

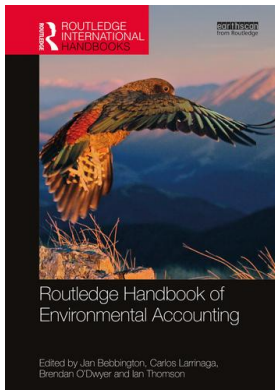
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26

CARBON

Robert Charnock, Matthew Brander and Thomas Schneider

Introduction

Momentum is building in the global effort to tackle climate change and it continues to rise on the agendas of business, finance, civil society, and government with accounting being implicated in this process. A pressing need thus emerges for accounting research that builds on scholarly insights to address the looming challenges of climate action. This chapter provides an overview of research related to carbon accounting, including natural science, technical, and social science research. In each area we describe prominent themes within these research domains and illustrate work undertaken. We also describe the research methods that tend to be used and the theoretical framings employed, and outline possible avenues for future research.

We begin by discussing how definitions of carbon accounting do not remain fixed in this rapidly evolving space. This chapter then reviews the scholarship “doing” carbon accounting and engaging in technical debate. It proceeds to also review scholarship “about” carbon accounting, which centres on its relationship with climate action, regulatory, and governance issues as well as the direction in which carbon accounting is evolving. We then set out promising avenues for research and theoretical development before concluding that climate change remains a pressing and crucial site that is primed for insights from accounting academics.

Ever-shifting definitions

Stechemesser and Guenther (2012) propose the following definition of carbon accounting:

Carbon accounting comprises the recognition, the non-monetary and monetary evaluation and the monitoring of greenhouse gas emissions on all levels of the value chain and the recognition, evaluation and monitoring of the effects of these emissions on the carbon cycle of ecosystems.

(Stechemesser and Guenther 2012, p. 35)

However, any attempt at a comprehensive definition may be doomed to failure as the diversity of practices that can be considered as “carbon accounting” is just too great and continues to grow. For instance, the definition above does not include estimating *changes* in emissions

caused by actions or decisions, which is a major field of carbon accounting practice. It also only mentions *emissions*, and not *removals* (i.e. the removal of greenhouse gases (GHGs) from the atmosphere). Ascui and Lovell (2011) offer a more open-ended approach by enumerating practices that can be subsumed under the title “carbon accounting”. This approach illustrates the way carbon accounting operates at different levels, from global and national inventories down to corporate or product-level assessments, and for different purposes, such as compliance, research, marketing, and risk management. The authors emphasise that their listings are not intended to be comprehensive and that further types of “carbon accounting” can be added.

Given the diversity of practices that can be called “carbon accounting”, we also take an open-ended approach to discussing “carbon accounting” research. As a result, if the reader sees something we have included and thinks “but that’s not carbon accounting”, it means we’ve reached the fuzzy edges of how the term is used. A final introductory point is that we use “carbon accounting” interchangeably with “greenhouse gas accounting”, and arguably the latter is a more accurate term as many GHGs don’t actually contain carbon. Nevertheless, “carbon accounting” is a helpful and ubiquitous shorthand.

Technical and natural science research

We distinguish between research that is *about* carbon accounting (i.e. where some form of carbon accounting practice is the research object) and research that is *doing* some form of carbon accounting (i.e. the research employs a carbon accounting method or engages with carbon accounting practices). Although much research discussed in this chapter (and book) is *about* carbon (and environmental) accounting, we also emphasise the importance of the latter variety. This section therefore offers an overview of research *doing* carbon accounting.

One area of research that *does* carbon accounting falls within the natural sciences, particularly geosciences, climate science, and ecology. Research in this area covers issues such as the global carbon cycle. For example, Liu et al. (2010) explore the magnitude of CO₂ removals from the atmosphere by aquatic organisms. Here the researchers are *doing* carbon accounting, rather than studying carbon accounting as a (social) research object.

A major research theme within this field is understanding the Earth’s response to increasing levels of GHG emissions, and the related concept of “carbon budgets”. Rogelj et al. (2016), who reviewed a number of such estimates and methods, concluded that the remaining budget from 2015, if the temperate increase is to be kept below 2°C, is 590–1,240 GtCO₂-equivalent to between 15 and 30 years of emissions at current levels. There is also often a *normative* element to this research (i.e. how to do carbon accounting better). The authors also argue that there *should be* greater consistency in the carbon budget methods used by the different working groups of the Intergovernmental Panel on Climate Change (IPCC). Although this kind of normative element is not always present within the natural science carbon accounting literature, our point is that this type of research is not solely descriptive or calculative.

Another field of research, that is *doing* carbon accounting, can be characterised as the “technical” literature, which employs some form of numerical method to calculate GHG emissions. A prominent example is the *life cycle assessment* (LCA) literature, which calculates GHG emissions (and other forms of environmental impact) across different stages of a product’s life cycle. For example, Eide (2002) studies the environmental impacts from industrial milk production, including agricultural emissions, processing, consumption, and the waste management of packaging, and reports figures in the range of 500–600 kgCO₂e per 1,000 L of milk (see also Chapter 17 of this handbook on materials and energy accounting).

These studies often apply a carbon accounting method to derive a numerical answer. However, normative method development remains an important theme within this field, especially in studies that apply carbon accounting methods to demonstrate a broader methodological point. For instance, Thomassen et al. (2008) demonstrate the way different forms of LCA give different results for milk production. In contrast, Ekvall et al. (2005) is an example of a conceptual study, with the authors suggesting that different forms of LCA align with either consequential or deontological ethical perspectives, and are therefore appropriate for different purposes.

A focal topic for method development, *par excellence*, is bioenergy. Searchinger et al.'s (2008) seminal study of US biofuel policy uses an economic model to project that demand for US corn ethanol will increase global agricultural commodity prices, and increase GHG emissions from indirect land use change. This paper sparked considerable debate not only within academia, but also within governments, on the appropriate use of different carbon accounting methods.

A noteworthy feature of the “technical” carbon accounting literature is its focus on LCA. There are many other methods used in practice – such as corporate GHG inventory accounting, project-level accounting, national GHG inventories – but relatively few academic studies use these methods. It appears to be a contingent feature of the research landscape that there is a large and highly active academic community for LCA, with dedicated journals and conferences, but little comparable activity focused on applying and developing other carbon accounting methods.

A final observation on what we have described as the “scientific” or “technical” carbon accounting literature is that it tends not to be “theorised”. That is, there is less need to enrich insights through theorisations of the empirical material. This is notably different from the academic research that treats carbon accounting as a social research object, which tends to use theory to make sense of carbon accounting practice and climate governance.

Research “about” carbon accounting

The research *about* carbon accounting largely focusses on *corporate* carbon accounting and disclosure, with less attention directed to national-level governance and accounting (e.g. Harris and Symons 2013; McGlade and Ekins 2015; Charnock and Hoskin 2020), product-level accounting and labelling (e.g. Ormond and Goodman 2015), and personal carbon accounts (e.g. Lövbrand and Stripple 2011). The following is an overview of some of the key themes and approaches within this extensive literature.

Corporate carbon disclosure

In the broadest sense, almost all corporate environmental disclosure literature includes carbon accounting, as carbon features in environmental disclosure and disclosure scores. Hahn et al.'s (2015) review of carbon disclosure studies, from 2005 to 2013, shows a marked increase in the number of publications, comprising a number of sub-themes (e.g. voluntary versus mandatory disclosure, real versus market effects) and research methods (e.g. regression analysis, content analysis, interview-based, field study and survey).

The work on carbon disclosure uses data such as sustainability reports, CDP (formerly the Carbon Disclosure Project) annual survey results, and/or mandatory company reports. Carbon disclosure requirements are becoming increasingly prevalent, via securities regulation and an array of laws that especially target large emitters (Schneider et al. 2018). The sheer volume of work on disclosure is a function of carbon reporting providing a new data source, combined with global warming becoming recognised as a material issue. For voluntary disclosures, the determinants of

disclosure are typically studied (Luo et al. 2012). Furthermore, CDP provides a large set of scope 1 and scope 2 emissions¹ data, which can be incorporated into research as “hard” data.

Theorisation is a central feature of disclosure research. This aims to enable and enrich explanations of the social phenomenon being studied, such as the amount and purpose of disclosure. The prevalence of legitimacy theory has arguably made it a theme unto itself (cf. Asci 2014). It implies that the more a firm pollutes, the more it discloses. Thus, the argument goes, more voluntary disclosure is harmful because disclosure is being used for the obfuscation of actual performance (Patten 2020). Stakeholder theory enjoys similar prominence, focusing on firm-specific responses to actual stakeholder demands (Fernando and Lawrence 2014; Roberts 1992). Although the seminal work in this area plays an important role in the literature, applications of these two theories have, at times, been rather vague and unreflective. We consider these instances of what Guthrie and Parker (2017) call *theoretical engorgement*. This is where researchers are compelled to insert a theoretical framework into research papers, even when this does not aid the sensemaking process or enrich research insights. As a result, we would warn emerging scholars embarking on yet another disclosure-based study to avoid taking legitimacy and stakeholder theory for granted. Rather, one must thoroughly and critically engage with the conceptual underpinnings of carbon disclosure research, focussing on building a theoretical contribution and justifying its value to academia, practice and policy.

Nevertheless, the main debate in carbon disclosure literature is between these two perspectives, as exemplified by Wei and Schaltegger (2017). They found that if a firm reports more under CDP, as reflected in disclosure score changes, there will be a decrease in carbon emission intensity in following years. So even if a firm starts reporting for obfuscation reasons, that reporting triggers real action because it pays more attention to the activity.

The disclosure literature also investigates the assurance of carbon disclosures. Again, sustainability assurance literature does encompass carbon disclosure audit, and the practice is comparably dominated by the big four auditing firms (KPMG 2017). However, carbon audit can be mapped more directly into the scientific or technical aspects of carbon accounting. These particularly relate to “hard” targets set by the firm or regulators. Green, Taylor, and Wu (2017, p. 31) state that “there is a clear and defined set of disclosures of measurable parameters”, arguing that this implies more similarities with a financial audit.

There has also been a substantial rise in regulatory guidance on carbon disclosure, both regarding environmental risk and disclosure (e.g. CSA 2019; BIS 2020), and specifically on carbon disclosure (e.g. SEC 2010). With both the regulatory and real effects of climate change becoming manifest, carbon accounting is now a material item for investors and thus falls under the continuous disclosure regulations underlying all major stock exchanges, or is specifically mandated by securities regulations (Bebbington et al. 2020; Schneider et al. 2018). In many ways, this renders the literature on carbon disclosure moot, particularly the work on voluntary disclosure of GHG emissions. Increasingly, carbon accounting practice (including in the CDP questionnaire) and research centres on addressing climate risk (and opportunity). This represents yet another expansion of what carbon accounting is. Indeed, the next section, focused on carbon management, sheds light on the surging interest in climate risk.

Carbon management

Climate risk and carbon management accounting

Climate risk has recently attracted increasing attention within academic research *about* carbon accounting. Since the landmark 2015 Paris Agreement on climate change, governments and

practitioners have become increasingly concerned about the physical, market and regulatory risks that climate change could pose to business and finance.

These risks are not entirely new to social and environmental scholarship. By the mid-1990s a range of primarily qualitative studies – drawing on interviews, case studies and documentary analyses – were already highlighting the litigation risks of environmental disasters (Coulson and Dixon 1995) and how climate change could be factored into risk management practice. However, there is renewed interest in this space, across academia, industry and policymaking. Where physical risks arise through the impacts of climate change, the market and regulatory risks are now seen as stemming from the prospect of a “carbon-constrained future” (Bebbington and Larrinaga-González 2008) and a global transition away from fossil fuels.

Bebbington et al. (2020) provided a recent example by exposing the (in)adequacy of current reporting practices within the fossil fuel sector. The study is based on the concepts of *unburnable carbon* and *stranded assets* that question whether existing fossil fuel resources can be burned if climate change goals are to be met. The authors used a multi-methods approach, combining a survey of accounting disclosure rules for fossil fuel resources, accounting disclosures made by fossil fuel firms, and stock market participants’ views on stranded asset risk.

The paper also exemplifies the value of theorisation in this rapidly evolving space, employing Miller and Power’s (2013) framework on the four roles of accounting to develop insights into how these ideas could become part of corporate reporting. In this manner, the paper provides a foundation for valuable theoretical development, which may be especially insightful for making sense of shifting climate risk perceptions and regulatory agendas, as well as proposing climate-related applications for existing accounting techniques.

A different perspective, however, is the managerialist approach. This sets aside questions of disclosure and centres instead on changes in management practices (Kumarasiri and Jubb 2016) ranging from mixed-methods case studies that help highlight the more carbon-intensive aspects of production (Cadez and Guilding 2017) to benchmarking approaches that identify supply chain hot spots (Acquaye et al. 2014). These management-oriented studies also offer insight into both the interplay between national policies, corporate strategies and carbon management accounting (Bui and Fowler 2019) and the emergence and development of new practice. This is exemplified by Gibassier and Schaltegger’s (2015) 12-month participant observation, which explores the parallel emergence of multiple carbon management accounting practices. The common theme, however, is the ongoing evolution of management accounting as it is called on to operationalise carbon control.

Emissions trading schemes and the accounting treatment of emission rights

Emissions trading schemes (ETSs), a mainstay of climate change mitigation, first came to prominence during the United States’ Acid Rain Programme (Burtraw et al. 2005). Braun shows how this earlier experience was pivotal to the European Union’s interest in the mechanism, following its failed attempt to implement a carbon tax (Braun 2009). These schemes have attracted considerable interest among accounting scholars interested in the sociology of markets, with scholars investigating ETSs through lenses of (in)commensurability (MacKenzie 2009; Lovell et al. 2013) and experimentation (Callon 2009).

Such studies are also exemplars of how theorisation within carbon accounting can problematise prevailing economic theories and unearth the rationales and ideologies that underpin climate governance. As Unerman and Chapman state:

[G]reater theoretical sophistication can play a vital role in the provision of robust evidence and understandings upon which existing practices can be evaluated and critiqued, and new and sounder practices developed.

(2014, p. 386)

For example, the question of how to account for emission rights has remained a heated subject since Bebbington and Larrinaga-González (2008) rekindled a debate on accounting problems associated with earlier sulphur dioxide trading schemes. This has prompted considerable effort to problematise ETS-related accounting treatments, from demonstrating how different treatments advance either a market imperative or a regulation and compliance notion (Mete et al. 2010), to arguing that emission rights are a financialisation of the atmosphere and that market-based solutions are inappropriate for a problem caused by markets (McNicholas and Windsor 2011).

With the proliferation of carbon markets around the world, these debates and accounting treatments are far from settled. Indeed the Chinese experience in transitioning from regional schemes to a national scheme appears especially noteworthy (Jotzo et al. 2018). Moreover, theoretical insights into the financialisation of climate change and their problematisation of market-based approaches have become an especially pressing topic since the Paris Agreement was forged and opened up new possibilities for climate governance.

Emergent directions for research projects

As discussed above, carbon accounting encompasses a diverse range and ever-evolving set of practices. Researchers therefore need to constantly look for emergent practices that either require testing and development (via natural scientific or technical research), or need explaining, problematising, and critiquing (via social and political science research). The following sections set out currently emergent areas that we identified, at the time of writing, as important and pressing areas for research.

International climate governance

When the Paris Agreement was reached in December 2015 it marked a fundamental shift in climate governance towards a decentralised “pledge and review” system (Charnock and Hoskin 2020; Falkner 2016). This raises significant and pressing questions, such as how nations are held accountable for their pledges, how to ensure financial flows are consistent with the Paris goals, and whether carbon accounting methods for national GHG inventories are fit for purpose.

These debates – and related work on the transparency of international flows of climate finance, technology and information (Weikmans and Roberts 2019) – have largely emerged outside of the accounting discipline. Yet there is much potential for accounting insights to inform these debates, especially by drawing on our rich vein of scholarship on accountability (Archel et al. 2011; Roberts 1991) and transparency (Gray 1992; Radcliffe et al. 2017). Indeed, there is also a growing need for the social sciences to engage with bodies such as the IPCC, whose highly influential synthesis reports are now looking beyond the natural sciences (Charnock and Thomson 2019). Now more than ever these bodies require insight into the suitability and effectiveness of different policy approaches to specific aspects of the climate agenda and region-specific impacts and risks.

Science-based target setting

An interesting area for further research, below the level of national governments, is the response of “non-state actors” – for example, regional governments, non-governmental organisations (NGOs), corporations, and public bodies – to the imperative for climate change mitigation (Bebbington and Harrison 2017). An increasingly prevalent framing is the concept and practice of “science-based target” setting (CDP et al. 2015), which involves setting sector- or company-level reduction targets that are consistent with the global goals of the Paris Agreement. Such initiatives deserve scrutiny from both the technical and social science research communities. For the former, there are crucial questions such as “are the proposed target-setting methods genuinely aligned with below 2°C pathways?” and for the latter there are questions such as ‘how do voluntary initiatives, such as science-based targets, shape organisational activity and influence regulatory agendas?’.

Negative emissions technologies

Negative emissions technologies (NETs) are technologies that remove GHGs from the atmosphere, such as bioenergy with carbon capture and storage (BECCS), afforestation, and direct air capture and storage. Such technologies will be required to achieve targets such as the UK government’s pledge to achieve net zero emissions by 2050 (UK Parliament 2008), and also for dealing with an emissions “overshoot” if warming exceeds 2°C (Smith et al. 2015). These technologies pose distinct accounting challenges, such as how to support NETs within existing incentive mechanisms, and how to allocate responsibility for historic contributions to cumulative emissions. We see the limited academic engagement in these matters as highly problematic and the topics as a key priority requiring urgent attention.

The avenues outlined above are only three of the emergent issues that warrant and would benefit from scholarly insight. There are, of course, many other valuable lines of inquiry. To name a few: shadow pricing and internal carbon pricing, carbon taxes, production and consumption-based accounting, financial accounting for carbon-based assets and liabilities, project-level accounting, marginal abatement costs, and the standardisation of carbon accounting practices. However, we must now turn to potential directions for theoretical development that may help our sensemaking on thematic challenges cutting across the carbon accounting agenda.

Emergent directions for theoretical development

As noted earlier in this chapter, the explicit use or development of theory does not appear to be a prominent or necessary feature of the academic research that *does* carbon accounting. However, within the literature *about* carbon accounting, and *about* sustainable development accounting more generally, there are calls for greater theoretical development (Unerman and Chapman 2014). We reiterate these calls by identifying thematic challenges where theoretical development may advance our efforts to make sense of, problematise, and inform action.

Larrinaga (2014) identifies a recurrent theme in the literature *about* carbon accounting: these are emergent and deeply contested practices. Following the spirit of early studies of accounting change (Hopwood 1983), we suggest that this theme is central to our contextual understanding of carbon accounting as a rapidly evolving and ever-expanding field. Here, Moore and McPhail (2016) offer an insightful approach to analysing levels of change. They demonstrate how strong structuration theory can be applied to grapple with the interplay between macro-, meso-, and

micro-levels of change. Furthermore, their theoretical analysis offers much-needed nuance to the homogeneity of institutional analyses, allowing them to begin unveiling the complex and reflexive interplay between multiple structuration processes and active agency. So, their study provides one approach for scholars interested in exploring dynamics across levels and sectors, through which carbon accounting practices may (or may not) coalesce over time.

Similarly, longitudinal studies of how carbon accounting emerges and evolves is especially suited to theoretical development. For example, Le Breton and Aggeri's (2019) work on *Bilan Carbon* – a French GHG accounting tool – draws on the Foucauldian concept of a strategic *dispositif* to analyse how the tool was created and disseminated. This focuses their analysis both on tracing the emergence of a network and on the intentionality in how elements were brought together when faced with responding to an emergency such as climate change.

However, there is still considerable scope and further need for theoretical development in this domain. Considering the overhaul seen in climate governance with the transition from the Kyoto Protocol to the Paris Agreement (Falkner 2016), certain thematic challenges have come to the fore. The shift towards a decentred version of climate governance further emphasises the importance of investigating interactions between a diverse range of state, private, and civil society actors. This will be pivotal for creating a dynamic through which the ambition of national pledges can be increased to a point aligned with limiting warming to well below 2°C. Here, decentred regulation scholars (Black 2008) can offer valuable conceptual insight into new forms of polycentric governance. This also adds to the challenge of coordinating efforts across multiple actors, an issue that has been the subject of much theoretical insight through notions of boundary objects (Bowker et al. 2016), mediating instruments (Miller and O'Leary 2007), and meta-governance (Charnock and Hoskin 2020).

Additional challenges are becoming immanent at the organisational level, adding to interest in dynamics between accounting and organisational action on climate change. Fortunately, decades of scholarly insights provide a remarkable foundation. For example, integrating carbon metrics into remuneration could draw valuable conceptual insights from performance management scholarship (Chenhall, Hall, and Smith 2013). Similarly, we should develop conceptual insights on how to operationalise the low-carbon transition through CAPEX decisions – mitigating locked-in emissions and the stranding of assets – from a wealth of extant studies (Larrinaga-Gonzalez and Bebbington 2001; Cushen 2013).

Conclusion

This chapter has reviewed key themes running through carbon accounting scholarship and has also introduced the reader to emergent themes that warrant further academic scrutiny. We have described a number of different types of research related to carbon accounting (i.e. natural science, “technical”, and social science research), and have emphasised that these areas are interconnected. For example, the natural science research on carbon budgets is used in more economics-focused research on stranded assets (McGlade and Ekins 2015) that is relevant to corporate-level analysis (see Bebbington et al. 2020). Alternatively, social science research may treat natural science or “technical” research as research objects, asking questions about the underlying assumptions and social processes that shape carbon accounting practice (Ascuí and Lovell 2012). Of course, given the breadth and shifting nature of carbon accounting research, there are a range of relevant issues that warrant further research but to which this chapter was not able to dedicate sufficient time.²

Yet this chapter has also highlighted the extent to which theorisation on carbon issues has and can continue to offer insights. Reiterating Guthrie and Parker's (2017) arguments, carbon

accounting scholarship may have, at times, engaged in *theory engorgement*, the inclusion of theoretical frameworks without due consideration of their applicability and the value this brings to the study. Similarly, we have emphasised that theorisation is not relevant to all types of research, and may even be an unhelpful distraction within applied studies. We do hope, however, to have illuminated the potential for theorisation within studies *about* carbon accounting, especially in problematising the utopian neoliberal impulses of financialisation and economisation and, in doing so, in opening up spaces for rethinking the vectors of possibility along which carbon accounting continues to evolve (Unerman and Chapman 2014).

To close, across the growing bodies of scholarship we described, there remains a pressing need for further academic insights on the linkages between carbon and accounting. Given the pressing nature of climate change, academic focus on the effectiveness of policies and practices in catalysing and directing climate action is essential. What is more is that civil society, businesses, financial organisations, and government agencies are grasping their increasingly important role in climate governance, which will continue to drive and reshape carbon accounting practices for decades to come. Considered as a whole, the linkages between climate change and accounting are set to remain a crucial site for scholarly attention, with the potential for highly impactful research projects and profound theoretical developments on the shifting landscape of what we call carbon accounting.

Notes

- 1 Scope 1 emissions are those from sources owned or controlled by the firm; scope 2 are emissions from purchased electricity, heating and cooling; and scope 3 are upstream and downstream indirect emissions. There is little evidence of a critical mass of scope 3 emissions being disclosed (Bebbington et al. 2020).
- 2 For instance, there appears to be considerable value in furthering our knowledge and understanding of standardisation, scenario planning and stress testing, development finance, climate change adaptation, operationalising and aligning action with the Paris Agreement, as well as project-level and policy-level carbon accounting.

References

- Acquaye, A., Genovese, A., Barrett, J., Koh, S.C.L., 2014. Benchmarking carbon emissions performance in supply chains. *Supply Chain Management: An International Journal* 19, 306–321.
- Archel, P., Husillos, J., Spence, C., 2011. The institutionalisation of unaccountability: Loading the dice of corporate social responsibility discourse. *Accounting, Organizations and Society* 36, 327–343.
- Ascui, F., 2014. A review of carbon accounting in the social and environmental accounting literature: What can it contribute to the debate? *Social and Environmental Accountability Journal* 34, 6–28.
- Ascui, F., Lovell, H., 2011. As frames collide: Making sense of carbon accounting. *Accounting, Auditing and Accountability Journal* 24, 978–999.
- Ascui, F., Lovell, H., 2012. Carbon accounting and the construction of competence. *Journal of Cleaner Production* 36, 48–59.
- Bebbington, J., Harrison, J., 2017. Global climate change responsiveness in the USA: An estimation of population coverage and implications for environmental accountants. *Social and Environmental Accountability Journal* 37, 137–143.
- Bebbington, J., Larrinaga-González, C., 2008. Carbon trading: Accounting and reporting issues. *European Accounting Review* 17, 697–717.
- Bebbington, J., Schneider, T., Stevenson, L., Fox, A., 2020. Fossil fuel reserves and resources reporting and unburnable carbon: Investigating conflicting accounts. *Critical Perspectives on Accounting* 66, 102083.
- BIS, 2020. *The Green Swan: Central Banking and Financial Stability in the Age of Climate Change*. Bank of International Settlements. Basel, Switzerland.
- Black, J., 2008. Constructing and contesting legitimacy and accountability in polycentric regulatory regimes. *Regulation and Governance* 2, 137–164.

- Bowker, G.C., Timmermans, S., Clarke, A.E., Balka, E., 2016. *Boundary Objects and Beyond: Working with Leigh Star*. MIT Press, Cambridge, MA.
- Braun, M., 2009. The evolution of emissions trading in the European Union – The role of policy networks, knowledge and policy entrepreneurs. *Accounting, Organizations and Society* 34, 469–487.
- Bui, B., Fowler, C.J., 2019. Strategic responses to changing climate change policies: The role played by carbon accounting. *Australian Accounting Review* 29, 360–375.
- Burtraw, D., Evans, D.A., Krupnick, A., Palmer, K., Toth, R., 2005. Economics of pollution trading for SO₂ and Nox. *Annual Review of Environment and Resources* 30, 253–289.
- Cadez, S., Guilding, C., 2017. Examining distinct carbon cost structures and climate change abatement strategies in CO₂ polluting firms. *Accounting, Auditing and Accountability Journal* 30, 1041–1064.
- Callon, M., 2009. Civilizing markets: Carbon trading between in vitro and in vivo experiments. *Accounting, Organizations and Society* 34, 535–548.
- CDP, UN Global Compact, WRI, WWF, 2015. *Science-Based Target Setting Manual: Driving Ambitious Corporate Climate Action*. Science Based Targets Initiative, London, UK. Available at <https://sciencebasedtargets.org/resources/files/SBTi-manual.pdf>
- Charnock, R., Hoskin, K.W., 2020. SDG 13 and the entwining of climate and sustainability metagovernance: An archaeological-genealogical analysis of goals-based climate governance. *Accounting, Auditing and Accountability Journal* 33, 1731–1759.
- Charnock, R., Thomson, I., 2019. A pressing need to engage with the Intergovernmental Panel on Climate Change: The role of SEA scholars in syntheses of social science climate research. *Social and Environmental Accountability Journal* 39, 192–199.
- Chenhall, R.H., Hall, M., Smith, D., 2013. Performance measurement, modes of evaluation and the development of compromising accounts. *Accounting, Organizations and Society* 38, 268–287.
- Coulson, A., Dixon, R., 1995. Environmental risk and management strategy. *International Journal of Bank Marketing* 13, 22–29.
- CSA, 2019. *Reporting of Climate Change Related Risks*. Canadian Securities Administrators. CSA Staff Notice 51–358.
- Cushen, J., 2013. Financialization in the workplace: Hegemonic narratives, performative interventions and the angry knowledge worker. *Accounting, Organizations and Society* 38, 314–331.
- Eide, M.H., 2002. Life cycle assessment (LCA) of industrial milk production. *International Journal of Life Cycle Assessment* 7, 115–126.
- Ekvall, T., Tillman, A.-M., Molander, S., 2005. Normative ethics and methodology for life cycle assessment. *Journal of Cleaner Production* 13, 1225–1234.
- Falkner, R., 2016. The Paris Agreement and the new logic of international climate politics. *International Affairs* 92, 1107–1125.
- Fernando, S., Lawrence, S., 2014. A theoretical framework for CSR practices: Integrating legitimacy theory, stakeholder theory and institutional theory. *Journal of Theoretical Accounting Research* 10, 149–178.
- Gibassier, D., Schaltegger, S., 2015. Carbon management accounting and reporting in practice: A case study on converging emergent approaches. *Sustainability Accounting, Management and Policy Journal* 6, 340–365.
- Gray, R., 1992. Accounting and environmentalism: An exploration of the challenge of gently accounting for accountability, transparency and sustainability. *Accounting, Organizations and Society* 17, 399–425.
- Green, W., Taylor, S., Wu, J., 2017. Determinants of greenhouse gas assurance provider choice. *Meditari Accountancy Research* 25, 114–135.
- Guthrie, J., Parker, L.D., 2017. Reflections and projections: 30 years of the interdisciplinary accounting, auditing and accountability search for a fairer society. *Accounting, Auditing and Accountability Journal* 30, 2–17.
- Hahn, R., Reimsbach, D., Schiemann, F., 2015. Organizations, climate change, and transparency: Reviewing the literature on carbon disclosure. *Organization and Environment* 28, 80–102.
- Harris, P., Symons, J., 2013. Norm conflict in climate governance: Greenhouse gas accounting and the problem of consumption. *Global Environmental Politics* 13, 9–29.
- Hopwood, A.G., 1983. On trying to study accounting in the contexts in which it operates. *Accounting, Organizations and Society* 8, 287–305.
- IPCC, 2006. *IPCC Guidelines for National Greenhouse Gas Inventories*. Intergovernmental Panel on Climate Change, IGES, Japan.
- IPCC, 2019. *Overview of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Kyoto, Japan.

- Jotzo, F., Karplus, V., Grubb, M., Löschel, A., Neuhoff, K., Wu, L., Teng, F., 2018. China's emissions trading takes steps towards big ambitions. *Nature Climate Change* 8, 265.
- Kolk, A., Levy, D., 2001. Winds of change: Corporate strategy, climate change and oil multinationals. *European Management Journal* 19, 501–509.
- KPMG, 2017. The road ahead: The KPMG survey of corporate responsibility reporting 2017. Zurich: KPMG International. Retrieved November 20, 2018.
- Kumarasiri, J., Jubb, C., 2016. Carbon emission risks and management accounting: Australian evidence. *Accounting Research Journal* 29, 137–153.
- Larrinaga, C., 2014. Carbon accounting and carbon governance. *Social and Environmental Accountability Journal* 34, 1–5.
- Larrinaga-Gonzalez, C., Bebbington, J., 2001. Accounting change or institutional appropriation?—A case study of the implementation of environmental accounting. *Critical Perspectives on Accounting* 12, 269–292.
- Le Breton, M., Aggeri, F., 2019. The emergence of carbon accounting: How instruments and dispositifs interact in new practice creation. *Sustainability Accounting, Management and Policy Journal* 11, 505–522.
- Liu, Z., Dreybrodt, W., Wang, H., 2010. A new direction in effective accounting for the atmospheric CO₂ budget: Considering the combined action of carbonate dissolution, the global water cycle and photo-synthetic uptake of DIC by aquatic organisms. *Earth-Science Reviews* 99, 162–172.
- Lövbrand, E., Stripple, J., 2011. Making climate change governable: Accounting for carbon as sinks, credits and personal budgets. *Critical Policy Studies* 5, 187–200.
- Lovell, H., Bebbington, J., Larrinaga, C., de Aguiar, T.R.S., 2013. Putting carbon markets into practice: A case study of financial accounting in Europe. *Environment and Planning C: Government and Policy* 31, 741–757.
- Luo, L., Lan, Y., Tang, Q., 2012. Corporate incentives to disclose carbon information: Evidence from the CDP Global 500 report. *Journal of International Financial Management and Accounting* 23, 93–120.
- MacKenzie, D., 2009. Making things the same: Gases, emission rights and the politics of carbon markets. *Accounting, Organizations and Society* 34, 440–455.
- McGlade, C., Ekins, P., 2015. The geographical distribution of fossil fuels unused when limiting global warming to 2°C. *Nature* 517, 187–190.
- McNicholas, P., Windsor, C., 2011. Can the financialised atmosphere be effectively regulated and accounted for? *Accounting, Auditing and Accountability Journal* 24, 1071–1096.
- Mete, P., Dick, C., Moerman, L., 2010. Creating institutional meaning: Accounting and taxation law perspectives of carbon permits. *Critical Perspectives on Accounting* 21, 619–630.
- Miller, P., O'Leary, T., 2007. Mediating instruments and making markets: Capital budgeting, science and the economy. *Accounting, Organizations and Society* 32, 701–734.
- Miller, P., Power, M., 2013. Accounting, organizing, and economizing: Connecting accounting research and organization theory. *The Academy of Management Annals* 7, 557–605.
- Moore, D.R.J., McPhail, K., 2016. Strong structuration and carbon accounting: A position-practice perspective of policy development at the macro, industry and organizational levels. *Accounting, Auditing and Accountability Journal* 29, 1204–1233.
- Ormond, J., Goodman, M.K., 2015. A new regime of carbon counting: The practices and politics of accounting for everyday carbon through CO₂e. *Global Environmental Change* 34, 119–131.
- Patten, D.M., 2020. Seeking legitimacy. *Sustainability Accounting, Management and Policy Journal* 16, ahead of print.
- Radcliffe, V.S., Spence, C., Stein, M., 2017. The impotence of accountability: The relationship between greater transparency and corporate reform. *Contemporary Accounting Research* 34, 622–657.
- Roberts, J., 1991. The possibilities of accountability. *Accounting, Organizations and Society* 16, 355–368.
- Roberts, R., 1992. Determinants of corporate social responsibility disclosure: An application of stakeholder theory. *Accounting, Organizations and Society* 17, 595–612.
- Rogelj, J., Schaeffer, M., Friedlingstein, P., Gillett, N.P., Van Vuuren, D.P., Riahi, K., Allen, M., Knutti, R., 2016. Differences between carbon budget estimates unravelled. *Nature Climate Change* 6, 245–252.
- Royal Society, Royal Academy of Engineering, 2018. *Greenhouse Gas Removal*. London: Royal Society and Royal Academy of Engineering.
- Schneider, T., Michelon, G., Paananen, M., 2018. Environmental and social matters in mandatory corporate reporting: An academic note. *Accounting Perspectives* 17, 275–305.
- Searchinger, T., Heimlich, R., Houghton, R., Dong, F., Elobeid, A., Fabiosa, J., Tokgoz, S., Hayes, D., Yu, T.-H., 2008. Use of U.S. croplands for biofuels increases greenhouse gases through emissions from land-use change. *Science* 319, 1238–1240.

- Securities and Exchange Commission, 2010. Commission guidance regarding disclosure related to climate change, Final Rule 6290. Securities and Exchange Commission. Washington DC, USA.
- Smith, P., Davis, S.J., Creutzig, F., Fuss, S., Minx, J., Gabrielle, B., Kato, E., Jackson, R.B., Cowie, A., Kriegler, E., van Vuuren, D.P., Rogelj, J., Ciais, P., Milne, J., Canadell, J.G., McCollum, D., Peters, G., Andrew, R., Krey, V., Shrestha, G., Friedlingstein, P., Gasser, T., Grübler, A., Heidug, W.K., Jonas, M., Jones, C.D., Kraxner, F., Littleton, E., Lowe, J., Moreira, J.R., Nakicenovic, N., Obersteiner, M., Patwardhan, A., Rogner, M., Rubin, E., Sharifi, A., Torvanger, A., Yamagata, Y., Edmonds, J., Yongsung, C., 2015. Biophysical and economic limits to negative CO₂ emissions. *Nature Climate Change* 6, 42.
- Stechemesser, K., Guenther, E., 2012. Carbon accounting: A systematic literature review. *Journal of Cleaner Production* 36, 17–38.
- Thomassen, M.A., Dalgaard, R., Heijungs, R., Boer, I., 2008. Attributional and consequential LCA of milk production. *The International Journal of Life Cycle Assessment* 13, 339–349.
- UK Parliament, 2008. *Climate Change Act 2008*. London, UK.
- Unerman, J., Chapman, C., 2014. Academic contributions to enhancing accounting for sustainable development. *Accounting, Organizations and Society* 39, 385–394.
- Wei, Q., Schaltegger, S., 2017. Revisiting carbon disclosure and performance: Legitimacy and management views. *The British Accounting Review* 49, 365–379.
- Weikmans, R., Roberts, J.T., 2019. The international climate finance accounting muddle: Is there hope on the horizon? *Climate and Development* 11, 97–111.