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Does It Pay to Be Green? A Total Quality Perspective

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ABSTRACT

The question of whether, when, and how efforts for better corporate environmental performance (CEP) improve corporate financial performance (CFP) remains controversial. We revisit this question from a total quality perspective, which unites previous research and highlights interdependencies between mediators of the CEP–CFP relationship. Total quality comprises internal process and product quality as well as stakeholders' perceptions. We use structural equation modeling in a German survey dataset and analyze two sample periods with different regulations and stakeholder expectations on CEP (2005–2010 and 2017–2022). For both samples, we find that better CEP leads to significantly better internal and external quality and also increased costs. For the early period, the improvements translate into higher revenues via external quality. For the more recent period, the improvements decrease costs via process quality. In both samples, we find a neutral effect on net CFP, implying that the documented cost or revenue benefits of green investments are counterbalanced by the associated additional costs.

JEL Classification: G18, G32, K38, K42, M41, M48, Q01

1 | Introduction

Ever since the question "Does it pay to be green?" was asked (e.g., Hart and Ahuja 1996, 30), there has been a controversial debate about *whether*, *when*, and *how* green investments pay off for firms (e.g., King and Lenox 2001; Hang et al. 2019; Galama and Scholtens 2021). While this debate remains unresolved (e.g., Grewatsch and Kleindienst 2017; Earnhart 2018; Yi et al. 2023), it is of great importance to transform the economy toward more sustainability and to support firms in making economic decisions, such as whether and how to invest in green technologies.

Empirical studies have found positive (e.g., Busch et al. 2022; Bendig et al. 2023), negative (e.g., Alexopoulos et al. 2018; Li et al. 2020), insignificant, and mixed associations (e.g., Hoang et al. 2020; Zhang et al. 2020) between corporate environmental performance (CEP)[1] and corporate financial performance (CFP).[2] These contradictory results are largely due to different measurement methods and study designs (e.g., Earnhart 2018; Hang et al. 2019; Galama and Scholtens 2021). In particular, the studies are based on different theories, which each supports a different direction of the relationship: The natural resource–based view supports a positive (e.g., Garcés-Ayerbe et al. 2022), agency theory a negative (e.g., Alexopoulos et al. 2018), or signaling theory a mixed relationship (e.g., Kumar et al. 2022) between CEP and CFP. The literature hence calls for a more holistic view on the relationship (e.g., Rintala et al. 2022; Chowdhury et al. 2023). We still agree with Guenther and Hoppe (2014, 689) that this literature can best be described based on the quote by Ullmann (1985, 540) that it is "in search of a theory".

Extant meta-studies (e.g., Wood 2010; Endrikat et al. 2014; Guenther and Hoppe 2014; Hang et al. 2019) identify a need for a comprehensive analysis based on a holistic theoretical framework. They find that a major reason for the inconclusiveness of prior research is the complex, endogenous, multistage,

and delayed relation between CEP and CFP, which is subject to various internal and external factors that are commonly analyzed one by one, but not comprehensively (e.g., Dixon-Fowler et al. 2013; Grewatsch and Kleindienst 2017; Bruna and Ben Lahouel 2022). The lack of a unified theory is particularly problematic because we cannot draw generalizable conclusions from the empirical findings without understanding the causal links.

In this paper, we address the relationship between CEP and CFP from a novel perspective. We propose that an important reason why green investments may affect CFP derives from superior *quality*, which improves operational efficiency or which customers are willing to pay for. By adopting this total quality (TQ) perspective, we aim to answer the need for a comprehensive analysis of the various internal and external factors of influence in a holistic theoretical framework.

TQ is a concept that aims to achieve superior operating performance through quality (e.g., Bouranta et al. 2019).[3] As suggested by the term "total," all people involved with the firm—both internally and externally—contribute to the TQ of a firm (e.g., Feigenbaum 1983; Klassen and McLaughlin 1993; Reeves and Bednar 1994; Hietschold et al. 2014). TQ management aims to continuously improve internal processes and generate high-quality products to meet or exceed the expectations and subjective perceptions of external stakeholders (e.g., Powell 1995; Khurshid et al. 2018). Internal and external quality are made up of many subordinate quality features and expectations of various stakeholder groups. TQ goes beyond mere compliance with quality standards (e.g., Franco et al. 2020). It includes the development of a comprehensive firm strategy, the involvement and training of employees (e.g., García-Alcaraz et al. 2019), continuous improvement of operations, internalization of feedback from suppliers, and fulfillment of customer requirements resulting in process and product innovations (e.g., Khurshid et al. 2018). Ecological aspects are a genuine part of quality because stakeholders increasingly require the products as well as the entire supply chain to conform to ESG standards (e.g., Beckford 2010; Khurshid et al. 2018; Abbas 2020b). Hence, the firm's endeavors for environmental improvements (i.e., CEP) can be considered an important element of TQ.

The management of TQ and CEP overlap with respect to the tools and underlying philosophies and can directly be integrated into one management system (Allur et al. 2018; Abbas 2020a), as is done, for example, in the European Foundation for Quality Management Excellence Model (e.g., De Menezes et al. 2022). Similarly, the International Organization for Standardization (ISO) issues standards for quality (ISO 9000) and environmental management (ISO 14000), which are applied voluntarily by numerous firms in conjunction (e.g., Heras-Saizarbitoria and Boiral 2013; Erauskin-Tolosa et al. 2020). Such integration provides firms with quality-related benefits such as improved operational efficiencies via better utilization of resources and waste management systems as well as improved competitive advantages (e.g., Tarí et al. 2012; Camilleri 2022). Poor CEP management affects the entire firm when stakeholders lose trust, customers reduce their purchases, and investors reduce the demand for the stock (e.g., Gill et al. 2012; Flammer 2013; Riera and Iborra 2016). Inferior CEP negatively affects the firms' external TQ perception even though other TQ dimensions may have been well managed. At the same time, superior CEP may contribute to higher TQ by, for instance, minimizing resource consumption and emissions during the production processes as well as during the usage of the products (e.g., Sammer and Wuestenhagen 2006; Jabbour 2009; Beckford 2010). A direct integration of TQ and CEP management may hence improve the firms' management process and output.

Despite these close conceptual ties, the TQ perspective on the CEP–CFP relationship has not been examined. Yet, doing so provides the advantage that the linkage between TQ and CFP is well studied and the TQ literature has identified the paths through which TQ relates to CFP. While quality improvements cause additional investment costs, they may also provide financial benefits through higher revenues and cost savings (e.g., Feigenbaum 1951). Considering CEP as a component of TQ hence allows us to analyze the CEP–CFP relationship based on the holistic framework of TQ and combine previously unconnected arguments of the CEP literature to detect interdependencies. Doing so reduces potential omitted variable biases.

We use structural equation modeling (SEM), which simultaneously analyzes multiple relations of endogenous and interdependent latent variables to provide a consistent, holistic methodological approach (e.g., Molina-Azorín et al. 2009; Hang et al. 2018). We investigate the influence of CEP on CFP via internal (process and product improvements) and external quality (stakeholders' perceptions) while considering their interrelations. In line with the TQ literature, we distinguish between the revenue and cost dimensions of CFP to gain more detailed insights into the underlying effects that define the relationship between CEP and net CFP. We apply multi-item measurement models based on theory and empirical results to overcome methodological shortcomings criticized in prior literature (e.g., Orlitzky 2003; Busch and Hoffmann 2011; Sila 2018a). Because prior literature indicates that the direct impact of CEP on CFP is delayed (e.g., Hang et al. 2019), we take time effects into account — both in the measurement of the variables and in additional analyses covering longer timeframes.

In addition, we study two sample periods because (a) the focus in the literature has shifted over time from the question of *whether* or not it pays to be green to the underlying *when* and *how* (e.g., Bartolacci et al. 2020; Kumar et al. 2021) and (b) environmental regulations and requirements have developed rapidly in the last two decades (e.g., Christensen 2021). First, we examine an early period (2005–2010) that is characterized by increasing public awareness for sustainability and the rise of voluntary CSR reporting. During this period, firms largely decided voluntarily whether or not to operate sustainably, and green firms could be viewed as first movers (e.g., Reitmaier et al. 2025).

Second, we study a recent period (2017–2022) in which the incentive for firms to act sustainably is increasingly based on external pressure and regulations (e.g., Gerwing et al. 2022; Vander Bauwhede and Van Cauwenberge 2022). Firms are increasingly forced to comply with various ESG regulations that directly or indirectly target the firms' CEP. For instance, the European Green Deal and related legislations target new environmentally friendly developments and reductions of activities and products that threaten the environment.

Further regulations affect firm behavior, like the European Non-Financial Reporting Directive 2014/95/EU (NFRD) and the follow-up Corporate Sustainability Reporting Directive (CSRD).[4] The reporting requirements are intended to increase public pressure on the firms, thereby improving the firms' behavior toward more responsibility (e.g., Christensen et al. 2021).

The recent period is thus characterized by high regulation intensity and high external pressure on the firms to become sustainable. In contrast, in the early period, the CEP–CFP relationship is largely driven by voluntary environmental efforts that provided firms with an opportunity for differentiation. Our study provides an analysis of the differential effects of these conditions. Additional moderation analyses for the early period examine the voluntary context that may influence the CEP–CFP relationship.

We examine German firms that participated in a broad survey of the Mannheim Innovation Panel (MIP), which is part of the EU's Community Innovation Surveys (CIS). The survey encompasses all dimensions of the TQ concept. It claims to be representative of the innovation activities of German firms. Recent studies using CIS data repeatedly call for country-level studies to gain more detailed insights (e.g., Ferreira et al. 2020; Parrilli et al. 2023). In Germany, the importance of innovation is high, and related spendings are similar to the United States (e.g., OECD 2024). In Europe, small- and medium-sized firms (SMEs) represent 99% of all firms (e.g., García-Quevedo et al. 2020). However, most studies only cover large, listed firms. As the MIP questionnaire is based on such SMEs, our study is largely representative for Europe, which strongly relies on SMEs. Because SMEs are typically less rich in financial resources than large firms, the need for investments in CEP to pay off is existential. In contrast, environmental improvements might be more strategic for large firms and only pay off in the long term. The results are likely affected by the stakeholders' interest in environmental protection. Given the currently different evolution of ESG-related regulations in Europe and the rest of the world, it is likely that the results in our European setting will differ from other non–European countries. The MIP hence offers a unique research base to analyze the questions of whether, when, and how it pays to be green from a TQ perspective for the European setting.

We find that better CEP leads to significantly better internal and external quality in both sample periods. However, the improvements in internal and external quality have different consequences on CFP in the two sample periods. For the early period, we find that external quality perceptions lead to higher revenues, which implies that stakeholders are willing to pay more for a premium quality "green" product during that period. In contrast, for the recent period, we find no effect on revenues. Stakeholders seem to have increased their expectations to an extent where environmentally friendly products do not receive a significant premium. Nonetheless, firms still benefit from better CEP as internal process quality improvements lead to decreased costs. This implies that firms experience cost savings that derive from the effects of green investments on process efficiency. Our analysis of net CFP shows that there is no overall effect on CFP, suggesting that in both periods, the costs of green investments are compensated by their positive effects: higher revenues due to higher quality perceptions in the early period and reduced costs due to process improvements in the recent period. This result is consistent with the idea that firms would only invest as long as the benefits compensate for the investment cost. The additional moderation analyses (see Section 4.4) further indicate that the results depend on industry, firm size, location, ownership structures, competition, and experience in CEP management.

Our contribution is threefold: First, we extend previous research on the CEP–CFP relationship by adopting a new approach — the TQ perspective. This holistic perspective allows us to comprehensively study mediating and moderating variables, consider time lags, and incorporate the multidimensionality of the variables. We extend prior literature that has only studied single mediators and has not considered potential interrelations. To measure quality, we include numerous internal product and process aspects as well as external quality aspects. The results not only show *whether* and *when* it is worthwhile for firms to be "green", but above all *how*, that is, through which paths. By conducting our study for two different periods, we also provide an understanding of the temporal development of the CEP–CFP relationship. The results show that green investments result in better internal and external quality and have no negative effect on net financial performance. While green investments imply costs, these can be compensated by either higher revenues for extended external quality (in the early period) or cost savings due to process improvements (in the recent period).

Second, our study leads to new insights and recommendations for sustainable corporate management. It is advisable for management to drive internal quality improvements because these can improve CFP either via external perceptions, which in turn is positively influenced by internal improvements, or directly via internal process improvements. Furthermore, our study supports the idea of a comprehensive TQM that integrates the multiple quality dimensions, including CEP, their interactions, and contextual influences to profoundly monitor financial implications of CEP investments. In particular, our moderation analyses show that the individual setting of a firm (regarding industry, firm size, location, ownership structures, competition, and experience in CEP management) has a significant influence on the financial implications of CEP. This is in line with the contemporary proposition of the International Integrated Reporting Framework to implement a connective multicapital focus in management by the so-called integrated thinking (IIRC 2021), now part of the International Sustainability Standards Board (ISSB). Taken together, our analyses highlight the importance of an integrated TQM that incorporates all the many CEP-related dimensions and firm individualities. Such clearer management focus may, in turn, help firms to fulfill recent reporting requirements such as the NFRD and CSRD that ask for financially material information, that is, ESG information that has an impact on firms' CFP.

Third, we provide new insights and recommendations for policymakers. As our results have shown, the negative impact of environmental investments on net CFP is largely compensated by positive consequences. The results show that there is no net benefit of green investments, implying that policymakers may need to provide the necessary incentives to invest in sustainable

technologies, to support transformation. Our moderation analyses show that particularly smaller firms face increased costs from CEP. These are the firms with fewer employees, and hence often less capacity for innovative additional projects, thus less capacity to accommodate additional environmental regulations and pressures. It is therefore particularly important to tailor public financial support to firm size as well as country and industry specificities. It is tantamount to address these CEP facets that indeed qualify to spur environmental change without destroying economic value (e.g., Flachenecker and Kornejew 2019). Our results further provide support for the view that regulatory initiatives, such as the NFRD and CSRD, provide stakeholders with better insights into the firms' internal processes. These insights improve their assessment of the firm's internal quality and hence also allow for a better monitoring of management (e.g., Christensen et al. 2021).

2 | Literature and Hypotheses

2.1 | Prior Literature on the CEP–CFP Relationship

There is an increasingly large literature on the relationship between CEP and CFP (e.g., Kumar et al. 2021; Chowdhury et al. 2023). Particularly, the direct CEP–CFP relationship has been studied extensively. The traditionalist view assumes a negative relation, while the revisionist view assumes a positive relation (Huang and Li 2017; Ben Lahouel et al. 2020). Consistently, empirical studies find positive (e.g., Farza et al. 2021; Yi et al. 2023), negative (e.g., Alexopoulos et al. 2018; Li et al. 2020), but also mixed and insignificant relations.[5] Hoang et al. (2020), for instance, find significantly positive, significantly negative, and insignificant associations between CEP and CFP, which they attribute to the different measures used for CEP and CFP in their study. Trumpp and Guenther (2017), Latan et al. (2018), and Zhang et al. (2020) conclude that the relationship between CEP and CFP is more complex and is U-shaped, which is why there are areas with negative and positive correlations between CEP and CFP.[6]

Meta-analyses conclude that the results on the CEP–CFP relationship depend on the considered variables, their conceptualization, and measurement (e.g., Endrikat et al. 2014; Friede et al. 2015; Alexopoulos et al. 2018). CEP can be measured using output-based or process-based environmental indicators. Output-based metrics include the consumption of energy, water, emissions, and waste (e.g., Busch et al. 2022), while process-based metrics include environmental policies and strategies (e.g., Xue et al. 2020). Hang et al. (2018) find that studies using output-based measures of CEP are more likely to show a positive relationship between CEP and CFP than studies using process-based measures. Guenther and Hoppe (2014) find that ranking- or rating-based CEP measures tend to positively relate to CFP, while reporting-based CEP measures tend to show negative or neutral results. CFP is measured with accounting-based and market-based metrics (e.g., Lu and Taylor 2016; Earnhart 2018). Accounting-based measures include revenue and costs as well as the profitability indicators return on sales (ROS), return on equity (ROE), and return on assets (ROA). Market-based measures include share price, market return (e.g., Lu and Taylor 2016), and Tobin's Q (e.g., Endrikat et al. 2014). Guenther and Hoppe (2014) find that questionnaire-based CFP measures tend to positively relate to CEP, while accounting-based CFP measures tend to show negative or neutral results.

Earnhart (2018) finds that most studies that use accounting-based metrics analyze the overall effect of CEP on net CFP, but only few analyze cost reductions or separate revenue and cost effects. No prior study has jointly analyzed the effects on revenues, costs, and net CFP, although the revenue and cost effects may (over-) compensate each other. Prior results of a neutral relation may hence be due to such compensation effects rather than the absence of an effect.

Prior research also discusses the impact of moderating factors that influence the CEP–CFP relationship: firm characteristics such as size, location, listing (e.g., Dixon-Fowler et al. 2013), corporate culture (e.g., Vastola et al. 2017), and policy (e.g., Nguyen et al. 2021), as well as industry characteristics (e.g., Hang et al. 2018). However, empirical studies rarely provide variants of their results depending on these moderators to improve the understanding of their impact (e.g., Earnhart 2018). More recent studies analyze mediating factors, that is, the paths through which CEP indirectly relates to CFP. Such studies find (partial) mediation by innovation (e.g., Zehir and Ozgul 2020), prominence and favorability (e.g., Zhang and Ouyang 2021), overall reputation (e.g., Bahta et al. 2020), human capital, corporate culture (e.g., Surroca et al. 2010), and sustainable competitive advantages (e.g., Saeidi et al. 2015). Such mediator analyses extend studies on the direct CEP–CFP relationship by considering additional correlated factors. However, they commonly analyze these one by one. Their interrelations are unexplored, and some omitted variable bias may remain. Meta-analyses observe a missing comprehensive basis (e.g., Wood 2010; Guenther and Hoppe 2014) and the literature calls for a more holistic view (e.g., Chowdhury et al. 2023). By adopting the TQ perspective,[7] we aim to answer these research needs. We use methods like SEM to include mediating and moderating variables in one comprehensive analysis, while considering time lags and the multidimensionality of the variables.[8]

2.2 | Total Quality and Its Relation to CFP

TQ is a holistic and versatile concept (e.g., Hietschold et al. 2014; Aquilani et al. 2017; Bouranta et al. 2019; Ho et al. 2023). Hietschold et al. (2014) show in their literature review that TQ typically comprises the following components: improved organizational performance, the focus on specific products, services or processes, the absence of error throughout the value chain, and the fulfillment of stakeholder requirements, particularly customer needs. Bouranta et al. (2019) identify five key components of TQ: process management, employee quality management, employee knowledge and education, quality practices of top management, and customer focus. Abbas (2020a) distinguishes six practices of TQ: process management, leadership, strategic planning, information and analysis, human resource management, and customer focus. The definition of TQ is evolving and includes all kinds of quality improvements, including new technologies such as artificial intelligence (e.g., Carvalho et al. 2021; Sader et al. 2022).

We follow the "European Foundation for Quality Management Excellence Model", which distinguishes between enablers, that is, practices and processes within the organization and results on key stakeholders (e.g., De Menezes et al. 2022). Accordingly, we differentiate between internal and external quality. Under internal quality, we subsume the quality of products and processes because they are controlled within the company. The term product includes not only physical products but also services. Internal product quality includes not only improvements in technical requirements and software but also usage characteristics, usability, availability, customer benefits, and design. Under the category of processes, we subsume procedures and methods. We measure internal process quality based on Porter's value chain, which distinguishes between primary and support activities (Porter 1985). Process quality hence includes improvements along all primary activities of the value chain such as development, production, logistics, marketing, and sales as well as in support activities such as information technology, administration, and organization.

For external quality, we follow Aquilani et al. (2017) and include other stakeholders beyond customers to provide a more comprehensive picture (e.g., Allur et al. 2018; Sila 2018b; Franco et al. 2020; Maswadeh and Al Zumot 2021). We distinguish between four stakeholder groups that are interrelated with the company: customers, capital market, employees, and opinion leaders. By including these internal and external factors in our study, we create a uniform and clear structure of TQ. We summarize factors that were previously considered in isolation by applying the method of multi-item measurement.

Prior TQ literature has analyzed the relationship between TQ and CFP in great detail: Products and services of higher quality increase the perceived utility of the product, enhance stakeholder satisfaction, attract customers, and increase their willingness to pay and rebuy, thereby increasing relative market shares and achieving higher prices (e.g., Porter 1985). In addition, quality improvements help reduce operating costs by improvements in operational efficiencies via better resource utilization and waste management systems, such as reduced waste and defective goods (e.g., Camilleri 2022). However, quality improvements also require investments, which decrease CFP (e.g., Baum et al. 2013). Overall, it depends on the magnitude of the revenue and cost effects whether TQ relates to increased or decreased net CFP (e.g., Hendricks and Singhal 2001).

Considering CEP as an element of TQ, we apply the TQ rationale to the CEP–CFP relationship: We explicitly differentiate cost and revenue effects of CEP instead of focusing on net CFP only. We further analyze the interrelations of the TQ dimensions, which mirror the separate mediators identified by prior research.

2.3 | Hypotheses Development

Prior research implies that increased corporate efforts for environmental improvements, that is, higher CEP, improve both product quality and process quality (e.g., Tariq et al. 2017; Hermundsdottir and Aspelund 2021). Higher CEP increases process quality by reducing resource consumption and emissions (e.g., Galama and Scholtens 2021; Li et al. 2022). Da Silva (2023) finds that CEP has a positive influence on technical efficiency. Shu et al. (2016) find that sustainable corporate management is more likely to lead to product innovations. Katsikeas et al. (2016) find that an environmentally friendly product development strategy increases the effectiveness of product development, which is reflected in the introduction of new products and improvements to existing ones. Product and process improvements being components of internal quality, we hypothesize:

H1a. *Higher CEP is positively associated with internal quality.*

Stakeholders increasingly request good CEP (e.g., Boccia and Sarnacchiaro 2018; Khan et al. 2021), which is an important incentive for firms to act accordingly (e.g., Cai and Li 2018; Gangi et al. 2020; Xie et al. 2024). Zhang and Ouyang (2021) note that the awareness and popularity of firms increase when they assume environmental responsibility. In addition, the likelihood of litigation decreases when firms assume environmental responsibility (e.g., Chakraborty et al. 2023), while irresponsibility is penalized, for example, by a loss of trust or stock price decreases (e.g., Flammer 2013; Riera and Iborra 2016). Jing et al. (2023) also note that employee satisfaction is lower when firms pollute more, leading to reduced CEP. However, the relation of CEP and external quality depends on stakeholders' specific expectations and perceptions (e.g., Petersen et al. 2021; Christensen et al. 2023). The example of the luxury goods' industry shows that stakeholders may even evaluate CEP negatively in certain cases (e.g., Kunz et al. 2020; Carranza et al. 2023). We test for a positive relation and hypothesize:

H1b. *Higher CEP is positively associated with external quality.*

Stakeholders' quality perceptions depend not only on CEP directly but—according to the TQ literature—also on product and process characteristics. Stakeholders reflect the internal quality, that is, the quality of products and processes, when building their external quality perceptions (e.g., Feigenbaum 1983; Grönroos 1984; Waller and Ahire 1996). Several empirical studies find a positive relation. For instance, Gangi et al. (2020) find that product innovation positively relates to reputation. Huang and Li (2017) find that product and process improvements positively relate to the firm's own evaluation of its reputation. Chen et al. (2023) find that approved patents, as a measure of high product and process quality, improve the stakeholders' image of firms. Quintana-García et al. (2022) analyze environmental innovation and cleaner production and find positive relations to reputation. However, stakeholders may not always be aware of internal improvements and have the necessary information (Boccia et al. 2019; Wei et al. 2018). We test for a positive relation and hypothesize:

H2. *Higher internal quality is positively associated with external quality.*

Regarding CFP, the TQ literature outlines that TQ improvements require financial investments and promise financial benefits in terms of cost savings and revenue increases (e.g.,

Feigenbaum 1951; Porter and van der Linde 1995; Baum et al. 2013). We argue that this likewise holds for CEP-based quality improvements. Prior research finds positive associations of green innovations with different aspects of CFP such as sales volume, market share, return on investment (e.g., Tang et al. 2018), profit growth, and cash flow from market operations (e.g., Huang and Li 2017). For CEP-based product improvements, literature finds evidence of an increased willingness to pay and rebuy, while low-quality products reduce revenues (e.g., Homburg et al. 2005; Kammerer 2009; Petersen et al. 2021; Xia et al. 2023). The paradox of consumerism, however, describes the gap between intended and actual behaviors with respect to CEP (e.g., Vermeir and Verbeke 2006). Examples from the luxury industry imply that stakeholders' claims to value high CEP do not translate into their buying decision and willingness to pay (e.g., Arrington 2017; Carranza et al. 2023). The paradox of choice further describes that too many choices may cause anxiety of a suboptimal choice (e.g., Schwartz 2004). With product improvements next to existing products, customers may refrain from buying any, causing revenues to decrease. We test the TQ perspective and hypothesize:

H3a. *Internal product quality improvements are positively associated with revenues.*

While product improvements generally increase revenues, process improvements reduce costs (e.g., Bhat 1999; Ambec and Lanoie 2008). Respective cost savings emerge at different stages (e.g., Porter and van der Linde 1995; Christmann 2000; Xie et al. 2019; Wang et al. 2021): Less resource and energy consumption in more efficient processes save expenses. Thorough monitoring reduces outage times and related costs. Eliminating toxic input factors saves storage costs, security costs, and employee costs due to lower safety and health risks. Less delay and rework save logistic and administration costs. Recycling fosters an efficient use of resources. Substitution of input materials, the use of by-products, and a reduction in waste and emissions save disposal costs, fees, and taxes. At the same time, such improvements demand high investment costs (e.g., Figge and Hahn 2005; Nuss et al. 2013), which require sufficient financial resources (e.g., Boccia et al. 2019; Ghosh Ray 2019). It is not clear from an empirical perspective whether cost reductions or investment costs predominate. Against the null hypothesis of an overall neutral relation, we hypothesize:

H3b. *Internal process quality improvements are negatively associated with costs.*

For CEP-based external quality improvements, we expect a relation to revenues and costs. The TQ rationale implies a positive relation to revenues as consumers preferably buy from firms that they perceive to have good quality and particularly good CEP (e.g., McWilliams and Siegel 2001; Al-Najjar and Anfimiadou 2012). Steenis et al. (2018), for instance, find that higher perceived sustainability of packaging contributes positively to consumers' purchase intention. Higher demand increases prices (e.g., Marshall 1890). Good external quality perceptions further increase stakeholder loyalty and competitive advantages (e.g., Ambec and Lanoie 2008; Aramburu and Pescador 2019). Prior empirical results imply a positive relation between high external quality perceptions and different measures of CFP (e.g., Roberts and Dowling 2002; Gangi et al. 2020; Miller et al. 2020). The paradox of consumerism, however, implies that external quality perceptions do not necessarily translate into favorable buying decisions that would affect revenues (e.g., Arrington 2017; Carranza et al. 2023). We test the TQ perspective and hypothesize:

H3c. *External quality improvements are positively associated with revenues.*

However, consumers do not always associate sustainable product improvements positively, for example, because they fear that products will lose functionality or because they associate more sustainable offerings with higher production costs that could be reflected in market prices, which has a negative impact on their purchasing decisions (e.g., Steenis et al. 2018). Firms must therefore make stakeholders sufficiently aware of quality improvements and their benefits, which is why they need to invest considerably in marketing, investor relations, nonfinancial reporting, and other information channels (e.g., McDonald and Oates 2006; Hoffmann and Fieseler 2012). For high external quality perceptions, firms hence incur not only the actual investment costs but also continuous costs to make transparent which investments have been made (e.g., Lee et al. 2018). On the other hand, improvements in perceived TQ also save costs: Suppliers with higher quality perceptions fear less risk and have higher trust. This decreases transaction costs for negotiating, closing, and monitoring contracts, such that the suppliers lower their prices (e.g., Roberts and Dowling 2002; Bergh et al. 2010). Higher quality perceptions increase employee motivation and lower staff fluctuation, which saves employee costs (e.g., Orlitzky et al. 2011). Good quality perceptions further increase public legitimacy by reducing the risk of disastrous boycotts. In addition, investors evaluate firms with higher reputation more favorably, reducing the cost of capital (e.g., Sen et al. 2006; Dhaliwal et al. 2011; Setiany and Suhardjanto 2021). We expect that investment and communication costs prevail and hypothesize:

H3d. *External quality improvements are positively associated with costs.*

To complete our analysis, we investigate whether CEP and CFP relate directly in addition to the indirect links via the interrelated TQ mediators. Again, we explicitly differentiate revenue and cost effects. CEP improvements may directly increase revenues if the effects are not fully mediated by the TQ effects considered previously. Against the null hypothesis of a neutral relation, we hypothesize:

H4a. *Higher CEP is positively associated with revenues.*

We expect that considerable investment costs for CEP improvements increase costs independent of potential cost savings due to improved TQ, which are part of the mediators. We hypothesize:

H4b. *Higher CEP is positively associated with costs.*

Figure 1 illustrates our comprehensive framework of hypotheses.

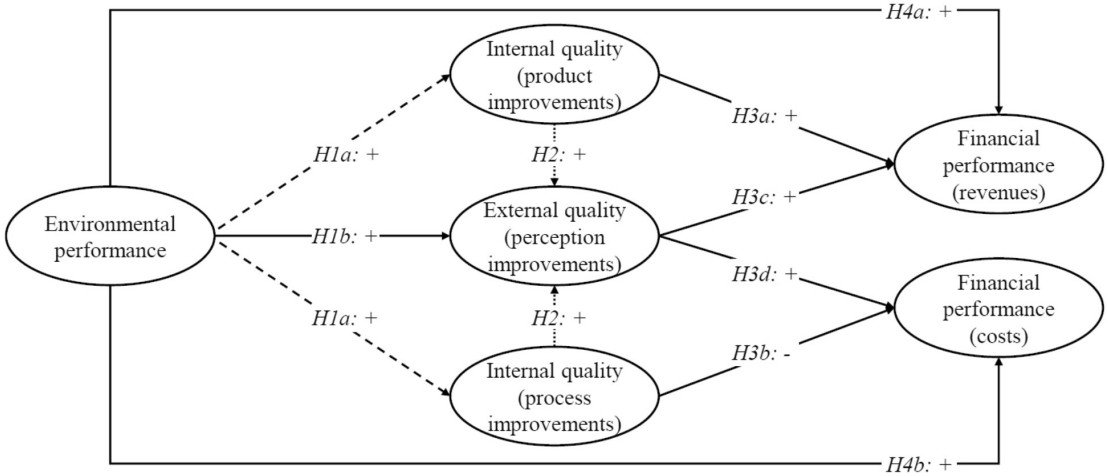

FIGURE 1 | Hypotheses. Figure 1 illustrates the comprehensive framework of hypotheses.

3 | Method

3.1 | Measurement of Constructs

A crucial step for empirically analyzing the CEP–CFP relationship is to identify suitable measures (e.g., McWilliams et al. 2006; Hang et al. 2018). Our models include different exogenous (CEP) and endogenous variables (TQ and CFP). Following Rossiter (2002), we proceed in two steps: (i) construct definition and (ii) search for suitable indicators. We use both potential types of indicators: Effect indicators from reflective model specifications are successors affected by the latent variable, whereas causal indicators from formative model specifications are predecessors determining the latent variable (e.g., Fornell and Bookstein 1982; Bagozzi 1984; Diamantopoulos and Winklhofer 2001; Rossiter 2002). Because causal indicators mostly relate to single aspects of the latent variable that do not necessarily correlate, multi-item measurement is generally recommended (e.g., Bagozzi 1994; Chin 1998; Helm 2005; Fuchs and Diamantopoulos 2009). Effect indicators, in contrast, are exchangeable as they generally move in the same direction as the variable that is to be measured (e.g., Chin 1998; Diamantopoulos 1999; Jarvis et al. 2003).

In line with prior studies (e.g., Martinez-Conesa et al. 2017; Baah et al. 2020; Bahta et al. 2020), we use indicators from a broad survey, that is, the MIP (see Section 3.3). Appendix 1 lists the indicators used per variable.

3.1.1 | Corporate Environmental Performance

To capture the multidimensionality of CEP (e.g., Schultze and Trommer 2012; Trumpp et al. 2015), we use 13 effect indicators of the firms' environmental impact.[9] Based on the idea of a circular economy that mitigates scarce resources and climate change by efficient resource (re-) use (e.g., Lieder and Rashid 2016; Makov et al. 2019; Zhu et al. 2019), the indicators include improvements in material and energy use, pollution, and recycling along the entire product life cycle. Still, we do not focus on one particular type of process or product by, for example, life cycle assessment (e.g., Blass and Corbett 2018; Kerdlap et al. 2022). Neither do we use cities or nations as measurement units (e.g., Streeck et al. 2021; Ballatore et al. 2022). Rather, we measure the indicators on the firm level, that is, over all products and processes of a firm, to provide insights on whether firms can gain sufficient financial return from environmental improvements to outweigh or even exceed respective investment costs. In line with, for example, Hamschmidt and Dyllick (2001) and Gonzáles-Benito and Gonzáles-Benito (2006), we split CEP into its product- (*CEPPROD*) and process-based components (*CEPPROC*). For robustness purposes (see Section 4.3), we analyze the effect of overall CEP (*CEP*) by combining *CEPPROD* and *CEPPROC*. We measure each indicator relative to the subsector mean to control for industry differences (e.g., Fombrun and Shanley 1990; Christmann 2000; Telle 2006), based on the NACE classification (for details, see Eurostat (2008)). We standardize each indicator as described in Equation (1) to enable consistent item parceling (e.g., Albers and Hildebrandt 2006).

$$X_{i\,(rel)(s)} = \frac{x_{i\,(rel)} - E\left(x_{i\,(rel)}\right)}{\sqrt{Var\left(x_{i\,(rel)}\right)}} \tag{1}$$

Changes in CEP via, for example, new organizational units, processes, or product compositions are complex and take time (e.g., Clarkson et al. 2011). Hence, we measure CEP over a change period of 3 years ($t=0$ to $t=3$). Cronbach's alphas above 0.91 for all indicators (0.90 in the late period) noticeably exceed the threshold of 0.7, supporting sufficient instrument quality (e.g., Nunnally 1978). Item-to-total correlations between 0.60 and 0.73 (0.54 and 0.72) exceed the threshold of 0.5 (e.g., Bearden et al. 1989). In addition, all criteria of the factor analysis are above the required thresholds.[10]

3.1.2 | Internal and External Quality

We separately analyze improvements in internal product (*PROD*) and process quality (*PROC*), whereby the definitions of product and process improvements in the MIP questionnaire are based on the definitions from the OSLO Manual

2018: "A product innovation is a new or improved good or service that differs significantly from the firm's previous goods or services and that has been introduced on the market" (OECD and Eurostat 2018, 70). "A business process innovation is a new or improved business process for one or more business functions that differs significantly from the firm's previous business processes and that has been brought into use in the firm" (OECD and Eurostat 2018, 72). We capture the absence or presence of improvements from an output-based perspective via dichotomous causal indicators that take different timeframes and implementation statuses into account. We use multi-item measures for *PROD* and *PROC* in the early period (2005–2010) but single-item measures in the late period (2017–2022) because of the changes in the MIP questionnaire. Additionally, for robustness purposes (see Section 4.3), we combine the dimensions of *PROD* and *PROC* in the late period into one measure of internal quality (*IQ*). We use item parceling to aggregate the indicators of *PROD* and *PROC* into comprehensive measures in the early period as well as to aggregate *PROD* and *PROC* into *IQ* in the late period (e.g., Rossiter 2002; Diamantopoulos and Siguaw 2006).

We further analyze improvements in external quality perceptions (*EQ*). The stakeholders' perception of a firm's performance and attractiveness is based on long-term personal experiences, knowledge, and emotions and thus comprises a cognitive and an affective component (e.g., Schwaiger 2004). We consider different types of stakeholders and measure *EQ* along four dimensions, that is, attractiveness to customers, the capital market, employees, and opinion leaders (e.g., Schwaiger 2004). Because all dimensions of a multidimensional construct should be defined and operationalized separately (e.g., Rossiter 2002), we apply item parceling per dimension,[11] before adding the dimensions into one measure (e.g., Kishton and Widaman 1994).

We measure *PROD*, *PROC*, *IQ*, and *EQ* relative to the subsector mean to control for industry differences (e.g., Christmann 2000). We standardize the indicators (e.g., Albers and Hildebrandt 2006) and measure them over the same 3-year change period as CEP. Integrating the target of CEP improvements into a business strategy can directly trigger incremental or radical product and process adjustments (e.g., Dangelico and Pujari 2010). Similarly, CEP improvements affect external quality perceptions timely because firms often communicate environmental policies or investment strategies before fully implementing them (e.g., Hetze 2016; Shabana et al. 2017).

In formative measurement models, content validity depends on theoretical considerations (e.g., Bollen and Lennox 1991; Diamantopoulos and Winklhofer 2001; Petter et al. 2007), which we consider to be sufficient for the TQ variables because their item compositions are based on established theory and research findings.[12] Linear regressions of *PROD*, *PROC*, *IQ*, and the dimensions of *EQ* on the respective indicators ensure estimation validity (e.g., Chin 1998; Diamantopoulos and Riefler 2008). All coefficients in the respective regressions take values above the critical threshold of 0.2 (e.g., Chin 1998). Each indicator is highly significant at the 1% level. The highest variance inflation factors (VIF) of 1.91 (indicators of *PROD*), 1.71 (*PROC*), and 2.22 (*EQ*) for the early period as well as 1.37 (*IQ*) and 1.16 (*EQ*) for the late period are noticeably below the critical threshold for formative models of 5.0 (e.g., Diamantopoulos and Riefler 2008).

3.1.3 | Corporate Financial Performance

In general, CFP displays the change in the firm's flows of material in terms of financial units. In our main analysis, we distinguish between revenues (*REV*) and costs (*COSTS*) because both revenue increases and cost decreases reflect CFP improvements (e.g., Klassen and McLaughlin 1996; Lankoski 2008; Sudha 2020). We additionally analyze net CFP (*CFP*) measured by return on sales (*ROS*), return on equity (*ROE*), and return on assets (*ROA*). All CFP variables are directly observable from accounting numbers. We measure their relative change over 1 year to capture the effect of CEP on the firm's financial resources.

Prior literature suggests that time lags influence the CEP–CFP relationship (e.g., Guenther and Hoppe 2014; Li et al. 2017). However, the length of the time lag is ambiguous. Hart and Ahuja (1996) find that the effects of emission reductions on CFP occur immediately, while Hang et al. (2019) document that the effect of CEP on CFP is significant only after at least 2 years and hence recommend using time lags of more than 2 years. Accordingly, we measure all CFP variables in the last year of the 3-year change period of CEP and the mediators ($t=3$). In addition, we measure the CFP variables at two additional points in time: the first ($t=4$) and the second year ($t=5$) after the change period.[13]

3.2 | Econometric Model

We use the method of SEM because of the multi-equation setting with multiple endogenous and interdependent latent variables that represent hypothetical rather than observable constructs.[14] We expect that product-based CEP affects product improvements and hence revenues, while process-based CEP affects process improvements and costs. To ensure model identification, we exclude the relations between *CEPPROD* and *PROC* and *CEPPROC* and *PROD*. We expect that *EQ* is affected by both CEP dimensions.

$$PROD_{t0-3} = \gamma_{11}\, CEPPROD_{t0-3} + \zeta_1 \tag{2}$$

$$PROC_{t0-3} = \gamma_{21}\, CEPPROC_{t0-3} + \zeta_2 \tag{3}$$

$$EQ_{t0-3} = \gamma_{31}\, CEPPROD_{t0-3} + \gamma_{32}\, CEPPROC_{t0-3} + \beta_{31}\, PROD_{t0-3} + \beta_{32}\, PROC_{t0-3} + \zeta_3 \tag{4}$$

$$REV_{t3} = \gamma_{41}\, CEPPROD_{t0-3} + \beta_{41}\, PROD_{t0-3} + \beta_{42}\, EQ_{t0-3} + \zeta_4 \tag{5}$$

$$COSTS_{t3} = \gamma_{51}\, CEPPROC_{t0-3} + \beta_{51}\, EQ_{t0-3} + \beta_{52}\, PROC_{t0-3} + \zeta_5 \tag{6}$$

Models 2 and 3 analyze the associations of CEP with internal quality improvements. We expect positive signs (H1a). Model 4 analyzes the associations of both CEP components and product and process improvements with external quality perceptions. We expect positive signs (H1b and H2). We also expect positive signs in Model 5 on the associations of product improvements

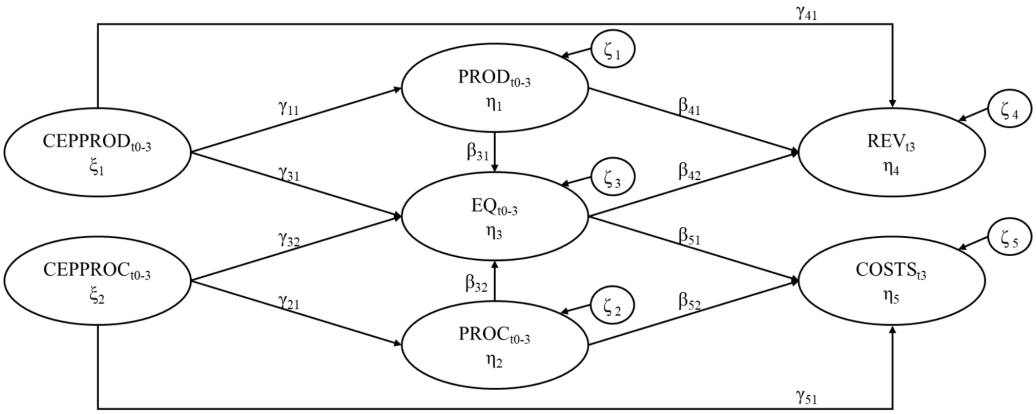

FIGURE 2 | Coefficients of the main structural equations model. Figure 2 presents the coefficients of the measurement models of the latent variables and the coefficients of the main model comprising Equations (2)–(6). All variables are defined in Appendix 1.

(H3a), external quality perceptions (H3c), and product-based CEP (H4a) with revenues. In Model 6, we expect negative associations of process improvements (H3b) and positive associations of external quality perceptions (H3d) with costs. The signs depend on whether investment costs or cost savings prevail. We further expect a positive sign for process-based CEP (H4b). Figure 2 depicts the model.

3.3 | Sample

We use factually anonymized data from the MIP by the Leibniz Center for European Economic Research (ZEW), following, for example, Ghisetti and Rennings (2014) and Horbach and Rammer (2020).[15] The MIP is part of the CIS of the European Union's Statistical Office (Eurostat) (e.g., ZEW 2020a), which is repeatedly used in other recent studies (e.g., Ferreira et al. 2020; Madaleno et al. 2020; Biscione et al. 2021; Parrilli et al. 2023; Zastempowski 2023; Prokop et al. 2024). Since 1993, the MIP has been collecting proprietary data on innovation activities by German firms of all sizes and industries yearly. The MIP follows the same methodological standards as all European CIS.[16] Germany provides an interesting context for our research because the importance of innovation is high. Germany spent between 2.4% and 3.2% of its GDP on R&D during the last two decades, which is similar to the United States (e.g., OECD 2024). The MIP provides extensive information on product, service, process innovations, related expenditures, and economic success. It allows researchers, practitioners, and politicians to evaluate the country's technological performance and identify barriers or facilitators of innovation (e.g., ZEW 2020a, 2020b). In addition, Germany puts high weight on ESG. It does not only follow and contribute to European ESG regulations but also sets national incentives like an award for best practice (BMAS 2024).

Our early sample period covers the years 2005–2010. We use CEP and TQ data for the years 2005 ($t=0$) to 2008 ($t=3$) for our main analyses to exclude biases in our firm-level results due to overriding effects of the European sustainability policy that accelerated after the Treaty of Lisbon became effective in Germany by 2009 (e.g., European Union 2012; STMUV 2023). These data stem from the MIP 2006 to 2009. The CFP data for 2008 stem from the MIP 2009. For additional analyses, we use financial data for 2008 ($t=3$) to 2010 ($t=5$) from the MIP 2011. We use additional CFP data from the Bureau-von-Dijk database DAFNE that contains financial data of German firms and uses the same anonymous firm identification codes as the MIP (DAFNE 2020). Our early sample initially includes 18,154 observations. We drop firms with inconsistent MIP information on operational units over time to exclude potential bias due to overriding changes in firm structures.[17] After further excluding observations with missing values, our final early sample comprises 5,791 observations for our main analyses. For our moderation analyses, the numbers of observations depend on the distribution of the observations on the respective moderating dimensions and potentially missing information on the classification items.

Our recent sample period covers the years 2017–2022. We use CEP and TQ data for the years 2017 ($t=0$) to 2020 ($t=3$) from the MIP 2018 to 2021 and CFP data for 2020 from the MIP 2021. Additionally, we use CFP data for 2020 ($t=3$) to 2022 ($t=5$) from the DAFNE database. Our recent sample initially includes 13,066 observations. After controlling for firms with inconsistent MIP information on operational units over time and excluding observations with missing values, our final late sample comprises 4,315 observations.[18]

Table 1 shows the descriptive statistics. The mean of about zero for *CEP* indicates that, on average, firms have not changed their CEP during the sample periods. The minimum of −4.12

(−2.14 in the late period) and the maximum of 8.92 (8.14) show that the highest CEP improvement is more extensive than the highest decrease. We observe similar patterns for the CEP components. *CEPPROC* shows a higher standard deviation and larger minimum and maximum values than *CEPPROD*, which might be due to the higher number of indicators. The means of *REV* and *COSTS* are about zero, indicating neither a revenue increase nor a cost reduction on average. The positive maxima show higher absolute values than the negative minima. In our early period, the same holds for the net CFP variants *ROS* and *ROE*. For *ROA*, the negative minimum is larger than the positive maximum. *PROD* and *PROC* show slightly negative mean values, while the positive maxima are somewhat larger than the negative minima. In our late period, the effects for *ROS*, *ROE*, and *ROA* and for *PROD* and *PROC* are

reversed: While for *ROS* and *ROE*, the negative minimum is larger than the positive maximum, for *ROA* the positive maximum is larger than the negative minimum. *PROD* and *PROC* show slightly positive mean values, while the negative minima are somewhat larger than the positive maxima. *IQ* shows a slightly negative mean value, while the negative minimum is

TABLE 1 | Descriptive statistics.

	2005–2010				2017–2022			
Variable	**Mean**	**SD**	**Min.**	**Max.**	**Mean**	**SD**	**Min.**	**Max.**
CEP_{t0-3}	0.00	1.82	−4.12	8.92	0.00	1.86	−2.14	8.14
$CEPPROD_{t0-3}$	0.00	2.16	−4.00	8.57	0.00	1.98	−2.18	7.01
$CEPPROC_{t0-3}$	0.00	5.24	−11.88	25.98	0.00	3.57	−3.79	16.36
$PROD_{t0-3}$	−0.02	1.65	−18.54	20.79	0.09	0.42	−4.00	3.79
$PROC_{t0-3}$	−0.05	1.70	−17.58	17.60	0.49	0.47	−4.15	1.28
IQ_{t0-3}	—	—	—	—	−0.33	1.41	−15.43	9.52
EQ_{t0-3}	0.00	2.12	−24.19	53.90	0.00	2.05	−51.06	52.61
REV_{t3}	0.00	1.00	−1.51	63.92	0.00	1.00	−0.10	50.80
$COSTS_{t3}$	0.00	1.00	−4.65	14.38	0.00	1.00	−0.48	13.85
ROS_{t3}	0.00	1.00	−12.84	18.06	0.00	1.00	−20.28	7.81
ROE_{t3}	0.00	1.00	−12.22	19.29	0.00	1.00	−27.88	10.10
ROA_{t3}	0.00	1.00	−26.30	4.29	0.00	1.00	−1.45	41.91

Note: Table 1 presents the descriptive statistics of the different CEP variables, the TQ mediators *PROD*, *PROC*, *IQ*, and *EQ*, and the different CFP variables for the periods 2005–2010 and 2017–2022.
All variables are defined in Appendix 1.

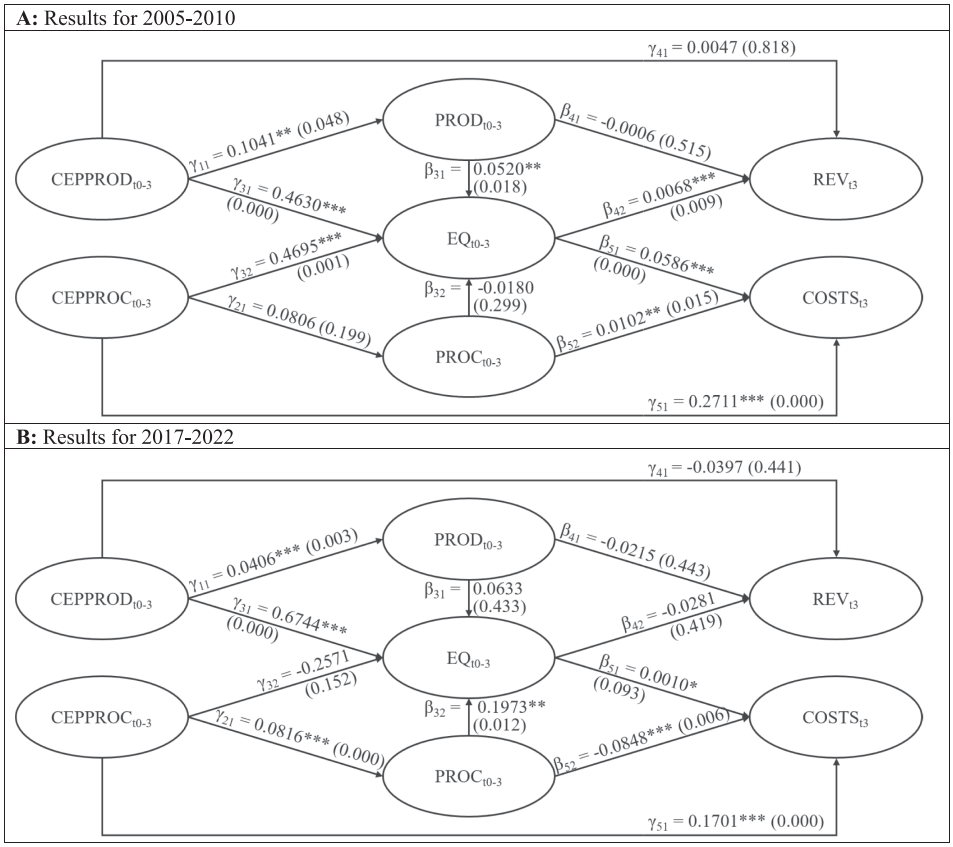

FIGURE 3 | Results of the main structural equations model. Figure 3 presents the coefficients of our main SEM estimation (*p*-values in parentheses). Panel A refers to the early period (2005–2010) and Panel B to the late period (2017–2022). *, **, and *** indicate that the estimated coefficients are statistically significant at the 10%, 5%, and 1% levels, respectively, using a two-tailed test. All variables are defined in Appendix 1.

larger than the positive maximum. For both periods, the mean of zero for *EQ* indicates that external quality perceptions did not change on average. The standard deviation is higher than for the other mediators, which indicates more pronounced differences between single firms.

4 | Results

4.1 | Results of the Main Analysis

Figure 3 presents the results of our main SEM estimation. Panel A shows the results for our early period (2005–2010), and Panel B shows the results for our late period (2017–2022). For both periods, the information criteria show reasonable values (Akaike: 268,829 (Panel B: 182,199); Bayes: 269,155 (182,511)). The comparative fit index of 0.9 (0.87) is close to the critical threshold (Bentler 1990), indicating a sufficient fit of the overall SEM. With 0.96 (0.95), the coefficient of determination is close to a perfect fit of 1.0 (Chin 1998).

We find that *CEPPROD* significantly relates to internal quality proxied by *PROD* (Panel A: $\gamma_{11} = 0.1041$, $p < 0.05$; Panel B: $\gamma_{11} = 0.0406$, $p < 0.01$) and to *EQ* (Panel A: $\gamma_{31} = 0.4630$, $p < 0.01$; Panel B: $\gamma_{31} = 0.6744$, $p < 0.01$), supporting H1a and H1b. In our early period, hypothesis H1b is additionally supported as the relation between *CEPPROC* and *EQ* is significant ($\gamma_{32} = 0.4695$, $p < 0.01$). In our late period, it is insignificant. We further find that *PROD* significantly relates to *EQ* in the early period ($\beta_{31} = 0.0520$, $p < 0.05$), whereas the relation is insignificant in the late period. While we do not find significant relations for our second proxy of internal quality *PROC* in the early period, we do so in the late period (*CEPPROC* and *PROC*: $\gamma_{21} = 0.0816$, $p < 0.01$; *PROC* and *EQ*: $\beta_{32} = 0.1973$, $p < 0.05$). This implies that in the past a higher CEP was not necessarily accompanied by process improvements and that external stakeholders might not have been sufficiently aware of process improvements to incorporate them into their quality perceptions. In contrast, process improvements may have become more important over time because of a possible higher environmental awareness in more recent times. This is in line with Rahmani et al. (2024) and Burki et al. (2018), who argue that process improvements depend on the proactivity of the top management. Overall, for both sample periods, we find significant relations between internal and external quality, which supports H2. Hence, analyzing the interrelations between mediators that were previously analyzed separately is an important step toward comprehensively assessing the CEP–CFP relationship.

The relationship between *PROD* and *REV* (H3a) is insignificant for both periods, consistent with the paradox of consumerism and the paradox of choice, which limit customers' willingness to pay for CEP in case of too many choices (e.g., Schwartz 2004; Arrington 2017). For the early period, the relationship between

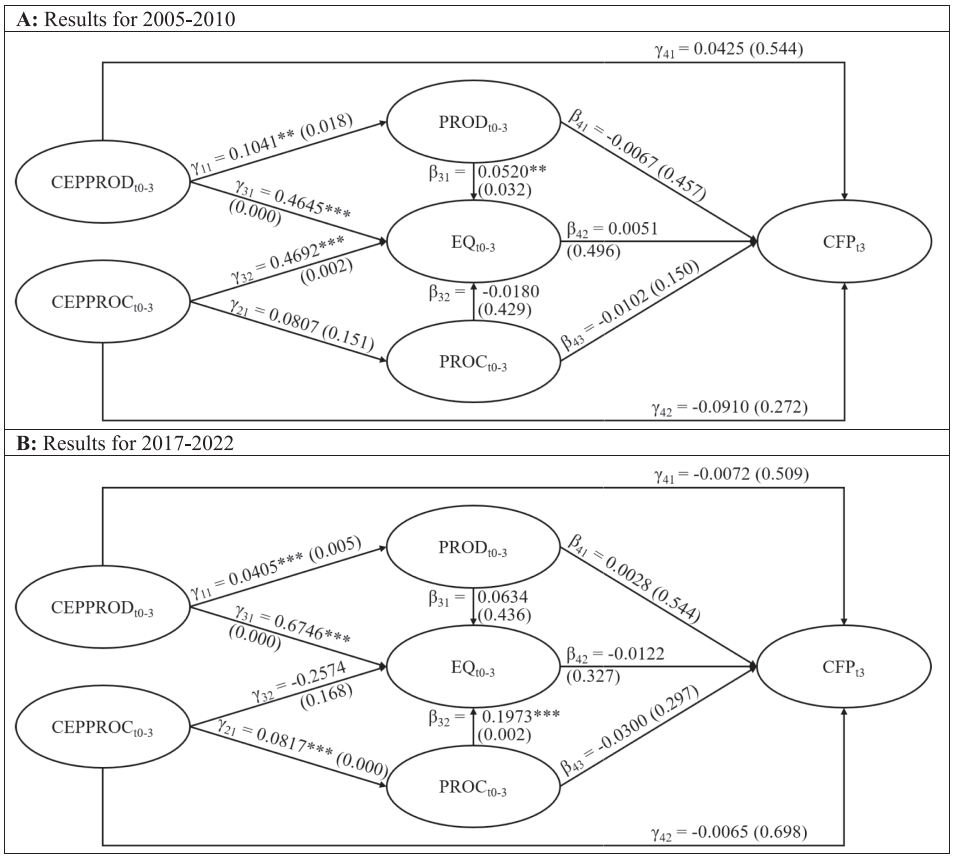

FIGURE 4 | Results of the structural equations model with net CFP (*ROS*). Figure 4 presents the coefficients of our SEM estimation with net CFP instead of revenues and costs, using *ROS* for net CFP (*p*-values in parentheses). Panel A refers to the early period (2005–2010) and Panel B to the late period (2017–2022). The results for *ROE* and *ROA* are comparable. *, **, and *** indicate that the estimated coefficients are statistically significant at the 10%, 5%, and 1% levels, respectively, using a two-tailed test. All variables are defined in Appendix 1.

PROC and *COSTS* is significant and positive ($\beta_{52} = 0.0102$, $p < 0.05$), while the relationship is significant and negative for the late period, supporting H3b ($\beta_{52} = 0.0102$, $p < 0.05$). From this, we can conclude that in the current time period, process improvements not only play a more important role in environmental management but also reduce costs. *EQ* positively relates to *COSTS* (Panel A: $\beta_{51} = 0.0586$, $p < 0.01$; Panel B: $\beta_{51} = 0.0010$, $p < 0.1$), supporting H3d, and—for the early period—also to *REV* (Panel A: $\beta_{42} = 0.0068$, $p < 0.01$), supporting H3c. The direct relationship between *CEPPROD* and *REV* (H4a) is insignificant for both periods, implying that the interrelated TQ mediators fully explain the relationship between CEP and revenues. The relationship between *CEPPROC* and *COSTS* is significant (Panel A: $\gamma_{51} = 0.2711$, $p < 0.01$, Panel B: $\gamma_{51} = 0.1701$, $p < 0.01$), supporting H4b.

In both time periods, the positive associations of CEP and internal and external quality with costs indicate that investment costs outweigh cost savings in the first place. Still, for the early period, our results indicate that external quality is the main channel through which CEP and related product improvements relate to higher revenues. High CEP seems to have exceeded stakeholders' expectations and caused a higher willingness to pay and rebuy. For the late period, we do not

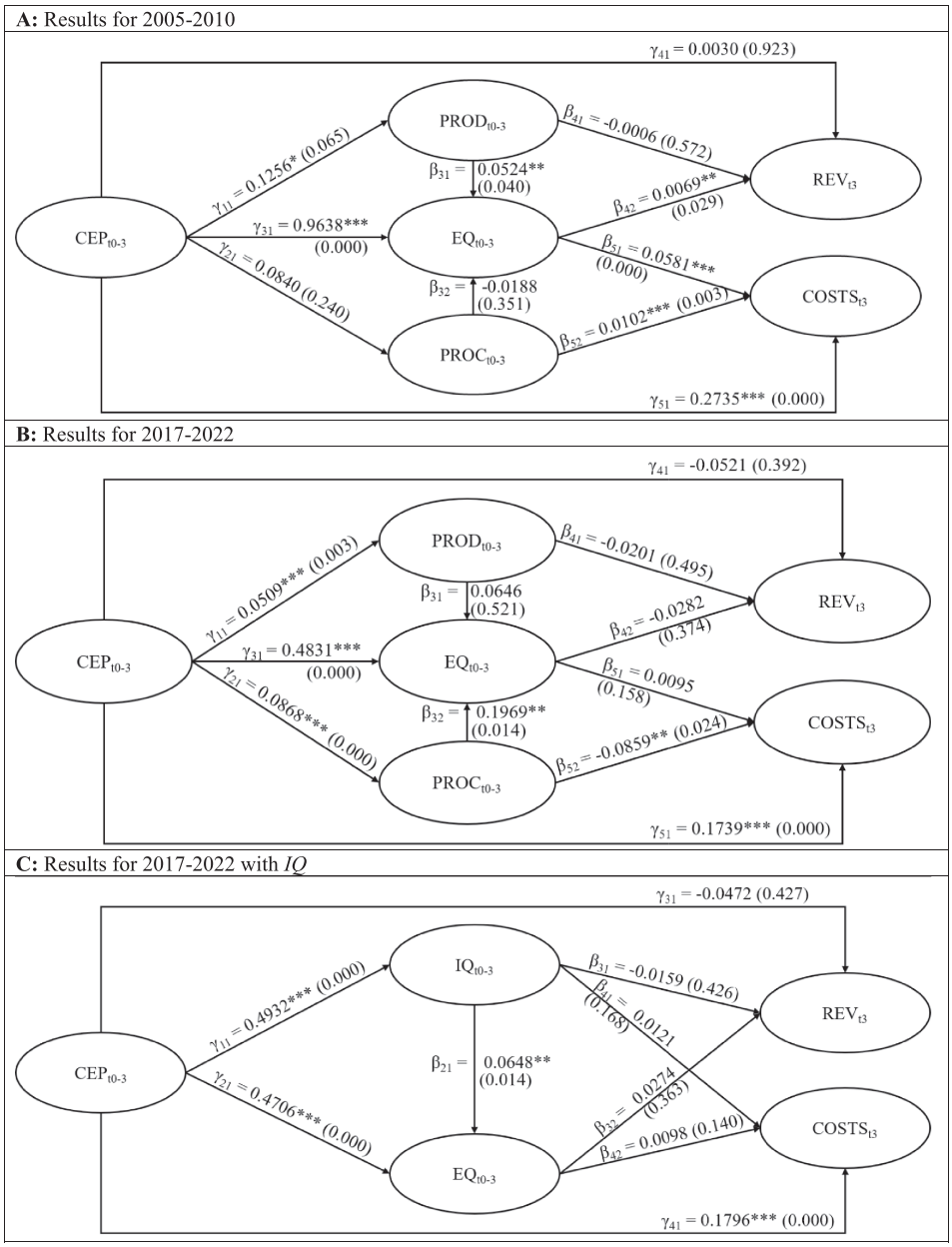

FIGURE 5 | Results of the robustness models with overall CEP. Figure 5 presents the coefficients of our robustness SEM estimation with overall CEP instead of the CEP components (*p*-values in parentheses). Panel A refers to the early period (2005–2010), and Panels B and C refer to the late period (2017–2022). Panel B analyzes the dimensions of internal quality (*PROD* and *PROC*) separately, while Panel C combines them into one measure (*IQ*). *, **, and *** indicate that the estimated coefficients are statistically significant at the 10%, 5%, and 1% levels, respectively, using a two-tailed test. All variables are defined in Appendix 1.

find an indirect increase in revenues, which we attribute to the increased external pressure and environmental regulations that firms need to fulfill. Hence, good CEP may no longer be a premium quality attribute but an obligation. This is in line with a recent study that analyzes the opposite, that is, corporate irresponsibility, and finds no significant consumer reaction on average (Christensen et al. 2023). Still, in the late period, CEP benefits firms by a reduction in costs via the channel of internal process improvements.

In $t=4$ and $t=5$, all relations between the TQ and the CFP variables turn insignificant, which implies that quality improvements lose their relevance for revenue increases (cost decreases) and cost increases after a relatively short period of time. Our findings are in accordance with the proposition by Hart and Ahuja (1996) that accounting-based measures of CFP react to changes in CEP in a timely manner.[19]

4.2 | Results for Net Financial Performance

We further analyze our main model using net CFP (*CFP*) instead of revenues and costs, such that Equations (5) and (6) are jointly replaced by the following equation:

$$CFP_{t3} = \gamma_{41}\, CEPPROD_{t0-3} + \gamma_{42}\, CEPPROC_{t0-3} + \beta_{41}\, PROD_{t0-3} + \beta_{42}\, EQ_{t0-3} + \beta_{43}\, PROC_{t0-3} + \zeta_4 \tag{7}$$

Equation (7) regresses all variables on net CFP, covering pairwise combinations of our hypotheses: The relationship between

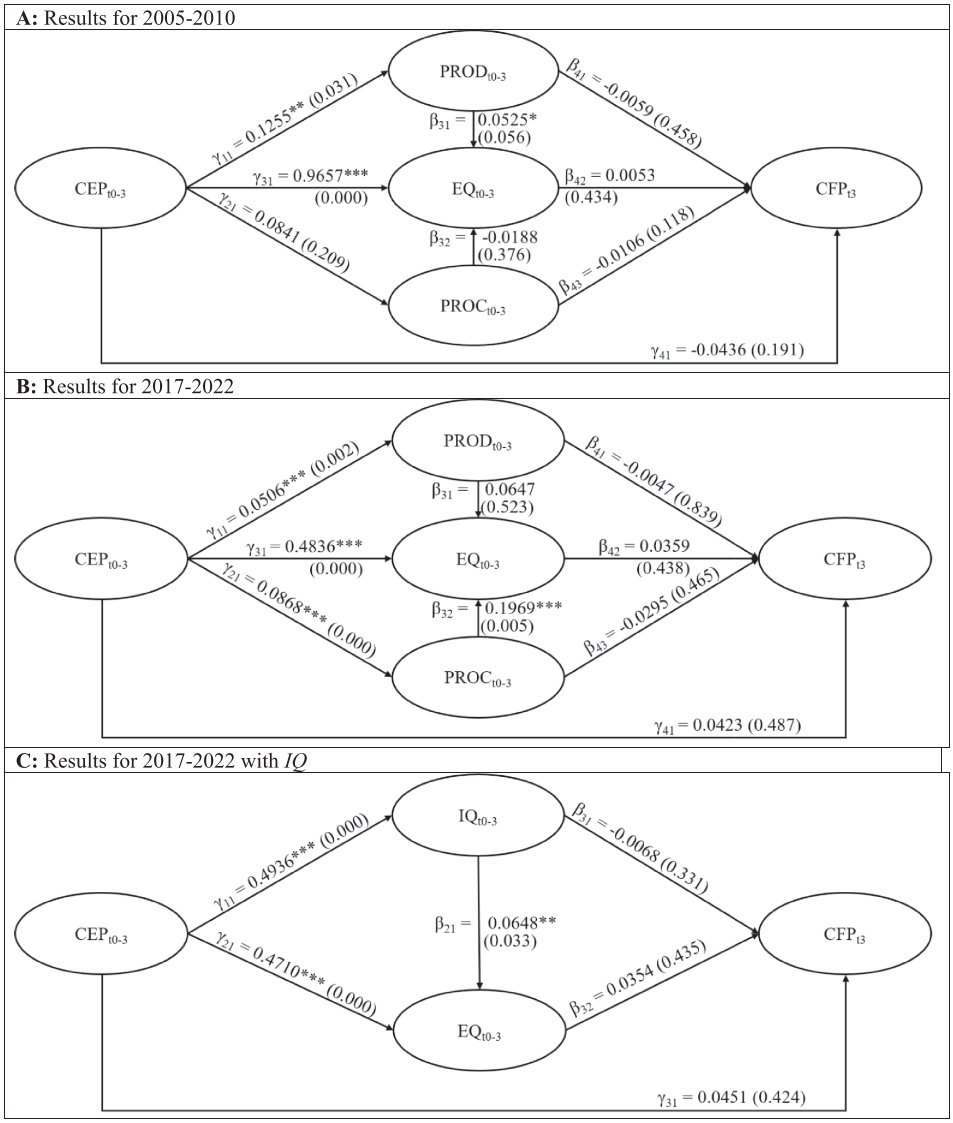

FIGURE 6 | Results of the robustness model with overall CEP and net CFP (*ROS*). Figure 6 presents the coefficients of our robustness SEM estimation with overall CEP instead of the CEP components and net CFP instead of revenues and costs, using *ROS* for net CFP (*p*-values in parentheses). Panel A refers to the early period (2005–2010), and Panels B and C refer to the late period (2017–2022). Panel B analyzes the dimensions of internal quality (*PROD* and *PROC*) separately, while Panel C combines them into one measure (*IQ*). The results using *ROE* instead of *ROS* are comparable. Using *ROA* for the early period, the relationship between *PROD* and *ROA* is positively significant at the 10% level ($\beta_{41}=0.0073$, $p<0.1$). The further relations are inferentially identical to those of *ROS*. *, **, and *** indicate that the estimated coefficients are statistically significant at the 10%, 5%, and 1% levels, respectively, using a two-tailed test. All variables are defined in Appendix 1.

TABLE 2 | Results of the main structural equations model—moderation analyses.

$$PROD_{t0-3} = \gamma_{11} CEPPROD_{t0-3} + \zeta_1 \quad (2)$$

$$PROC_{t0-3} = \gamma_{21} CEPPROC_{t0-3} + \zeta_2 \quad (3)$$

$$EQ_{t0-3} = \gamma_{31} CEPPROD_{t0-3} + \gamma_{32} CEPPROC_{t0-3} + \beta_{31} PROD_{t0-3} + \beta_{32} PROC_{t0-3} + \zeta_3 \quad (4)$$

$$REV_{t3} = \gamma_{41} CEPPROD_{t0-3} + \beta_{41} PROD_{t0-3} + \beta_{42} EQ_{t0-3} + \zeta_4 \quad (5)$$

$$COSTS_{t3} = \gamma_{51} CEPPROC_{t0-3} + \beta_{51} EQ_{t0-3} + \beta_{52} PROC_{t0-3} + \zeta_5 \quad (6)$$

				(A) Main results	(B) Industry effects		(C) Firm size effects			(D) Location effects		(E) Ownership effects		(F) Competitive strategy effects		(G) Age of CEP mgmt. system effects	
				ALL	***IND*=2**	***IND*=3**	***SIZE*=1**	***SIZE*=2**	***SIZE*=3**	***LOC*=0**	***LOC*=1**	***OWN*=0**	***OWN*=1**	***CSTR*=0**	***CSTR*=1**	***AGE*=0**	***AGE*=1**
				N=5,791	*N*=3,046	*N*=2,653	*N*=3,456	*N*=1,569	*N*=766	*N*=4,008	*N*=1,783	*N*=920	*N*=1,121	*N*=606	*N*=2,302	*N*=547	*N*=327
Hypothesis	**Path**	**Exp. sign**	**Path coeff.**	**Coeff. (*p*-value)**	**Coeff. (*p*-value)**	**Coeff. (*p*-value)**	**Coeff. (*p*-value)**	**Coeff. (*p*-value)**	**Coeff. (*p*-value)**	**Coeff. (*p*-value)**	**Coeff. (*p*-value)**	**Coeff. (*p*-value)**	**Coeff. (*p*-value)**	**Coeff. (*p*-value)**	**Coeff. (*p*-value)**	**Coeff. (*p*-value)**	**Coeff. (*p*-value)**
H1a	*CEPPROD* → *PROD*	+	γ_{11}	0.1041** (0.048)	0.0890 (0.123)	0.1375** (0.048)	0.2133** (0.011)	0.0485 (0.616)	−0.0695 (0.613)	0.0798* (0.066)	0.2073 (0.123)	0.1185 (0.602)	0.3716** (0.023)	−0.0448 (0.785)	−0.0080 (0.940)	−0.1966 (0.140)	0.3876 (0.136)
	CEPPROC → *PROC*	+	γ_{21}	0.0806 (0.199)	0.1769** (0.013)	−0.0437 (0.679)	0.1134 (0.122)	0.0601 (0.609)	0.1405 (0.425)	0.0112 (0.865)	0.2862** (0.026)	0.1737 (0.486)	0.3052 (0.176)	0.0221 (0.893)	0.0887 (0.335)	0.0359 (0.852)	0.0780 (0.766)
H1b	*CEPPROD* → *EQ*	+	γ_{31}	0.4630*** (0.000)	0.3647** (0.019)	0.5774*** (0.001)	0.6910*** (0.000)	0.2381 (0.186)	0.2937 (0.199)	0.4703*** (0.000)	0.3726 (0.138)	0.5314 (0.128)	0.7905*** (0.002)	−0.1767 (0.434)	0.1188 (0.461)	0.4805** (0.042)	0.1016 (0.811)
	CEPPROC → *EQ*	+	γ_{32}	0.4695*** (0.001)	0.5813*** (0.002)	0.3208 (0.159)	0.1002 (0.568)	0.7256*** (0.001)	0.7522** (0.014)	0.4458*** (0.005)	0.5515* (0.064)	0.2310 (0.578)	0.3117 (0.364)	0.7516*** (0.006)	0.4130** (0.031)	0.2041 (0.529)	0.9523* (0.094)
H2	*PROD* → *EQ*	+	β_{31}	0.0520** (0.018)	0.0755*** (0.000)	0.0247 (0.630)	0.0290 (0.514)	0.0994*** (0.003)	0.0644 (0.124)	0.0912*** (0.000)	−0.0223 (0.743)	0.0357 (0.552)	0.0830*** (0.000)	0.0280 (0.416)	−0.0204 (0.311)	0.1137** (0.018)	0.0866* (0.092)
	PROC → *EQ*	+	β_{32}	−0.0180 (0.299)	−0.0322 (0.212)	−0.0046 (0.892)	−0.0558* (0.073)	0.0485 (0.157)	−0.0309 (0.411)	−0.0449** (0.018)	0.0370 (0.336)	0.0069 (0.861)	0.0494* (0.067)	−0.0649 (0.157)	0.0015 (0.958)	−0.0113 (0.832)	0.0238 (0.675)
H3a	*PROD* → *REV*	+	β_{41}	−0.0006 (0.515)	−0.0020 (0.350)	0.0009 (0.157)	0.0015 (0.318)	−0.0040 (0.165)	−0.0010 (0.260)	−0.0015 (0.214)	0.0013 (0.577)	0.0014 (0.536)	−0.0022 (0.512)	0.0010 (0.520)	−0.0028 (0.111)	−0.0041 (0.225)	−0.0001 (0.933)
H3b	*PROC* → *COSTS*	+	β_{52}	0.0102** (0.015)	0.0053 (0.528)	0.0145*** (0.008)	0.0139** (0.038)	0.0100 (0.196)	0.0012 (0.883)	0.0106** (0.035)	0.0100 (0.216)	0.0097 (0.222)	0.0043 (0.465)	0.0124 (0.494)	−0.0009 (0.901)	0.0071 (0.622)	−0.0014 (0.919)
H3c	*EQ REV*	+	β_{42}	0.0068*** (0.009)	0.0088* (0.069)	0.0048*** (0.000)	0.0096** (0.036)	0.0030** (0.030)	0.0039 (0.117)	0.0029*** (0.001)	0.0145* (0.081)	0.0002 (0.868)	0.0040 (0.453)	0.0094* (0.080)	0.0019 (0.399)	−0.0023 (0.436)	0.0029 (0.464)
H3d	*EQ COSTS*	+	β_{51}	0.0586*** (0.000)	0.0672*** (0.000)	0.0498*** (0.000)	0.0677*** (0.000)	0.0615*** (0.000)	0.0198** (0.035)	0.0614*** (0.000)	0.0524*** (0.000)	0.0249*** (0.004)	0.0450*** (0.001)	0.0071 (0.776)	0.0418*** (0.001)	0.0486*** (0.000)	0.0569*** (0.003)

(Continues)

TABLE 2 | (Continued)

H4a	*CEPPROD*	+	γ_{41}	0.0047 (0.818)	0.0056	0.0035	−0.0149	0.0532	−0.0095	0.0192	−0.0278	0.0063	0.0848	0.0167	0.0256	0.0585	−0.0102
	REV				(0.857)	(0.434)	(0.415)	(0.400)	(0.264)	(0.259)	(0.385)	(0.496)	(0.305)	(0.137)	(0.477)	(0.245)	(0.548)
H4b	*CEPPROC*	+	γ_{51}	0.2711***	0.2879***	0.2432***	0.3265***	0.2404***	0.1821***	0.2686***	0.2740***	0.2666***	0.3289***	0.0986	0.1945***	0.1688***	0.2970***
	COSTS			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.203)	(0.002)	(0.006)	(0.009)

Note: Table 2 presents the coefficients of our main SEM estimation with moderating effects (*p*-values in parentheses) for the early period (2005–2010). Column A presents the results for our full sample (as depicted in Figure 3, Panel A). Column B presents the results for the subsamples of different industrial sector categories (1 = primary sector (resource provision; no observations), 2 = secondary sector (production), 3 = tertiary sector (services)). Column C presents the results for the subsamples of different firm size (1 = small (< 50 employees), 2 = medium (≥ 50, < 250 employees), and 3 = big (≥ 250 employees)). Column D presents the results for the subsamples of different firm locations (0 = old federal state of Germany, 1 = new federal state of Germany). Column E presents the results for the subsamples of different ownership structures (0 = no family ownership, 1 = family ownership). Column F presents the results for the subsamples of different competitive strategies (0 = prevalent strategy is cost leadership, 1 = prevalent strategy is differentiation). Column G presents the results for the subsamples of different ages of the CEP management system (0 = introduced before $t = 0$, 1 = introduced in $t = 0$, $t = 1$, $t = 2$, or $t = 3$).

All variables are defined in Appendix 1.

*, **, and *** indicate that the estimated coefficients are statistically significant at the 10%, 5%, and 1% levels, respectively, using a two-tailed test.

internal quality and CFP (H3a and H3b) depends on whether revenue increases and cost reductions compensate the investment costs for internal quality improvements. The relationship between external quality and CFP (H3c and H3d) depends on whether financial benefits from external quality improvements compensate the costs for marketing and other communication channels. For the direct CEP–CFP relationship (H4a and H4b), prior literature finds different signs (see Section 2.1). Figure 4 shows our results using *ROS* for net CFP. Results are similar using *ROE* or *ROA*.

Our inferences on the relations between CEP and internal and external quality (H1a and H1b) and between internal and external quality (H2) remain qualitatively unchanged. CEP shows a significantly positive relation to internal and external quality, which supports H1a and H1b. Internal quality shows a significantly positive relation to external quality, which supports H2. In contrast, we find no significant relations of CEP and internal and external quality with net CFP. This implies that the indirect relations of CEP to higher revenues (to reduced costs) and its direct relation to increased costs as found in our main analysis compensate each other.

When we compare the results for the two different time periods, we find that in both periods, the direct costs are compensated by the benefits of higher CEP, but the effects are different in the two periods, as outlined in Section 4.1: While high CEP increased revenues via external quality in the early period, it decreases costs via internal process quality in the more recent times, which are characterized by stronger environmental policies and stakeholder expectations. Both documented compensation mechanisms are in line with the theory of the firm in that CEP investments, like other investments, are a result of supply and demand and hence cannot provide excess returns in competitive markets (e.g., McWilliams and Siegel 2001). Nevertheless, a neutral CEP–CFP relationship as found by some prior studies (e.g., Griffin and Mahon 1997; McWilliams and Siegel 2000) might contain significant underlying relations to CFP components that are relevant for firms' strategy development and management. Our results further support meta-analytical inferences that the CEP–CFP relationship highly depends on variable measurement (e.g., Orlitzky et al. 2003; Guenther and Hoppe 2014; Hang et al. 2019).

4.3 | Robustness

For robustness purposes, we analyze our main and our net CFP model for overall CEP (*CEP*) instead of its components (*CEPPROD* and *CEPPROC*). The first robustness model is as follows:[20]

$$PROD_{t0-3} = \gamma_{11}\, CEP_{t0-3} + \zeta_1 \quad (8)$$

$$PROC_{t0-3} = \gamma_{21}\, CEP_{t0-3} + \zeta_2 \quad (9)$$

$$EQ_{t0-3} = \gamma_{31}\, CEP_{t0-3} + \beta_{31}\, PROD_{t0-3} + \beta_{32}\, PROC_{t0-3} + \zeta_3 \quad (10)$$

$$REV_{t3} = \gamma_{41}\, CEP_{t0-3} + \beta_{41}\, PROD_{t0-3} + \beta_{42}\, EQ_{t0-3} + \zeta_4 \quad (11)$$

$$COSTS_{t3} = \gamma_{51}\, CEP_{t0-3} + \beta_{51}\, EQ_{t0-3} + \beta_{52}\, PROC_{t0-3} + \zeta_5 \quad (12)$$

For the late period, we additionally combine the dimensions of internal quality (*PROD* and *PROC*) into one measure (*IQ*) because then we can only use single-item measures for *PROD* and *PROC* due to changes in the MIP questionnaire, while we use multi-item measures in the early period. We use the following model:

$$IQ_{t0-3} = \gamma_{11}\, CEP_{t0-3} + \zeta_1 \quad (13)$$

$$EQ_{t0-3} = \gamma_{21}\, CEP_{t0-3} + \beta_{21}\, IQ_{t0-3} + \zeta_3 \quad (14)$$

$$REV_{t3} = \gamma_{31}\, CEP_{t0-3} + \beta_{31}\, IQ_{t0-3} + \beta_{32}\, EQ_{t0-3} + \zeta_4 \quad (15)$$

$$\mathrm{COSTS}_{t3} = \gamma_{41}\, \mathrm{CEP}_{t0-3} + \beta_{41}\, \mathrm{IQ}_{t0-3} + \beta_{42}\, \mathrm{EQ}_{t0-3} + \zeta_5 \quad (16)$$

For both robustness models, we analyze net CFP. First, we replace Equations (11) and (12) as follows:

$$CFP_{t3} = \gamma_{41}\, CEP_{t0-3} + \beta_{41}\, PROD_{t0-3} + \beta_{42}\, EQ_{t0-3} + \beta_{43}\, PROC_{t0-3} + \zeta_4 \quad (17)$$

In the same manner, we replace Equations (15) and (16) in the additional analyses for the late period as follows:

$$CFP_{t3} = \gamma_{31}\, CEP_{t0-3} + \beta_{31}\, IQ_{t0-3} + \beta_{32}\, EQ_{t0-3} + \zeta_4 \quad (18)$$

The results in Figures 5 and 6 show that all inferences remain qualitatively unchanged: CEP significantly relates to quality improvements, to higher revenues via external quality perceptions (to reduced costs via internal process improvements), and to higher costs, while the relation to net CFP is insignificant.

4.4 | Additional Moderation Analyses

To analyze the influence of contextual factors, we rerun our main model for subsamples of the early sample, split along one of six dimensions a time. Prior studies have identified several relevant moderators of the direct CEP–CFP relationship in different settings (see, e.g., Guenther and Hoppe (2014) for an overview). Our broad sample allows us to analyze whether these moderators lead to different results within one and the same specification of analysis as asked for by, for example, Earnhart (2018). Table 2 presents the results. Column A shows the results for our full sample (as depicted in Figure 3) for comparison purposes. Columns B–G show that how CEP affects CFP directly and indirectly via TQ depends on industry, firm size, location, ownership structures, competition, and experience in CEP management. Appendix 2 discusses the results in detail. Consistent with our main results, the results of the moderation analyses support the notion that with increasing CEP regulation and stakeholder expectations, CEP improvements tend to no longer translate into higher external quality and hence higher revenues.

5 | Conclusion

We contribute to the research on whether, when, and how it pays for firms to be green in terms of CFP (e.g., King and Lenox 2001; Guenther and Hoppe 2014; Yi et al. 2023) by drawing on the connection between CEP and TQ as a unifying framework to fill the respective research need identified in prior literature. The TQ perspective provides a comprehensive theoretical basis to analyze the CEP–CFP relationship. We take the multidimensionality of the variables and time lags into account as recommended by prior meta-analyses. We distinguish between two time periods—an early period (2005–2010) and a late period (2017–2022) – to account for the intermediate shift in CEP–CFP research as well as in environmental regulations and requirements. For the early period, we find that CEP significantly relates to quality improvements and to higher revenues via external quality perceptions. In those times, high CEP seems to have exceeded stakeholders' expectations and caused a higher willingness to pay. For the late period, we do not find these effects, which we attribute to the increased external pressure and environmental regulations that firms need to fulfill. Hence, good CEP may no longer be a premium quality attribute but an obligation. Still, we find that CEP significantly relates to quality improvements and benefits firms by lower costs via internal process improvements. In both periods, CEP directly causes costs. Investigating internal and external quality within one study, we unify selective insights of prior studies on proxies for either of them. We find that internal quality improvements and external quality perceptions are significantly related, emphasizing the importance to simultaneously analyze different mediators and their interrelations to reduce omitted variable bias.

We further add to prior literature by differentiating the revenue and cost dimensions of CFP in line with the TQ literature. While CEP has a neutral effect on net CFP, it has a significant effect on revenues and costs: In the early period, the indirect effect of CEP on higher revenues via external quality compensates the direct effect of CEP on higher costs. In the late period, compensation stems from an indirect effect of CEP on cost reductions via internal process improvements. This explains prior results of neutral relations when analyzing net CFP only and implies that firms do neither improve nor reduce their financial resources by CEP investments because of compensatory effects. Hence, firms can improve their CEP without destroying financial value by improving quality.[21]

Our moderation analyses for the early period further indicate that the results depend on industry, firm size, location, ownership structures, competition, and experience in CEP management. Hence, the effects of voluntary CEP improvements are not universal but depend on firm-specific conditions. Overall, our analyses show the pattern that CEP does not increase EQ and hence revenues in contexts of higher CEP regulation.

Moreover, our study provides conclusions and recommendations for sustainable corporate management to steer firms in terms of CFP and for nonfinancial reporting as increasingly mandated in many parts of the world. Particularly nowadays, management should improve CEP and hence internal processes to offset investment costs related to CEP improvements. Firms may have superseded stakeholder perceptions with their CEP efforts resulting in higher revenues before sustainable regulations have developed. Nowadays, however, high CEP is indispensable and does no longer lead to additional revenues. Still, more efficient internal process quality through management focused on CEP as a dimension of TQ may save costs that compensate the up-front investments.

Such clearer management focus may, in turn, help firms identify financially material information as asked for by stakeholders and recent nonfinancial reporting regulations like the NFRD and CSRD.

Our study also provides new insights and recommendations for policymakers. As our results have shown, the negative effect of environmental investments on net CFP is largely offset by positive consequences but that there is no net benefit. Our moderation analyses show that particularly smaller firms face cost increases. These are the firms with less employees, that is, often less capacity for innovative additional projects. As a consequence, policymakers may need to provide the incentives necessary for firms to make green investments to support the transition toward sustainability. Still, additional regulatory programs may lead to confusion and overload that may prevent the intended changes in firms' CEP investment behavior. Therefore, it is particularly important to adequately tailor such programs and incentives to industry and country circumstances (Flachenecker and Kornejew 2019).

Future research might investigate the implementation of integrated TQ management, for example, based on case studies or interviews. Integrated reporting is one possibility to fulfill the new reporting requirements. From a TQ perspective, it would be particularly interesting whether this directive has changed not only reporting but also the strategic management focus of adopting firms. While the MIP provides in-depth insights into corporate innovation based on firm surveys, further research is needed to gain insights from different perspectives: For example, questionnaires to customers or the broader public could provide measures of external quality perceptions from an outside perspective. Such research can provide more detailed insights on how different facets of TQ shape the CEP–CFP relationship. In addition, future research might extend the scope of analyses to provide insights into broader settings than that of the German firms taking part in the MIP.

Our German sample is well suited for studying our research question, and focusing on one country comes with the advantage of holding institutional characteristics constant (Leuz 2003). However, given its focus on SMEs, it is unclear whether the results would generalize to larger, listed firms and other environments outside the EU. Because the MIP is part of the broader European CIS and covers SMEs that represent 99% of all firms in Europe (e.g., García-Quevedo et al. 2020) and because many environmental regulations that hold in Germany are also effective throughout the EU, our study is largely representative of European countries. To analyze whether our results hold in other countries, the CIS may provide an adequate starting point for comparable data.[22] In addition, future studies might analyze other countries with currently less environmental regulation, as was the case in Germany during our early period analyses. In light of the increasing regulatory pressure on firms to invest in CEP, it would further be interesting to analyze the implications of different CEP strategies within a TQ framework, that is, whether proactive or reactive changes in CEP provide different direct and indirect effects on TQ and CFP.[23] To conclude, the question "(When and how) does it pay to be green?" may still be up for further research despite the multitude of existing studies.

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Conflicts of Interest

The authors declare no conflicts of interest.

Endnotes

[1] The term CEP is widely used in prior literature and conceptualized via different measures (see, for instance, Guenther and Hoppe (2014) or Earnhart (2018) for an overview). We use a direct, operational, and firm perception–based measurement and understand CEP as a firm's efforts to avoid or at least reduce its negative environmental impacts.

[2] Prior studies measure CFP by different stock market, accounting, or internal management variables (see, for instance, Guenther and Hoppe (2014) or Earnhart (2018) for an overview). We use revenues, costs, and net CFP (return on sales, on equity, and on assets) to capture the effects of environmental improvements on the financial resources of the firms.

[3] The concept of TQ was first proposed by Feigenbaum (1951) under the term "total quality control". It was further shaped under the term "total quality management" (TQM) by, for instance, Juran (1951), Crosby (1979), and Deming (1982) and has been adopted rapidly by firms (e.g., Snape et al. 1996; Ghobadian and Gallear 2001; Prajogo and Sohal 2006).

[4] The NFRD has rendered nonfinancial reporting mandatory as of 2017 for firms of public interest with more than 500 employees. The CSRD from 2022 increases requirements and scope of nonfinancial reporting.

[5] Theories range from a positive to a negative as well as a neutral relation. The Porter hypothesis (Porter 1990; Porter and van der Linde 1995), the natural resource–based view (Hart 1995), the stakeholder theory (Davis 1973), the social impact theory (Latané 1981), and the slack resources theory (Cyert and March 1963) assume a positive association. The trade-off hypothesis (Levitt 1958; Friedman 1970) and the theory of managerial opportunism (Preston and O'Bannon 1997) predict a negative association. The theory of the firm (McWilliams and Siegel 2001) and the stewardship theory (Donaldson and Davis 1991) propose a neutral relation.

[6] Further literature in search of explanations for the differences in prior research results refers to a bidirectional relationship between CEP and CFP (e.g., Busch and Friede 2018; Hang et al. 2019) or an optimal level of CEP investments depending on internal as well as external determinants (e.g., Salzmann et al. 2005; Lankoski 2008; Wang et al. 2016; Trumpp and Guenther 2017).

[7] From a TQ perspective, the mediators are all part of TQ: Innovations reflect internal quality improvements. Prominence and favorability as well as overall reputation reflect external quality. Human capital like employee satisfaction and training programs as well as corporate culture are direct drivers of internal and potentially also external quality. Sustainable competitive advantages are based on improvements in both internal and external quality.

[8] Some studies already use SEM in related analyses (e.g., Sambasivan et al. 2013; Huang and Li 2017; Saeidi and Othman 2017; Sila 2018a), but none of them differentiates the revenue and cost dimensions of CFP in their model, includes the various moderators, and incorporates the interrelations between the separate mediators.

[9] We do not measure CEP by external rankings or ratings, which commonly combine indicators from the categories "environmental impact," "regulatory compliance," and "organizational processes" in significantly varying ways (Delmas and Blass 2010). We do neither

define CEP as the fulfillment of stakeholder expectations (Schultze and Trommer 2012), because we consider stakeholder perceptions as an external quality attribute that we analyze as a successor of CEP.

[10] With values of 0.90 (0.92) (*CEP*), 0.70 (0.75) (*CEPPROD*), and 0.89 (0.90) (*CEPPROC*), the Kaiser–Meyer–Olkrin criteria for our CEP measures are above the threshold of 0.6 (e.g., Kaiser and Rice 1974), indicating a good cohesiveness of the underlying indicators. With values of 0.92 (0.92) (*CEP*), 0.83 (0.83) (*CEPPROD*), and 0.90 (0.88) (*CEPPROC*), factor reliability is above the critical threshold of 0.6 (e.g., Bagozzi and Yi 1988). The Fornell–Larcker criterium requires that the average variance of each indicator should be higher than its square correlation with other constructs (e.g., Fornell and Larcker 1981). A highest square correlation of 0.16 (0.05) (*CEP*), 0.24 (0.04) (*CEPPROD*), and 0.15 (0.09) (*CEPPROC*), respectively, supports high discriminant validity. The chi square test of independence (e.g., Pearson 1900) supports a good overall model fit at the 5% significance level. After correction for correlation of the error terms, values of the comparative fit index (e.g., Bentler 1990) and the Tucker–Lewis index (e.g., Tucker and Lewis 1973) of 0.96 (0.93) and 0.94 (0.90), respectively, are above the critical threshold of 0.9.

[11] Because of changes in the MIP questionnaire, we measure "attractiveness to opinion leaders" as a single-item construct in the late period.

[12] In contrast to reflective measurement models, correlations of the indicators in formative measurement models do not stem from the model and the indicators as dependent variables correlate with the respective error term. Hence, model quality criteria like factor reliability or discriminant validity cannot be applied meaningfully (e.g., Bollen and Lennox 1991; Nunnally and Bernstein 1994; Diamantopoulos and Winklhofer 2001; Jarvis et al. 2003; Petter et al. 2007).

[13] We find that significant relations mainly disappear with longer time lags. Hence, we do not tabulate the results for $t=4$ and $t=5$ but provide additional information in the text or in footnotes.

[14] While regression analyses typically analyze models with only one equation or several independent equations and path analyses analyze interdependent equations with concretely observable variables, SEM can incorporate latent variables (e.g., Jöreskog 1978; Kaplan 2009).

[15] Find further information on the data provision related to the MIP here: https://kooperationen.zew.de/en/zew-fdz/use-files/scientific-use-files.html (accessed May 9, 2024).

[16] Find further information on the MIP here: https://www.zew.de/en/publications/zew-expertises-research-reports/research-reports/innovations/mannheim-innovation-panel-the-annual-german-innovation-survey (accessed May 9, 2024).

[17] The MIP differentiates between segment, single firm, and affiliated group of firms. The Kruskal and Wallis (1952) test indicates that the data are uniformly distributed across the three types of operational units ($p<0.01$).

[18] The MIP covers a representative sample that remains generally stable over time. However, it is continuously adjusted for firm bankruptcy, mergers, or acquisitions and is extended by a random sample of newly founded firms every second year (e.g., ZEW 2020b). Therefore, the firms included in our two samples are not neccessarily the same even though we use data from the same survey.

[19] In the early sample period, regarding the direct relation between CEP and CFP, we find a significantly negative relation between *CEPPROC* and *COSTS* in $t=4$, that is, a decrease in costs when we consider a longer time lag ($\gamma_{51}=-0.0848$, $p<0.01$). This might be due to learning effects from CEP implementations and hence lower investment costs such that the cost savings prevail. As in $t=3$, we do not observe a significant relation between *CEPPROD* and *REV* in $t=4$. In $t=5$, the effects of CEP on costs and revenues are insignificant. This indicates that the significance of the relationship between CEP and CFP disappears at a certain point in time, which is consistent with the findings by Hang et al. (2019). For the late sample period, we do not find any significant relations between CEP and CFP in $t=4$ and $t=5$.

[20] In comparison to our main model, each equation contains *CEP* instead of the respective component(s). Equation (10) is reduced by one variable compared to Equation (4) in our main model that includes both CEP components.

[21] Lee et al. (2018) draw on Pascal's wager and the parallel to religious beliefs: One does not lose much by living in accordance with a belief that was false, but one would if living contrary to a belief that was essentially true. Our study provides empirical evidence that firms do not gain but also incur no net cost when contributing to a greener environment and the endeavor to save the earth from climate risks.

[22] One might expect that our results for the late period might also hold in other European countries because of common European ESG regulations. Still, recent studies using the CIS data to analyze other environmental- or innovation-related topics find parallels as well as differences in their results across countries. For example, Prokop et al. (2024) find a reverse relation between eco-innovation and business model innovation in each analyzed state (Germany, Czech Republic, and Greece), but their results on the relationship between eco-innovation and environmental benefits differ across the states. Parrilli et al. (2020) find variations in business innovation modes across European countries.

[23] See, for instance, Dixon-Fowler et al. (2013) for a related meta-analysis without TQ considerations.

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Appendix 1

List of Variables

Panel A: Environmental performance

			2005–2010			2017–2022		
Variable	**Measurement**	**Model specification**	**Composition**	**Items**	**Source**	**Composition**	**Items**	**Source**
CEP	Improvements in environmental performance, $t=0$ to $t=3$	Reflective	Multi-item	Items of *CEPPROC* and *CEPPROD*	MIP 2009	Multi-item	Items of *CEPPROC* and *CEPPROD*	MIP 2021
CEP-PROC	Improvements in process-based environmental performance, $t=0$ to $t=3$	Reflective	Multi-item	1. Material use per unit of output 2. Energy use per unit of output 3. CO_2 "footprint" 4. Air pollution 5. Water pollution 6. Soil pollution 7. Noise pollution 8. Polluting or hazardous materials 9. Recycling of waste, water, or materials	MIP 2009	Multi-item	1. Material use per unit of output 2. Energy use per unit of output 3. CO_2 "footprint" 4. Air pollution 5. Water or soil pollution 6. Noise pollution 7. Fossil fuel 8. Hazardous materials 9. Recycling of waste, water, or materials	MIP 2021
CEP-PROD	Improvements in product-based environmental performance, $t=0$ to $t=3$	Reflective	Multi-item	1. Energy use of products 2. Air, water, soil, or noise pollution of products 3. Recyclability of products 4. Share of new products with positive environmental effects	MIP 2009	Multi-item	1. Energy use of products 2. Air, water, soil, or noise pollution of products 3. Recyclability of products 4. Product life cycle	MIP 2021

Panel B: Internal and external quality

			2005–2010			2017–2022		
Variable	**Measurement**	**Model specification**	**Composition**	**Items**	**Source**	**Composition**	**Items**	**Source**
PROD	Internal product quality improvements, t = 0 to t = 3	Formative	Multi-item (item parceling)	1. Product improvements last 3 years 2. Design improvements last 3 years 3. Product improvements last 3 years, not yet completed 4. Product improvements planned for next year 5. Product improvements planned for year after next year	MIP 2006 2007 2009	Single item	Product improvements last 3 years	MIP 2018 2021

Panel B: Internal and external quality

			2005–2010			2017–2022		
Variable	**Measurement**	**Model specification**	**Composition**	**Items**	**Source**	**Composition**	**Items**	**Source**
PROC	Internal process quality improvements, $t=0$ to $t=3$	Formative	Multi-item (item parceling)	1. Process improvements last 3 years 2. Organizational improvements last 3 years 3. Process improvements last 3 years, not yet completed 4. Process improvements planned for next year 5. Process improvements planned for year after next year	MIP 2006 2007 2009	Single item	Process improvements last 3 years	MIP 2018 2021
IQ	Improvements in internal quality, $t=0$ to $t=3$	Formative	—	—	—	Multi-item (item parcelling)	1. Product improvements last 3 years (*PROD*) 2. Process improvements last 3 years (*PROC*) 3. Improvements in innovation last 3 years, not yet completed 4. Improvements in innovation planned for next year 5. Improvements in innovation planned for year after next year	MIP 2018 2021
EQ	Improvements in external quality perceptions, $t=0$ to $t=3$	Formative	Multi-item (item parceling)	1. Attractiveness to customers a. Quality of goods or services b. Time to respond to customer needs c. Marketing innovations 2. Attractiveness to the capital market a. Market share b. Profitability c. Debt ratio 3. Attractiveness to employees a. Personnel expenses b. Training expenses c. Percentage of employees with graduate degree 4. Attractiveness to opinion leaders a. Environmental pollution b. Health/safety c. Number of information sources d. Cooperation with external partners	MIP 2006 2007 2009 and DAFNE (2c)	Multi-item (item parcelling)	1. Attractiveness to customers a. Quality of goods or services b. Customized solutions c. Marketing innovations 2. Attractiveness to the capital market a. Market share b. Profitability c. Debt ratio 3. Attractiveness to employees a. Personnel expenses b. Training expenses c. Percentage of employees with graduate degree 4. Attractiveness to opinion leaders (cooperation with external partners)	MIP 2018 2019 2021 and DAFNE (2c)

Panel C: Financial performance

Variable	**Measurement**	**Model specification**	**Composition**	**Items**	**Source (2005–2010)**	**Source (2017–2022)**
REV	Change in revenues, $t=3$	None (manifest variable)	Single item	Revenues	MIP and DAFNE	DAFNE
COSTS	Change in costs, $t=3$	None (manifest variable)	Single item	Operating expenditures	MIP and DAFNE	MIP and DAFNE

Panel C: Financial performance						
Variable	**Measurement**	**Model specification**	**Composition**	**Items**	**Source (2005–2010)**	**Source (2017–2022)**
CFP	Change in net financial performance, $t=3$					
	1. Change in return on sales (*ROS*)	None (manifest variable)	Single item	Return on sales (return to equity providers divided by sales)	MIP (1.) and DAFNE	DAFNE
	2. Change in return on equity (*ROE*)	None (manifest variable)	Single item	Return on equity (return to equity providers divided by equity)	DAFNE	DAFNE
	3. Change in return on assets (*ROA*)	None (manifest variable)	Single item	Return on assets (return to equity and debt providers divided by total assets)	DAFNE	DAFNE

Panel D: Moderators						
Variable	**Measurement**	**Model specification**	**Composition**	**Items**	**Source (2005–2010)**	**Source (2017–2022)**
IND	Industry proxy, indicator variable with 1 = primary sector (resource provision) 2 = secondary sector (production) 3 = tertiary sector (services)	None (manifest variable)	Single item	Sector	MIP	—
SIZE	Size proxy, indicator variable with 1 = small (< 50 employees) 2 = medium (≥ 50, < 250 employees) 3 = large (≥ 250 employees)	None (manifest variable)	Single item	Number of employees	MIP	—
LOC	Location proxy, dichotomous variable with 0 = old federal state of Germany 1 = new federal state	None (manifest variable)	Single item	Location	MIP	—
OWN	Ownership proxy, dichotomous variable with 0 = no family ownership 1 = family ownership	None (manifest variable)	Single item	Ownership	MIP	—
CSTR	Competitive strategy proxy, dichotomous variable with 0 = prevalent strategy is cost leadership 1 = prevalent strategy is differentiation	Formative	Multi-item	1. Cost strategy a. Reduced material or energy costs b. Reduced personnel costs c. Increased capacity 2. Differentiation strategy a. Increased product quality b. New product innovations c. Increased range of goods or services	MIP	—
AGE	Age of CEP management system proxy, dichotomous variable with 0 = introduced before $t=0$ 1 = introduced in $t=0$, $t=1$, $t=2$, or $t=3$	None (manifest variable)	Single item	Age of environmental management system	MIP	—

Appendix 2

Discussion of the Results of the Moderation Analyses

This appendix extends Section 4.4 and discusses the results of our moderation analyses (Table 2) in more detail. Table 2 repeats the results for our early sample (as depicted in Figure 3, Panel A) for comparison purposes (Column A). Columns B–G show differences in the results when considering other moderators than time differences (industry, firm size, location, ownership structures, competition, and experience in CEP management).

Column B of Table 2 analyzes the effect of the industry type based on the three-sector theory (Fisher 1939) and differentiates the secondary (manufacturing, $IND=2$) and tertiary sectors (services, $IND=3$). Our sample comprises only 92 observations in the primary sector (raw materials, $IND=1$), which is insufficient for meaningful results from SEM. The industry sector classification is independent from other variables like *CEP*, which reduces the risk of undetected correlation. The positive relation between *CEPPROD* and *PROD* is only significant for the tertiary ($\gamma_{11}=0.1375$, $p<0.05$), not the secondary sector ($\gamma_{11}=0.0890$, $p>0.1$). The relationship between *CEPPROC* and *PROC*, in contrast,

turns significant for the secondary sector ($\gamma_{21}=0.1769$, $p<0.05$). This implies that CEP relates to internal quality (H1a) via process rather than product quality improvements for the manufacturing sector. The relationship between *CEPPROC* and *EQ* (H1b) is not significant for the tertiary sector ($\gamma_{32}=0.3208$, $p>0.1$). This might be due to industry-specific stakeholder demands for CEP (e.g., Brammer and Pavelin 2006; Guenther and Hoppe 2014; Grewatsch and Kleindienst 2017) and corresponds to the insignificant relationship between *CEPPROC* and *PROC* for this sector. Regarding the relationship between internal and external quality (H2), the positive relation between *PROD* and *EQ* is only significant for the secondary ($\beta_{31}=0.0755$, $p<0.01$), not for the tertiary sector ($\beta_{31}=0.0247$, $p>0.1$). The relationship between *PROC* and *EQ* is insignificant for both ($\beta_{32}=-0.0322/-0.0046$, $p>0.1$). Regarding the relations to CFP (H3a to H4b), the only difference between the subsamples is that the relationship between *PROC* and *COSTS* is insignificant for the secondary sector ($\beta_{52}=0.0053$, $p>0.1$), where process quality improvements seem to cause cost reductions that compensate the respective investment costs. All other inferences are comparable to the full sample and across the two subsamples.

Column C analyzes the effect of firm size based on the number of full-time employees. Following the European Commission (2003), we differentiate between firms with less than 50 employees (*SIZE* = 1), between 50 and 249 employees (*SIZE* = 2), and 250 employees or more (*SIZE* = 3) based on firms' employee count in 2008. We do not use monetary measures of firm size as these likely correlate with our CFP measures. *CEPPROD* and *PROD* (H1a) and *CEPPROD* and *EQ* (H1b) are only significantly related for small firms ($\gamma_{11}=0.2133$, $p<0.05$ / $\gamma_{31}=0.6910$, $p<0.01$). The positive relation between *CEPPROC* and *EQ* (H1b) is only significant for medium ($\gamma_{32}=0.7256$, $p<0.01$) and large firms ($\gamma_{32}=0.7522$, $p<0.05$), which implies that stakeholders of larger firms are better informed about process-based CEP and incorporate related improvements into their quality perceptions. Regarding the relationship between internal and external quality (H2), the positive relation between *PROD* and *EQ* is only significant for medium firms ($\beta_{31}=0.0994$, $p<0.01$), and the relationship between *PROC* and *EQ* is negatively significant for small firms ($\beta_{32}=-0.0558$, $p<0.1$). Stakeholders of smaller firms thus seem to be more critical about internal quality as process improvements relate to lower external quality perceptions. Regarding CFP (H3a to H4b), there are two differences between the subsamples: First, the relationship between *PROC* and *COSTS* is only significant for small firms ($\beta_{52}=0.0139$, $p<0.05$). This is in line with other studies. For example, Madaleno et al. (2020) find additional costs of innovation in the context of environmentally friendly demands particularly for small firms. Second, the relationship between *EQ* and *REV* is only significant for small and medium firms ($\beta_{42}=0.0096/0.0030$, $p<0.05$). A possible explanation is that smaller firms face less external pressure and lower ex ante outside expectations such that they can more easily exceed expectations and benefit from external quality improvements (e.g., Brammer and Pavelin 2006; Dixon-Fowler et al. 2013; Guenther and Hoppe 2014; Grewatsch and Kleindienst 2017). All other inferences are comparable to the full sample and across the two subsamples.

Column D analyzes regional effects and compares firms from the old and the new German federal states. With this categorization, we follow Rennings and Rammer (2011) and Horbach et al. (2012). The federal states differ along the dimensions of regulation (e.g., funding of environmental innovations) and market environment (e.g., purchasing power). The new federal states (*LOC* = 1) have earlier and stronger regulatory and societal initiatives for environmental responsibility compared to the old federal states (*LOC* = 0). Regarding H1a, we observe that the positive relation between *CEPPROD* and *PROD* is only significant for firms from the old federal states ($\gamma_{11}=0.0798$, $p<0.1$), whereas the relationship between *CEPPROC* and *PROC* turns significant for firms from the new federal states ($\gamma_{21}=0.2862$, $p<0.05$). The relations between *CEPPROD* and *EQ* (H1b) and *PROD* and *EQ* (H2) are only significant for firms from the old federal states ($\gamma_{31}=0.4703$ / $\beta_{31}=0.0912$, $p<0.01$). This might be due to higher and more challenging stakeholder expectations in the new federal states such that realized improvements are not enough to increase external quality perceptions (e.g., Guenther and Hoppe 2014). This is also in line with our main results that compare an early and a late sample period that particularly differ in CEP regulations and stakeholder expectations. For *PROC* as an alternative measure of internal quality improvements, however, the relation to *EQ* is significantly negative for firms from the old federal states ($\beta_{32}=-0.0449$, $p<0.05$). The positive relation between *PROC* and *COSTS* (H3b) is only significant for firms from the old federal states ($\beta_{52}=0.0106$, $p<0.05$). These results imply that firms from the old federal states face additional costs and declining external quality perceptions from process improvements. All other inferences are comparable to the full sample and across the two subsamples.

Column E compares family-owned firms and firms with other types of ownership. We follow prior literature (e.g., Melnyk et al. 2003; Dixon-Fowler et al. 2013; Garcés-Ayerbe et al. 2022) that contrasts private family-owned firms (*OWN* = 1) to firms with other types of ownership (*OWN* = 0). We do not have full information on ownership structure for all firms such that we cannot allocate all firms to the subsamples. Hence, the subsamples only describe the full sample partly. Several relations are only significant for family-owned firms: *CEPPROD* and *PROD* (H1a, $\gamma_{11}=0.3716$, $p<0.05$), *CEPPROD* and *EQ* (H1b, $\gamma_{31}=0.7905$, $p<0.01$), *PROD* and *EQ* (H2, $\beta_{31}=0.0830$, $p<0.01$), and *PROC* and *EQ* (H2, $\beta_{32}=0.0494$, $p<0.1$). This is in line with the proposition that public firms face greater outside pressure than private firms, which limits their choice of CEP initiatives and reduces the likelihood of exceeding stakeholder expectations (e.g., Dixon-Fowler et al. 2013). The following relations are not significant for neither subsample, which might be due to the lower number of observations compared to the full sample: *CEPPROC* and *EQ* (H1b, $\gamma_{32}=0.2310/0.3117$, $p>0.1$), *PROC* and *COSTS* (H3b, $\beta_{52}=0.0097/0.0043$, $p>0.1$), and *EQ* and *REV* (H3c, $\beta_{42}=0.0002/0.0040$, $p>0.1$). All other inferences are comparable to the full sample and across the two subsamples.

Column F analyzes competitional effects. According to Porter (1980), firms can generate competitive advantages following a cost (*CSTR* = 0) or differentiation strategy (*CSTR* = 1). To classify firms, we use indicators of the MIP: For cost orientation, we use (1) reduced material or energy costs, (2) reduced personnel costs, and (3) increased capacity. For differentiation, we use (1) increased product quality, (2) new product innovations, and (3) increased range of goods or services. In the survey, firms can award between zero and three points per indicator, dependent on whether the respective indicator is of no, minor, medium, or major relevance to them. In total, a firm can score between zero and nine points per strategy. *CSTR* indicates the strategy, which the firm scored higher. We do not have full information on the indicators for all firms such that we cannot allocate all firms to the subsamples. Hence, the subsamples only describe the full sample partly. Some relations are not significant for neither subsample: *CEPPROD* and *PROD* (H1a, $\gamma_{11}=-0.0448/-0.0080$, $p>0.1$), *CEPPROD* and *EQ* (H1b, $\gamma_{31}=-0.1767/0.1188$, $p>0.1$), *PROD* and *EQ* (H2, $\beta_{31}=0.0280/-0.0204$, $p>0.1$), and *PROC* and *COSTS* (H3b, $\beta_{52}=0.0124/-0.0009$, $p>0.1$). The positive relation between *EQ* and *REV* (H3c) is only significant for firms that prioritize cost orientation ($\beta_{42}=0.0094$, $p<0.1$). These firms might set higher market entry barriers than their peers and also increase competitors' costs because setting the bar high raises stakeholders' expectations also for competitors. This increases competitive advantages and hence revenues (e.g., McWilliams et al. 2002; Guenther and Hoppe 2014). The positive relations between *EQ* and *COSTS* (H3d, $\beta_{51}=0.0418$, $p<0.01$) and *CEPPROC* and *COSTS* (H4b, $\gamma_{51}=0.1945$, $p<0.01$) are only significant for firms that prioritize differentiation. The insignificant results for cost-oriented firms are in line with the proposition that these firms do not face noticeably higher costs after improvements in CEP and external quality, that is, that cost reductions outweigh investment costs for these firms (e.g., Reinhardt 1999; Guenther and Hoppe 2014). All other inferences are comparable to the full sample and across the two subsamples.

Column G tests the effect of how long a firm has engaged in CEP management. We differentiate between firms that had already implemented a CEP management system before our observation period (before $t=0$; *AGE* = 0) and firms that implemented a CEP management system

during our observation period ($t = 0$ to $t = 3$; $AGE = 1$). The relationship between CEP and CFP should be stronger for firms that are more familiar with CEP management (e.g., Melnyk et al. 2003). Experience might increase the quality of CEP management, which moderates the relationship between CEP and CFP (e.g., Menguc and Ozanne 2005; Guenther and Hoppe 2014). We do not have full information for all firms such that we cannot allocate all firms to the subsamples. Hence, the subsamples only describe the full sample partly. Some relations are not significant for neither subsample: *CEPPROD* and *PROD* (H1a, $\gamma_{11} = -0.1966/0.3876$, $p > 0.1$), *PROC* and *COSTS* (H3b, $\beta_{52} = 0.0071/-0.0014$, $p > 0.1$), and *EQ* and *REV* (H3c, $\beta_{42} = -0.0023/0.0029$, $p > 0.1$). Regarding H1b, *EQ* is significantly related to *CEPPROD* for firms with a longer history of CEP management systems ($\gamma_{31} = 0.4805$, $p < 0.05$), while *EQ* is significantly related to *CEPPROC* for firms that implemented environmental management systems later ($\gamma_{32} = 0.9523$, $p < 0.1$). This implies that product-based CEP improvements, compared to process-based CEP improvements, translate into external quality improvements after a longer period of CEP management, that is, with more experience. All other inferences correspond to our full sample analyses and do not differ between the subsamples. Overall, our moderation analyses highlight that how CEP affects CFP depends on the specific context.