Carbonising financial assets: between commodification and assetization of carbon relations

Julius Kob, Warwick Business School, University of Warwick
Julius.kob@wbs.ac.uk

Katharina Dittrich, Warwick Business School, University of Warwick
Katharina.Dittrich@wbs.ac.uk

December 2024

--- Working paper: please do not cite or reference this paper without permission of the authors and an explanation of the context of its usage---

Introduction

At the latest since the 1990s, Greenhouse Gas (GHG) emissions have become the officiated signal for anthropogenic temperature rise in the planet's atmosphere and a central access point in efforts not only to monitor but also to intervene in the Earth System. Accounting practices, and here in particular carbon accounting, play a crucial role in measuring GHG emissions, assigning responsibility to different types of actors (individuals, organisations, cities or states) and coordinating efforts to address the climate crisis. This can be understood as part of accounting in the Anthropocene (Bebbington et al., 2020; Bebbington and Rubin, 2022) and an integrated understanding of accounting in the interaction of human societies with the Earth System in the wider ecological crisis.

In 2015, the Paris Agreement set out a far more encompassing climate policy framework, which, amongst other things, formulated more explicitly the role of a particular industry for global climate action: that of the financial sector. Specifically, Article 2.1c of the Paris Agreement requires public and private finance to make "finance flows consistent with a pathway towards low greenhouse gas (GHG) emissions." For private finance to take this active role, a range of disclosure guidelines emerged that require and guide both real-economy companies and financial firms to calculate and disclose their GHG footprint. Amongst these, the voluntary Taskforce for Climate-related Disclosure (TCFD) guidelines became particularly prominent and subsequently served as the basis for mandatory guidelines in multiple jurisdictions.

Whilst most environmental accounting focuses on the impact of activities on the environment and the climate, TCFD shifted from a focus on environmental impact to financial impact. In other words, the TCFD guidelines set to supply especially financial actors with the emissions of the companies and assets they invest in to facilitate the assessment of financial impact of emissions on financial portfolios. Whilst the viability and efficacy of climate-related disclosure policies and regimes (e.g., Ameli et al., 2020, 2021; Andrew and Baker, 2020; Christophers, 2017; Ryan-Collins, 2019) as well as the elicitation of single (financial) materiality as opposed to double materiality (e.g., Adams et al., 2021; Täger, 2021) constitute important areas of debate and research, in this paper we instead turn our attention to the very practical and material workings of this emerging accounting landscape – financed emissions accounting

– as a microfoundational problematisation of carbon accounting for financial impact in, and thus potencies of climate mitigation through, finance in the escalating ecological crisis.

The main challenge in accounting for GHG emissions is translating the actual molecules released into the atmosphere into emissions figures that can be assigned to industrial facilities, houses, cars, or farms, and aggregated up to organizations, cities and countries. This is usually not done through direct measurement of GHG emissions at the point of release but rather through measuring a proxy, e.g., the burning of gas, and using emission factors to convert these into estimates and guidelines like the GHG Protocol to assign them to specific entities. Financed emissions sit at the end of a long chain of conversions, from the measuring of fossil fuel usage or land use to carbon emission estimates of electricity use and heating in offices to conversion into CO2 equivalents to aggregation up to subsidiaries, companies and even countries and finally linking these emissions to the financing provided by institutional investors.

Whilst research on carbon accounting has covered different parts of these conversions, investigating, for example, the disclosure of GHG emissions by companies (e.g., He et al., 2022), the various calculative devices used in these conversations (e.g., Charnock et al., 2021), the nature and functioning of emissions trading schemes and carbon markets (Bebbington and Larrinaga-González, 2008; Lovell et al., 2013; MacKenzie, 2009) and the impact of corporate carbon disclosure on the valuation of firms (Baboukardos, 2017; Chapple et al., 2013), the topography of actors in emissions accounting for finance is lacking one crucial locus of investigation: emissions data providers. These providers not simply package reported emissions data to their clients but instead spend a large amount of resources on the collection, (co-)production, estimation, curation and maintenance of corporate emissions data in their ever-increasing databases.

The conversions of emissions information necessary also in these activities of data providerscan be understood and analysed through the perspective of the Sociology of Translations (Callon, 1984; Latour, 1999). From this view, intermediaries such as data providers engage in crucial acts of ‘translation’ that become consequential for how financial institutions can ‘act at a distance’, i.e., direct their investees’ operations and products towards emitting fewer GHG emissions. Against the background of this perspective, our research question is: What role do data providers play in the chain of translation of financed emissions? And what are the implications of this for financial institutions efforts to intervene in the climate crisis? To answer these questions, we draw on a three-year multi-sited and team-based ethnography that examined

on-the-ground practices in green finance. We traced in detail the practices of one of the leading commercial data providers in collecting, curating, producing and delivering financed emissions data to their clients and complemented these insights with expert interviews at other data providers and observations of how emissions data are used by financial institutions.

We find that data providers' translational activities bring the emission accounts of companies into a specific relational form so that the relationships between these emission accounts conform with the relational character of financial portfolios. Achieving this relational form requires reducing the specificity of a company's emissions account and amplifying its relationship to other company emission accounts. In turn, this amplification occurs within the general repository of financed emissions of data providers, what we refer to as their 'emissions universes'. These emissions universes contain between 10,000 to 35,000 companies or assets, depending on the provider, and ensure that the business model of data providers is scalable to serve as many financial institutions as possible. To ensure the stability of the relationships across the universe, the translational activities of providers build up a high degree of self-referentiality, i.e., the emission accounts of companies, once brought into the provider's universe, refer primarily to the other emission accounts within the same universe. Our findings thus indicate that the production of financed emissions is driven primarily by matters of concern around portfolio relationality and provider market affordances, and tracing back to actual sites of emissions is of little concern here.

Our findings suggest a number of implications for our understanding of the role of data providers and the role of financed emissions in enabling financial institutions' acting at a distance. First, our findings demonstrate commercial data providers as important centres of calculation for financed emissions and show how their market-shaped character influences the production of financed emissions. Second, as long as emissions do not yet constitute a market signal strong enough to move markets on a broader scale, financed emissions in the form of financial references, even though enabling portfolio management activities, such as, monitoring of portfolio emissions, will not be sufficient on their own to enable pricing climate risks into the (re)valuation of financial assets. What is more, because the heuristic feature of environmental accounting is lost by outsourcing the production of financed emissions to data providers, financed emissions in themselves are not helpful for other carbon reduction strategies that financial institutions may use, such as, climate solutions or engagement.

In conclusion, due to the specific translational transformations and the self-referentiality within providers' universes, it appears that at the moment, financed emissions do not possess the qualities that would enable the kind of 'acting at a distance' that is required in the Anthropocene's widening ecological crisis.

Theory background

Environmental accounting and Accounting in the Anthropocene

We situate our approach in the field of environmental accounting in which we hone in on the perspective of 'accounting in the Anthropocene' (Bebbington et al., 2020; Bebbington and Rubin, 2022). The Anthropocene, an initially stratigraphic but subsequently more widely used and expanded concept, denotes humans' profound impact on the Earth System to the degree that the comparatively stable conditions of the preceding geological time period, the Holocene, are shifting through accelerating changes in the planet's atmosphere, biosphere, and geosphere towards much more precarious conditions for life on Earth (Crutzen and Stoermer, 2000; Lade et al., 2020; Rockström et al., 2009; Steffen et al., 2007). Fundamentally problematising the modern differentiation between humans and Nature, the notion of the Anthropocene lends to ontological redefinitions of human-environmental interactions (Oldfield et al., 2014) as well as epistemological redefinitions of traditional boundaries of academic disciplines and their research objects (Ellis et al., 2016) – in the latest update to the 'planetary boundary' assessment, Earth System science today almost casually notes the 'anthroposphere' in the list of interacting planetary systems (Richardson et al., 2023).[1]

At the same time and especially since Gray's seminal work (Gray, 1990; Gray et al., 1988), environmental accounting has grown into a field that forms a locus for creating, disseminating and applying accounts of societies' relationships with the natural environment (Bebbington et al., 2021; Hopwood, 2009). Environmental accounting has been particularly attentive to the need for combining various types of knowledge and acknowledging the breadth across disciplines and practices required to create environmental accounts (Bebbington and

[1] In turn, such profound ontological and epistemological re-evaluations provoked a proliferation of conceptual adaptation and problematisation over the last few decades, sometimes referred to as the "Anthropo-scene" (Lorimer, 2017) and attuned to various human-environmental mechanisms, historic causalities and contingencies, and analytical and political perspectives (Dibley, 2012; Toivanen et al., 2017).

Larrinaga, 2014). With this stance and given the otherwise dominant position of economics within the overall discipline, environmental accounting scholars have cautioned that such conventional economics approaches may very well lead to misrepresentations of relationships between organisations and environments and that environmental accounts need to escape the constrictions of financial accounting (de Aguiar and Bebbington, 2021; Lohmann, 2009; Michelon, 2021; Unerman et al., 2018). Thus, from the beginning and initially without the explicit notion of the Anthropocene, accounting scholars have long appreciated the complexity inherent in the relationships of organisations and societies more broadly with the natural environment. The more recent mobilisation of the concept of the Anthropocene in environmental accounting can therefore be seen as an extension and reinforcement of the positioning of accounting as central to societies' management of environmental change (Bebbington et al., 2020; Bebbington and Rubin, 2022; Edwards, 2017).

Thus, the Anthropocene marks not necessarily a new object of accounting scholarship. But accounting can also be seen as more fundamentally connected to the Anthropocene: however broadly or narrow one wants to cut the analytical and ontological boundaries, with the acknowledgement of anthropogenic environmental change it becomes clear that accounting holds a relationship with the Earth System that is, of course, exceeding a strictly representational one. Instead, it can be seen as an active component of the continuous and contingent becoming of socioenvironmental realities through expansive economic activities – the acceleration of environmental change through accelerating economic activities is at the heart of the Anthropocene diagnosis (Steffen et al., 2016; Zalasiewicz et al., 2015) – for instance in replicating neoclassical economics' treatment of environmental (and other non-economic) aspects as 'externalities' in financial accounting (Lohmann, 2009; Unerman et al., 2018) and thus omitting them from a more direct treatment in otherwise differently performative accounts of organisational realities (e.g., Georg and Justesen, 2017). On the other hand, especially environmental accounting embraces such 'externalities' and its own role in providing accounts for an active management of organisational-environmental relationships with explicit interventional goals (O'Dwyer and Unerman, 2016).

With accounting placed within the Anthropocene in such ways, especially Bebbington and her colleagues have drawn up a broad topography of the term and its concepts for the discipline (Bebbington et al., 2020; Bebbington and Rubin, 2022). For a consistent perspective, we follow here an actor-network theoretical lens also with regards to the Anthropocene, one

that Bebbington et al. have recognised but so far left "beyond the scope" of their work (ibid: 163). In this paper, we will therefore expand this perspective on the Anthropocene and integrate it analytically more deeply as a condition and co-product of accounting to make sense of the practice and implications of financed emissions accounting.

Sociology of Translation in the Anthropocene

For such a continued integrated understanding of accounting's role and practices in an Anthropocene period, we suggest the lens of the Sociology of Translation (Callon, 1984; Latour, 1999), taking also into account Bruno Latour's more recent political-ecology work (Latour, 2014, 2017, 2018). Actor-network theory-inspired research with the approach's emphasis on flat ontologies among humans and nonhumans has led in accounting and often related cross-disciplinary fields, such as the social studies of finance, to a host of fruitful scholarship primarily around calculative practices and devices, aiming at a broader view towards agency of and interaction between humans, technical devices and infrastructures, organisations, and markets. (Callon, 2009; Corvellec et al., 2018; Justesen and Mouritsen, 2011; MacKenzie, 2006; Millo and MacKenzie, 2009; Mouritsen, 2018; Muniesa, 2014; Vollmer, 2009).

Latour and Callon's work around a Sociology of Translation and actor-networks as an established analytical framework in accounting research has incorporated especially the integral components of material and semiotic production of 'circulating references' (accounting inscriptions) and subsequently enabled 'acting at a distance' (control or management), highlighting the reciprocity of knowledge construction and agency along chains or networks of translations (mediation) (Robson and Bottausci, 2018). In line with earlier seminal work of Burchel et al. (1980, 1985), accounting emerges not as passive reflection but as active intervention in the contexts and relations it is embedded in and applied to (Justesen and Mouritsen, 2011): the productive creation of representations that, then, can and will lead to and shape action upon not only references but also the entities they signify.

Only limited attention from accounting scholarship has been spent on Latour's more recent work (e.g., Vollmer, 2020), in which he turns the above understanding and especially Modes of Existence (Latour, 2013) towards the advancing ecological crisis and the Anthropocene (Latour, 2017). This simultaneous expansion and concentration of the actor-network perspective onto planetary ecology allows Latour to apply his relational ontology to interactional human and nonhuman agencies that make up and are continuously producing the

Anthropocene condition (ibid.; Opitz, 2016). Mobilising the chemist James Lovelock's Gaia hypothesis on the generative role of organic life for the constitution of the Earth System, Latour keeps the actor-network's flat ontological treatment of actants, agencies and agents (Latour, 2005; Latour et al., 2012) in place and situates the distributed 'Anthropos' within it (Latour, 2014). This, in turn, reinforces the Anthropocene's problematisation of the duality of human and Nature, something already fundamental in the Sociology of Translation (Latour, 1999).

By doing so, it allows to understand anthropogenic environmental change as the outcome of human activities – chiefly economic ones – and as a vital part of the Earth System's metabolism, connecting effectively social theory to the assessments and perspectives of Earth System science and environmental governance (Latour, 2018). Global warming in the Anthropocene appears, then, as a 'hybrid object', neither purely human nor natural, but relationally comprised of chains of translations and interactions between human and nonhuman actants such as atmospheric particles, scientific instruments, simulations, bodies of water, soils, political summits, industrial technologies, capital expenditures, CSR reports, etc. (Sprenger, 2019: 464; Latour, 2017). Accounting can, thus, be understood as a vital component in the interactional networks of such a planetary situation, by forming chains of translations that take part in shaping (inter)action between the anthroposphere and the bios- and geosphere.

Carbon Accounting as Chains of Translation

Carbon accounting in particular can be thought of as the primary way of creating translational chains connecting atmospheric molecules to specific emitters across the planet (Walenta, 2021) (see also Figure 1). In an example used by MacKenzie's account on carbon markets (2009), for instance, we can see how the early parts of emissions translation chains look like. University of Edinburgh's heat and power plant emits in its gas combustion carbon dioxide, but 'counting' it is already a complex operation of translations in which a device, the 'corrector meter', converts temperature and pressure from the gas pipe of the generator into volumes and then into mass of natural gas and then translates it further into estimates of carbon emissions via a multiplication factor (ibid.: 444).

This can be understood as a chain of translations in which yet to be combusted natural gas becomes (through the more granular translations from temperature, pressure, volumes to mass) a sign for its material transformation into emitted carbon dioxide after combustion in

form of an estimated number of CO_2. The specific molecules of natural gas "lose […] matter through successive reductions" (Latour, 1999: 55) but also "gain […] relative universality" (ibid.: 70) in form of a standardised CO_2 emission number. While the actual natural gas is burned and the resulting carbon dioxide released above the pinnacles of Edinburgh's Old Town into the atmosphere, the sign of the CO_2 number will travel elsewhere and change into yet other forms.

These operations of 'reduction' of matter and 'amplification' of specific forms of commensuration generate signs that become the objects of carbon accounting, which are

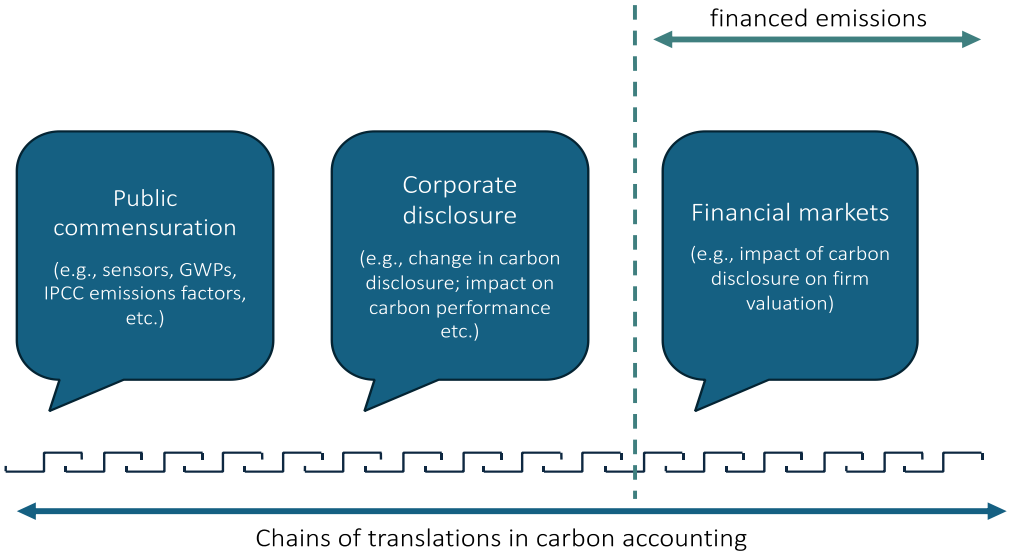

Figure 1: carbon accounting as chains of translation

themselves being reduced again and aspects amplified in other forms and networks, such as sector- production- and activity-specific Scope 1, 2, and 3 emissions collected and calculated (i.e., translated) by emitting companies. Such accounting inscriptions enable mobility e.g., in form of corporate disclosure figures in CSR or other reports, but also in various and sometimes conflicting modes and formats (Alexander and Fisher, 2020; Haslam et al., 2014; Michelon, 2021), and followed by different forms of interpretation (de Aguiar and Bebbington, 2021; Haque et al., 2016; Lodhia and Martin, 2012) and, hence, further translations. Carbon accounting research has most extensively focused on such company disclosures (He et al., 2022), for example highlighting difficulties, variability and contextuality of commensurating emissions accounting inscriptions around organisational boundaries or GHG emissions categorisations into Scopes (Bowen and Wittneben, 2011; Cooper and Pearce, 2011; Milne and Grubnic, 2011; Young, 2010).

Networks of inscriptions are also characterised by the assemblage of various calculative devices and practices from different and distributed professional and institutional areas including natural, technical and social sciences (Charnock et al., 2021: 360), the public and private sector, and on multiple levels, from global and national GHG inventories down to corporate or product- level assessments of GHG emissions (Ascui and Lovell, 2011). Amongst these various devices, the GHG protocol, the de-facto standard for carbon accounting, plays a central role. This standardisation of carbon foot-printing for companies, projects, and more, focuses on the assignment of responsibility for GHG emissions to organisations. It differentiates emissions via the principle of 'scoping', which defines organisational boundaries of control over activities that cause GHG emissions. Scope 1 emissions represent direct GHG emissions that occur at a company's site or one that is controlled by it. Scope 2 emissions represent 'indirect' emissions from the generation of purchased energy consumed by a company. Scope 3 emissions represent any other 'indirect' GHG emissions from the value chain of a company and are divided into upstream emissions that occur in the supply chain and downstream emissions that occur as a consequence of using the firm's products or services. Besides the GHG protocol and its various annexes, the assemblage of various devices and practices also includes scripts and emissions factors from actors such as the CDP, the International Energy Agency, the IPCC, several GHG accounting tools, emissions models and inherent assumptions, etc. (e.g., Edwards, 2010; MacKenzie, 2009).

Financed emissions accounting, shifting matters of concern and the 'management' of the Anthropocene

What operations and networks of translations in general achieve is to "establish particular knowledges of remote objects and subjects so as to facilitate control and 'action at a distance'" (Robson and Bottausci, 2018: 68). In the case of carbon accounting this pertains to one of the fundamental issues of the Anthropocene: the reduction of carbon emissions and, ultimately, contributing to the decarbonisation of the 'anthroposphere' helping to adjust Earth System interactions towards Holocene-like conditions (Richardson et al., 2023).

While constructing corporate emissions as accounting inscriptions are acts of fact production, it is the interests, goals and sociomaterial relations that are involved in the formation of networks and assemblages that determine how such inscriptions can be formed,

represent the world and shape realities. Thus, knowledge production and inscriptions are interventional processes driven by 'matters of concern', i.e., the result of interactions and negotiations between actors in such networks that articulate what and how realities are and can be shaped (Latour, 2004, 2008, 2013; Justesen and Mouritsen, 2011; Robson and Bottausci, 2018).

For acting at a distance driven by matters of concern around environmental impact, this means effective organisational change (Bebbington et al., 2021; Gray et al., 1995; Laughlin, 1991) that facilitates emissions reductions in business and operational models. Much of carbon accounting research has focused on the corporate side of emissions disclosure and found some initial evidence for a positive association between carbon disclosure and carbon performance (Berg et al., 2024; Downar et al., 2021; Qian and Schaltegger, 2017), but whether this association is sufficiently strong and produces results fast enough remains questionable, particularly in carbon-intense sectors (CDP, 2023).

To further drive such organisational change and, thus, emissions reduction and decarbonisation, the Paris Agreement, TCFD, regulators, civil society groups and industries have focused on the financial industry as a transmission channel for emissions reduction efforts in the real economy, primarily through climate-related reporting mechanisms. As a market-based mechanism, this programme of reporting in finance, however, assembles additional elements leading to redirected matters of concern. For climate-related reporting in market-based finance, the proposed causal chain changes in that disclosure is supposed to enable market discipline, which keeps financial stability in check and by inserting climate change as climate risk, the principal goal has to shift from environmental impact to financial impact (O'Dwyer and Unerman, 2020). Provided climate risks (downside and upside) lead to sufficient financial impact, i.e., that it can manifests as a strong enough market signal on asset values, market discipline will take care of excessive (climate) risk taking in capital markets. Since climate risk is (so far) primarily represented by carbon emissions, market discipline and rational action should lead to emissions reduction through ensuring financial stability (c.f. Christophers, 2017). In other words: to enable acting at a distance by finance, i.e., enacting organisational change in the real economy to reduce carbon emissions, more immediate matters of concern need to shift, through instruments of risk, from direct climate mitigation to ensuring financial stability.

Carbon accounting as chains of translations is thus extended into the realm of financial actors whose own Scope 1 and 2 emissions are of much lesser concern than the emissions from

operations of the assets they own or help finance – in the GHG protocol these financial activities were classed into Scope 3 Category 15 and called 'financed emissions'[2]. The relationship between financial institutions and their Scope 3 Category 15 emissions is supposed to elicit acting at a distance through the carbon accounts of companies in the hands of those who finance them (NZAOA, 2023; PCAF, 2020; TCFD, 2017), following, in other words, the mantra of 'what gets measured, gets managed' (Carney, 2015). In practice, as we will show, this means a shift in attention from environmental impact of assets' emissions to financial impact of assets emissions in financial portfolios.

While the relationships between translational processes, representational inscriptions, and forms of management are well established in accounting scholarship (Mouritsen, 2018), not much attention has yet been paid to those between the construction of emissions accounts of companies and management through such accounts by financial institutions towards companies. Carbon accounting research on financial markets and actors has so far primarily focused on either the role, functioning and nature of emissions trading schemes and carbon markets (Bebbington and Larrinaga-González, 2008; Callon, 2009; Hopwood, 2009; Lohmann, 2009; Lovell et al., 2013; MacKenzie, 2009) or on the impact of corporate carbon disclosure on the valuation of firms (Baboukardos, 2017; Chapple et al., 2013; Clarkson et al., 2015; Griffin et al., 2017; Matsumura et al., 2013). While the latter, in its perspective on the influence of emissions on financial valuation, is concerned with financial impact and, thus, already more akin to the shift towards financial impact in environmental reporting (O'Dwyer and Unerman, 2020), we know that the quantitative form and risk perspective of carbon disclosure may help financial actors to ingest such inscriptions for valuation (Clarkson et al., 2015; Eccles et al., 2011; Plumlee et al., 2015). What we know much less about are the translational processes of turning corporate emissions accounts into financed emissions accounts, which form the basis not only for valuation but also for the desired managerial feedback from finance to companies. This is important since the production of knowledge has fundamental implications for how it is used.

[2] The GHG Protocol's standard on these 'indirect' Scope 3 Category 15 emissions was subsequently refined by a financial industry-led body, the Partnership for Carbon Accounting Financials (PCAF), further differentiating between financed emissions, facilitated (capital market issuance) emissions and insurance-associated emissions (PCAF, 2020, 2022a, 2022b, 2023) – in the context of this paper we will refer to these only as 'financed emissions' since we focus primarily on the supply-side of creating the underlying emissions data (which are the same for all types) and not so much the type-specific disclosure by financial institutions.

A crucial locus of investigation is thus currently missing from the topography of actants and actors in financed emissions accounting: that of emissions data providers.

Intermediation by various distributed actors in financial activities characterises modern financial markets and services (Arjaliès et al., 2017; Beunza and Garud, 2007; Knorr-Cetina and Preda, 2012), which includes that of financial intelligence and data providers (e.g., Besedovsky, 2018; Carruthers, 2013). In the recently intensifying arena of 'green finance' moving from niche to mainstream markets, the increasingly central role of environmental, social and governance (ESG), analytics and data services firms has rightly caught much attention in the empirical field (e.g., Harris, 2023) as well as in academic research (e.g., Fichtner et al., 2023). These commercial data providers are a vital part also in the networks of translations of carbon accounting, adding intermediating practices and devices to the chains through which carbon accounts are produced. These activities, however, have been less targeted by accounting research, especially on a granular level of qualitative inquiry. By taking serious the material and social processes and realities of accounting in the Anthropocene through the perspective laid out above, we try to understand in the remainder of this paper the assemblages and networks of translations through which financed emissions are created and tease out the central and so

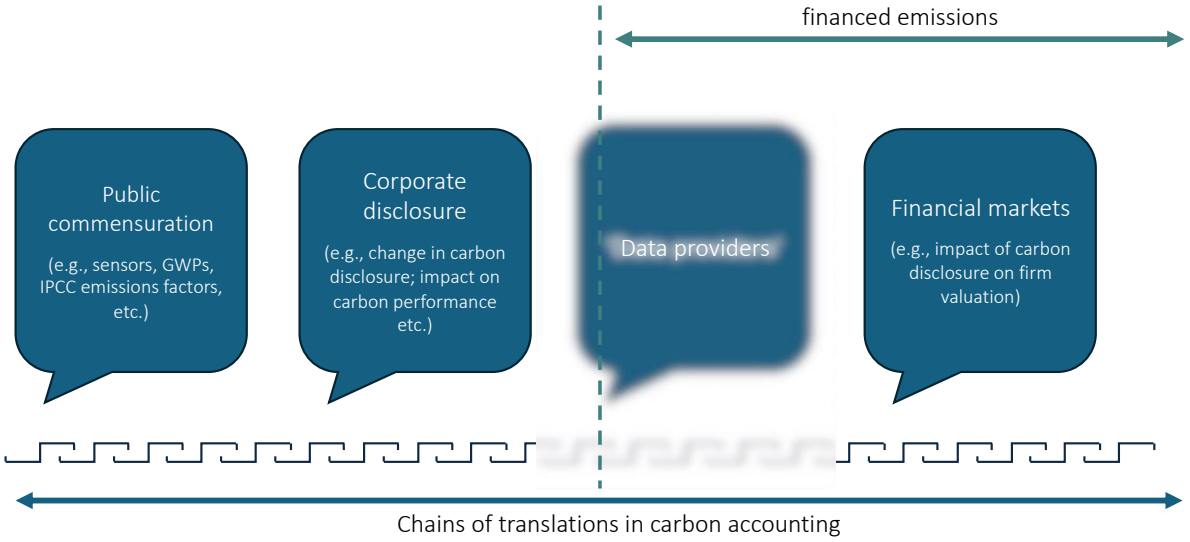

Figure 2: carbon accounting as chains of translation extended by intermediation of data providers

far under-researched translational work of data providers.

Research Methods

The context of emissions data providers

Our main object of investigation are the practices of commercial service providers that collect, model, curate and deliver corporate emissions data to financial institutions. Whilst emissions accounting for financial institutions began already in 2000 when the non-profit organisation CDP – formerly known as the Carbon Disclosure Project – started asking companies to disclose their climate impact, nowadays financial institutions, primarily source their financed emissions from commercial providers. These providers are often part of larger economic and financial intelligence organisations, whose core services may be, for instance, providing market indices, proxy voting services, conventional ratings and/or more specialised ESG ratings, or portfolio management analytics and solutions. In the wake of the 2015 Paris Agreement and the increasing demand from clients for climate data and analytics, many of the large providers, including MSCI Inc., Moody's Corporation, Sustainalytics, Trucost and ISS have formed separate climate teams and built these out through the acquisition of more specialised firms or teams within these firms, such as Oekom, Ethix, SouthPole, FourTwentySeven, CarbonDelta and others. The climate teams typically provide GHG emissions data as well as other climate analytics services, such as climate risk analysis, including both transition and physical risk; impact assessment; identification of green companies, solutions and revenues; involvement with fossil fuels; analysis of stranded assets, etc. Financed emissions accounting, thus, is embedded in and, as we will show, driven by affordances of fast growing markets of sustainability information for finance, of which the market of financed emissions data is an important one.

As the demand for financed emissions data increased exponentially over time, emissions data providers responded by expanding the repositories of companies they cover. Most data providers started out with compiling direct emissions (known as Scope 1 emissions[3]) and emissions derived from energy that companies purchase (known as Scope 2 emissions) and in the last two years started to compile indirect value chain emissions (known as Scope 3 emissions). They did so initially for listed equity and credit and have subsequently expanded

[3] According to the GHG Protocol (WBCSD and WRI, 2004).

into other asset classes, including sovereigns, real estate and private assets, such as private equity, infrastructure, and private debt. Today, the number of companies that data providers cover range from 10,000 to 35,000 and more. While this growing number reflects the (rather non-linear) increase of companies that report emissions, it also represents the competitive raison d'être in the provider market and that 'coverage', the number of companies comprising it, is one of the most central criteria for being chosen by clients: "Coverage is everything", tells us a seasoned ProviderCo top manager (Steve, interview 06/04/2021). Over time, as the repositories of covered companies grew, so, too, did the data collection and curation practices of providers become more sophisticated. Providers extended their databases, advanced their estimation models and formalised their methodologies for collecting data.

Ethnographic fieldwork

This paper emerges from an in-depth, three-year ethnographic exploration of how the financial sector produces and uses knowledge on climate change. A complex web of organisations, ranging from different types of financial institutions (e.g., banks, insurance companies, asset managers, pension schemes etc.), investor networks, data providers, NGOs, consultants and regulators are involved in creating, disseminating and using different climate-related data, tools and frameworks. To grasp the work of these various actors as well as the connections between them, the research employed a multi-sited, team-based ethnographic approach whereby multiple researchers study the phenomenon of interest in different sites (Jarzabkowski et al., 2015; Marcus, 1995). Data collection began in January 2021, lasted until December 2023, and involved five researchers, including the principal investigator, two PostDoctoral researchers, a PhD student and a research assistant. In total, the team traced the actions of seven different organizations and five Net Zero (NZ) alliances and spoke to numerous industry experts (see Table 1).

Table 1: Overview of Data Collection (2021 to 2023).

Instances	InsureCo	ProviderCo	Investor network	NGO	Bank	Open-source	Asset Manager	Five NZ initiatives[4]	Industry Experts	Policy	**Total**
Interviews	91	51	18	13	79	33	41	31	59	8	**424**
Observations	86	85	4	7	81	76	3	21	25	4	**392**

[4] The five Net Zero initiatives include the Science-based Targets Initiative (SBTi), the Net Zero Asset Owners Alliance (NZAOA), the Net Zero Banking Alliance (NZBA), the Paris Aligned Investment Initiative (PAII) and the Net Zero Asset Managers initiative (NZAMi).

Feedback Sessions	3	5	2	1	1	3	0	2	1	0	**18**
Access Conversations	21	4	2	2	3	1	6	1	11	0	**51**
Total	**201**	**145**	**26**	**23**	**164**	**113**	**50**	**55**	**96**	**12**	**885**

As common for ethnographic methods, the research approach was based on deep immersion in, and close observation of the work of others via techniques, such as, observations, interviews and close reading of documents (Ybema et al., 2009). Following the central idea of practice theory (Nicolini, 2012) the focus of the data collection was on what people actually do in practice, the resources and materials they use and the meanings they give to these activities. In the context of the Covid19 pandemic and the subsequent shift to working from home, the majority of the data collection took place online, with a stronger focus on participation in online meetings and online interviews.

Of interest to this paper are two organisations that we worked with since the beginning of the data collection, ProviderCo and InsureCo (all names are pseudonyms). ProviderCo is one of the leading providers of climate data, tools and advisory. It has developed complex models for physical and transition risk assessment, solutions for net zero target setting and new approaches for estimating Scope 3 GHG emissions data. InsureCo is a large multi-national insurance company, asset owner and asset manager. The company has worked collaboratively with many others to develop new approaches to climate risks, it has set climate targets, and integrated climate risk metrics and climate targets into its governance, risk management and decision-making processes.

Our interest in the calculation of financed emissions emerged early on in the fieldwork: we realized that (1) GHG emissions data was one of the main sources of information that InsureCo and other financial institutions used for both their internal monitoring and external disclosure of climate-related metrics, and (2) that collecting and curating this data is far from straightforward. At ProviderCo, we thus delved into the details of their data collection practices by interviewing staff members on ProviderCo's methodology for collecting and estimating emissions data, attending training sessions of new staff members and observing so-called 'tech meetings' where data analysts discussed difficult cases of company reports. At InsureCo, we followed closely how participants used GHG emissions data for calculating carbon intensity and other carbon-related metrics, monitoring these metrics and analysing them for change over

time. We observed how InsureCo sometimes identified issues with specific GHG emissions numbers and raised these with their data provider (not ProviderCo). In parallel, we also interviewed other selected data providers (including InsureCo's provider) and financial institutions on their production and use of companies' GHG emissions data. These interviews allowed us to triangulate our observations and insights from InsureCo and ProviderCo and understand that they were truly representative for the issues that others encountered as well.

Data analysis

Our data analysis followed an iterative, inductive approach (Miles and Huberman, 1994) involving four steps. We iterated between the steps, when the results of a subsequent step indicated that we needed to revise a prior step. We began by mapping the entire production process of emissions data at ProviderCo and identifying distinct sequences within this process (Langley, 1999): (1) data collection, (2) data modelling, (3) data curation, and (4) data challenge. Next, we identified the practices, that is, the recognizable and repeated doings and sayings, and the material devices involved (Reckwitz, 2002; Schatzki, 2012) that ProviderCo used in each of these sequences. For example, in data collection, an important practice was that of 'investigating emissions data.' For each practice, we identified the specific actions that made up this practice. For example, investigating emissions data included actions such as understanding and judging on how a company reports, investigating and recalculating emissions data, checking external verification for the reported data etc. The Appendix provides an overview of the sequences, the practices and the specific actions within these practices.

In the next step, we analysed each action to identify the translational transformations that occurred in each of them. We gradually clustered these transformations into four acts of translation that ProviderCo regularly performed in order to integrate the emission accounts of companies into their repositories. We analyzed how through reducing the specificities of a company's emissions account and amplifying it within the data provider's repository, a company's emissions were brought into a particular relational form. At this stage, we noted the increasing self-referentiality of emission accounts within the provider's repositories and paid particular attention to how this self-referentiality was achieved and its consequences.

In the third step, we analysed in more depth the role of ProviderCo's clients in producing financed emissions and how InsureCo worked with their provider on issues in emissions data. We found that client challenges were important in evolving ProviderCo's emission practices, in

clients gaining trust in ProviderCo's work and in maintaining and reenforcing the stability of ProviderCo's repositories. At this stage, we also carried out member checks with specific individuals at ProviderCo, who only suggested minor changes and confirmed that our observations and analysis reflected a good understanding of the practices at ProviderCo.

Throughout our analysis, we itered back and forth with the literature on carbon accounting, environmental accounting and Accounting for the Anthropocene and reflected on the broader implications of this translation work for the ability of financial institutions to act at a distance.

Findings

Assemblages of carbon accounting for financed emissions

As we look across the various stages of the chains of translations in carbon accounting, we have moved very quickly into textual forms. Where we are zooming into now, the physical matter of things such as the natural gas of Edinburgh University's heat and power plant (MacKenzie, 2009), has been long lost through reductions in myriads of translations whose amplifications helped transform them into other forms, gaining qualities of basic mathematical character. Emissions figures of the kind relevant for the creation of financed emissions are those often found in different kinds of reports, such as CSR reports, TCFD reports, CDP reports, or annual statements of investee companies. In such cases where companies do disclose their own carbon footprints, it means that they engage in the chains of translations themselves to transform various things such as amounts of fuel combusted on site, production volumes of products, purchased energy, owned capital goods, products' life cycle analyses, etc. often via emissions multipliers or 'factors' into standardised numerical values of CO_2 – almost always, the seven Kyoto-mandated GHGs are in these processes already commensurated into the reference carbon dioxide, designated as carbon dioxide equivalents or CO_2e (WBCSD and WRI, 2004).

Emissions numbers in corporate emissions accounts are 'educed' in an assemblage of actors, such as corporate CSR departments, public and commercial carbon accounting tools, emissions factors, carbon accounting advisories and consultants, guidelines and protocols, regulatory frameworks, and much more. Although corporate emissions footprints are becoming more standardised and mandatory, reporting remains to different degrees

unsystematic and hard to compare, for instance due to reporting inconsistencies, incomplete organisational boundaries, or the exclusion of parts of companies' activities (Klaaßen and Stoll, 2021). Companies, in general, produce situated accounts of their carbon performances and so company accounts differ in terms of temporality (i.e., when emissions data is produced), format (e.g., shaped by different mandatory and disclosure standards) and substance (i.e., different applications of the GHG protocol).

While these accounts are in principle publicly available, financial institutions very rarely make direct use of them for financed emissions accounting. Instead, they subscribe to emissions data feeds for their portfolios from commercial data providers, such as ProviderCo. As introduced above, data providers are embedded in a wider and expanding assemblage producing sustainability and environmental information for the financial industry.ProviderCo is not only part of this wider market of 'green finance' inscriptions, but also comprises internally various arrangements that help them in the creation of financed emissions.

As with most large emissions data providers in the financial sector, ProviderCo's climate-specific service is the result of a number of acquisitions in the climate data and analytics market that occurred especially since 2015. An important device that emerged at the intersections of these developments is the location for storing emissions data, ProviderCo's emissions database 'CarbonBase' [name changed], which was created many years ago as an Excel-based application and has since gone through numerous upgrades and is now hosted on a database API. This database has grown rather organically over the years and the selection of companies has been driven by affordances of financial institutions' portfolios. CarbonBase offers a number of formalising features that shape ProviderCo's translational activities. For instance, the emissions data collection interface shows the most relevant company information while allowing to manually create emissions inscriptions for the respective company in different units, such as metric tonnes, kilograms or pounds of CO_2e, the source type such as companies' CSR, annual, or CDP reports, the different emissions Scopes, comments on the data collection process, and many more data points.

Carbon Base is accompanied by a range of devices supporting, and in some cases driving, ProviderCo's financed emissions accounting, which are all mounted onto the data collection and analysis interfaces. Most crucial among them are the emissions estimation models, which calculate assets' emissions from a range of proxy data and emissions factors in combination with internal sector emissions averages. Other devices include, for instance, an

automated scoring system that assesses the quality of reported emissions and a range of categorisation systems that help to classify assets in various ways, such as the very crucial internal sector classification system or an internal asset identification system from an adjacent database. Alongside CarbonBase and connected devices, ProviderCo continuously produces and reconfigures methodology papers around its emissions data collection. In addition, more senior and experienced team members convey internal conventions to other, more junior or newer team members in training sessions and regular (usually weekly) meetings in which more difficult cases of companies are discussed and collective decisions made. Inspections of companies' emissions accounts and choosing specific interpretations is, thus, always both individual and collective, as well as embodied by the combination of analysts, infrastructures and devices. Part of this provider-specific assemblage of financed emissions accounting are, ultimately, also financial institutions' portfolios in form of portfolio data extraction sheets with references to investment positions.

Translational practices and processes of financed emissions accounting

Financed emissions accounting is, thus, a distributed assemblage of practices, actors, devices and infrastructures, whose translational outcome is to bring asset's emissions into a new and particular form. The primary matters of concern that drive the translational activities are those of financial impacts of emissions (as the primary signal for climate risk) which are located in financial portfolios. Hence, to understand the specific relational form that emissions need to be brought into to become financed emissions, it is important to understand the relational character of financial portfolios. Fundamentally, financial portfolios, whether comprising investments, loans or insurance policies, are relational creatures in the sense that they are constructed and managed (e.g., maintained or changed) not simply as a sum of entities but as a specific arrangement of these entities' relationships. Portfolios bring assets into specific relationships with each other for instance through risk-return, sector or regional profiles that are expressed in different ways such as diversification, (re)balancing or hedging. Specific assets are selected from the investible universe based on how they fit within these relationships of the existing portfolio assets or the devised underlying strategy. What providers, therefore, need to do is to elicit the relationships between assets' emissions so that they can conform in this relational form as references in a financial portfolio. This relational form that can add to the other types of relationships in financial portfolios then enables financial institutions to compare

the emissions of one asset to other assets in the same sector or asset class and to aggregate up to asset class, sector or portfolio level. Achieving this relational form requires reducing the specificity of an asset's carbon account and amplifying its relationship to other assets' (equally specificity-reduced) carbon accounts. But there is a market affordance that necessities a crucial detour in these translations.

Since data providers' business model requires their offering to be scalable, that is enabling to serve as many clients as possible while avoiding redundancy and ensuring efficiency in their financed emissions production, they construct a general repository which some of them refer to as their emissions 'universe'. Derived from the financial parlance of the 'investible universe', an emissions universe represents a pool of individual emissions of assets that financial portfolios may hold. As such a pool, it exhibits a similar characteristic as an investible universe: as 'a whole', in a borrowed Latourian sense (Latour et al., 2012), it is smaller than its parts because it still lacks the relational qualities of a specific portfolio. To solve this issue between universality of scalability and relationality of assets' emissions, providers create what we want to call their financed emissions universes as a form of a universal relational proto portfolio.

Even though colloquially referred to as data providers, what they provide from a sociology of translation perspective is not mere data but 'achievements' (Latour, 1999: 42): they achieve 'universal' relationships between assets' emissions numbers by translating them into financed emissions numbers within the confines of their own financed emissions universes. A crucial part of this achievement is maintaining the stability of these relationships across their universe, which also allows providers to meet generic carbon accounting affordances such as completeness, consistency, or accuracy of accounts (PCAF, 2020; WBCSD and WRI, 2011). Inductively derived from our empirical research at ProviderCo and other providers, we identify four distinct types of translational practices that help them achieve stable relationships between assets' emissions in the form of financed emissions.

Completing

Completing is an important translational practice when encountering absences or high ambiguity in emissions data and other information necessary for interpreting an asset's emissions, since the stability of relationships between emissions accounts requires parity of information. Thus, providers fill in gaps by finding alternative sources of emissions information,

such as other reports, or producing modelled estimates, to ensure an account can fully relate (e.g., along all emissions Scopes or across years) to other accounts in the universe. The following presents an example from our field notes for the practice of completing:

> *In a data collection meeting at ProviderCo, Steve, the head of the climate data team, brings up Tapas Inc. [name changed], a restaurant chain. Together with Mark and Ruth, Steve looks at the electricity consumption table in the firm's CSR report and they notice that the company used both commas and points as decimal segregators in the same table, so the differentiation between small and large values is unclear. They ponder over how to understand the numbers, until Steve concludes "this looks very unreliable to me", simple mistakes in the table of GHG emissions put him off. Looking at the company page in CarbonBase, he notices that they decided to estimate the emissions for this company in the previous year. They look up Bloomberg entries, which show CDP estimates, which also do not add up with either of the possible interpretations. Steve prefers to go with ProviderCo's internal estimation model again for this year, too. They decide to register and approve the estimate in CarbonBase's collection interface. (ProviderCo observation, 02/06/2021 – min 00:06-00:09)*

In this case, the high ambiguity from potentially having to guess between a decimal point and a thousand separator, leads Steve to disregard the reported emissions number of this asset and treat it, ultimately, as absent by substituting it with a model estimate – in other cases, for instance, they use a number from a CDP report instead of or in absence of a CSR report. The incompleteness and/or ambiguity of the company's emissions account, which might not only be a nuisance but also provide important signals for what a company accounts for and manages, is lost in this act of translation. Instead, what is gained is the form of a complete emissions account for the asset that has the same form and hence makes it comparable to the accounts of other companies in the universe.

Cleaning

A seemingly more mundane but also important translational practice is cleaning. If not absent or overly ambiguous, assets' emissions may instead entail inaccuracies, that is imprecise information, smaller errors or deviating formats in emissions accounts, which may also pertain to other economic data used for proxies or even providers' own internal estimation models. An instance from our field notes exemplifies this case:

In another meeting, they are discussing an Australian healthcare company, whose emissions look a bit odd compared to their own CarbonBase and Bloomberg's past numbers. They investigate for a while and find that they have not yet recalculated the numbers from the new report, given that Europe and US-based ProviderCo records December to December annual emissions numbers while Australia reports June to June emissions numbers. Because ProviderCo's registers emissions "when they actually happen, not when they are reported", they need to split this company's emissions in half and add up half of last year's reported emissions to have a full calendar year's emissions. (ProCo observation, 04/06/2021)

Specificity is reduced by sorting out formal messiness, here via recalculations but in other instance also by judgements, losing context and locality (and potentially local accuracy) while through such commensuration relationality between assets' emissions from different contexts and localities is gained and the universe's stability ensured.

Consolidating

Consolidating is another crucial practice that pertains primarily to translational interventions towards inconsistencies in accounting methodologies applied in assets' emissions accounts, such as setting different organisational boundaries year-on-year. Although not always easy to detect, such methodological inconsistencies need to be consolidated to ensure that emissions performance of an asset remains contingent over time and complete and, through this, comparable to other assets' emissions. In a conversation with Steve, he explains to us how they deal with inconsistent reporting and boundary setting of holding companies:

"We say if a parent company has more than 50 percent share and if they have not themselves fully accounted for subsidiaries emissions so far, we are going to do that for them. So, for [a large and diversified US holding], even if it has 80 percent control in [an energy company], 100 percent emissions of [it] are added to the parent's emissions and are reflected there. So, for us, the guiding principle is operational control from GHG Protocol. If you have operational control, you can call the shots." (Steve interview, 16/02/2022)

Translation in form of consolidation reduces the intricacies of the situated, and here potentially intentionally misappropriated, application of accounting frameworks, i.e., how this company defined its organizational boundary. At the same time, it amplifies the relation to other assets

by transforming the emissions numbers to conform with conventions of the universe (i.e., using the principle of operational control from the GHG Protocol) and gain relational consistency.

Categorising

Categorising, finally, is a highly consequential translational practice that involves classifying, defining, and understanding assets' activities with respect to their emissions. To establish a relationship between assets' emissions, it is necessary to understand how similar or different the sources or contexts of their generation are and, thus, how to compare them – a cement company's emissions may be low compared to another cement company but high compared to a brick producer. This comparison is usually determined by sector and sub-sector classifications of assets, but common sector classification systems used in the management of financial portfolios, such as GICS, ICB, or NAICE, differ in defining companies' activities, can be applied differently, and the reference frame is often not attuned to emissions. Providers, therefore, often have internal, more emissions-focused sector systems, into which assets' activity profiles need to be translated. An excerpt from our field notes illustrates this often tedious translational work:

> *Steve adds a new company to the emissions repository, a Chinese micro fabrication company, and checks information from ProviderCo's internal financial intelligence database, which feeds into CarbonBase. It does not have a sector classification recorded. He then pulls up different online sources for company information, such as Creditriskmonitor, Zoominfo, and Bloomberg. Here, he finds a rather vague SICS classification entry: "special industry machinery, not elsewhere classified". This does not help to understand exactly what the company is doing. He goes to their website, inspects images of machinery displayed here and some rather cryptic information given in English [he does not speak Mandarin]. Steve ponders several different possibilities for classifying the company in CarbonBase's internal sub-sector system. Would it fit the sub-sector "semiconductor" or "semiconductor equipment"? He looks up what the model estimates would be for either interpretation and emissions-wise the difference would be huge, i.e., 900 vs. 25000 tons of CO_2e. Steve iterates between the information he finds online and different internal sub-sectors, including "technology distributors", "industrial machinery," "electronic equipment manufacturers" and "industrial equipment." Steve reminds the team of the importance to classify companies not according, for instance,*

to NAICS, but to what it is the companies are producing, which is represented best by their internal classification. He feels most comfortable with "electronic equipment manufacturers", given the research he has done, and the small emissions difference to the other likely sub-sector candidate ("industrial equipment"). (ProCo observation, 03/06/2021)

The specificity or plurality of assets' activities are thus reduced, and an internally consistent codification of an asset is gained that amplifies its emissions' relation to other peer assets in the universe.

Financed emissions as circulating references in self-referential universes

As we have shown, both by the larger framing of carbon accounting as chains of translations and the specific translational practices of providers in financed emissions accounting, significant reductions and amplifications happen along the way and, once brought into the provider universe, it is the amplification of the relationships between assets' emissions that constitute financed emissions. Produced in these ways, financed emissions as numerical materialisations of relations between assets only exist at scale within financed emissions universes of data providers.[5] If relationships are sufficiently stable, financed emissions can then be understood as 'circulating references', that is inscriptions that designate "the quality of the chain of transformation" (Latour, 1999: 310) and thus realising the applicability, or circulation, of assets' emissions in a financial context. For accountants, the important characteristic of such references is that such "production of numbers is a process, which only refers to its own internal consistency and claims only in a very limited sense that it has captured the world." (Mouritsen, 2018: 133). As a kind of proto portfolio, a provider's financed emissions universe is, thus, the 'centre of calculation' for inscriptions that reduce and amplify remote sites of GHG emissions, making them connectible to financial institutions' portfolios by building up a high degree of self-referentiality.

[5] Unless financial institutions themselves translate assets' emissions accounts directly into their portfolios, which is very rarely the case and only when portfolios are sufficiently small or concentrated.

In this section, we pay attention to the construction of self-referentiality in relational assets emissions. In practice, we observed four processes at providers, distinguishable by the very tasks of analysts' work: data collection, data modelling, data curation, and data interrogation. But in terms of their 'relational achievements' they can be subsumed as parts of two interlocking phases that enable the stability of assets' emission relationships through which financed emissions become circulating references within an increasingly self-referential universe: (1) asset integration, and (2) portfolio integration (see also Figure 3).

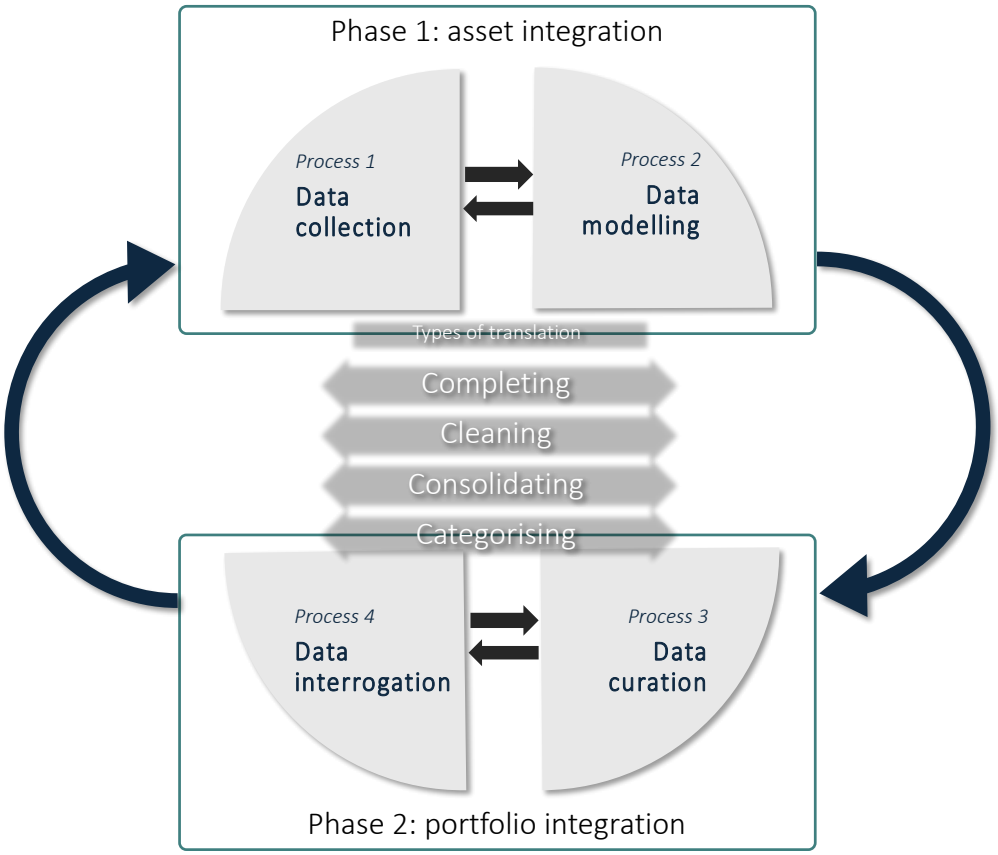

Figure 3: ProviderCo's financed emissions production

Phase 1: Asset Integration

The first phase can be called asset integration and it entails processes of data collection and data modelling, which constitute the creation and expansion of the provider universe. Data collection involves searching, finding and interpreting companies' disclosed emissions accounts and bringing them into the provider's data repository, thus inscribing and relating them to the provider's universe. The examples for translational practices above primarily reflect activities in this process, but already refer to the process of data modelling as well. Regarding the latter, data modelling involves the construction, testing, refinement, and application of emissions

estimation models to substitute or benchmark assets' emissions, or to create them in the first place where they do not exist.

From the outset, translational practices in data collection have the premise to produce emissions inscriptions in relation to other assets' emissions in the universe, as indicated in the above examples. Here we focus on three of the various devices through which this relationality is constructed in an increasingly self-referential way: (1) the trust metric, (2) the internal sector classification system, and (3) emission estimation models. With regards to the first device, ProviderCo uses –this device to categorise reported emissions of assets into either 'strong', 'moderate', or 'weak' quality. About one third of the metric is based on whether or not a published account has external verification by an auditor. The trust metric also compares the difference between the reported emissions and CDP-reported emissions, if they exist; the higher the difference the lower the trust metric. The most important part of the metric, however, is based on historical variation, i.e., year-on-year variation in emissions numbers within CarbonBase. The code checks whether these variations lie within a certain threshold range of difference and then assigns a higher score if they are closer to each other, and a lower score if the discrepancy is larger. If the asset does not have historical emissions in CarbonBase, the current average of the sub-sector the asset is assigned to will be referenced against. Even though the two other factors in the metric are of an external nature (i.e., checking for auditor verification and comparing the difference between reported and CDP emissions), the strongest orientation in the trust metric is already relating the quality check of reported emissions to the universe's internal consistency (i.e., consistency with historical emissions figures). This contribution to self-referentiality is embodied by the translational practices where the score is embedded in the data collection interface of CarbonBase and used as a reference point.

Another important type of commensuration devices of providers is, of course, the internal sector classification systems, which stabilise assets' complexity within a more or less granular but distinct relationship to emissions sources in form of the (sub-)sectors they are sorted into. In ProviderCo's case, these amounted at the end of 2022 to almost 150 different categories. At the time, they would allocate an asset to no more than one single sub-sector in order to stay coherent, but there were plans to develop approaches on how to either allocate multiple sub-sectors or split assets' emissions up into different sub-sectors. Although inspired by some standard classification systems, the internal one has grown and changed substantially in the past years along the expansion of their universe to more assets and more years of

recorded emissions. This means that each change or addition to the category system needed to be developed in-step with the integration of new accounts of assets, or in other words, the universe and the sector system cannot contradict but must refer to each other.

The most crucial source of self-referentiality in providers' financed emissions universes, however, is data modelling. Deeply connected to data collection, as the examples for translational practices above show, this is the process in which the relationality between assets' emissions gets most amplified. Estimations are still very much used since there remain many companies who do not or only partially report emissions (especially Scope 3), but the increasing number of mandating disclosure regulations have set an upward trend in reporting. Although originally built to estimate those emissions that are not disclosed by companies, i.e., to deal with 'pure' absence, emissions modelling has grown into the practices and infrastructure of providers much more deeply, constituting the backbone of stability in the relationships between emissions, whether reported ones or estimated. This is because estimation models feed into the universe, either by producing the numbers directly or acting as a benchmark to allow reported ones in. At the same time models are constantly (re)calibrated against the universe, often using internal sub-sector averages or samples of high-quality reporting assets sometimes referred to as 'golden samples'. This crucial simultaneity of in- and output of models in the very substance of the universe increases self-referentiality even more. Appropriating an example from Latour's amazon expedition (Latour, 1999: 58f), it can be thought of as if the Munsell code, a standard catalogue assigning ID numbers to an entire palette of colours used by Latour's scientists to translate soil colours into figures, would to some degree continuously change the reference colours on its pages depending on the soil colours previously checked with it. The standardising effect then primarily applies, or refers, to itself and the specific soils translated.

Emissions modelling at providers can be broadly understood as complex translational practices of completing. Estimation models are usually regression models where the dependent variable is the amounts of emissions and the independent variables are factors that are meant to predict emissions, such as revenue, cost of goods, assets, employee numbers, etc. The emissions numbers that relate to these factors are taken from the provider's own emissions universe; which factor is 'revealed' as a good predictor already hinges on, or refers to, the universe itself. Also practices of categorising are chiefly important here, since models are based on sub-sectors and these sub-sectors need to be defined by representative reporting

companies from the provider's universe. Primary and secondary models are then constructed, where the primary ones have the highest possible correlation between a combination of factors and emissions output. Secondary models are built for cases where data on predictive factors of companies are scarce and, thus, run on fewer factors. Bob, a modeller at ProviderCo, comments here: *"If, let's say, the company has been bad at reporting and it's a small company in the domain, then you need to go research all these numbers [different predictive factors]. It's not easy to research cost of goods, it's not easy to research assets. It's easy to research [number of] employees and revenue because that's something which is easily available on the website. So that secondary model is like a fallback option."* This shows that not only assets' emissions accounts require translational work but also proxy information such as economic data, for which ProviderCo needs to account for by further translational practices in completing and cleaning, when applying the models for concrete estimation.

Modelling as a central translational intervention also illustrates the different degrees or qualities of reduction in the process. For instance, models tend to be driven by the contexts of better-quality reporting (e.g., Europe, US) on whose available reported data they are based and calibrated against. This can lead to ambiguity or bias, when they are applied for different regional contexts where reporting is not as good, such as in Asia. For example, pharmaceutical companies in Europe usually have fairly low energy consumption Scope 2 emissions, while in China, pharmaceutical companies tend to have their own in-house coal-fuelled power generation units, so they produce much higher Scope 1 emissions for energy supply. ProviderCo is trying to refine and contextualise models, but since they are working on a global scale, it is difficult to balance global universality and local specificity. In contrast, for some conventional electricity companies, they have data on the amount of produced energy (in GWh) from each fuel source. Here, ProviderCo calculate emissions directly from physical output factors and effectively do the same carbon accounting using the same input as the company would, *"because electricity prices, fuel prices etc., can change too much. And these are big emitters, so we do not want to take that high risk of too much variation if we have a standardized model based on revenues or employees, let's say."* (Interview Bob). When there are no data on GWh of produced energy, they use MW installed capacity, "when you assume plant load factors running 300 days a year at 70 percent capacity for coal, 30 percent capacity for solar and stuff like that. And then, you know, some standards available in some theory papers or research papers and then use that and say, OK, this is my number for them."

Models are recalibrated when changes in the difference in modelled and reported emissions are getting too big. But to ensure internal consistency, the threshold here is often rather high. This, in turn, can be an issue for the relational stability between assets' emissions if changes in the universe happen but models are not recalibrated, or if recalibration happens and estimated emissions change too intensely vis-à-vis reported ones because of it. Keeping assets' emissions relationships stable is a continuous task, underscoring self-referentially not as a passive but an active translational feature. The centrality of modelling for the self-referentiality of financed emissions universes is, therefore, very high, because it feeds back into and is embodied by the translational practices of analysts' practices and it is an inherent part of universe construction, as well as a reference point to other devices such as the trust metric and the sector systems.

Phase 2: Portfolio Integration

While the first phase of establishing relational stability of assets' emissions creates and expands a provider's universe through increased self-referentiality, the second phase integrates and translates financial institutions' portfolios into the universe. This phase entails processes of data curation and data interrogation. In data curation we have to switch our perspective towards how financial institutions' portfolios are being plugged into the provider's universe, translating asset relationships of the specific portfolio to assets' emissions relationships of the provider's proto portfolio. In data interrogation, clients request explanations for individual emissions numbers of their portfolio assets, instigating 'tracing back' the chain of translations performed by the provider. This leads to further stabilisation of assets' emissions relationships sometimes through additional, corrective translational practices towards certain universe inscriptions but much more often by reinforcing the validity of existing relationships and the integrity of the universe. Both processes, we find, contribute to the self-referential nature of financed emissions universes in this second phase, since, rather than merely delivering emissions numbers, providers bring clients' portfolios into the universe's emissions relationships and thereby reinforce them.

When faced with clients' specific asset portfolios, it is important to understand this process of data curation as one of translating such portfolios into the financed emissions universe and not the other way around. This is because the translational practices we observed are concerned with referencing clients' assets towards the stabilised relationships they have

built in the first phase of financed emissions production. For example, providers have templates, either on their client-facing platforms or in form of Excel files, through which clients submit a variety of information on their portfolio holdings, such as assets' names, their denominated currencies, types and amounts of investments, investment weights in the portfolio, and where applicable the assets' International Securities Identification Numbers (ISIN). At ProviderCo, CarbonBase receives portfolio data from clients whose holdings' ISINs are automatically matched to asset IDs of ProviderCo's internal identifier system, which is hosted in an underlying ProviderCo-wide financial intelligence database. Here, translational practices especially of completing and categorising are involved.

While the infrastructure of devices, such as client data harvesting portals or sheets, the identifier systems and the matching functionality of CarbonBase, automatically translate portfolio assets into provider universe assets relationships, very often manual translation is also needed. Practices of completing can illustrate the otherwise automated steps, as the following excerpts from our field notes about a training session for new employees show:

> *Ruth, an analyst, opens a new portfolio request and uses a check functionality in CarbonBase that pulls an Excel file which shows the ISINs mapped to internal IDs, including those of subsidiaries to parent companies, and the blanks for portfolio positions that could not be mapped – a red flag in CarbonBase indicates which positions in client portfolios require manual attention. She now needs to assign the remaining assets within ownership structures based on one of ProviderCo's internal market intelligence databases which includes ownership information from data vendors such as FactSet, Compustat, or CapitalIQ. Steve explains to the new analysts: "we simply search it in the database, try to go into [the assets'] structure and try to understand where does the company lie." In this case, it is a Special Purpose Vehicle of a large carmaker. Steve notes, "So for this, the case is very clear. I cannot have emissions for this financing [entity], it's only for raising finance, it's not doing any activity […]. So we map it simply to the parent". (ProviderCo observation, 02/06/2021).*

This act of translation establishes inside the provider universe, and nowhere else, the critical relationship between assets' financed emissions, since 'mapping' a non-emitting financial instrument to its car-producing issuer means translating its financing activity as one supporting and enabling the carmaker's activities that produce GHG emissions. Of course, this relationship is already drawn in ProviderCo's universe, but in this case needed to be manually redrawn

during the integration of the client portfolio because the automated system was missing the ISIN in the submitted client portfolio data.

The nature of financed emissions relationships can be understood primarily in forms of ownership structures, i.e., boundaries, and types of assets' activities, i.e., (sub-)sectors. In the example above, the ownership relations were clear to Steve and both entities were located in the same sub-sector. In other instances, both the ownership relations as well as the differences in sub-sector allocation need to be considered in order to integrate client portfolio assets into the universe relationships. In the field note excerpt below, the team revisits the large and diversified US holding already mentioned in the example on consolidating translational practices:

> *The holding comprises about 10 larger firms that are of interest for the client portfolio. Given a stake in underlying firms of larger than around 55% and the resulting revenue streams towards the holding company, ProviderCo's position on this is that anyone investing in this holding is "de-facto investing in those companies. Your emissions are [all of these] and not just [the parent company's], and that's what we put in our system. […] On the other hand, no emissions of parents are allocated to the subsidiaries. So we don't do it downstream. We do it only going up because that's also in line with the risk logic. So if you have a parent, which is a big energy producer from multiple energy streams like coal, gas, wind etc, that has very high emissions and they have a subsidiary which is solely into solar and a client of us has invested in both and we model separately for this solar company, then they will see that their emissions from this one are much lower as compared to their emissions for investment in the parent." (ProviderCo observation, 31/05/2021)*

Applying this rationale to establishing assets' emissions relations not only shows that the translational effort here is an active one that requires judgement, it also demonstrates the deeply embedded risk perspective in the relational nature of financial portfolios. Steve makes sure in this example that the team has understood correctly the previous translation of the ownership and sub-sector relationships that 'educed' the financed emissions relationship between the different types of subsidiaries and their parent.

With the process of data curation, the portfolio's asset positions are 'mapped', i.e., their properties such as investment share transported into the universe's assets emissions, which starts to make visible the gained quality of financed emissions as circulating references. The

reduction of the client portfolio assets involved here leaves the client's portfolio relationships intact in the sense that the assets' investment weight, i.e., the share of a specific asset in relation to the rest of the portfolio assets, as their most central relational property are re-applied upon delivery of portfolio emissions. The translational process of data curation recreates the asset combination of a financial portfolio, attaches the assets to the universes' assets financed emissions numbers and then assigns the client's specific portfolio assets weightings to those numbers, establishing an integrated and stable relationship between the portfolio and the universe.

Once delivered, the client portfolio has been expressed through the provider universe's financed emissions. Self-referentiality of the universe has not only been maintained throughout the process of data curation but also extended into the client portfolio in form of relationally stable portfolio emissions – an inscription on which especially TCFD-inspired frameworks chiefly depend. In the process of data interrogation, finally, this self-referentiality gets further reinforced, strengthening financed emissions as circulating references between provider universe and client portfolios. The circulating quality of such inscriptions is realised by the traceability of translations along the chain, to 'travel back and forth' the transformations (Latour, 1999; Mouritsen, 2018) that inscriptions went through from remote places towards a centre of calculation that is the provider's universe.

Financial institutions, once they received their portfolio emissions, often monitor emissions performances of assets over time, do sensibility checks on numerical differences between assets and sectors, or compare provider numbers with those reported by assets. Based in these instances of trying to trace back translational activities of providers, they tend to run into what looks like 'interruptions' in the translational chains, gaps between different transformational states that they cannot explain, which question the 'truth-value' of references that otherwise enables them to circulate, i.e., to be used as a financial reference of emissions. Such an instance is illustrated in the following excerpt from our field notes from research at InsureCo, a large insurer and institutional investor, who tend to inspect their portfolio emissions in detail:

> *Joshua, an analyst in InsureCo's risk team, tells us about a recent case of a water company whose emissions appeared to be grossly inflated: "[Lisa] noted that the carbon intensity score was really high for Q1 compared to 2020. […] she found out that there's a [water] company where [our provider] had reclassified the parent of [that company],*

and so because they had reclassified the parent, it had moved from the old parent, which was a reported score, to a new parent, which was an estimated score. So, it had gone the other way in terms of the way you'd want it to go [i.e., emissions number rose]. And so, the estimate was way higher than the reported score and that was [the reason for the high Q1 numbers]." (Joshua interview, 03/06/2021). In another meeting, Patrick explains how they discussed the problem with their data provider: "They provide an estimate for [the water company], which is extremely high. And we pointed out that, if you actually look at what [the company] said publicly, that carbon intensity score, it's not necessarily valid. And again, we told them that but whether or not they want to take that figure or not, is another question. We do talk to [the provider], but it is down to them to actually change scores." (InsureCo observations, 23/11/2021)

Although Joshua and his colleagues suspect a corrupted element in the translational chains of their provider, in this case InsureCo's provider later highlighted that such translational decisions ensured internal consistency within their universe and that in this case estimating the emissions of the parent company was the most diligent way to represent InsureCo's financed emissions due to the ambiguous changes and reporting of the water company. While clients can, and sometimes do, engage in this tracing exercises, they are aware of the issue of consistency between assets' emissions relations and tend to play the management of stability back to the provider, which points to providers' epistemic power as the central producers of financed emissions.

Although InsureCo uses a different provider than ProviderCo, we have observed many such instances in the process of data interrogation internally at ProviderCo. Crucial to the integrity of universe stability is the maintenance of its self-referentiality, which is reinforced in such acts of tracing-back the transformations that produced financed emissions inscriptions by revisiting and sometimes reworking but mostly reassuring past translational activities. Client requests occur very frequently at providers and often they can be solved by the more client-facing teams, for instance whether data for specific companies has been estimated or not. More complicated requests, often brought up by more sophisticated clients, are channelled to the research team directly for deeper investigation, as shown in the following excerpt from our field notes:

One of ProviderCo's clients has noticed that ten companies in their portfolio had large changes in carbon footprints between the data feeds received in November 2020 and

the one received in May 2021. The client suspects the reason to be either changes in the estimation models or from changing from estimated to reported emissions. Steve chooses one of the positions, a steel company, which had a negative jump in emissions. He looks up the company page in CarbonBase and finds that, indeed, this company's emissions had been estimated the previous year before they started reporting emissions the following year. "The easy answer is that the company was approximated last year based on an iron ore mining company [sector categorisation] and this year it's reporting", says Steve. The model should have reached at least a 'ballpark' number in the range of reported emissions. The suspicion is that the problem might lie with the sub-sector classification of the asset. Steve pulls up the company's Scope 1 and 2 emissions page for 2019 in CarbonBase, from where he opens the attached CSR report. In that year, they had categorized the company as an iron ore mining company. The team now goes into an elaborate search about what the company actually does. They conclude that, indeed, the company is into mining, so the only remaining explanation for the big difference can lie within the reported numbers. The team digs deeper into the annual and CSR reports from this year. In the end, the decision is made that the reported emissions of this company are not to be fully trusted, and so the team changes the reported emissions to model estimates and relay the answer and solution back to the client. (ProviderCo observation, 02/06/2021)

The reiteration of translational practices reassures the transformations of assets emissions accounts into financed emissions relations of the provider universe, or in other words, the tracing-back reinforces these relationships' stability, their quality as circulating references, and thereby the integrity of the entire financed emissions universe. Very rarely are assets, i.e., companies, contacted directly to trace back translational chains prior to providers' translational activities, and those instances we observed did not lead to substantial reworking of universe inscriptions.

This does not mean that we suggest that the chains of translations work only from corporate emissions accounts to financed emissions translations and inscriptions – they can be traced backwards. But the 'immutability' of circulating references here, i.e., financed emissions inscriptions as 'valid' references for financial portfolios, is the relationality of assets' emissions that lets them become meaningful within the relational nature of portfolios. It is, therefore, the consistency and stability of such relationships that is important, which means that the

reference towards portfolio requirements seems higher than those towards the distant points of physical GHG emissions. The contingency of this high level of self-referentiality shows the horizon of financed emissions 'circularity', since emissions have been made mobile as financial references primarily between providers' proto-portfolios and clients' financial portfolios, which are contained in, dependent on and contribute to the stability of providers' financed emissions universes as the central location in which financed emissions are created and exist.

Discussion

Financed emissions as an expression of asset emissions relationships have provoked an expanding network of interacting actors, devices, interests and dynamics. The nature of financed emissions, the assemblages they are created through, and the form they take embody a growing perpetuation of financial practices and logics attaching to and increasingly shaping climate-related matters of concern. Financial and market dynamics imbued in a thus attempted management of the Anthropocene condition via accounting practices and inscriptions carry a range of consequences for and beyond finance and the climate. In the following, we discuss a number of interrelated implications that can be drawn from our specific conceptual framing and our research findings.

Matters of concern in financed emissions accounting: portfolio relationality and provider market affordances

As we have argued in the conceptual section, TCFD-like climate-related disclosure as the main driver behind financed emissions accounting shifts 'matters of concern' in finance's interaction with climate aspects from environmental to financial impact by eliciting concerns for financial stability from asset emissions located in financial institutions' portfolios. As we have shown, for asset emissions to become meaningful references within a portfolio, their relational qualities to other asset emissions need to be constructed, through which financed emissions can be created. Understanding carbon accounting as long and complex chains of translations helps keeping track of how physical atmospheric molecules are being connected with their sources and, in the case of financed emissions accounting, with the financial enablers of such emitting sources. Throughout these chains, practices, devices and infrastructures of calculation and commensuration are brought together as results of negotiations and intersections of various

interests, goals and affordances as matters of concern, which determine the very nature of accounting inscriptions of GHG emissions.

While on the corporate emissions accounting side, for instance, the very concept of emissions scopes and boundary setting was the outcome of negotiations of a diverse set of interests, arguably leading to a trimmed horizon of assignable responsibility for corporate emissions (Walenta, 2021), we have shown how interest and affordances in financed emissions accounting are rooted in the very practical, material and conceptual conditions of data providers' translational activities. On the one hand, the relational form of financial portfolios requires practices of reduction and amplification to create financed emissions as the relationships between asset emissions so that they can be comparable references within specific portfolios' asset relationships. On the other hand, data providers' competitive positions in the market for financed emissions accounting and the wider market for sustainability information affords these relationships to be constructed in provider-specific financed emissions universes, whose self-referential character enables the stability that these relationships require to become circulating references.

These specific emissions associations are, thus, the outcome of an assemblage driven by *matters of concern* around *portfolio relationality* and *provider market affordances*, and lead to financed emissions as stable references which, however, in order to remain stable, circulate primarily within the confines of providers' universes. Tracing back or 'revisiting' actual sites of emissions, be it through more direct contact with companies or further understanding their emissions processes to act towards organisational change and environmental impact, is not the concern here. Instead, it is the financial impact that is meant to be 'educed' in form of financed emissions for which arrangements need to concern the stability of emissions relationships so that they can work as references enabling financial institutions to apply portfolio management activities. These pertain primarily to (a) monitoring of asset and portfolio emissions, (b) aggregating asset emissions to portfolio level for disclosure,[6] and (c) setting internal caps for portfolio emissions thresholds (akin to generic portfolio risk management practices).

[6] Financial institutions' disclosures are, of course, used as the result of another translational chain, which outputs aggregated portfolio emissions. These are mobilised references used to e.g., scrutinise financial institutions' climate-related positions and performance. But for acting at a distance through these financed emissions back in the chain of translations to emitting companies runs into the same issue of self-referential provider references and universes.

Whilst in principle such portfolio emissions management could enable pricing climate risks into the (re)valuation of assets, thereby encouraging divestment from high-emitting assets or sectors and increasing investments in low-emitting assets or sectors, in practice it appears that emissions have not yet reached a market signal strength necessary to move markets on a broader scale. For example, valuation of assets based on emissions aspects has so far a mixed track record and has not shown sufficient effects on company behaviour (Eren et al., 2022). Divestment, although shown to be an effective tool if applied at market scale (c.f., Cojoianu et al., 2021; Ding et al., 2020), is widely regarded by mainstream financial institutions as undesirable (Heeb et al., 2023).

If emissions would become a market signal strong enough to move markets on a broader scale, it is reasonable to assume that financed emissions could develop a more structural effect. However, we suggest that solely requiring companies to disclose emissions and financial institutions to account for their financed emissions is not enough, but most probably still ultimately depends on the introduction of regulatory emissions- or climate risk-related capital requirements. In this sense, the rather depoliticising attempts of climate integration through TCFD-like disclosure programmes, e.g., as initially envisioned by Mark Carney (Carney, 2015), seems misguided in the task of tackling an Anthropocene condition that is ultimately political (Latour, 2018; Opitz, 2016) and not simply a technocratic question of neutral market mechanics (Christophers, 2017, 2022; Gabor, 2021).

Circumvention of the heuristic feature of environmental accounting

If financed emissions accounting on its own is not effective for climate-risk based (re)valuation of assets or outright exclusions via direct divestment, the question is whether it could potentially support other strategies that financial institutions have at their disposal in the climate context, such as investments in co-called climate solutions and direct climate-related engagement with investee companies (NZAOA, 2023). For climate solutions, e.g., new or transitioning companies offering services or products that replace high emitting activities with lower emitting ones, financed emissions in the current stage are of relatively low value since they are more concerned with past and present emissions rather than future ones. Due to the high level of assumptions around technological, market and use factors, climate solutions especially with regards to emissions require very contextual and individual perspectives that do not lend themselves to high degrees of commensuration and comparability present in financed

emissions. Here, concepts around 'avoided emissions' and transition plans are potentially of more help, although they come with their own set of caveats, as we will discuss with respect to sustainability information market dynamics further down. More fundamentally, in an accelerating ecological crisis, future emissions reductions through climate solutions that require a longer onset are helpful but not sufficiently immediate to alleviate at least some of the detrimental effects that are increasingly materialising now and in the very near future. The 'management' of the Anthropocene condition requires interventions in the present.

The so far adamantly preferred strategy for such acting at a distance by financial actors is the engagement of investee companies to reduce emissions (and other environmentally and socially harmful activities) (Marti et al., 2023). For this form of acting at a distance, financial institutions need a good contextual understanding of the company's current sources of emissions and its potential strategies for reducing them. Here, the messiness and ambiguities of company emissions accounts could be productive to generate understanding and dialogue. Bebbington and Larrinaga, for example, note the necessarily incomplete nature of knowledge around the 'natural system'; the "inherent contestability and multiple framings of the 'social', as an object of knowledge"; and the multiple ways in which 'externalities' can be defined (2014: 399, 406). As an inherent element in accounting, ambiguity can yield constructive properties (Power, 1995), because it leaves some necessary room for interpretation, problematising and evolving understanding. The discursive nature of creating accounting inscriptions can be understood as located in the gap between reduction and amplification that translational acts bridge to arrive at an inscription. What is lost and gained in translation, as shown in our findings, is subject to decisions and networked interactions, and thus in principle always contestable. But rather than a constraint to accessing reality, it should be perceived as a productive feature, or as Bebbington and Larrinaga put it: "contestability of an account is not a limitation. Rather, it is a reality with which any account must work." (Bebbington and Larrinaga, 2014: 406).

Assets' emissions can, thus, be a fruitful source of productive ambiguity, for instance in the numerous investigations of NGOs, think tanks and activists scrutinising (often high emitting) companies through their published emissions accounts. However, financed emissions, as we have shown, are constructed to do the very opposite: inscriptions reflecting stable, coherent, and consistent relationships; or in other words, the reduction of ambiguous features of corporate emissions accounts enables the amplification of stabilised relationality of financed emissions required for portfolio treatment. The necessary deeper, situated and contextual

understanding of an assets' emissions and, thus, options for their reductions cannot be provided by financed emissions. Acting at a distance through the ownership relationships of investors (but also structurally important through the availability of loans and insurance covers) that are meant to provide the necessary influence on assets' potential change and 'transition', is circumvented in the case of financed emissions. The referential quality is that of a stable relationality between assets within providers' universes within which they can circulate and tracing back translations is limited within these confines. Of course, this does not mean that tracing back translations beyond these confines is impossible,[7] but the value add that providers deliver is the very outsourcing of this tracing and the subsequent reduction of ambiguities that could have yielded more heuristic properties in the interaction between financial institutions and their assets through the assets' emissions accounts.

Data providers as central intermediaries/centres of calculation

The starting point of our paper was that the topography of actants and actors in financed emissions accounting was lacking one crucial locus of investigation: emissions data providers. Our paper hones in on the crucial role that data providers play in the chains of translations of carbon accounting and how they constitute important centres of calculation for financed emissions. Whether anticipated or not, TCFD-like disclosure programmes have instigated a rapidly growing and already vast and highly competitive market space for sustainability and environmental information, whose evolving market dynamics and affordances participate in the social, political and material interactions and negotiations of finance's climate-related matters of concern. Acknowledging the positions and roles that such providers are assigned, take on, and themselves create is important for understanding the complex phenomenon of 'green finance' and its issues.

By investigating the translational work of providers, an often-debated issue in this field – the issue of the black boxed nature of emissions models – appears differently than previously thought. Financial institutions, and by extension also regulatory perspectives, tend to be passionately critical and sceptical of providers' emissions estimation models. Despite universe-internal back-tracing processes and attempts to provide some transparency to clients, the

[7] For example, the investor coalition Climate Action 100+ targets specific sets of companies and does os in part based on their reported emissions – although they make often use of the investigative reports by NGOs and activists mentioned above.

perception of such models as black boxes reinforces the general position of key actors like TCFD, PCAF or the Net Zero Asset Owners Alliance of preferring reported emissions over estimated ones. Although providers, in principle but also to appease clients, argue similarly, we have shown that the high degree of self-referentiality required to create emissions universes so that clients' portfolio assets' emissions properly relate to one another, relies fundamentally on deeply integrated models and their estimates due to their centrality in keeping emissions relationships stable.

The increasing epistemic power position of providers is, thus, not a result of simply intellectual property claims, as often alleged. The issue does not lie primarily with the black-box character of the model 'at the surface' of the discourse. Rather, it lies at the centre of the entire market-based programme of the financial impact perspective as a result of the portfolio requirement of relationality in tandem with the scalability requirements of the financed emissions and wider sustainability information industry.

Another important aspect is that the market-shaped character of this emerging accounting landscape is further exacerbated by increasing regulation around reporting and integration of such information into financial decision making. Driving up fierce competition in the provider market and the need for more scalability, we observed at several providers restructuring efforts to disintegrate the four production processes of financed emissions. For instance, the process of data collection at ProviderCo is now being integrated into a centralised department for general data collection on all datapoints the company gathers, which goes far beyond emissions. Analysts here, located separately in jurisdictions with lower income costs, are generalists (not emissions accountants) and strictly follow data collection guidelines and scripts as well as automated reference points such as the universe-dependent trust metric and estimation model benchmarks. Analytics delivery and consulting teams take over data curation, separate customer services teams take over the majority of the process of data interrogation, while data modelling remains the remit of the original climate team. The latter is, at other providers, often more and more complemented with AI technologies. The increasing mechanisation and compartmentalisation are likely to lead to forms of internal black-boxing around translational practice and processes as well as an increased self-referential lock-in of financed emissions' referential horizon.

Financed emissions accounting as templates for other environmental matters

Against this backdrop, the general landscape of sustainable finance keeps evolving and expanding within and beyond the climate contexts. Across the field, data providers become more prevalent while reporting programmes and regulation take more aim at financial practices and structures. Here, the basic structures and affordances of financed emissions production seem to serve as templates for other inscriptions. In the political and markets arenas as well as in academic discourse, providers have been primarily looked at for their role and work around ESG or sustainability ratings. Our study, however, shows that their role is much more fundamental by providing what is often understood as 'raw data' but what constitutes a highly interventional chain of translations creating sustainability-related information for financial markets. Within the climate theme, information collection, production and provision are being structured similarly, for instance, with regards to the more forward-looking assessment of companies' net zero commitments, targets, and transition plans. At ProviderCo we followed closely a newly compiled team of analysts translating net zero commitment and target information of assets to extend CarbonBase with a new dimension of data points, while triangulation interviews showed similar efforts were underway at other providers, too.

Here, the heuristic function of translational work for acting at a distance, discussed above, seems even more crucial than for that of past and present financed emissions. This is because the level of ambiguity, uncertainty and contextuality of imagined future changes to business models, production processes and technologies, and their projected effects on emissions and other environmental performances are much higher. The juxtaposition of efforts necessary to interact with and translational scrutiny needed to deal with this ambiguity could yield promising didactic potential for transition interventions by financial investors and services. Yet, the translational work starts to be taken on by data providers, who are integrating in and thus extending out the size and substance of their universes with such assessments. Catering, again, to the portfolio form, assets' climate targets have to adhere to relational stability achieved by the maintenance of self-referential dynamics of provider universes. Although still at an early stage since regulation around targets and especially transition plans are only starting to be introduced, the integration of such 'data points' translated out of target and transition plan information by providers is already very much in use – and their relational stability imbued

– in commercial devices such as Implied Temperature Rise metrics or Climate Value at Risk models.

A potentially more important point goes beyond financed emissions themselves and pertains the (infra)structures of translational work that act as a template for other inscriptions in the realm of environmental accounting. The climate integration through TCFD-like frameworks is seen as spearheading other sustainability aspects such as biodiversity, water and social climate justice issues. This active embedding of other Anthropocene aspects into the workings of financial practices, such as the Taskforce on Nature related Financial Disclosures (TNFD), may well follow similar market-based structures not only with regards to the causal chains constructed in visions of reporting-based financial interventions in the name of financial stability, but also regarding the underlying market-based structures for the provision of environmental accounting inscriptions necessary to mobilise them. The networks of translations for financed emissions is but one element in the wider assemblage that is 'green finance' but as the most developed (albeit still evolving) component, it will, like TCFD in general, have a formative effect towards other aspects, their integration, and how finance knows and acts on them.

Conclusion

This brings us back to the role of accounting in the Anthropocene. Contributing to the perspective of accounting as one of many active and interactional parts of Earth System dynamics, we argue that TCFD-like programmes should be understood as an activ(ated) component in the 'anthroposphere' that is supposed to help manage its interactions with other planetary systems. While such accounting programmes' interactional potential and effects will have to be evaluated as we proceed further into unchartered territory of Earth System developments, analysing financed emissions accounting as one of these programmes' central elements can provide a first attempt for a better understanding of their workings and issues.

By positioning the financial sector as a transmission channel for emissions reduction efforts via shifting attention from environmental impact towards financial impact, the extension of the causal chain for interventional change in the real economy attempts to ingest financial portfolios as finance's axis of financial practices and influence. To supply financial actors with

knowledge of their assets' climate profiles, GHG emissions enter financial portfolios in the particular, relational form of financed emissions to enable portfolio management practices to recognise asset emissions. As we have argued, the current forms of management (monitoring, disclosing, and capping) offer little potential for transmitting – or acting at a distance for – the immediate changes necessary to reduce emissions in economic processes. While the general influence and efficacy of portfolio management towards the assets managed by them is an important question in this context (Chenet et al., 2021; Christophers, 2017), we have focused rather on the nature of financed emissions and found that due to their specific translational transformations and their self-referential locus in providers' emissions universes, they provide at the moment not the qualities that would enable the forms of 'acting at a distance' required to affect assets' emissions performance and, thus, manage critical elements in the Anthropocene's widening ecological crisis.

Financed emissions accounting and its inscriptions in their present form rather seem to be distracting activities and direct resources towards stability of portfolio emissions relationships and commensuration and away from acting at a distance on contextual and situated climate aspects of assets. Although not invalidating claims of occasional purposeful distraction of financial climate-related action, our findings point more to the underlying characteristics of the assemblages that produce the inscriptions that seem to distract more direct action. Mandates of TCFD-like programmes, through risk notions and an amplification of financial climate impact, have instigated matters of concern around financial stability and portfolio management, which has prompted a rapidly expanding market for financed emissions and other environmental information. With matters of concern being reinforced in between these dynamics, concerns around environmental impact and more immediate actions that could be taken in the present seem to be crowded out or delayed.

As components in the Anthropocene, translational networks of environmental accounting bear effects, be it in form of action or inaction towards organisational changes, and thus affect the interactional conditions of Earth System dynamics one way or another. But matters of concern as the loci of shaping how such networks can work are not set in stone. The TCFD framework has by now been moved into the remits of the ISSB which transforms its accounting programme into the wider guidelines of accounting practices. While currently excluding this concept, 'double materiality', i.e., considering both financial and environmental

impact, could move current concerns out of a rather isolated portfolio perspective of financed emissions and instigate needs for 'tracing back' emissions translations beyond provider universe boundaries, thus enabling a more heuristic character of finance's interaction with carbon accounts and assets.

In general, escaping the self-referential confines of portfolio perspectives and the fixation on overly stable and unambiguous accounting inscriptions as well as the information market dynamics they instil, environmental accounting in a different form could yield more discourse and contextual influence over real economy organisations, processes, and performance, and thus may reinforce concerns more immediately attending to much needed changes in the 'anthroposphere' of the Earth System.

References

Adams CA, Alhamood A, He X, et al. (2021) The double-materiality concept: application and issues. Amsterdam: Global Reporting Initiative. Available at: https://www.globalreporting.org/media/jrbntbyv/griwhitepaper-publications.pdf.

Alexander K and Fisher PG (2020) Central Banking and Climate Change. In: Fisher PG (ed.) Making the Financial System Sustainable. Cambridge: Cambridge University Press, pp. 49–74.

Ameli N, Drummond P, Bisaro A, et al. (2020) Climate finance and disclosure for institutional investors: why transparency is not enough. Climatic Change 160(4): 565–589.

Ameli N, Kothari S and Grubb M (2021) Misplaced expectations from climate disclosure initiatives. Nature Climate Change 11(11): 917–924.

Andrew J and Baker M (2020) Corporate Social Responsibility Reporting: The Last 40 Years and a Path to Sharing Future Insights. Abacus 56(1): 35–65.

Arjaliès D-L, Grant P, Hardie I, et al. (2017) Chains of Finance: How Investment Management Is Shaped. Oxford: Oxford University Press.

Ascui F and Lovell H (2011) As frames collide: making sense of carbon accounting. Accounting, Auditing & Accountability Journal J. Milne M and Grubnic S (eds) 24(8). Emerald Group Publishing Limited: 978–999.

Baboukardos D (2017) Market valuation of greenhouse gas emissions under a mandatory reporting regime: Evidence from the UK. Accounting Forum 41(3): 221–233.

Bebbington J and Larrinaga C (2014) Accounting and sustainable development: An exploration. Accounting, Organizations and Society 39(6): 395–413.

Bebbington J and Larrinaga-González C (2008) Carbon Trading: Accounting and Reporting Issues. European Accounting Review 17(4). Routledge: 697–717.

Bebbington J and Rubin A (2022) Accounting in the Anthropocene: A roadmap for stewardship. Accounting and Business Research 52(5). Routledge: 582–596.

Bebbington J, Österblom H, Crona B, et al. (2020) Accounting and accountability in the Anthropocene. Accounting auditing & accountability journal 33(1). Bradford: Emerald Publishing Limited: 152–177.

Bebbington J, Larrinaga C, O'Dwyer B, et al. (eds) (2021) Routledge Handbook of Environmental Accounting. Milton Park, Abingdon, Oxon: Routledge.

Berg F, Oliver Huidobro J and Rigobon R (2024) On the Importance of Assurance in Carbon Accounting. 4734240, SSRN Scholarly Paper. Rochester, NY. Available at: https://papers.ssrn.com/abstract=4734240 (accessed 13 March 2024).

Besedovsky N (2018) Financialization as calculative practice: the rise of structured finance and the cultural and calculative transformation of credit rating agencies. Socio-Economic Review 16(1): 61–84.

Beunza D and Garud R (2007) Calculators, Lemmings or Frame-Makers? The Intermediary Role of Securities Analysts. The Sociological Review 55(2): 13–39.

Bowen F and Wittneben B (2011) Carbon accounting: Negotiating accuracy, consistency and certainty across organisational fields. Accounting, Auditing & Accountability Journal J. Milne M and Grubnic S (eds) 24(8). Emerald Group Publishing Limited: 1022–1036.

Burchell S, Clubb C, Hopwood A, et al. (1980) The roles of accounting in organizations and society. Accounting, Organizations and Society 5(1): 5–27.

Burchell S, Clubb C and Hopwood AG (1985) Accounting in its social context: Towards a history of value added in the United Kingdom. Accounting, Organizations and Society 10(4): 381–413.

Callon M (1984) Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St Brieuc Bay. The Sociological Review 32(1_suppl). SAGE Publications Ltd: 196–233.

Callon M (2009) Civilizing markets: Carbon trading between in vitro and in vivo experiments. Accounting, Organizations and Society 34(3–4): 535–548.

Carney M (2015) Breaking the tragedy of the horizon – climate change and financial stability. Speech. London. Available at: https://www.bis.org/review/r151009a.pdf (accessed 1 March 2017).

Carruthers BG (2013) From uncertainty toward risk: the case of credit ratings. Socio-Economic Review 11(3): 525–551.

CDP (2023) Only 5% of global emissions are covered by on-track targets, new Tracker from CDP finds. Available at: https://www.cdp.net/en/articles/media/only-5-of-global-emissions-are-covered-by-on-track-targets-new-tracker-from-cdp-finds (accessed 28 February 2024).

Chapple L, Clarkson PM and Gold DL (2013) The Cost of Carbon: Capital Market Effects of the Proposed Emission Trading Scheme (ETS). Abacus 49(1): 1–33.

Charnock R, Brander M and Schneider T (2021) Carbon. In: Bebbington J, Larrinaga C, O'Dwyer B, et al. (eds) Routledge Handbook of Environmental Accounting. Milton Park, Abingdon, Oxon: Routledge, pp. 353–364.

Chenet H, Ryan-Collins J and Van Lerven F (2021) Finance, climate-change and radical uncertainty: Towards a precautionary approach to financial policy. Ecological Economics 183: 106957.

Christophers B (2017) Climate Change and Financial Instability: Risk Disclosure and the Problematics of Neoliberal Governance. Annals of the American Association of Geographers 107(5). Taylor & Francis: 1108–1127.

Christophers B (2022) Fossilised Capital: Price and Profit in the Energy Transition. New Political Economy 27(1). Routledge: 146–159.

Clarkson PM, Li Y, Pinnuck M, et al. (2015) The Valuation Relevance of Greenhouse Gas Emissions under the European Union Carbon Emissions Trading Scheme. European Accounting Review 24(3). Routledge: 551–580.

Cojoianu TF, Ascui F, Clark GL, et al. (2021) Does the fossil fuel divestment movement impact new oil and gas fundraising? Journal of Economic Geography 21(1): 141–164.

Cooper S and Pearce G (2011) Climate change performance measurement, control and accountability in English local authority areas. Accounting, Auditing & Accountability Journal J. Milne M and Grubnic S (eds) 24(8). Emerald Group Publishing Limited: 1097–1118.

Corvellec H, Ek R, Zapata P, et al. (2018) Acting on distances: A topology of accounting inscriptions. Accounting, Organizations and Society 67: 56–65.

Crutzen P and Stoermer E (2000) The 'Anthropocene'. International Geosphere-Biosphere Programme (IGBP) Newsletter (41). Global Change Newsletter: 17–18.

de Aguiar TRS and Bebbington J (2021) Financial accounting and the natural environment. In: Bebbington J, Larrinaga C, O'Dwyer B, et al. (eds) Routledge Handbook of Environmental Accounting. Milton Park, Abingdon, Oxon: Routledge, pp. 95–107.

Dibley B (2012) 'The shape of things to come': Seven theses on the Anthropocene and attachment. Australian Humanities Review (52). Epub ahead of print 2012.

Ding N, Parwada JT, Shen J, et al. (2020) When Does a Stock Boycott Work? Evidence from a Clinical Study of the Sudan Divestment Campaign. Journal of Business Ethics 163(3): 507–527.

Downar B, Ernstberger J, Reichelstein S, et al. (2021) The impact of carbon disclosure mandates on emissions and financial operating performance. Review of Accounting Studies 26(3): 1137–1175.

Eccles RG, Serafeim G and Krzus MP (2011) Market Interest in Nonfinancial Information. Journal of Applied Corporate Finance 23(4): 113–127.

Edwards PN (2010) A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming. Cambridge, Mass: MIT Press.

Edwards PN (2017) Knowledge infrastructures for the Anthropocene. The Anthropocene Review 4(1): 34–43.

Ellis E, Maslin M, Boivin N, et al. (2016) Involve social scientists in defining the Anthropocene. Nature 540(7632): 192–193.

Eren E, Merten F and Verhoeven N (2022) Pricing of climate risks in financial markets: a summary of the literature. BIS Papers (130). Epub ahead of print 9 December 2022.

Fichtner J, Jaspert R and Petry J (2023) Mind the ESG Gaps Transmission Mechanisms and the Governance of and by Sustainable Finance. Copenhagen: DIIS - Danish Institute for International Studies.

Gabor D (2021) The Wall Street Consensus. Development and Change 52(3): 429–459.

Georg S and Justesen L (2017) Counting to zero: accounting for a green building. Accounting, Auditing & Accountability Journal 30(5). Emerald Publishing Limited: 1065–1081.

Gray R, Owen D and Maunders K (1988) Corporate Social Reporting: Emerging Trends in Accountability and the Social Contract. Accounting, Auditing & Accountability Journal 1(1). MCB UP Ltd: 6–20.

Gray R, Walters D, Bebbington J, et al. (1995) The Greening of Enterprise: An Exploration of the (NON) Role of Environmental Accounting and Environmental Accountants in Organizational Change. Critical Perspectives on Accounting 6(3): 211–239.

Gray RH (1990) The Greening of Accountancy: The Profession after Pearce. Certified research report / Chartered Association of Certified Accountants 17. London: Certified Accountants Publications.

Griffin PA, Lont DH and Sun EY (2017) The Relevance to Investors of Greenhouse Gas Emission Disclosures. Contemporary Accounting Research 34(2): 1265–1297.

Haque S, Deegan C and Inglis R (2016) Demand for, and impediments to, the disclosure of information about climate change-related corporate governance practices. Accounting and Business Research 46(6). Routledge: 620–664.

Harris L (2023) Rise of the Climate Rating Agencies. The American Prospect, 12 April. Available at: https://prospect.org/api/content/6015e258-d87d-11ed-bd1d-12163087a831/ (accessed 14 April 2023).

Haslam C, Butlin J, Andersson T, et al. (2014) Accounting for carbon and reframing disclosure: A business model approach. Accounting Forum 38(3). Routledge: 200–211.

He R, Luo L, Shamsuddin A, et al. (2022) Corporate carbon accounting: a literature review of carbon accounting research from the Kyoto Protocol to the Paris Agreement. Accounting & Finance 62(1): 261–298.

Heeb F, Kölbel JF, Paetzold F, et al. (2023) Do Investors Care about Impact? The Review of Financial Studies Ramadorai T (ed.) 36(5): 1737–1787.

Hopwood AG (2009) Accounting and the environment. Accounting, Organizations and Society 34(3): 433–439.

Jarzabkowski P, Bednarek R and Cabantous L (2015) Conducting global team-based ethnography: Methodological challenges and practical methods. Human Relations 68(1). SAGE Publications Ltd: 3–33.

Justesen L and Mouritsen J (2011) Effects of actor-network theory in accounting research. Accounting, Auditing & Accountability Journal Richard Baker C and Chiapello E (eds) 24(2). Emerald Group Publishing Limited: 161–193.

Klaaßen L and Stoll C (2021) Harmonizing corporate carbon footprints. Nature Communications 12(1). 1. Nature Publishing Group: 6149.

Knorr-Cetina K and Preda A (eds) (2012) The Oxford Handbook of the Sociology of Finance. First Edition. Oxford: OXFORD UNIVERSITY PRESS.

Lade SJ, Steffen W, de Vries W, et al. (2020) Human impacts on planetary boundaries amplified by Earth system interactions. Nature Sustainability 3(2). 2. Nature Publishing Group: 119–128.

Langley A (1999) Strategies for Theorizing from Process Data. Academy of Management Review 24(4). Academy of Management: 691–710.

Latour B (1999) Pandora's Hope: Essays on the Reality of Science Studies. Cambridge, Mass.: Harvard University Press.

Latour B (2004) Why Has Critique Run out of Steam? From Matters of Fact to Matters of Concern. Critical Inquiry 30(2). The University of Chicago Press: 225–248.

Latour B (2008) What Is the Style of Matters of Concern? Two Lectures in Empirical Philosophy. Spinoza lectures. Assen: Van Gorcum.

Latour B (2013) An Inquiry into Modes of Existence: An Anthropology of the Moderns. Cambridge, Mass. ; Harvard University Press.

Latour B (2014) Agency at the Time of the Anthropocene. New Literary History 45(1): 1-18,153.

Latour B (2017) Facing Gaia: Eight Lectures on the New Climatic Regime (tran. C Porter). Cambridge, UK ; Medford, MA: Polity.

Latour B (2018) Down to Earth: Politics in the New Climatic Regime. English edition. Cambridge, UK ; Medford, MA: Polity.

Latour B, Jensen P, Venturini T, et al. (2012) 'The whole is always smaller than its parts' – a digital test of Gabriel Tardes' monads. The British Journal of Sociology 63(4): 590–615.

Latour Bruno (2005) Reassembling the Social: An Introduction to Actor-Network-Theory. Clarendon lectures in management studies. Oxford: Oxford University Press.

Laughlin RC (1991) Environmental Disturbances and Organizational Transitions and Transformations: Some Alternative Models. Organization Studies 12(2). SAGE Publications Ltd: 209–232.

Lodhia S and Martin N (2012) Stakeholder responses to the National Greenhouse and Energy Reporting Act: An agenda setting perspective. Accounting, Auditing & Accountability Journal 25(1). Emerald Group Publishing Limited: 126–145.

Lohmann L (2009) Toward a different debate in environmental accounting: The cases of carbon and cost–benefit. Accounting, Organizations and Society 34(3): 499–534.

Lorimer J (2017) The Anthropo-scene: A guide for the perplexed. Social Studies of Science 47(1): 117–142.

Lovell H, Bebbington J, Larrinaga C, et al. (2013) Putting Carbon Markets into Practice: A Case Study of Financial Accounting in Europe. Environment and Planning C: Government and Policy 31(4). SAGE Publications Ltd STM: 741–757.

MacKenzie D (2006) An Engine, Not a Camera: How Financial Models Shape Markets. Inside technology. Cambridge, Mass. ; London: MIT Press.

MacKenzie D (2009) Making things the same: Gases, emission rights and the politics of carbon markets. Accounting, Organizations and Society 34(3): 440–455.

Marcus GE (1995) Ethnography in/of the World System: The Emergence of Multi-Sited Ethnography. Annual Review of Anthropology 24. Annual Reviews: 95–117.

Marti E, Fuchs M, DesJardine MR, et al. (2023) The Impact of Sustainable Investing: A Multidisciplinary Review. Journal of Management Studies: joms.12957.

Matsumura EM, Prakash R and Vera-Muñoz SC (2013) Firm-Value Effects of Carbon Emissions and Carbon Disclosures. The Accounting Review 89(2): 695–724.

Michelon G (2021) Financial markets and environmental information. In: Bebbington J, Larrinaga C, O'Dwyer B, et al. (eds) Routledge Handbook of Environmental Accounting. Milton Park, Abingdon, Oxon: Routledge, pp. 165–178.

Miles MB and Huberman AM (1994) Qualitative Data Analysis: An Expanded Sourcebook. SAGE.

Millo Y and MacKenzie D (2009) The usefulness of inaccurate models: Towards an understanding of the emergence of financial risk management. Accounting, Organizations and Society 34(5): 638–653.

Milne MJ and Grubnic S (2011) Climate change accounting research: keeping it interesting and different. Accounting, Auditing & Accountability Journal J. Milne M and Grubnic S (eds) 24(8). Emerald Group Publishing Limited: 948–977.

Mouritsen J (2018) From Numbers to Interventions and Back: How Do Accounting Facts and Management Concerns Interact? In: Mellemvik F and Gårseth-Nesbakk L (eds) Dealing with Expectations and Traditions in Research. Nordic Open Access Scholarly Publishing.

Muniesa F (2014) The Provoked Economy Economic Reality and the Performative Turn. Culture, economy and the social. London: Routledge/Taylor and Francis..

Nicolini D (2012) Practice Theory, Work, and Organization: An Introduction. OUP Oxford.

NZAOA (2023) Increasing Climate Ambition, Decreasing Emissions. Progress Report of the Net-Zero Asset Owner Alliance 3, October. UNEP FI. Available at: https://www.unepfi.org/wordpress/wp-content/uploads/2023/10/NZAOA-Third-Progress-Report.pdf.

O'Dwyer B and Unerman J (2016) Fostering rigour in accounting for social sustainability. Accounting, Organizations and Society 49. Reflecting on 40 years of Accounting, Organizations and Society - Part II: 32–40.

O'Dwyer B and Unerman J (2020) Shifting the focus of sustainability accounting from impacts to risks and dependencies: researching the transformative potential of TCFD reporting. Accounting, Auditing & Accountability Journal 33(5). Emerald Publishing Limited: 1113–1141.

Oldfield F, Barnosky AD, Dearing J, et al. (2014) The Anthropocene Review: Its significance, implications and the rationale for a new transdisciplinary journal. The Anthropocene Review 1(1): 3–7.

Opitz S (2016) Neue Kollektivitäten: Das Kosmopolitische bei Bruno Latour und Ulrich Beck. Soziale Welt 67(3). Nomos Verlagsgesellschaft mbH: 249–266.

PCAF (2020) The Global GHG Accounting and Reporting Standard for the Financial Industry. First Edition, 18 November. Partnership for Carbon Accounting Financials. Available at: https://carbonaccountingfinancials.com/files/downloads/PCAF-Global-GHG-Standard.pdf (accessed 12 October 2021).

PCAF (2022a) Financed Eimssions. The Global GHG Accounting and Reporting Standard Part A. Second Edition. Partnership for Carbon Accounting Financials. Available at: https://carbonaccountingfinancials.com/files/downloads/PCAF-Global-GHG-Standard.pdf (accessed 16 February 2024).

PCAF (2022b) Insurance-Associated Eimssions. The Global GHG Accounting and Reporting Standard Part C. Partnership for Carbon Accounting Financials. Available at: https://carbonaccountingfinancials.com/files/downloads/pcaf-standard-part-c-insurance-associated-emissions-nov-2022.pdf (accessed 16 February 2024).

PCAF (2023) Facilitated Eimssions. The Global GHG Accounting and Reporting Standard Part B. Partnership for Carbon Accounting Financials. Available at: https://carbonaccountingfinancials.com/files/PCAF-PartB-Facilitated-Emissions-Standard-Dec2023.pdf (accessed 16 February 2024).

Plumlee M, Brown D, Hayes RM, et al. (2015) Voluntary environmental disclosure quality and firm value: Further evidence. Journal of Accounting and Public Policy 34(4): 336–361.

Power M (1995) Auditing, Expertise and the Sociology of Technique. Critical Perspectives on Accounting 6(4): 317–339.

Qian W and Schaltegger S (2017) Revisiting carbon disclosure and performance: Legitimacy and management views. The British Accounting Review 49(4): 365–379.

Reckwitz A (2002) Toward a Theory of Social Practices: A Development in Culturalist Theorizing. European Journal of Social Theory 5(2). SAGE Publications Ltd: 243–263.

Richardson K, Steffen W, Lucht W, et al. (2023) Earth beyond six of nine planetary boundaries. Science Advances 9(37). American Association for the Advancement of Science: eadh2458.

Robson K and Bottausci C (2018) The sociology of translation and accounting inscriptions: Reflections on Latour and Accounting Research. Critical Perspectives on Accounting 54: 60–75.

Rockström J, Steffen W, Noone K, et al. (2009) A safe operating space for humanity. Nature 461(7263). 7263. Nature Publishing Group: 472–475.

Ryan-Collins J (2019) Beyond voluntary disclosure: why a 'market-shaping' approach to financial regulation is needed to meet the challenge of climate change. 61, Policy Note, 21 March. SUERF. Available at: https://www.suerf.org/publications/suerf-policy-notes-and-briefs/beyond-voluntary-disclosure-why-a-market-shaping-approach-to-financial-regulation-is-needed-to-meet-the-challenge-of-climate-change/.

Schatzki TR (2012) A Primer on Practices: Theory and Research. Brill.

Sprenger F (2019) Epistemologien des Umgebens: zur Geschichte, Ökologie und Biopolitik künstlicher environments. Edition Medienwissenschaft Band 65. Bielefeld: transcript.

Steffen W, Crutzen PJ and McNeill JR (2007) The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature? Ambio; Stockholm 36(8): 614–21.

Steffen W, Leinfelder R, Zalasiewicz J, et al. (2016) Stratigraphic and Earth System approaches to defining the Anthropocene. Earth's Future 4(8): 324–345.

Täger M (2021) 'Double materiality': what is it and why does it matter? In: Grantham Research Institute on climate change and the environment. Available at: https://www.lse.ac.uk/granthaminstitute/news/double-materiality-what-is-it-and-why-does-it-matter/ (accessed 15 April 2023).

TCFD (2017) Final Report: Recommendations of the Task Force on Climate-related Financial Disclosures. Recommendations of the Task Force on Climate-related Financial Disclosures, 15 June. Basel: Task Force on Climate-related Financial Disclosures (TCFD), Financial Stability Board (FSB), Bank for International Settlement (BIS).

Toivanen T, Lummaa K, Majava A, et al. (2017) The many Anthropocenes: A transdisciplinary challenge for the Anthropocene research. The Anthropocene Review 4(3): 183–198.

Unerman J, Bebbington J and O'dwyer B (2018) Corporate reporting and accounting for externalities. Accounting and Business Research 48(5). Routledge: 497–522.

Vollmer H (2009) Management accounting as normal social science. Accounting, Organizations and Society 34(1): 141–150.

Vollmer H (2020) Public value and the planet: accounting in ecological reconstitution. Accounting, Auditing & Accountability Journal 34(7). Emerald Publishing Limited: 1527–1554.

Walenta J (2021) The making of the corporate carbon footprint: the politics behind emission scoping. Journal of Cultural Economy 14(5). Routledge: 533–548.

WBCSD and WRI (eds) (2004) The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard. Rev. ed. Geneva, Switzerland : Washington, DC: World Business Council for Sustainable Development ; World Resources Institute.

WBCSD and WRI (2011) Corporate Value Chain (Scope 3) Accounting and Reporting Standard: Supplement to the GHG Protocol Corporate Accounting and Reporting Standard. Greenhouse Gas Protocol. Available at: https://ghgprotocol.org/sites/default/files/standards/Corporate-Value-Chain-Accounting-Reporing-Standard_041613_2.pdf.

Ybema S, Yanow D, Wels H, et al. (2009) Organizational Ethnography: Studying the Complexity of Everyday Life. London: SAGE.

Young A (2010) Greenhouse gas accounting: global problem, national policy, local fugitives. Sustainability Accounting, Management and Policy Journal 1(1). Emerald Group Publishing Limited: 89–95.

Zalasiewicz J, Waters CN, Williams M, et al. (2015) When did the Anthropocene begin? A mid-twentieth century boundary level is stratigraphically optimal. Quaternary International 383. The Quaternary System and its formal subdivision: 196–203.

Appendix: Production process of financed emissions

Sequence	Practices	Actions
(1) Data collection	Finding emissions data	Identifying when to search/find emissions data
		Searching for emissions numbers in different reports (CSR, annual)
		Selecting one emissions declaration
	Investigating emissions data	Understanding and judging on how a company reports
		Tracing back/recalculating/splitting emissions data
		Checking for external verification
		Confirming external verification in CarbonBase
		Comparing different sources for the same emissions
	Classifying companies' sub-sectors	Understanding a company's activities
		Comparing to peers (via models, if emissions are not reported)
		Translating industry classifications into internal subsectors
		Registering sub-sector classification
	Registering emissions data	Entering data into database
		Assessing emissions data quality
		Deciding for reported data source
		Deciding for estimated data source
		Monitoring/logging decisions
(2) Data modelling	Producing estimated emissions	Checking factor data
		Deciding for factor data
		Confirming or correcting factor data
		Selecting model (primary or secondary) and applying coefficient
		Investigating estimates of sub-sector
		Deciding for current or for other sub-sector model
		Registering estimated emissions
(3) Data curation	Emissions attribution	Harvesting of client data
		Mapping ISIN to ProviderCo ID
		Adding not-covered companies
		Assigning subsidiaries to internal IDs
		Understanding ownership structures
		Deciding for ownership relation
		Assigning ownership status/relation
(4) Data challenge	Interrogating data (carried out by financial institution)	Monitoring and doing sensibility checks on provider data
		Checking other data sources for company emissions
		Identifying discrepancy between provider data and other data sources
		Requesting explanation by provider
	Justifying or adjusting data	Receiving client request
		Assigning the relevant expert
		Investigating client request
		Deciding for justification
		Deciding for adjusting
		Replying to client request