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Carbon accounting: a systematic literature review

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ABSTRACT

The term carbon accounting is widely used by scientists in various disciplines and is found particularly often in discussions of the integration of aspects of climate into accounting. However, no consistent definition of carbon accounting exists. Thus, the objective of this paper is to derive a definition of carbon accounting by means of a systematic literature review that includes different perspectives and research streams. Based on this review and the use of computer-assisted qualitative data analysis software, the 129 identified and investigated literature sources were divided into four sections: carbon accounting at the national scale, at the project scale, at the organizational scale and at the product scale. Additionally, at each scale, we differentiated between non-monetary and monetary aspects and explained the purpose of the study. Based on these findings, a definition of carbon accounting is proposed that can be used by academics to operationalize their research questions, by legislators to delimit obligatory and voluntary accounting and by practitioners to establish carbon accounting in companies.

1. Introduction

The consideration of greenhouse gases (GHG) in entrepreneurial decisions is attracting growing attention, largely due to the introduction of emissions trading in the European Union (EU) and recent work by the Intergovernmental Panel on Climate Change (IPCC), the Stern Report, and the Carbon Disclosure Project. Due to emissions trading, carbon dioxide (CO_2) allowances must be entered in annual financial statements. Therefore, these allowances are also considered in management accounting. Hence, the question arises whether and how all other climate-relevant aspects are recognized in management accounting. These aspects include companies' GHG emissions, which are not included in emissions trading schemes. Because we focus on carbon emissions, our research addresses climate change mitigation and does not include adaptation to climate change (Directive 2003/87/EC).

Thus far, the GHG Emission Allowance Trading Scheme (ETS) in the EU includes only CO_2 emissions from power generation plants and energy-intensive facilities (production and processing of ferrous metals, mineral industry, and other activities of industrial plants for the production of pulp from timber or other fibrous materials and from paper and board with a production capacity exceeding 20 tons per day) (Directive 2003/87/EC). Since the beginning of 2012, the aviation sector has been integrated into the EU ETS (Directive 2008/101/EC). CO_2 emissions from other processes are not included, nor are all other GHGs listed in the Kyoto Protocol, such as methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6) (Directive 2003/87/EC). Legislation, customers and investors may motivate companies to mitigate GHG emissions.

In accountancy companies the discussion on the integration of aspects of climate change mitigation into accounting is often called carbon accounting (KPMG, 2008; Hespenheide et al., 2010). However, both natural scientists and financial analysts use this term. Do these groups have the same understanding of this term, and, if not, how do their understandings differ? We examine whether carbon accounting is an integral part of environmental accounting in the same way that environmental accounting is an integral part of accounting.

These questions were the starting point for a literature review intended to examine the understanding of carbon accounting in various research areas and to offer a definition that includes a multitude of research streams. We begin our analysis by introducing the structure of environmental accounting from an economic perspective. Because carbon accounting is emerging as a subset of this concept, just as environmental accounting has emerged as a subset of accounting (Schaltegger and Burritt, 2000), we stress the importance of one specific environmental topic to focus attention on environmental issues.

The paper is organized as follows. After an introduction to environmental accounting, we derive a structure for our systematic literature review to analyze the different research streams. In

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Section 3, we explain the methodology. We then present and discuss the results.

2. Environmental accounting from an economic perspective – the starting point for carbon accounting

Schaltegger and Burritt (2000) define environmental accounting as a subset of accounting that addresses "activities, methods and systems [as well as] recording, analysis and reporting of environmentally induced financial impacts and ecological impacts of a defined economic system (e.g. firm, plant, region, nation, etc.)" (p. 63). Burritt et al. (2002) also emphasize two sides of environmental accounting, the non-monetary and monetary aspects. Like Schaltegger and Burritt (2000), Bennett and James (1998) and the United States Environmental Protection Agency (USEPA) (1995) note that the term "environmental accounting" is used at different scales. The USEPA (1995) differentiates between three types of environmental accounting, depending on their focus and their audience: national income accounting, financial accounting and managerial or management accounting. *National Income Accounting*, as a macro-economic measure, focuses on the consumption of a nation's natural resources, expressed in physical and/or monetary units. This type of accounting is of interest for politicians as well as citizens. A distinction between financial and management accounting is common within organizations (International Federation of Accountants (IFAC), 2005). *Financial Accounting*, which addresses an external audience (e.g., investors, tax authorities, or creditors), includes data collection, account balancing, auditing of a firm's financial statements and external reporting. The inclusion of environment-related information into financial data, such as earnings and expenses for environment-related investments or environmental liability, can be described as environmental financial accounting. Financial reporting follows the regulations of national laws and international standards. Environmental performance-related information has become part of voluntary reporting to external stakeholders. A firm's *management accounting* identifies, collects and analyzes information on a division, a facility, a product line, or a system for internal purposes. According to the IFAC (2005), management accounting is defined as "the management of environmental and economic performance, through the development and implementation of appropriate environment-related accounting systems and practices. While this may include reporting and auditing in some companies, environmental management accounting typically involves life cycle costing, full-cost accounting, benefits assessment, and strategic planning for environmental management." (p. 19). Monetary data encompass the material costs of product and non-product outputs, waste and emission control costs, prevention and other environmental management costs, research and development costs, and less tangible costs. In contrast, environmental or physical data consist of information about material inputs (raw and auxiliary materials, packaging materials, merchandise, operating materials, water, and energy) and outputs (product and non-product output, such as solid waste, hazardous waste, wastewater and air emissions) (IFAC, 2005).

In summary, both an internal and an external perspective can be identified at the organizational scale (Fig. 1). Monetary and non-monetary information are included in both perspectives. Hence, the internal perspective encompasses monetary environmental management accounting and physical or non-monetary environmental management accounting. Both areas can be considered environmental management accounting. In contrast, from the external perspective, it is possible to differentiate monetary environmental regulatory from voluntary accounting and physical or non-monetary environmental regulatory from

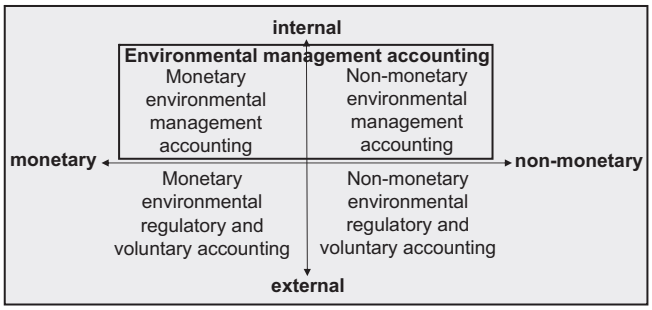

Fig. 1. Environmental accounting (Sources: Bartolomeo et al., 2000; Burritt et al., 2002).

voluntary accounting. We do not combine these two areas into financial accounting because this term is typically used in monetary terms. The differentiation between regulatory and voluntary accounting originates from a time when external accounting was initiated by regulatory authorities. Currently, organizations also account for monetary and physical information voluntarily to inform their stakeholders.

It is clear that environmental accounting can be realized not only at an organizational scale but also at the firm, plant, regional and national scales (Schaltegger and Burritt, 2000). Moreover, a product line can be the focus of observation (IFAC, 2005). Therefore, Fig. 1 is also applicable for other scales.

From this economic perspective on environmental accounting, we now explore the literature on carbon accounting by using a systematic literature review to answer our research questions: "How is the term carbon accounting defined?" and "What is the understanding of carbon accounting?".

3. Methodology

We could not identify any previous systematic review focusing on a definition or an understanding of carbon accounting. According to Littell (2008), a systematic review "aims to comprehensively locate and synthesize research that bears on a particular question, using organized, transparent, and replicable procedures at each step in the process." (p. 1) in order to identify, in our case, the scientific contributions in the field of carbon accounting (Tranfield et al., 2003). Thus, our review provides an interdisciplinary and an international overview of the current understanding of carbon accounting. Fink (2010) proposes four steps for a systematic review, which we used as a foundation and which we enriched by using the structure proposed by Tranfield et al. (2003). In the first step, we selected our research questions, the bibliographic article databases and websites, as well as the appropriate search terms. Then, we used practical review criteria for the inclusion or exclusion of the relevant literature. In the third step, we developed and applied methodological review criteria. Finally, we synthesized our findings.

3.1. Step 1: Selecting research questions, databases, websites, and appropriate search terms

Because we could not identify any comprehensive article on carbon accounting, our research questions for the systematic review was rather broad: "How is the term carbon accounting defined?" or "What is the understanding of carbon accounting?" To search the literature, we chose the search term "carbon * accounting", which also comprised, for example, "carbon dioxide accounting". Additionally, we used the chemical symbol CO_2 ("CO_2 * accounting"). Because CO_2 belongs to the family of GHG, we also decided to use the terms "greenhouse gas * accounting" as well as