regulatory obligation and consumer expectation mix is a good mix to drive change forward.

Section 2: General questions

Can you tell us more about your company and your data services?

What clients do you focus on?
Mostly asset managers and asset owners and basically the whole financial sector. Within the organisation we also have a sustainable finance department which focuses on other corporates.

Please explain what data you provide to clients. Financial data and/or ESG data?
We don't supply financial data; this is more in the Morningstar division. ESG is all within the Sustainalytics part of the company. We use revenue and other data for our ESG reports, but do not supply

financial reports to clients.

What do you see as the most important role for data providers in the emerging carbon reporting/disclosure landscape?
Personally, I think the most important thing is supporting the clients. It is one thing to give them the data, but the client often needs help to interpretation this data and guidance on how to get to the end goal, where data is only a means. How to utilise this data to reach the end goals towards emission reduction and aligning with climate goals.

Are you familiar with the PCAF method and approach?
Yes. I read their first report some years back.

Section 3: Data specific questions

What kind of ESG data do you provide? Is the focus on environmental data?
We provide water use data and translated into climate risk. And assess the risk of transitioning to a low carbon economy.

What data on GHG emissions do you provide?
Our emissions data set covers 14.000 entities. This works as a standardised universe which we use at Sustainalytics. This is based on different indices clients can be interested in. Mainly look at equities but are also expanding to fixed income. For now, focus is on equity, corporate bonds (not sovereign bonds).
For which asset classes?
equity and bonds mainly
Or for which sectors?
All sectors.
Is this global or regional?
Global (14.000 companies).
Yearly or quarterly
We use an annual estimation model. Of 14.000 companies about 3000 companies max. report on their GHG emissions. This information we feed into the estimation model. This is run by the end of the year and data gets released in January. There is a minimum of 10 entities that report within each sub-industry to use the estimation model. After the annual release the averages gets fixed in the model, so when we make adjustments to per-company info is the same. We don't do quarterly updates. Only updates on quarterly basis is adding reports from 'late' reporters to replace the estimated data.

8. Extra question: Challenge between data reporting, which goes per financial year for most companies and thus gets released/reported at different moments. How do you handle this issue? We use a rule of thumb where we use emissions per calendar year based on the year more than 6 months are based on within the report.
(Example stated by interviewer: when company X discloses emissions in a report called 'sustainability report 2019' published in May 2019, but in detail the reported emissions come from the months April 2018 – March 2019. In this case the data is fed to the estimation model as reported emissions in 2018, since 9 out of 12 months the GHG emissions are based on are linkable to calendar year 2018.)

Do you provide data in scope 1, 2 and 3? Working on a data estimation model for scope 3, but for know we only provide scope 1 and scope 2. Also, in the past we have not provided data on scope 3. Mainly because scope 3 reporting still has a lot of challenges in both quality and the use case for clients. A

lot of clients/institutions don't know what to do with this data and how to use it. This relates directly back to the role of data providers in a more educative role and helping clients to understand and use the emissions data in the right way in a certain use case.

Scope 3 model is under construction. It will probably be a full estimated model without using any reported data.

When covering scope 3, can you share your method for including/estimating Scope 3 emissions? Do you separate this into all 15 categories?
Yes.

How do you gather all the needed data for your clients?
We have a collection team of about 7 people. They work on collecting impact metric data. This includes GHG emissions, water use and all other factors in the environmental data. Their strength is being able to assess the figures a certain company is allocating to scope 1 and scope 2 and to judge if this data lives up to the standards from Sustainalytics. Especially focusing on investigating and interrogating the report to see if it covers the whole company operations and no key aspects are left out in the environmental impact assessment. Another issue comes up with new markets starting to report where often small but crucial mistakes happen in the reporting. For example, a use of magnitude that is out of order with mainstream reporting, such as using [ten thousand tonnes CO_2] instead of [tonnes CO_2] of [M tonnes CO_2]. When such irregularities are not spotted this can lead to major mistakes when interpreting this data. In the past we also used CDP data, but since recently we stopped using their data. CDP is a non-profit and voluntary based organisation with limited resources. We felt our own team could do better doing quality checks on the data.

Section 4: Emissions, data availability and data quality

What approach do you have/use to improve data availability and quality?
Primarily this happens in the research team as explained above. There are also some automated checks in place within the system that will flag major changes compared to last years data. Another check in place is checking if total emissions is matches up to the sum of scope 1 and scope 2 emissions.

How do you model existing data gaps on Scope 1, 2 and 3?
Estimation data is mainly used on portfolio level to assess intensities and give a picture of total emissions. It is advised to clients not to use this figure when engaging with clients. The estimation data provides a number that represents the right order of magnitude, rather than an exact number of the emissions of a certain company.

Can you share any information on your model and methodology for estimating these data gaps?

What do you see as the biggest issue/barrier in making scope 3 reporting mandatory? Or would you see it as an opportunity?
Scope 3 is very broad with all the different categories. What we see on the reporting side for instance is that business travel is the most reported category. This is obviously not the most relevant category in most cases. It indicates that on the corporate side still a lot has to be done on improving the reporting. This is not necessarily a criticism on the corporate reporting side, because we know it is so difficult to report on scope 3. It is a big ask for most companies to do, especially for medium and small companies. From most of these you can not expect them to be able to thoroughly report on their full scope 3. There is already enough struggle to report on scope 1 and scope 2. As a provider you should decide between delivering the reported data and acknowledging the limitations of this data or to try and come up

with estimations that give a broader picture. When doing the estimation, you must be clear on what you estimate. Do you provide an estimation for the whole of scope 3 or for specific (more relevant) categories per sub-industry? And how do you make these kinds of decisions. This is also a reason scope 3 emissions estimations will differ a lot between data providers.

This last issue is making the use of scope 3 data even more challenging. Top level investors usually get their data from different data providers. The reported data they receive should be the same across data providers, but the estimated figures will differ due to certain model assumptions. The challenge for these investors will be to decide when to use which data and how to interpret the different figures.

For scope 3 data in general there is an understanding in the field an among investors that scope 3 data is important and that it can provide a better picture of the impact of investments. However, using this data to engage or make investment decisions is not yet possible because of the challenge around scope 3 (data quality, double counting, relevant categories, limited reporting).

At the same time, I do think this regulatory interference can help. Scope 3 issues are already known for many years, but there has not been much improvement or progress. This regulatory pressure could be the push that is needed to make scope 3 data usable. So, in general I think it is good to have more requirements around carbon reporting and carbon data. But there should be enough flexibility and taking account challenges around scope 3.

EU TEG and PCAF approach is a phase-in of scope 3 based on sectors to make scope 3 incorporation mandatory. Would you agree with this approach?

Do you use scoring methods to assess data quality and availability? (explain PCAF methods on this scoring)
We don't provide this scoring in our raw data that we provide. In our carbon risk product, we have some data scoring in place, but it is more about scoring a company to their peer group then scoring the data itself. Also, we also use this scoring with reported data and not with the estimated data. Here we don't do a comparison between companies in the same peer group.

Section 5: Methodological questions

Do you use an approach to attribute emissions for clients or do you only provide the requested data? If yes, do you use the PCAF attribution approach (using EVIC and/or balance sheet Equity + Debt for not listed companies) to attribute emissions from companies? (*further questions only relevant when answered yes)*
We provide raw data on one side or we provide a portfolio reporting. We can put together a report that compares emissions from a portfolio to a benchmark. This includes attribution analysis. Main metric we use here is carbon intensity by revenue (WACI). We don not use enterprise value to attribute emissions. In the current reports we use intensity and a part on absolute emissions.

Can you share your definition of Enterprise Value? What is included? If possible, please share detailed formulas and the underlying elements from financial reports/balance sheet that are included within the main elements of EVIC (e.g. what are the elements included for calculating 'book value of debt').
We see the upside of enterprise value. And what I value about PCAF is the method approach per asset class. Particularly for fixed income I see the added value of Enterprise value. I think, when data is available, enterprise value is the best denominator to use. This is also reflected in the EU Taxonomy where EV is recommended. An important challenge we see is the inconsistency in the market about the definition of Enterprise Value. At Sustainalytics we use the financial data from Morningstar. For all our entities in the database (14.000 companies) we want to use the same figure, but for enterprise value this is not yet available. When this will move to be the main metric used in the market, we will obviously pay more attention to this the enterprise value discussion. For now, we see this movement

mostly in Europe and in North America most attention still goes to revenue figures.

What climate impact metrics do you use for financial institutions? (Absolute carbon footprint, intensity, WACI, others)
I agree on using different metrics for different use cases has its value. However, when providing multiple metrics to the client you also make it more complicated. You can explain to the client how to interpret the difference between the different metrics and in which use case which metric is most relevant to use. But this has again to be communicated to the outside world in their reports and explain what metrics are used and why. Especially when changing from one metric to another. It is still quite hard to assess which is most meaningful from a reporting perspective.

Which intensity metrics do you calculate, and which do you feel is most appropriate? How do you calculate them and on what level (portfolio or individual company level)? Please share any discovered pros/cons for each?

Do you make any corrections to your (intensity) calculations to be able to compare portfolio carbon performance over time? And if so, how do you correct for market changes, inflation, currency changes, etc. Please share the detailed correction formulas.
No corrections are made. We use our financial input data from Morningstar and covert currencies based on daily exchange rates.

Section 6: Questions PCAF method specific

Considering the PCAF method, would your provider be able to apply this method in calculating your clients carbon footprint? (Like a PCAF data package.)
Our focus is mainly on the revenue metric, which differs from the recommendations from PCAF. We do hear sounds from our clients that report according PCAF and request data from us to do so. PCAF focuses more on ownership approach. Here we can calculate intensity in a different way based on the preferences of the client. For those we often ask them to provide the financial input data. So, we can provide the client according to PCAF when they specifically ask. Normally we first explain what the differences are in certain metrics and what we can provide. When they do need a divergent data set, we can provide this on request.

Are you already actively recommending your clients to apply PCAF or willing to do this when the Global standard is launched?

Can you share your main comments or issues with the PCAF method if any? No specific issues.
I think PCAF is more accurate, but also more complex than our standard at Sustainalytics. PCAF is more detailed and this has its value but also a challenge to have such a break down for all 14.000 entities in the database. We are constantly busy on how to evolve and improve our products. I really appreciate the PCAF initiative on this break down in asset classes and especially the efforts made on fixed income are, on a personal level, very interesting. I think consistency around reporting is very important in the current market. Having a lot of different metrics can cause difficulties due to financial institutions reporting in a different way. The efforts of PCAF to standardise this are therefore valuable. However, it is also important that these kind of initiatives as PCAF, TCFD etc. are also standardised in some way. Now there is some confusion in the market about which initiative has the best approach and unclarity about if the initiatives are contradictory or not. I think there are not, but on the financial institutions side I see confusion on what they should use, what they should do and why. The focus from PCAF on the North American market is also a good thing to align markets.

Section 7: Providers and their differences

Do you experience (big) differences in data provided by other data providers? What is your viewpoint on the cause of these differences?

What do you think is needed to improve comparability between data providers?
I don't see differences between data providers as something very negative. Also, I don't see a lot of clients that are uncomfortable with the level of difference in data between several providers. When this difference would be in reported data this problem would be bigger, since reported data should always be the same. On the estimation side there is the understanding estimation is an art and not a science. Meaning differences will always be there, but this is not problematic. I think all approaches have their pros and cons. Differences in the market are fine, if all providers have the same order of magnitude. On this part we are not there yet, and we still see also differences in order of magnitude in the data provided. Here the issue is around the level of reported data in the market. When reporting in the market improves also the estimation models accuracy will improve.

Please share any remaining comments, issues or solutions you experience with the asset classes listed equity / listed corporate debt?

E.7 INTERVIEW INDEPENDENT EXPERT

Interviewed organisation: Independent expert in the data providers field
Name interviewee: Libby Bernick – former business line director in Trucost and former head of sustainability initiatives at Morningstar
Date and interview duration: 30-8-2020; 57:19 minutes

Section 1: Introduction

How would you describe your role within the company?
I have spent my entire career working with businesses to help them use sustainability related data to inform business decisions. Carbon accounting was always sort of a subset of using sustainable related data. This practice started a number of years ago when I was assigned as the environmental specialist at an electric company. Here came the introduction in thinking of making products greener and low on carbon. From there on I started to work with corporation to assess their carbon emissions using LCA approaches in a capacity with specialist consultant PE 5 winds. Here we developed tools for bottom up LCA for carbon. The focus was to help business understand their carbon footprint and the carbon footprint of their products from cradle to grave.

Later in my career I worked for UL environment. The work here focused on large brands to understand their environmental performance of their products. From there I went to Trucost and helped this company set up their North American business. We worked with banks, asset managers, development banks etc. to understand ESG performance of their products. The last nine years I worked in this emerging field of ESG performance in a role with Trucost as a director of one of the global business lines. After Trucost I took a job at Morningstar to head up all sustainability initiatives in this company. Most time I spend here was incorporating ESG data in products for investor clients of Morningstar to help decision making of these investors. The focus throughout my career has mainly been on the

climate aspect of ESG and have a lot of experience with using climate data.

Would you say that there is a changing approach towards sustainability in the financial sector?

Absolutely, the past decade has shown a big change in the use of sustainability data in investment decision making. This was first practice only used by specialist investors with a focus on sustainability. Now this had become a widespread practice throughout the whole industry. Banks have seen their role and understanding their part in the transition to a low carbon economy. There has been a clear change in the financial industry for organisations that started to measure their climate performance. There is also a greater awareness on lobbying and how to use measurement of climate impact to the organisations advantage. Actual sustainable flows that go into climate solutions are still limited, but the number of investors putting money in ESG optimized funds has gone up rapidly. The capital flow into sustainable funds in the first half of 2020 were as much as the amount from the whole 2019. However, when looking at total capital markets the amount going into sustainable funds is still below 5%. Meaning that there is still a long way to go, but the first steps are taken at this moment. The hard thing is that the capital flows are updated quarterly but linking this flow to the actual climate related impact is challenging because the time lack between the environmental performance disclosure.

In your opinion, do you think financial institutions should be held responsible for their financed emissions?

When it comes to climate change it is very important for all actors in the financial system to understand, measure and quantify their environmental contribution. This represents their risk and opportunity towards investment impact on climate change.

Section 2: General questions

Can you tell us more about your company and your data services?

What clients do you focus on?

Please explain what data you provide to clients. Financial data and/or ESG data?

What do you see as the most important role for data providers in the emerging carbon reporting/disclosure landscape?
One of the much important roles is to make carbon data transparent for market participants. Being able to quantify accurately and robustly to have good quantitative data available to enable investors on their turn to understand this climate related data.

Next to transparency data providers have a vital role in making the data accurate and aims to answer the question an investor has. Link the right use case to the right data to answer the right question. Here they use tools and metrics to understand the data.

Are you familiar with the PCAF method and approach?
Yes.

Section 3: Data specific questions

What kind of ESG data do you provide? Is the focus on environmental data?

When covering scope 3, can you share your method for including/estimating Scope 3 emissions? Do you separate this into all 15 categories?
One of the biggest challenges is that corporate companies do not disclose carbon data. Only about 7000 companies in the world disclose on their carbon data. When you say there are 40.000 listed companies and only 7000 report it becomes clear there is a big lack in data. This is not solved by estimating data.

The second challenge is the varying difficulty in reporting between different categories. One of the easier categories is upstream supply chain emissions, but one more hard is for instance the category 15 financed emissions. One of the often reported categories are the travel GHG emissions, but this is one of the minor impacting categories in terms of magnitude. Downstream emissions have a lack of standardisation where it is hard and unclear how to measure such emissions. Same issue goes for emissions linked to investments.

When all companies in the world would do a good job on estimating scope 1 and scope 2 emissions, we would not need any scope 3 data. When this would be available data providers would not have to estimate these upstream and downstream emissions. The starting issue is the lack in reporting on scope 1 and 2.

How do you gather all the needed data for your clients?

Section 4: Emissions, data availability and data quality

What approach do you have/use to improve data availability and quality?

How do you model existing data gaps on Scope 1, 2 and 3?

Can you share any information on your model and methodology for estimating these data gaps?

What do you see as the biggest issue/barrier in making scope 3 reporting mandatory? Or would you see it as an opportunity?
Scope 3 accounting focuses on value chain emissions but is does not take into account physical risk. As an investor this physical risk should be of even concern to investors. But this part is not included in the current approach and understanding around scope 3 emissions. Where the focus is only the GHG emissions.

EU TEG and PCAF approach is a phase-in of scope 3 based on sectors to make scope 3 incorporation mandatory. Would you agree with this approach?
The EU should be applauded for their progressive thinking and legislation on this topic. On terms of priority I think the priority should be with making sure that all companies report well on scope 1 and scope 2. And then move attention to investing in scope 3 and improving scope 3 data. Scope 1 and 2 reporting and accounting could use more focus to start with the basics.

Do you use scoring methods to assess data quality and availability? (explain PCAF methods on this scoring)

Section 5: Methodological questions

Do you use an approach to attribute emissions for clients or do you only provide the requested data? If yes, do you use the PCAF attribution approach (using EVIC and/or balance sheet Equity + Debt for not listed companies) to attribute emissions from companies? (*further questions only relevant when answered yes)*
I would say there is lack of clarity and also lack of understanding on how to use this portfolio data. How do you actually measure the risk and then do something about it (take action)? It all starts with

how to measure and then take the step to understanding what the data means and what can you do with the data.

Can you share your definition of Enterprise Value? What is included? If possible, please share detailed formulas and the underlying elements from financial reports/balance sheet that are included within the main elements of EVIC (e.g. what are the elements included for calculating 'book value of debt').
I think Julie Raynaud put together a good document comparing all data providers and approaches used for attribution and other practices for analysing portfolio emissions. The challenge is that investors need to start with the end. What is the question I want to answer and from there on see what data you want to use and in what way. Carbon risk for equity and debt, the ownership approach is challenging. However, when the investor wants to understand the ownership on financed emissions in a full equity portfolio the ownership approach could be correct. Again, the question the investor is trying to answer decides on what analytics are useful and which data is needed to run these analytics.

What climate impact metrics do you use for financial institutions? (Absolute carbon footprint, intensity, WACI, others)

Which intensity metrics do you calculate, and which do you feel is most appropriate? How do you calculate them and on what level (portfolio or individual company level)? Please share any discovered pros/cons for each?

The biggest advantage for using revenue is being able to do an analysis throughout asset classes. When only equity you can use Market Cap but when looking across asset classes you will need to use other metrics.

For institutional investors the metric used most is the carbon intensity metric aggregated on fund level based on market cap. With this research you can add knowledge in this debate. By shining a light on here is where I think things need to be standardised and where data providers really can add value to investors by making this metric more broadly available or enhancing standardisation. This could be combined with prioritising which data is most needed and needs most attention to in the end make most impact with using financed emissions.

Besides equity and bonds related emissions coming from mostly corporates, there is also infrastructure and alternative assets emissions. When you look at prioritising data linked to these assets by data providers what would then be most important in these asset classes. Which one does contribute most to climate related emissions? When knowing what asset class emits most, you can assign a metric to this part arguing this particular metric is most useful to understand these asset emissions. Therefore, this metric should be further developed and get more attention. This part is missing in the current discussion. Most focus is on corporate equities and related emissions, but less on the discussion identifying which asset class contributes most to climate related emissions.

Do you make any corrections to your (intensity) calculations to be able to compare portfolio carbon performance over time? And if so, how do you correct for market changes, inflation, currency changes, etc. Please share the detailed correction formulas.

What do you see as the most important needs for a successful harmonised methodology for carbon accounting (especially attribution)?
We need a harmonised method; a standard. Everybody then needs to use this standardised approach and disclose accordingly. This means a standard for carbon accounting and disclosure.

Section 7: Providers and their differences

Do you experience (big) differences in data provided by other data providers? What is your viewpoint on the cause of these differences?
There are big differences between data providers in terms of data they include. Some providers only have data on about 7000 listed companies where others have about 14000 different companies represented in their database. Also in scope 3 incorporation there are still differences, where some providers have a system and approach in place to estimate scope 3 data where others do not provide scope 3 data. Also differences are caused by different approaches considering different emission factors and other estimated approaches.

What do you think is needed to improve comparability between data providers?
There should be standards in place for companies to disclose their emissions in a harmonised and scalable way. I don't know if this should be translated into a regulation, but first thing the industry needs is a standard. There are multiple authorities that should be capable of setting out such a standard to improve corporate emission reporting.

Please share any remaining comments, issues or solutions you experience with the asset classes listed equity / listed corporate debt?

F ALL CARBON FOOTPRINT EXPOSURE METRICS

- Weighted Average Carbon Intensity:

$$\sum_{i}^{n}\left(\frac{Current\ value\ of\ investment}{Current\ Value\ of\ portfolio} * \frac{issuer's\ scope\ 1\ and\ 2\ GHG\ emissions}{issuer's\ \$M\ revenue}\right)$$

- Total Carbon Emissions

$$\sum_{i}^{n}\left(\frac{Current\ value\ of\ investment}{issuer's\ market\ capitalisation} * issuer's\ scope\ 1\ and\ 2\ GHG\ emissions\right)$$

- Carbon footprint

$$\frac{\sum_{i}^{n}\left(\frac{Current\ value\ of\ investment}{issuer's\ market\ capitalisation} * issuer's\ scope\ 1\ and\ 2\ GHG\ emissions\right)}{Current\ Value\ of\ portfolio\ \$M}$$

- Carbon Intensity

$$\frac{\sum_{i}^{n}\left(\frac{Current\ value\ of\ investment}{issuer's\ market\ of\ capitalisation} * issuer's\ scope\ 1\ and\ 2\ GHG\ emissions\right)}{\sum_{i}^{n}\left(\frac{Current\ value\ of\ investment}{issuer's\ market\ capitalisation} * issuer's\ \$M\ revenue\right)}$$

- Exposure to Carbon-Related Assets

$$\sum \$M\ Current\ value\ of\ investments\ in\ carbon\ related\ assets$$

More detailed metrics provides by TCFD and their recommended purpose.

- Apportioned UCC: The total additional costs arising (in)directly for a given scenario/year at the portfolio level.
- EBIT at Risk: The percentage of Earnings at Risk due to UCC. This highlights areas of risk across the portfolios and can be fed into financial analysis.
- EBIT Margin Reduction: Implied change in EBIT margins based on a scenario/year compared to the current margins. The metric allows for signaling of red flags in the portfolio where the deterioration of margin is significant.
- EV/EBIT Change due to UCC: Implied change in a valuation multiple due to reduced earnings in a scenario/year. This assess the overall implications on the valuations of companies.
- VOH with EBIT at Risk: Total value of holdings where EBIT at risk is above a certain threshold (e.g. 10%). Identifies companies that are facing the most significant carbon price risk across the portfolio.

- VOH with Negative Margins: Companies whose EBIT margin becomes negative after incorporating the UCC. This is used to flag companies that would potentially no longer operate profitably.

Accelerating climate transition through finance: Towards an improved methodology for carbon accounting in the financial sector

J.M. Knorringa, K. Blok, A. Correljé, E. Schröder

***Abstract*—Carbon accounting in the financial sector has experienced a rapid growth over the last years. Both private and public attention focused their attention on the role the financial sector can play in accelerating the transition to a low carbon economy. More than 80% of the financial institutions worldwide acknowledge the importance of GHG accounting for their loans and investment. However, less than 20% of these institutions actually measure and report on their climate impact. An often heard argument for this lacking carbon disclosure is data quality and estimation models to improve this data. This is however already one step to far, this research aims to address and improve the approach that forms the basics for carbon accounting. This study goes into the existing carbon accounting methodologies and metrics. The existing approaches are analysed by testing them to a set of accounting criteria. Based on this analyses alternative accounting approaches are proposed and assessed on their contribution and sensitivity in order to come to an improved practice for carbon accounting. This improved practice should enable the financial sector to harmonise their approach in carbon accounting to ensure high comparability, transparency and consistency in the landscape of carbon accounting.**

***Index Terms*—Carbon accounting, allocation principles, portfolio carbon footprint metrics, Greenhouse Gas Protocol, Attributing emissions, sustainable finance, carbon disclosure, standardisation.**

I. Introduction

THE environmental, social and economic challenges the world's society is facing are substantial and broadly addressed by several initiatives like the United Nations Paris agreement and the 2030 Agenda for Sustainable development. Effective climate mitigation will not be achieved if individual entities seek after their own interests independently. Only when the response to mitigate GHG emissions is cooperative, and with an international focus, the required level can be reached. Without mitigation, the IPCC assessment report states that 'warming is more likely than not to exceed 4°C above pre-industrial levels by 2100' [1, p. 5]. The risks expected to follow from a temperature rise above 4°C are significant. To help and accelerate the progress in order to fight these challenges, financial institutions can have an essential role [2], [3]. Incorporating environmental gets increased attention and is known as the Environmental, Social, and Governance (ESG) investment approach [4]. This approach is integrated through the Principles of Responsible Investment (PRI) in more than 2200 asset owners representing over 80 trillion US dollars in assets under management [5]. This can be seen as a strong indicator of the willingness around the world to integrate ESG principles into investment decisions. Also, client interest in this topic is increasing, but in practice, progress remains constrained.

A. Research problem

The failing of previous climate policies combined with the lack of knowledge and standards has led to a 'finance gap' for sustainable low carbon investments [6]. According to the [7], there is a need for a capital increase of 50% on an average annual basis until 2030 for investments towards a low carbon economy. Bridging this long term finance gap will require new metrics and especially a good understanding of what these metrics show to investors. Clear and well-understood metrics will support governments to integrate financial climate targets in their policy frameworks and action plans.

According to the Global Investor Survey On Climate Change from 2013, 83% of asset owners and 77% of asset managers considers climate change to be of material risk to their investments across the entire portfolio [8]. The climate snapshot of the Principles for Responsible Investment shows a similar result of 74% of their 410 investor signatories being aware of the issues climate change brings to their investment portfolio. However, only 2% has already incorporated climate factors on a strategic level and less than 20% reports on their financed emissions [9].

The main reason for this conflict between willingness and desired progress is a lack of standardized methods and metrics for the financial industry [10], [11], [12], [13]. [6] conclude that the development of a standard focusing on carbon performance indicators will be most likely to get comprehensive support from the financial institutions. A particular standardised method will help investors and policymakers to develop new approaches in allocating capital toward financing the transition towards a low carbon economy.

In this research, the goal is to find an improved method to attribute emissions to financial institutions in order to help these institutions with measuring and disclosing GHG emissions from their investment portfolio to understand their emission impact in the real economy. Therefore a fair distribution of emissions, for equity and bonds, to the financial sector is required. This will enable the financial industry to steer their investments in order to reduce GHG emissions and to limit the threats of climate change. This paper aims to answer the following question:

"What is the preferred approach to measure financed emissions for financial institutions considering listed equity investments and bonds?"

II. KNOWLEDGE BASE

Carbon accounting has become a topic of high interest during the last decade [14], [15]. This is also shown in the number of companies reporting their GHG emissions to the Carbon Disclosure Project (CDP). CDP published 2043 companies reporting in 2009 and 8446 companies reporting in 2019 [16]. However, only 182 of these companies made the 'A-list' of CDP, indicating that the organisation has the leadership level of climate reporting. This indicates the willingness and attention for carbon accounting but the inability of achieving complete and high-quality reporting again. Next to the CDP, several other public and private initiatives are focusing more on financed emissions. At the moment, there are about 25 GHG reporting frameworks worldwide to assess GHG emissions related to investments. Most frameworks are requiring emission data on scope 1 and 2 and in some cases also scope 3. These initiatives aim to assist in dealing with climate-related solutions for the financial sector. One of the key issues, as described in this thesis, is the development of a uniform and harmonised carbon accounting method and framework [17], [18]. The field where initiatives are working on the development of such a framework is rapidly evolving [19], [20]. However, no widely accepted approach for accounting carbon emissions for financial institutions has been established yet [21].

Measurement of financed emissions and carbon disclosure is still voluntary when looking at the international context. This is one of the main reasons for the lack of harmonisation, which leads to incomparable disclosure on carbon-related performance and information [22]. Another barrier lies within the fast arising initiatives working on a carbon accounting standard. Despite the best efforts and intentions, these initiatives are also striving to become the leader in the carbon accounting landscape. This causes fragmentation in the carbon accounting world and could very well lead to several widely supported approaches of accounting and disclosure methods. The risk in this development is 'wait-and-see behaviour' from the financial sector for one globally accepted standard to measure financed emissions. Waiting for the ultimate outcome and having one excellent globally accepted standard could lead to more years of waiting, where the need to take action to mitigate climate impact is now.

A. Financed emissions

The climate impact caused by activities from companies can be expressed in a wide range of factors, such as water use, land use, deforestation and carbon emissions. For this research, we only focus on the carbon emissions from these companies and focus on who should be responsible for these emissions. Defining climate risk also asks to distinguish 'physical risk' and 'carbon risk'. Physical climate risk relates to extreme weather events and the increase of sea levels. These risks can cause a direct impact on investments, for example, damage to real estate or infrastructure investments. Secondly, there is the carbon transition risk that relates to investment devaluation due to market change, climate policy and technological development. The transition need is widespread over sectors and does not only affect energy companies. Also, sectors like transportation, infrastructure, agriculture and many more are affected by this transition. This is another form of risk and the most interesting one for financial investors. Therefore financed emissions are defined as the GHG emissions related to carbon risk of an investment.

B. Knowledge gap

Previous research has indicated the dominating influence the financial institutions have on the economy, society and sustainable development [23], [24], [25], [26]. They have a position to channel capital to different markets, regions and sectors. According to [27] the financial market is at a tipping point in playing an essential role for the world stabilising and mitigating climate change and reach global emission reduction goals by 2050. Researchers agree that one of the critical steps for the financial sector to be able to play such a role is a harmonised approach for carbon accounting. Much attention within carbon accounting goes to improving underlying data, where an often heard measure is making carbon reporting mandatory. A subject maybe evenly important, but with much less attention is the measurement of financed emissions. *"You can't manage what you can't measure."* For financial institutions to be able to contribute to mitigating climate change and to channel capital to climate solutions and more sustainable businesses, they need a straightforward approach for measuring the emissions from their loans and investments.

III. METHODS

Assessing different alternatives for this methodology will be done based on stakeholder needs. To construct these needs and assess the alternatives the systems engineering approach developed by [28] will be used. They define the function of systems engineering as "an appropriate combination of the methods and tools of systems engineering, made possible through use of suitable methodology and systems management procedures, in a useful process-oriented setting that is appropriate for the resolution of real-world problems, often or large scale and scope." [28]. In this research, their approach, shown in figure 1, is used translated in three basic steps and two phases of system definition considering the formulation of the problem, analysis and interpretation. And secondly the system development and lastly system deployment.

One of the core sources for identifying these needs are literature and desk research into market studies and reports looking into climate accounting. Relevant stakeholders here are data providers, consultancy firms and financial institutions themselves. This will also lead to an overview of carbon accounting principles as applied in the current market. These needs will be translated into criteria to assess current methods and identify shortcomings. Using these shortcomings, alternative approaches are introduced to improve the link with the needs identified as most important.

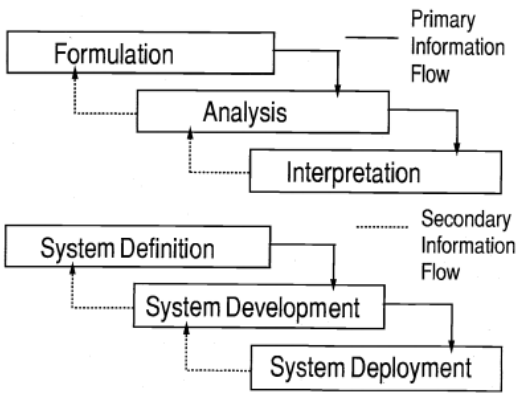

Fig. 1. The three basic steps and phases of systems engineering [28].

To investigate how these alternative approaches can be applied in real life, the exploratory research will be combined with a third source to test technical application. With the use of Excel and sample carbon emission and financial data, a test investment portfolio with real data is set up. This sample is used for the purpose of illustration and testing existing, and new carbon accounting approaches. The financial data relies on the data provider S&P Capital IQ [29], where access is provided by Guidehouse Research Services. The data is verified with annual reports and open source data from Yahoo Finance by a random sample. Carbon emission data relies on the reports published through the Carbon Disclosure Project and is verified with annual sustainability reports by a random sample.

IV. Carbon accounting principles

The first categorisation in methods can be made between backward or forward-looking metrics and indicators. There are roughly three options, where historical trends and point-in-time relate to backwards-looking data, and forward-looking methods rely on some sort of company preparedness analysis to assess their future performance [30]. Most financed emissions frameworks that currently exist are based on point-in-time data. However, there is a rising interest in forward-looking performance frameworks to make arguable predictions on a companies alignment with global goals to limit the world's temperature rise. Forward-looking indicators are often linked with scenario analysis as seen in practice with the 2 degrees investment initiative, PACTA and TPI. In this research, forward-looking methodologies are seen as most appropriate for target setting and strategy development, as shown in figure 2. When it comes to measuring impact and responsibility for a particular climate impact, historical data is most appropriate to use in the step considered as measuring financed emissions [31].

A. Attribution principles

After defining the focus on backwards-looking accounting data, the allocation of economic activity represented in emissions to financial instruments is the next challenge. This is probably the most complex step since it has no groundwork in traditional accounting frameworks. Two common approaches are identified from reviewed methodologies as the 'portfolio-weight' and the 'balance sheet' approach. The common equation used to account for emissions can be defined as follows:

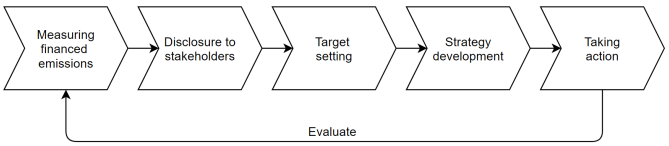

Fig. 2. Role of carbon accounting and financed emissions in climate portfolio alignment landscape, derived from [32]

$$u_f = \sum_{i}^{n} (\frac{p_i}{a} \times u_i) \tag{1}$$

where u_f is the emission unit allocated to the investment portfolio, p_i is the value of the investment or financial product of company i in the investment portfolio, a is the financial metric or allocation factor and determines the weight factor for the allocation, and u_i is the absolute emission unit of the company i. The main challenge is to define a, where the other variables are basically represented as total emissions from a company u_i and the invested value in the investor portfolio p_i. The fraction $\frac{p_i}{a}$ determines the amount of the total emission unit is allocated to the portfolio.

1) Balance sheet approach: The balance sheet approach has two options. The first one is to allocate all economic activities to the equity part of the balance sheet of a company. This approach is used to back-calculate the related emissions to an equity investment. Allocating only to equity is considered the 'shareholder method' where market capitalisation is used to define ownership based on the equity investment in the portfolio. Market capitalisation refers to the total US dollar market value of a company's outstanding shares of stock. Commonly referred to as "market cap," it is calculated by multiplying the total number of a company's outstanding shares by the current market price of one share.

The second method is called the 'financier method'; this considers creditors and shareholders to have equal responsibility for the emissions of a company they invest in. When allocating emissions to equity and creditors separately, the biggest issue that arises is double counting (allocating the same unit of emissions from economic activity to two different financial instruments). The upside of this separately considered allocation is that this allocation approach is not influenced by market prices, since the equity-based ownership can be defined in a percentage of the total available shares. Since the aim of this research is to improve the methodology for allocating emissions to both equity and bonds from listed companies, the financier approach is of most interest.

B. Normalisation principles

Normalisation plays an important role in creating performance benchmarks for carbon accounting and normalisation allows to compare investor portfolios. Equation 1 represents

the emissions unit allocated in absolute value. Bigger portfolios are expected to have a higher emissions output than smaller portfolios since they invest more capital and have therefore bigger responsibility over emissions from the companies they invest in. In order normalise the footprint to allow for comparison between investment portfolios the following accounting principle is used.

$$cl_f = \frac{\sum_i^n (\frac{p_i}{a} \times u_i)}{\sum_i^n n_i} \tag{2}$$

In equation 2 cl_f represents the normalised climate impact of the portfolio and n_i is the normalisation factor. Applying this principle results in a relative carbon footprint. The first normalisation factor that can be applied is based on company activity and economic units such as barrels of oil or tonnes of steel produced. This approach does not allow for portfolio-level aggregation where comparison over multiple sectors is required. Therefore, only the second approach is considered in this research. This approach uses portfolio size to define emissions per million dollar invested. This approach takes into account the investor's portfolio size and allows for comparison between portfolios.

C. Current carbon disclosure metrics

To select a set of metrics to investigate further, there is a need to scope down the methods into asset classes. Asset classes are a classification system for financial products to divide a portfolio into different categories. The most common asset classes are equity, bonds, cash and cash equivalents, real estate and project finance. In this research, the focus is on listed equity and corporate debt (bonds); therefore only metrics will be considered covering one or both of these asset classes focusing on the balance sheet approach.

The first effort to measure financed emissions was made by the GHGP. In their technical guidance, as an addition on the scope 3 emission standard from the GHGP, [33] provides an emission attribution calculation for four types of investments: Equity investment, Debt investment, Project finance and Managed investment and client services.

Building on this idea from the GHGP, four other main metrics are proposed by the TCFD. These are often used in the field and followed by most methods for multiple purposes. In the TCFD 2017 report, they present five main metrics [34]: total carbon emissions (TCE), carbon footprint (CFP), carbon intensity (CI), weighted average carbon intensity (WACI) and exposure to carbon-related assets (ECRA). This section will review and compare these metrics and will end up with an overview of their pro's and con's.

1) Total carbon emissions (TCE): The first metric to discuss forms the basis of all other metrics and represents the portion of GHG emissions linked to an investment as a total amount. The TCFD defines this TCE metric as "the absolute greenhouse gas emissions associated with a portfolio, and is expressed in tons [CO_2-equivalents] CO_2e". The TCE is calculated according the following formula:

$$\sum_i^n (\frac{Invested\,value_i}{Market\,capitalisation_i} * (issuer's\,scope\,1\,and\,2)_i) \tag{3}$$

2) Carbon footprint (CFP): The CFP metric can be seen as an addition or extension to the TCE metric. Is normalises the TCE by the total portfolio value (commonly expressed per 1M dollars). This results in the unit [tonnes CO_2e/$M invested] and is defined by the following equation:

$$\frac{\sum_i^n (\frac{Invested\,value_i}{Market\,capitalisation_i} * (issuer's\,scope\,1\,and\,2)_i)}{Current\,Value\,of\,portfolio\,\$M} \tag{4}$$

3) Carbon intensity (CI): Carbon intensity (CI) is a metric used to express the carbon efficiency of an investment portfolio. This metric allows financial institutions to measure the amount of GHG emissions per revenue of the companies in the portfolio over time. Efficiency at a company level is normally best expressed by using sector-specific measures like tons of steel, distance travelled or generated power. In this case sales are seen as the best available measure since comparison happens across industries. The CI metric is expressed in [tonnes CO_2e/$M] and is computed as follows:

$$\frac{\sum_i^n (\frac{Invested\,value_i}{Market\,capitalisation_i} * (issuer's\,scope\,1\,and\,2)_i)}{\sum_i^n (\frac{Invested\,value_i}{Market\,capitalisation_i} * issuer's\,\$M\,revenue)} \tag{5}$$

4) Weighted average carbon intensity (WACI): The fourth metric the TCFD describes is the weighted average carbon intensity (WACI). The WACI is the most meaningful metric according to the TCFD and represents the "portfolio exposure to carbon intensive companies". The WACI is also expressed in [tonnes CO_2e/$M] and is recommended to use when accounting for the financial carbon intensity. The WACI is computed by the following expression:

$$\sum_i^n (\frac{Invested\,value}{Portfolio\,Value} * \frac{issuer's\,scope\,1\,and\,2}{issuer's\,\$M\,revenue}) \tag{6}$$

D. assessment

Using these criteria, the current identified metrics are assessed using the priority check-mark method described by [35]. This selection method ranks the criteria as high, medium or low in priority. When a criterion is met, the method will receive 1, 2 or 3 check-marks based on the priority. The advantage of this method is the ease to use and the high level of understanding from users. The following metrics are considered during the assessment.

- Total carbon emissions as described by the TCFD (TCE).

TABLE I
ASSESSMENT CRITERIA

	Criteria	Description
1)	Practicability	Underlying data should be understandable for all parties and practical to implement.
2)	Consistency	Output of results are timely and give a current understanding of the situation.
3)	Accuracy	The user is able to do a complete portfolio assessment considering all investments.
4)	Comparability	Produce results that allow comparison between asset classes for listed equity and corporate bonds.
5)	Transparency	Results should be reliable and transparent in a way the results are verifiable.
6)	Robustness	Results are not clouded by external effects.
7)	Context	Where possible, metrics should be compared to values outside the bank's portfolio.

- Carbon footprint metric as described by the TCFD (CFP).
- Carbon intensity metric as described by the TCFD (CI).
- Weighted average carbon intensity metric as described by the TCFD (WACI).

TABLE II
METRIC ASSESSMENT WEIGHTED AGAINST SYSTEM CRITERIA

Criteria	TCE	CFP	CI	WACI
Practicability	✓	✓	✓	✓
Consistency	✓	✓	✓	✓
Accuracy	✓	✓	×	×
Comparability	×	×	×	✓
Transparency	✓	✓	×	✓
Robustness	✓	✓	×	×
Context	×	✓	✓	×

Comparability is a major issue for metrics that are based on attribution by market capitalisation, which is the case for the TCE and CFP. Using revenue instead of market capitalisation allows for comparison but has issues on its own. Revenue does not ensure 100% emission attribution and therefore less suited to use for answering the responsibility question financial investors have. Also, there is a bias towards companies producing luxury goods.

V. ALTERNATIVES

In the currently used methods, 100% of emissions are attributed to equity. In case also a method is prescribed for debt separately, it will cause the effect of over-allocation (double-counting). On the other hand, it is proposed and often applied to attribute over revenue (carbon intensity) instead of market cap, but in this case, you can not make sure 100% of emissions are allocated. Three alternatives are proposed for emission attribution for a combined asset class of listed equity and corporate bonds. The alternatives are listed below and further explained throughout this chapter, including their advantages and disadvantages. At the end of the chapter, the metrics are added to the weighting matrix for the 7 selected criteria.

- Allocation by Enterprise Value (Including Cash) (EVIC)
- Allocation by Balance Sheet Total (BST)

A. EVIC

EVIC is defined as the sum of the market capitalization of ordinary shares at fiscal year end, the market capitalization of preferred shares at fiscal year-end, and the book values of total debt and minorities' interests. Enterprise value is an indicator commonly used in the accounting world for assessing a company in case of a merger or takeover. It gives a comprehensive indication of the company's value including the equity market value, current short-term and long-term debts and cash and cash equivalents on the balance sheet. In the world of carbon accounting enterprise value was introduced to solve the issue of double counting when allocating emissions to both equity and debt separately. This approach is recommended to use for the listed equity and bonds asset class. However, the classic approach of enterprise value where cash is subtracted does not work from a carbon accounting perspective. Normally cash is subtracted to fictively pay off debts when assessing a company's value. When allocating emissions cash subtraction leads to imperfect allocation. Therefore, EVIC was introduced to solve this issue and to be able to strive for 100% allocation of emissions. An important limitation of EVIC that should be recognized is the possibility of high year-on-year variations caused by a changing debt-to-equity ratio.

B. BST

Balance sheet total is computed by the sum of total liabilities and total equity. The balance sheet total can be found on the balance sheet as 'Total Assets' or can be computed with the underlying components. Balance sheet total allows for allocating emissions to both equity and debt investment without double counting. The main advantages of using the balance sheet total are (1) the accessibility of the required data and (2) is the relatively low market volatility due to the use of book value from equity. The book value of a share is much less volatile compared to the market value of a share. Moreover, the market value is often of greater value. This value difference is expressed in the price-to-book-ratio. This ratio was 3.53 end of year 2019 according to the S&P 500 index. On the downside this ratio already indicates that the weight on debt investors when allocating emissions is much higher than in case the market value of equity is used. This strengthens the criticism in the discussion about appreciating equity in contrast to debt investments.

TABLE III
SIMPLE CALCULATION EXAMPLE USING EVIC AND BST FOR INVESTEE WITH SHARES OUT=1000, SHARE VALUE BOOK=5, SHARE VALUE MARKET=10, EMISSIONS=1000

EVIC	Market cap	Book value of debt (interest-bearing debt)	EVIC	Invested Value (owned shares = 100)	Allocated emissions
Equity	10000	4000	14000	1000	**71.4**
Debt	10000	4000	14000	400	**28.6**
BST	Book value equity	Total liabilities	BST	Invested Value (owned shares = 100)	Allocated emissions
Equity	5000	5000	10000	500	**50**
Debt	5000	5000	10000	400	**40**

C. Results

The differences between both approaches are mainly in the balance sheet items the alternatives use to compute a level of responsibility and financier ownership. These choices lead to a significantly different output when allocating emissions. Table III shows a simplified but accurate example of the difference in outcome when using either Enterprise Value Including Cash or Balance Sheet Total. It becomes clear that EVIC puts more weight on equity holders compared to the BST principle.

VI. DISCUSSION

This research has highlighted the range of options in approaches for carbon accounting. The range of choices and other findings show that the financial system is getting closer to defining a standard, but a global harmonised and widely used standard will still need some time. Many of the carbon accounting issues can be solved by learning from financial accounting. Nonetheless, some accounting issues require new approaches. From a financial accounting perspective bonds and equity can be separated, but in carbon accounting is has become clear this leads to allocation issues.

An important aspect of achieving a harmonised standard is to let go of seeking for one metric to assess portfolio climate performance. The discussion should move to find the best selection of metrics to cover all use cases. In many cases not one accounting principle rules over all the others, but the most appropriate one to use depends on the purpose. An investor making a decision should be aware of the differences, challenges and benefits from different metrics. A decision for a certain approach can influence the outcome and therefore the decision making process significantly. This research focused mainly on the allocation principle and what metric suits best to do so. Recognising there is not 'one size fits all' solution for climate aligned investment is crucial in the coming process of developing a harmonised carbon accounting standard. Several initiatives working on such a standard have to be open to other approaches and identify opportunities to be complementary instead of defending their approach as the one-and-only right direction.

A. Limitations and recommendations

Investment portfolios from pension funds, banks and other investors will have thousands of observations in outstanding loans and investments. Piloting the proposed methodology on a real investment portfolio would be a recommended next step. This research focused on listed equity and bonds investments. However there are multiple other asset classes out there of which many have no standardised accounting approach yet. This can be considered a limitations of the proposed approach, since this does not automatically solve challenges that are arising in other asset classes. Last, the method used to assess the discussed metrics is decided to keep a simple approach. This improves the understandability and makes the results easy to communicate. However, a more detailed assessment (using more criteria) could lead to other insights.

VII. CONCLUSIONS

The objective of this research is to develop an improved methodology for carbon accounting in the financial sector. This will contribute to the current efforts being made in developing a harmonised carbon accounting standard for the global field in order to improve comparability, consistency and transparency in the financial sector.

"What is the preferred approach to measure financed emissions for financial institutions considering listed equity investments and bonds?"

Financed emissions are defined as the GHG emissions from the real economy associated with loans and investment from the financial institution. To measure the impact of the financed emissions several principles and metrics have been discussed. This researched concludes that measuring financed emissions is the basis for all other carbon accounting and should focus on the allocation of emissions from a responsibility perspective. This responsibility can be expressed by measuring emissions from the financier perspective and allocate emissions to both equity and debt investment. The preferred approach following from this research should be using Enterprise Value Including Cash in order to allocate emissions to a financial institution using equation 7.

$$\sum_{i}^{n}\left(\frac{Invested\,value_i}{issuer's\;EVIC_i} * (issuer's\;scope\;1,\;2,\;and\;3)_i\right) \quad (7)$$

Furthermore, the research recognises that measuring financed emissions using the allocation through EVIC is not

a complete method to measure climate impact from loans and investments. There are other metrics better suited for different purposes. Allocating emissions in absolute terms presents the most literal form of carbon emission impact of the total portfolio. However, when the purpose is comparison among investors there is a need for a relative carbon footprint where the normalisation principle is used to cancel out the influence of portfolio size. Investing more will inevitably mean more financed emissions. Normalising by portfolio size serves the purpose of comparing investors and could be a first step for a benchmark on carbon performance. Also for this process EVIC should be the preferred metric to use in equation 8.

$$\frac{\sum_{i}^{n}(\frac{Invested\,value}{issuer's\,EVIC_i} * issuer's\,scope\,1,\,2\,and\,3)}{Current\,Value\,of\,portfolio\,\$M} \quad (8)$$

In conclusion, this research provides an overview of several accounting principles and current metrics being used to address climate impact of investment portfolios. From the challenges and shortcomings the use of EVIC is proposed to use for measuring financed emissions. In the end it is believed a carbon accounting methodology should hold multiple metrics for a specified use case. This will eventually provide the tools for the financial sector to make steps towards target setting, tracking their performance and actual emission reduction. A widely accepted and harmonised standard is what the financial sector needs in order to shift capital towards climate transition solution and accelerate the global climate transition.

A. Future research

The main findings and discussions left some open gaps to fill with future research. Some interesting directions are identified to follow up in further research related to methodology development for carbon accounting in the financial sector. Research into quantification of the assessment criteria could provide a solution to have a stronger link. In this way also quantitative analysis can be provided on the performance of a method. Another suggestion for further research would be an investigation into the combination of forward looking based and backward looking based accounting principles. Also, an option for further research could be an investigation into secondary influences from the financial market such as exchange rate influences and inflation. A research into the pace of GHG emissions reporting could contribute to a more flexible way of practising carbon accounting. When emission streams become more general practice and get real time updates in the same frequency as monetary streams the data will improve rapidly. How this higher frequency of reporting can contribute to the decision making process for loans and investment will be a valuable addition to this field.

To conclude, the carbon accounting principles in the financial sector and incorporation of this practice is still a rather new field of research. This rapidly evolving landscape will take form in the coming years and numerous of new interesting and challenging topics will arise in this process.

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