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Prospects for Environmental Management Accounting in the Age of Decarbonization: Focusing on Internal Carbon Pricing

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In recent years, many companies have positioned efforts to decarbonize as a central issue in their environmental strategies. On the other hand, environmental management accounting has so far provided little effective consideration of the information and measures that support the realization of such strategies. Internal carbon pricing (ICP) has the potential to be one of the few management accounting methods that can directly address the above challenges. This study focuses on the importance of ICP as a new challenging issue in environmental management accounting that contributes to decarbonization management and examines the implications of using it and how to set it up. This work examines internal carbon pricing as a mechanism to encourage greenhouse gas (GHG) emission reductions within the framework of management accounting in order to evaluate the direction of the development of environmental management accounting in the decarbonization era. The paper explores the functioning of internal carbon accounting schemes and their impacts through the case of Microsoft Corporation and

evaluates the influence on investment decisions of ICPs, which have gained attention in recent years as a tool to encourage GHG reductions. Additionally, the configuration and integration of ICP with management systems such as budgeting are studied. The study demonstrates that ICP provides a new path for environmental management accounting in the age of decarbonization based on these factors.

Keywords: decarbonized management, carbon neutral, environmental management accounting, internal carbon pricing.

Introduction

The Intergovernmental Panel on Climate Change (IPCC) report 2022 points to a wide range of climate risks, including food, health, poverty, and war (Warren et al., 2021). To address these climate crises, the international community adopted the Paris Agreement in December 2015 at the 21st Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC) in Paris, France, as a new international framework for reducing greenhouse gas emissions and other actions after 2020, which entered into force the following year, 2016. In response to this, countries that are parties to the Paris Agreement, such as France and Germany, have declared "carbon neutrality by 2050" (GHG emissions minus their anthropogenic reductions balance, meaning that real emissions are zero) aiming to achieve virtually zero emissions (it means subtraction of the "amount absorbed" by afforestation and forest management from the "amount emitted" of carbon dioxide and other greenhouse gases, and reduction of the total to practically zero (MoEFCC, 2022) of CO_2 and other greenhouse gases (GHG) one after another. In other words, the Paris Agreement has been the catalyst for the world's shift from a "low-carbon" to a "decarbonized" economy.

Since then, governments have strengthened regulatory policies such as emissions trading and carbon taxes to achieve carbon neutrality, and environment and social governance (ESG) investments, mainly by institutional investors and financial institutions, have progressed, and many companies around the world have set goals for decarbonization. Indian companies are no exception: "Vedanta", for example, has set a goal of "Vedanta Carbon Zero", aiming to achieve zero GHG emissions by 2050. Similarly, "Tata Consultancy Services" plans to achieve net zero emissions by 2030 and company "Mahindra and Mahindra" by 2040.

In light of these trends, this study focuses on internal carbon pricing as a new issue for environmental management accounting in the decarbonization era and examines its operation and setting method. Specifically, after summarizing the characteristics of internal carbon pricing, the significance of establishing a new environmental management accounting method that contributes to decarbonization management and its setting method will be discussed through examples and Microsoft's case study.

Environmental management accounting, which can provide both financial and non-financial information about the environment, is expected to play a very important role in achieving a company's environmental strategy of decarbonization management. However, it has been pointed out that current environmental management accounting, centered on material flow cost accounting (MFCA), tends to give priority to short-term profits rather than environmental conservation, with the pursuit of improvement effects on the production side as the central issue (Walz and Guenther, 2021).

An approach called internal carbon pricing (ICP), which establishes voluntary regulations to internalize the economic costs of GHG emissions, has been attracting attention in recent years as a way to support corporate efforts to decarbonize. A survey report by CDP India (the Carbon Disclosure Project (CDP), a British non-governmental organization (NGO) that operates a global disclosure system to help investors, companies, nations, regions, and cities manage their environmental impacts, which in India has been active since 2012 as CDP India) (2021) reveals that about 130 Indian companies have already introduced ICP, and it is clear that practical interest is growing. ICP is expected to facilitate decision-making on decarbonizing investments and measures from a long-term perspective with an eye on the future. ICP has the potential to bring about new developments in environmental management accounting.

ICP is recommended by the Ministry of Environment, Forest, and Climate Change (MoEFCC), India, as a tool

to promote GHG reductions, and its effectiveness in reducing GHG emissions has been demonstrated (Vadera et al., 2024). However, a company's primary objective is to pursue economic value; even if GHG emissions can be reduced, the company cannot sustain its activities unless it can secure sufficient profits to satisfy investors. Therefore, ICP is expected to stimulate organizational behavior that leads to GHG emission reductions, while at the same time reducing production costs by increasing the efficiency of management resource use, thereby improving the financial performance of the company (Trinks et al., 2022).

Nevertheless, so far, no empirical evidence has yet been presented on the relationship between ICP and corporate performance. In addition, if the additional costs of achieving decarbonization management cause companies to miss out on profits, the stock market valuation of the company in question may decline, possibly harming the interests of shareholders. Therefore, ICP needs to be discussed within a management accounting framework in order to ensure the balance between GHG emission reduction targets and profit targets expected in the decarbonization era. This is because the internal carbon price is a target for companies to strive for carbon neutrality throughout their organizations, and management accounting has contributed to various management issues of organizations by providing a framework for setting reasonable targets to be achieved and controls to ensure their realization.

As indicated above, ICP refers not so much to the price itself but rather to the setting of the price and the overall management activities through this price. It should be noted that, at least in this study, ICP is discussed primarily in this sense.

Environmental management accounting to support the realization of decarbonization strategies

The goal of the Paris Agreement is to limit the increase in global average temperature to 1.5°C above pre-industrial levels. Specifically, the agreement calls for "halving global CO_2 emissions over a time horizon of less than 10 years, until 2030, and reducing emissions to zero over the following 20 years" (Copley, 2023).

Governments are not the only ones increasingly concerned about the climate crisis. ESG investments are becoming more popular, especially among institutional investors and financial institutions, and major institutional investments and financial institutions in Europe and the United States, such as the New York State Retirement Fund in the United States, the National Employment Savings Trust, and JP Morgan Chase in the United Kingdom, have announced a series of investment plans based on decarbonization (Ekins and Zenghelis, 2021). Thus, as society moves rapidly toward decarbonization, addressing environmental issues is not simply a matter of corporate social responsibility but has already become an important component of corporate strategy. In other words, we are entering an era in which environmental strategies are becoming indispensable.

According to Palmié et al. (2023), environmental strategy is "the process of recognizing the legitimacy and importance of environmental issues in the formulation of organizational strategy and incorporating them into organizational strategy." That environmental strategy consists of "a series of measures that reduce a company's impact on the environment, such as reducing energy consumption, using renewable energy, and establishing environmental management systems" (Pérez-Valls et al., 2019). In any case, environmental strategies are by no means independent of management accounting. The success of such a strategy depends on various aspects, such as material flow, employee knowledge and experience, and interdepartmental communication and cooperation (Amoako, 2020). If so, so-called environmental management accounting will play a very important role in the realization of environmental strategies by providing financial and non-financial information about the environment (Solovida and Latan, 2017).

As a field of management accounting, environmental management accounting began to attract attention around the 1980s. A wide range of issues such as environmental investment decisions, environmental costing, and life cycle costing have been discussed (Walz and Guenther, 2021). Among the many issues to be considered in environmental management accounting, MFCA seems to have played a leading role since 2000. MFCA was developed in Germany as an environmental management accounting method based on eco-balance and later developed in Japan (Walz and Guenther, 2021). MFCA has quickly become the center of environmental management accounting, as it provides a framework that contributes to the improvement of resource productivity by grasping the fate of discarded

parts and materials as material flows, which have been overlooked by conventional management methods, and by contributing to the reduction of not only the quantity of materials but also their costs.

MFCA has become widely popular through its contribution to corporate profits by reducing waste. However, the emphasis on cost savings has limited MFCA as a solution to environmental problems. If so, how effective can MFCA be in realizing environmental strategies where decarbonization is a central issue? We will examine this question next.

Environmental strategy and MFCA

Studies have been developed for more than a decade to explore the use of MFCA not only to contribute to waste reduction but also to a low-carbon society. Bux and Amicarelli (2022) point out that MFCA can be a management tool to reduce CO_2 emissions by adopting GHG emission units of materials instead of unit costs based on MFCA material data. Nyide (2016) also mentions the potential of MFCA to contribute to low-carbon management by calculating GHG emissions from material losses.

In MFCA, material loss indicates a waste of resources. Therefore, the reduction of material losses can be evaluated as reducing environmental impacts, and through this, it contributes to the reduction of environmental impacts as well as improving the resource productivity of the production process. Therefore, some argue that if material losses are reduced, CO_2 emissions associated with the consumption of the material in question can be reduced (Walz and Guenther, 2021). Against this background, Walz and Guenther (2021) have proposed a method to analyze CO_2 emissions associated with the consumption of material losses using MFCA.

Assume that 100 000 euros worth of steel material is input in the production of products and that this is converted into 45 000 euros worth of products (positive products) and 55 000 euros worth of material losses (negative products) in the processing in Process 1. The GHG emissions associated with the production of the product and the generation of material losses can be prorated to 1.296 t and 1.584 t, respectively. Thus, based on the MFCA data, it is possible to ascertain MFCA-CO_2 information, and thus the reduction of material losses contributes to curbing the CO_2 emissions associated with the generation of said losses (Walz and Guenther, 2021).

Needless to say, MFCA focuses on reducing material loss costs. By reducing material losses, the associated CO_2 emissions are reduced, thereby facilitating the realization of a low-carbon economy. However, as noted above, companies are shifting their environmental goals from low-carbon to decarbonization. In order to achieve decarbonization, not only CO_2 emissions from material losses must be reduced, but also CO_2 emissions from products must be reduced at the same time. If so, the goal must be to reduce not only GHGs from material losses but also total CO_2 emissions from the entire production process.

MFCA is not, nor can it be, a method that aims to derive a specific outlook or methodology that contributes to the reduction of CO_2 emissions in order to decarbonize. The objective is to visualize the quantity and cost of material losses in comparison with those of products and to separate positive and negative products in terms of CO_2 emissions. Therefore, MFCA, the current mainstream of environmental management accounting, cannot play a sufficient role in achieving the long-term strategy of "decarbonization" that companies are expected to pursue in the future.

In addition, the current MFCA focuses on improving short-term profits through increased resource productivity rather than on contributing to solving environmental problems. However, this is a limitation due to the instrumental nature of MFCA, and one cannot hope that this analysis will lead directly to measures that reduce waste and CO_2. In addition, although not limited to MFCA, the subject of discussion in existing environmental management accounting has been almost exclusively limited to production processes. However, CO_2 or GHG, which are indicators for evaluating a company's environmental performance, are affected not only by production processes but also by all corporate processes, including decision-making processes and business management processes. Therefore, carbon neutrality can never be achieved unless the company as a whole is able to promote behavioral change toward decarbonization. Unfortunately, existing environmental management accounting has paid little attention to environmental issues in business processes other than production, and in order for environmental management accounting to contribute to achieving carbon neutrality, it must necessarily take into account the overall CO_2 emissions of the entire enterprise.

Thus, there are at least two problems with existing environmental management accounting. The first is that it prioritizes short-term profits and lacks a long-term perspective on environmental issues. The second is that it focuses only on the production process and neglects to analyze the impact of environmental issues from a company-wide perspective. What, then, are the requirements for environmental management accounting that will contribute to the rapidly advancing decarbonized society? In the next section, we will discuss a framework for environmental management accounting that achieves carbon neutrality with the help of ICP, which is currently the focus of much attention.

Methods

ICP is a voluntary regulatory method for companies to internalize the economic costs of their GHG emissions. ICP is regarded as the most effective way to assess and manage the risks associated with GHG emissions (CDP, 2021). CDP's research reports that, by 2020, 853 companies worldwide had implemented ICPs, and an additional 1159 companies planned to do so within two years (CDP, 2021). As mentioned above, about 250 Indian companies have already introduced ICP or plan to do so within two years (CDP India). For example, it was reported that Tata Chemicals introduced ICP in July 2021 at 10 000 rupees/t for use in investment decisions on energy-saving equipment, and Tech Mahindra introduced ICP as a criterion for investment decisions. In addition, some companies, such as Infosys, not only use ICP as a criterion for investment decisions but also consider the CO_2 reduction effect of their products as additional "income" and calculate it for products with larger CO_2 reductions.

On the other hand, the number of ICP-related papers is increasing on the research side as well. In fact, a review of the number of papers on Web of Science that include internal carbon price as a topic over the past five years shows a marked increase.

Porter's hypothesis discusses the relationship between environmental regulation and industry competitiveness. It is argued that well-designed environmental regulations have the effect of inducing organizational innovation and consequently improving organizational competitiveness (Rubashkina et al., 2015), Trinks et al. (2022) have investigated firms' motivations for implementing ICPs. Lilliestam et al. (2021) have analyzed barriers to ICP implementation. An empirical study of U.S. companies by Zhu et al. (2022) shows that companies with ICP reduced CO_2 emissions per employee and CO_2 emissions per revenue by 13.5% and 15.7%, respectively. Nevertheless, while existing studies discuss the external effects of ICP, such as GHG emission reductions and environmental information disclosure, there is little discussion of the impact on decision-making and control mechanisms. In addition, according to the MoEFCC (2022), there are currently more than 100 Indian companies that have adopted ICP, but many are still in the process of considering specific applications of ICP. In other words, it can be assumed that most companies still have many questions about the use of ICP and its effects. On the other hand, it is a fact that many companies are planning to fully implement ICP in their investment decisions between 2022 and 2030. Will ICP be able to meet these expectations?

Investment decisions are where ICP contributions can be expected to be most significant. While it is possible to reduce GHG emissions by improving productivity, RandD and capital investment can be expected to have a greater impact on GHG emissions reduction than fundamental or improvement activities. The following hypothetical example illustrates the use of ICP in investment decisions.

Example

Assume now that there are two investment alternatives A and B, both with an economic life of 5 years. The cost of capital is 10%. To simplify the problem, tax shields are not considered. First, let us calculate the profitability of the investment alternatives without considering ICP using net present value.

As Table 1 shows, the calculations resulted in net present values of 64.57 million rupees and 33.97 million rupees for Proposals A and B, respectively. In the existing discussion on investment decision-making, it is assumed that the investment proposal with the highest profitability is the superior investment proposal, and since the net present value of Proposal A is higher than that of Proposal B, the decision is basically made to invest in Proposal A. Although it is necessary to consider long-term returns and risks when making large capital and equipment investments, the existing net

Table 1. *Calculation of net present value (unit: 10 000 rupees)*

	Plan A			Plan B		
	Net cash flow	Capital cost (10%)	Present value	Net cash flow	Capital cost (10%)	Present value
0 Year	–9000			–10 000		
1 Year	3000	0.9091	2727	2500	0.9091	2273
2 Year	3200	0.8264	2644	2900	0.8264	2397
3 Year	5300	0.7513	3982	4700	0.7513	3531
4 Year	5300	0.683	3620	4700	0.683	3210
5 Year	4000	0.6209	2484	3200	0.6209	1987
Net present value	2727 + 2644 + 3982 + 3620 + 2484 + 9000 + 6457			2273 + 2397 + 3531 + 3210 + 1978 + 10 000 + 3397		

present value method framework has not incorporated the effect of GHG emission reductions in its evaluation. Therefore, if the realization of an environmental strategy is the goal, it is necessary not only to calculate the profitability of the investment project but also to consider the effect of GHG emission reductions at the same time. In addition, in order to realize carbon neutrality, it is necessary to make investments that anticipate drastic GHG emission reduction effects from the RandD and equipment introduction stages. Furthermore, corporate managers have not shown much interest in information presented in physical units of GHG emissions (Walz and Guenther, 2021). In the current situation where carbon neutrality is eagerly awaited, it is necessary to incorporate GHG-related economic indicators into the evaluation of the profitability of investment.

The ICP is precisely the indicator that meets this expectation. ICP is a way to internalize the economic costs of GHG emissions, and therefore, incorporating it into the profitability assessment of an investment proposal allows for an integrated evaluation of the financial and non-financial effects of the investment proposal. In addition, about 60% of companies that have implemented ICP use it as reference data for investment decisions (CDP, 2021). Let us examine a case study of an evaluation of an investment proposal that takes ICP into account.

Here, the ICP is assumed to be 126 000 rupees/t, referring to the market price of emissions trading in the EU. Then, the net present value is recalculated by adding the ICP to the cash flow calculations for Proposals A and B.

Table 2. *Calculation of net present value considering ICP (unit: 10 000 rupees)*

Investment Proposal A						
	Net cash flow	Emissions	Emission costs	CO_2 discount CF	Capital cost (10%)	Present value
Year 0	–9000					
Year 1	3000	900	1134	1866	0.9091	1696
Year 2	3200	1000	1260	1940	0.8264	1603
Year 3	5300	1500	1890	3410	0.7513	2562
Year 4	5300	1500	1890	3410	0.683	2329
Year 5	4000	1200	1512	2488	0.6209	1545
Net present value 1696 + 1603 + 2562 + 2329 + 1545 – 9000 = 735						

Investment Proposal B						
	Net cash flow	Emissions	Emission costs	CO_2 discount CF	Capital cost (10%)	Present value
Year 0	–10 000					
Year 1	2500	350	441	2059	0.9091	1872
Year 2	2900	400	504	2396	0.8264	1980
Year 3	4700	700	882	3818	0.7513	2868
Year 4	4700	700	882	3818	0.683	2608
Year 5	3400	600	756	2644	0.6209	1642
Net present value 1872 + 1980 + 2868 + 2608 + 1642 – 10 000 = 970						

In order to quantify the qualitative risk of future climate change, the CO_2 discounted CF is calculated by taking the estimated amount of expected CO_2 emissions of each investment proposal multiplied by the ICP and adding it to the net present value of the investment proposal as a cash outflow. The result of the net present value calculation using this CO_2 discounted CF is the cash flow after deducting the costs expected to be incurred to reduce CO_2 emissions in the future. This makes it possible to calculate the net present value in relation to CO_2.

As shown in Table 2, the net present value of Proposal A and Proposal B is 7.35 million rupees and 9.7 million rupees, respectively, and unlike in the previous example, the net present value of Proposal B is higher than that of Proposal A, prompting the decision to invest in Proposal B. The net present value calculation using ICP shows that if any costs are incurred to reduce GHG emissions, the cash flow or return from the proposed investment will be reduced by any costs incurred to reduce GHG emissions. Therefore, the ICP-based evaluation of investment alternatives will encourage the selection of investments with lower GHG emissions, thereby saving a large amount of future environmental costs. Naturally, this would support the achievement of the company's environmental strategy goals.

In the profitability evaluation of existing investment proposals, it was not possible to evaluate the economic return and GHG emissions from such investments on the same level. Therefore, business managers were forced to make a choice between prioritizing economic returns or the magnitude of environmental impacts. On the other hand, if the ICP is employed in the adoption of investment proposals, GHG emissions will be homogenized with economic returns and literally transformed into an integrated scale for evaluating the profitability of investment proposals. This is the greatest benefit of the ICP, but to maximize it, the ICP itself must be set at a feasible level. In the previous example, the price obtained from the emissions trading market was used for the calculation, but this is not an ICP in the original sense. The same applies to the use of other carbon credits (although carbon credits do not have a strict definition, they are generally defined as a quantified value for the amount of GHG reductions and removals that can be traded among countries and companies) as well as emission rights and emission trading prices. These prices or credits are meant to compensate companies for their inability to reduce GHG emissions on their own by purchasing the necessary amount of emission reductions from the market. At the very least, the cost of emission reductions would need to be kept below the market price if companies are to take steps to reduce their GHG emissions on their own.

In any case, the issues surrounding the setting up of the ICP and another contribution expected from the ICP will be discussed below.

Effect of ICP on generating funds for environmental investment

Another contribution of the ICP can be pointed out as its effect in raising funds for environmental investments within the company. For example, by establishing an "internal carbon charge" for business units and other divisions, GHG emissions can be recognized as a cost for the division, thereby incentivizing employees in each division to voluntarily reduce GHG emissions (Lewandowski and Ullrich, 2023). Here, internal carbon charging is the practice of charging a cost share based on the GHG emissions of each division, department, or business project.

Microsoft Corporation (further – Microsoft) is considered the most successful example of using this mechanism. Microsoft declared its commitment to carbon neutrality in 2012, set up an ICP the following year, and began operating an internal carbon charging system. Microsoft's ICP calculates the internal carbon charge by adding the internal initiative costs, green energy purchase costs, and carbon offset (carbon offset means investing in external reduction activities when it is difficult to reduce the amount of GHG emissions commensurate with the company's GHG emissions and offsetting the amount of emissions and reductions by compensating for the shortfall) costs (called the environmental initiative portfolio cost by the company) and dividing by the company's total annual GHG emissions to arrive at the internal carbon charges as shown in *Equation (1)* (DiCaprio, 2013).

Here, internal initiative cost refers to the total cost of promoting GHG emission reductions within a company. Green energy purchase costs are calculated by dividing the total annual GHG emissions by the carbon emission factor of green electricity and multiplying by the unit cost per unit of green electricity, as in *Equation (2)* (DiCaprio, 2013).

Carbon offset costs are then calculated by dividing the total annual GHG emissions by the number of carbon offsets and multiplying by the price per carbon offset, as in *Equation (3)* (DiCaprio, 2013).

$$ICP = \frac{Internal\ initiative\ costs\ +\ green\ energy\ purchase\ costs\ +\ carbon\ offset\ costs}{Total\ annual\ GHG\ emissions} \quad (1)$$

$$Green\ energy\ purchase\ costs = \frac{Total\ annual\ GHG\ emissions}{Carbon\ emission\ factor\ of\ green\ power} \times Unit\ price\ per\ unit\ of\ green\ powe \quad (2)$$

$$Carbon\ offset\ cost = \frac{Total\ annual\ GHG\ emissions}{Number\ of\ carbon\ offsets} \times Price\ per\ carbon\ offset \quad (3)$$

Microsoft thus aggregates the amount of GHG emitted by each business unit's activities and multiplies this amount by the ICP, which is collected from each business unit on a quarterly basis. The internal carbon charge collected will be invested in various internal and external carbon offset projects as a new investment fund to realize the environmental strategy. In addition, the internal carbon charge is included as a line item in each business unit's income statement, and an expense budget is prepared for the charge (DiCaprio, 2013).

In the three years since the implementation of the internal carbon charge, Microsoft has redirected funds generated by the charge to a variety of internal and external investments, resulting in a reduction of approximately 7.5 million tonnes of GHG emissions and annual cost savings of over $10 million. In addition, the project is said to have contributed to improving the lives of approximately 3.2 million people in developing countries through investments in carbon offset projects (DiCaprio, 2015).

Results and Discussion

Although more and more companies are planning to implement ICPs, a number of issues still remain regarding ICPs. The most important of these challenges relates to how ICPs are set up. Decisions on evaluating the profitability of proposed investments and the willingness of management and employees to reduce GHG emissions will depend on exactly how the ICP is set. On the other hand, setting it too high could lead to a preference for decarbonization-oriented projects, which could hurt the organization's performance.

In this regard, Lilliestam et al. (2021) point out that the difficulty in setting the ICP at an appropriate level, in addition to the lack of technology to determine GHG emissions according to the size of the company, is the main obstacle to the introduction of the ICP.

There have been three methods of setting ICPs: shadow pricing, implicit pricing, and internal carbon charging, as shown in Table 3. Of these, shadow pricing is used by about half of the companies (CDP, 2021).

Table 3. *Classification of ICP setting methods*

	Shadow price	Implicit price	Internal fee
Definition	It is a hypothetical carbon price that companies put on their carbon emissions to manage the anticipated future costs that will be incurred by carbon emissions when assessing the risks and opportunities for companies due to climate change (WBCSD, 2017).	It is an implied carbon price that retrospectively calculates the cost a company spends to reduce its CO_2 (CDP, 2021).	It is a system that charges each business unit or department for the CO_2 emissions generated by the company's activities (CDP, 2021).
Operation method	Combined with investment projects, the ability to visualize the impact of CO_2 emissions on project profitability is expected.		Funds raised would be redistributed to invest in decarbonization projects. In addition, the internal carbon charge is expected to have the effect of directing employees' attention to decarbonization management and promoting changes in internal behavior.
Exchange of money	None		Yes
Problems	Since these are hypothetical prices, if the rationale for setting them cannot be clearly stated, it could lead to erroneous decisions.	The method cannot react to future risks because it is a retrospective calculation based on measures already taken by the company.	Business units with high emissions are under a heavy financial burden, which could lead to internal dissent. Unless the funds collected are explicitly invested in emission reduction products, they do not incentivize employees.

In particular, it appears to be used more often as a medium- to long-term investment planning, risk management, and strategy formulation tool (Lilliestam et al., 2021). However, since shadow pricing is only a hypothetical price, it may not effectively promote emission reductions if the rationale for setting it cannot be clearly stated, while at the same time, it may lead to overemphasis on decarbonization, which could lead to a company's business crisis.

The implicit price is then calculated based on the costs a company has spent to reduce its GHG emissions. The implicit price, like the shadow price, is used to quantify the investment required to meet GHG emission reduction targets but does not generate actual cash flows. CDP reports that about 20% of companies appear to use this implicit price (CDP, 2021). However, the problem with implicit pricing is that it is calculated based on historical data and thus cannot reflect the risk of future regulatory tightening.

Finally, the internal carbon charge has already been described in light of the Microsoft case but differs significantly from the other two methods in that it involves a practical exchange of money. Internal carbon charging requires each division or business unit to bear additional costs based on its GHG emissions. This is unique in that it allows each division to recognize GHG emissions as a cost to the division and provides an incentive for division managers and employees to take voluntary action to reduce GHG emissions (Lewandowski and Ullrich, 2023). In other words, divisions or business units with high GHG emissions would be assigned additional costs based on their GHG emissions, thus motivating them to curb their GHG emissions in order to improve the performance of the business unit. In the long run, it is expected to also promote behavioral and cultural change within the company, thereby facilitating the achievement of a decarbonization strategy. Many companies appear to be attempting to channel funds raised through internal charges back into investments in decarbonization projects, as Microsoft did earlier (Lewandowski and Ullrich, 2023). CDP reports that about 15% of companies have set up ICPs in the form of internal carbon charges (CDP, 2021).

ICP as a management accounting indicator

In addition to the above three methods of setting ICPs, other methods include the use of external market

prices such as emissions trading market prices and carbon credits, the use of the social cost of carbon, and internal consultation to determine ICPs. While the existence of an external market price will give a certain degree of rationality to the internally set internal carbon price, a single market price is not necessarily appropriate for all companies. Since each company has different GHG emission reduction targets and marginal abatement costs, using the emission trading market price directly as an ICP is not a reasonable approach.

It has also been suggested that the ICP should be based on the social cost of carbon (Alakkas et al., 2023). The social cost of carbon is defined as "the cost of the additional impact damage (i.e., marginal impact damage cost) caused at a future point in time by the emission of one additional unit of carbon dioxide at a given point in time, discounted back to the point in time of carbon dioxide emissions" (Finch and Bergh, 2022). From an economic perspective, there is a theoretical basis for setting the ICP in terms of the social cost of carbon and implementing GHG reduction policies. However, since the social cost of carbon is calculated by a wide range of indicators, including GHG concentrations, temperature variability, GDP, and discount rates (Khabarov et al., 2022), it is almost impossible for companies to calculate it (Finch and Bergh, 2022) due to the uncertainty associated with scientific estimation.

The ICP, which is determined through internal consultation, in fact, corresponds roughly to a shadow price, which reflects future risk, and an implicit price, which is calculated based on historical information. Both shadow and implicit prices are intended to encourage investment in projects that have the potential to reduce GHG emissions. Shadow prices can reflect future risks and are therefore reasonable for use in evaluating investment projects that will reduce GHG emissions in the future, such as capital renewal and RandD. On the other hand, since the implicit price was calculated based on the cost spent by a company to reduce GHG emissions, it is also reasonable for use in the evaluation of projects that aim to offset GHG emissions that are difficult to reduce. Therefore, depending on the nature of the investment project, it may be necessary to change the way the ICP is set up.

For a company to be carbon neutral, it must both reduce and offset its GHG emissions. Since different ICPs need to be set for different decarbonization decisions, simply using external market prices or shadow or implicit prices as ICPs will not necessarily result in costs that reflect the GHG emissions of the entire company. Therefore, as seen in Microsoft's ICP setting discussed earlier, it seems likely that the movement toward setting a sort of unified ICP within a company will accelerate by combining several methods. However, even in such a case, careful consideration should be given to which method and how much weight should be given to which method. This is because not only GHG emissions but also the difficulty level of measures to reduce GHG emissions vary depending on the characteristics and nature of activities and investment projects implemented by divisions, business units, and their departments, and thus there is a risk of dissatisfaction among organizations depending on the ICP setting method.

The realization of the strategic goal of carbon neutrality requires the cohesion of all departments within a company. To this end, it is essential that the ICP be set at a level that is acceptable to all organizations within the company. Unfortunately, we cannot present a concrete path to this goal at this time, but even if the method of setting ICP is not technically reasonable, ICP must make a significant contribution as an action indicator to lead environmental strategies to realization. For example, it seems to us that this is very similar to the role played by target cost in cost planning. In cost planning, the target cost itself is not necessarily set based on the technical basis that guarantees its realization. In that sense, it is literally just a target, but in most cases, it is actually positioned as a must-achieve target. Therefore, it has been pointed out that the difficulty of achieving such goals and the tension that arises when they are not achieved elicit great efforts from organizational members and motivate them to strive toward the goals (Khoruzhy et al., 2023).

Nevertheless, we do not intend to deny the search for a rational way to set ICP, and although there have been many discussions on how to set ICP, there has been no explicit discussion on how to set ICP in a way that encourages organizations to work together to reduce GHG emissions. In any case, it is reported that many companies in India set their ICP at the 5000 to 10 000 rupees level, but most companies seem to be in a limbo situation, so to speak, as to what level this should be set at (MoEFCC, 2022). This may be due to a vague feeling among companies that pursuing a reasonable ICP setting may not always bring the best results. To confirm this point, it would be urgent to conduct an

interview survey of companies that have introduced ICPs, with a view to identifying issues related to ICP setup and collecting information on the scope of use and operation of ICPs themselves.

Incentives in the internal carbon charging system and integration into the budget system

As indicated in the results and discussion section, the greatest benefit of the ICP is that the prices obtained from the emission trading market can be used to evaluate investment proposals in order to prepare for GHG regulation. However, it is not appropriate to consider ICP only in specific situations such as the evaluation of investment proposals. For example, in Asia, which is the main overseas base for Indian companies, external regulations such as carbon taxes and emission trading that directly affect corporate finances are not in place as in Europe, so there is no incentive for management to avoid external regulatory risk. In the absence of incentives, simply using the ICP to evaluate investment proposals will also make it difficult to gain an internal understanding of decarbonization-oriented investments by business managers and employees who are not directly involved in investment decisions.

Linking goals to incentives is critical to strategy realization (Valuckas, 2019). If the strategic goal of decarbonization is not linked to incentives at all, then efforts and actions to decarbonize will not be stimulated. In this regard, Microsoft's internal carbon charging system, discussed above, is expected to provide incentives for business units to reduce GHG emissions, since business unit profits are measured by the profits after taking into account carbon costs from the ICP. Under this system, a certain cost (internal carbon cost) is imposed on the actual GHG emissions, and the imposed cost is deducted from the divisional profit of each business unit. Such costs will not be recorded in the financial statements for external publication but will be recorded in the divisional financial statements for internal management. Since GHG emissions are primarily related to energy and electricity use, imposing an internal carbon cost on the division would mean questioning the division's energy and electricity procurement and efficiency. This seems to be a similar mechanism to the internal interest rate system. The internal interest rate system is a question of the efficiency of the division's financing. In addition, just as the internal interest rate system focuses on making division managers aware of their responsibility to manage funds, the internal carbon accounting system focuses on making division managers aware of their responsibility to manage GHG emissions. Therefore, the implementation of an internal carbon charging system will encourage division managers to manage their GHG emissions and can also be used as a performance evaluation tool to assess the appropriate environmental performance of division managers.

However, even without an internal carbon accounting system, departments can still obtain information on their GHG emissions. However, we believe that introducing an internal carbon accounting system and incorporating GHG emission costs into the income statement would be an effective way to make department managers more actively aware of the importance of addressing environmental issues and motivate them to work toward solutions.

In addition, another mechanism that needs to be considered is the integration of GHG emission reduction action plans into the budget system. According to the CDP Climate Change Questionnaire 2021 (CDP has conducted an annual survey of companies' decarbonization efforts; the decarbonization efforts of the surveyed companies, including the setting up and operation of ICPs, are disclosed in the form of a database), the GHG emission reduction action plans of Windstream in the U.S., TOFAŞ in Turkey, and Huawei in China have already integrated their corporate GHG emission reduction plans into their budget systems through internal carbon charging schemes. Others, such as ALD Automotive in France and JSW Energy in India, have linked bonuses for business units or employees to the achievement of emission reduction targets set through internal carbon accounting schemes. Thus, an important approach is to use internal carbon accounting to increase incentives for emission reductions.

In the current era of decarbonization, a company's environmental performance has become an important evaluation indicator that affects corporate value as much as its financial performance. The goal of carbon neutrality is no longer something special. If that is the case, it will be necessary to integrate ICP into the daily management system, rather than consider it separately from the existing management system.

Conclusions

This study has discussed the direction of the development of environmental management accounting in the decarbonization era by discussing internal carbon pricing as a tool to promote GHG emission reductions within the framework of management accounting. This is not a sufficient contribution to the realization of the long-term environmental strategy of carbon neutrality or decarbonization management that companies are expected to pursue in the future. The paper analyzes the impact on investment decisions of the operation of ICPs, which have been attracting attention in recent years as a tool to promote GHG reductions, and examines the operation of internal carbon accounting schemes and their effects through the case of Microsoft Corporation. Furthermore, we examine how ICP is set up and integrated with management systems such as budgets. Based on these considerations, we show that ICP suggests a new direction for environmental management accounting in the era of decarbonization.

There are many unresolved issues regarding ICP, including how to set it up, make decisions on decarbonization, and integrate it into budget systems. In addition, ICP has rarely been discussed within the field of management accounting. However, in India, the incentives to reduce GHG emissions are not as strong as in Europe, as strict environmental regulations that promote GHG emission reductions are not yet in place. Therefore, how to promote GHG emission reductions through corporate management systems will become even more important in the future. In this regard, if the role of management accounting is to influence the decisions and actions of business managers through the creation and communication of information supported by an accounting scale, and to support the realization of common organizational goals through such influence, then ICP is unquestionably a management accounting tool, and it has characteristics that differ from any conventional information. ICP is a revolutionary tool because it integrates two normally incompatible metrics, securing economic returns and reducing GHG emissions, and allows for their consideration on a homogeneous scale. In this sense, ICP is not only groundbreaking but also has the potential to become an effective environmental management accounting tool to support the realization of corporate environmental strategies.

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