

Article

# Environmental Sustainability as a Source of Product Innovation: The Role of Governance Mechanisms in Manufacturing Firms

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**Abstract:** Over the past two decades, since the emergence of the triple bottom line philosophy, the relationship between environmental sustainability and corporate performance has received a lot of attention, but has generated mixed or often even contradictory results. A few recent studies have inferred that innovations are the missing link that connects the environmental sustainability of a firm to other performance metrics; however, the evidence of such a proposition has been restricted to being conceptual or anecdotal. Relying on a knowledge governance approach, this study presents exploratory empirical evidence indicating that the impacts of a firm's sustainability initiatives on its innovation performance originate from the governance mechanism it uses for sustainability, not sustainability outcomes per se. We tested this research proposition by using a subsample of Global Manufacturing Research Group's global survey data. Our results support the positive impacts of two widely-used environmental sustainability governance mechanisms (i.e., internal monitoring and supplier collaboration) on product innovation capability. The findings further provide more useful and effective options for manufacturing firms and managers, to establish environmental sustainability governance mechanisms that can be converted into product innovation capability.

**Keywords:** environmental sustainability; governance mechanism; internal monitoring; supplier collaboration; product innovation

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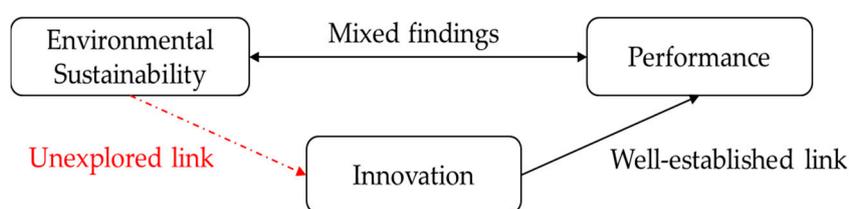
## 1. Introduction

The importance of sustainable manufacturing has become undeniable. Many leading manufacturers such as Hewlett-Packard, IKEA, and Ford have actively attempted to incorporate environmental sustainability (ES) into their supply chains [1,2]. As per the latest statistics, the world's 250 largest companies, by revenue, now publish corporate responsibility reports on a regular basis to meet heightened consumer expectations on sustainable economic development [3]. The link between ES and economic performance has received significant and growing attention from academic communities. Porter and Kramer [4], in their seminal article, discussed the future directions of ES research and proposed the "shared value" framework as a new way to look at the business-society relationship that does not treat corporate success and social welfare as a zero-sum game.

Despite two decades of research, however, the direct causation between ES and firm performance is still obscure and not well understood, with mixed findings [5]. The vast majority of contemporary literature on ES has focused on one broad question: "Does ES pay?" This group of scholars, including Green et al. [6] and Yang et al. [7], has argued that ES promotes firm performance. The opposite research stream, including Wiengarten and Pagell [8] and Wiengarten et al. [9], explored the question of "how to achieve ES?" and found that environmental performance of a firm was improved only under

certain circumstances. Still other studies have explored the correlation (not causation) between ES and firm performance and related theoretical or contextual issues. For instance, Karnani [10] discussed the trade-off relationships between corporate sustainability initiatives and profitability. Schoenherr and Talluri [11] investigated the contingent effect of the national culture in which firms operate on the association between ES and supply chain performance.

Recent sustainability studies have begun to shed some light on the link between ES and innovation. Relying on the well-established knowledge base of innovation-focused research, most of these works have treated ES as one of many other performance dimensions (such as cost, stock price, return on investment, etc.), and highlighted the positive influences of innovation on ES outcomes (e.g., [12–14]). This stance, however, is being challenged by recent observations of the high-tech firms competing in innovation-intensive industries. Samsung has been accused of (and charged with) its semiconductor fabrication workers reporting cases of leukemia and brain tumor in multiple lawsuits [15]. Foxconn, Apple’s key manufacturing partner, has also faced criticism for its environmental record [16]. Collectively, these examples contradict the conventional belief that innovations result in improved corporate environmental performance. Rather, Porter and Kramer [4] asserted the purpose of the firm must be redefined as creating shared value (CSV), not just profits per se, which will bring new approaches to generate greater innovation. A recent global survey by Kiron et al. [17] of more than 2600 executives and managers also found that sustainability activities often lead to business model innovation. In the same vein, in their seminal *Harvard Business Review* article, Nidumolu et al. [18] defined sustainability as “a mother lode of innovations”. These pioneering studies collectively are inferring that the ES of a firm could lead to elevated corporate performance through its innovation capability; however, few empirical investigations exist for this theoretical proposition. This gap is illustrated in Figure 1.



**Figure 1.** Research gaps in environmental sustainability and innovation literature.

This study draws on the knowledge governance approach (KGA) [19,20] from organizational economics to explore an important, but sparsely researched theme: sustainability as a source of innovation. Corporate innovation requires cooperation among internal and external actors of a firm, and sharing and managing their knowledge have been identified as key success factors [21]. Different from the conventional knowledge-based view, the KGA argues that the knowledge-based capabilities of a firm, including innovation, emerge from the deployment of appropriate governance mechanisms. Applying this logic to the domain of sustainability research, we suspect that firms’ quest for ES, not ES performance per se, helps them develop distinct capabilities that drive innovations. In this regard, the present study aims to contribute to triple bottom line and corporate governance literature by examining how a firm’s governance mechanism for ES (i.e., internal control and supplier collaboration) impacts on its product innovation capability. To achieve this goal, we analyze the large Global Manufacturing Research Group database (GMRG), surveyed by individual manufacturing plants. This unit of analysis makes our findings more robust and useful in that: (1) most ES practices are actually implemented at plant level, not firm level [22]; (2) their impacts on product innovation outcome are better observed at plant level [23]; and (3) firms can minimize the cost and risk of implementing our findings on a small scale before introducing them to the entire organization.

The rest of the paper is organized as follows. In the next section, we outline our theoretical background and provide research hypotheses. Section 3 details our research methods, followed by

Section 4 that discusses the results and implications of our empirical investigation. In Section 5, we conclude our research, note its limitations, and provide further research directions.

## 2. Theoretical Background and Research Hypotheses

### 2.1. Environmental Sustainability and Firm Performance: Mixed Findings

Since John Elkington's introduction of triple bottom line philosophy, much of the contemporary literature on ES has emphasized its direct influence on firm performance. For instance, Green et al. [6] showed that the implementation of green purchasing leads directly to improved economic performance of manufacturing firms, and Yang [7] found the reduced environmental impacts of a firm improve its competitiveness, in terms of service quality, productivity, and profits. More recently, Narasimhan et al. [24] extended this view by exploring the role of the involved entities' supply chain positions. They found that companies closer to final consumers achieve greater financial benefits from Forest Stewardship Council certification, a widely-acknowledged international standard in the management and supply of sustainably produced timber.

However, this stream of research has been constantly challenged by another group of scholars supporting the influence of certain supply chain performance dimensions on ES outcomes of a firm. The evidence includes the direct positive impacts of quality management practices [8] and supplier relationships [25] on the success of environmental management initiatives. Wiengarten et al. [9] further explored this view by showing that the influence of a firm's lean/quality investments on its operational performance is amplified through environmental practices such as ISO 14001, pollution prevention, recycling of materials, and waste reduction.

Given these mixed findings, recent studies are more interested in exploring any existing patterns, rather than causations, of the relationship between ES and firm performance. For instance, Schoenherr and Talluri [11] compared the plants located in the U.S. and Europe regarding how their ES initiatives are associated with plant efficiency, in terms of including cost, quality, delivery, and lead time. Going further, Karnani [10] criticized corporate social responsibility (CSR) initiative as an "illusion" due to its lack of economic justification. He argued: (1) No CSR would be needed if the market were perfectly efficient ("zone of possibility"); and (2) governments, not firms, would be much more effective in achieving maximum social welfare in an inefficient market ("zone of disaster").

### 2.2. Environmental Sustainability and Innovation

The impact of innovation on corporate sustainability was once regarded as a promising research topic by many innovation-management scholars. This has resulted in many research findings on the impacts of a firm's eco-innovation [14] or organizational innovation [13] activities on its ES performance. As discussed earlier, however, this stream of research has not fully explained the recent ES failures of highly innovative companies and/or industries. Facing this gap, Nidumolu et al. [18] argued that smart companies now treat sustainability as innovation's new frontier in their seminal paper. This proposition was echoed by Peloza et al.'s [26] global survey, which called for future research to investigate the relationship between ES and the innovation culture of a firm. Despite the repeated calls by a few pioneering studies such as Porter and Kramer [4] and Kiron et al. [17], to the best of the authors' knowledge, the possible influence of ES on innovation has largely remained conceptual and anecdotal. The most recent work on this link, Kennedy et al. [12], suggested five organizational typologies to utilize radical product innovation for environmental performance, based on an in-depth case study of a Dutch multinational life science company.

### 2.3. Governance Mechanisms for Environmental Sustainability

Corporate governance refers to the structure of rights and responsibilities among the parties with a stake in the firm, and plays a key role in achieving strategic goals and furthering the firm's vision [27]. In this regard, it has become one of the most researched topics in the organizational management

literature. As the consumer preference for environmentally-friendly products increases, more firms are attempting to incorporate ES into their strategic goals by establishing sustainability policies or codes of ethics. IKEA demands the strictest standards of environmental sustainability of its suppliers, and Ford of Europe implements its own Product Sustainability Index from the beginning of the vehicle development process.

The understanding of governance mechanism for ES has become essential to make sure a firm's entire supply chain operates in alignment with its ES objectives; however, this area has been relatively neglected by researchers. A few exceptions include the studies of Wu [28] and Yang et al. [29], that recommended the establishment of green supply chain integration and green culture, respectively, as drivers of effective green innovation. These early studies initiated the theoretical investigations of how to leverage ES for innovation, but are associated with several limitations to serve as 'hands-on' guidelines. First, supply chain integration and corporate culture are still arguably vague concepts, due to their multi-level/scope definitions [30,31]. From the company's standpoint, therefore, it will not be an easy task to understand where they could start or what exact actions are needed. The goal of complete supply chain integration or uniform corporate culture is also not universally accepted as an ideal state. Cox and Stacy [32] argued the cultural diversity of a firm promotes team creativity and innovation, and Van Donk and van der Vaart [33] found that the integration of a supply chain dominated by shared resources and limited capacity is hardly possible or feasible or possible when customer demand is relatively uncertain. Such uncertainties make it challenging for firms to understand how much integration or cultural assimilation is required for its ES initiative to achieve the targeted innovation outputs. Last, it is never an easy task to integrate supply chain entities or build a company-wide culture for ES. It is often very challenging to integrate different supply chain entities with conflicting interests [34], and corporate culture tends to change slowly over time [35]. Of course, such organizational changes also can encounter resistance from involved entities that hampers their overall benefits [36].

Organizations should be managed on the basis of overarching mechanisms to ensure they build and maintain the governance structure that best serves their goals [37]. However, the governance mechanism that can support the effectiveness of sustainable operations has been unclear to both academics and practitioners. Corporate governance literature has extensively debated two governance mechanism types—control and collaboration—as key drivers in achieving strategic goals of a firm [38]. First, control as a governance mechanism is based on the perspective of transaction cost economics, which focuses on the efficiency of controlling opportunistic behaviors of transaction partners, to safeguard specific investment [39]. In contrast, collaboration as a governance mechanism is anchored on the resource-based view that argues the competitive advantage of a firm depends on how to better exploit the organization-specific resources beyond its boundary [40]. Drawing upon the literature of these two most representative governance mechanisms, this study investigates how a firm's internal monitoring (proxy of *control* mechanism) and supplier collaboration (proxy of *collaboration* mechanism) for ES impact its product innovation capability.

### 2.3.1. Internal Monitoring for ES and Innovation

Many sustainability studies have regarded internal monitoring as a pivotal piece in the successful implementation of ES initiative and practices (e.g., [41,42]). Performance metrics fulfill the fundamental activities of measuring how well a firm's endeavors are being implemented and serve as guidelines for a firm's supply chain initiatives by reflecting its underlying priorities [43]. In this regard, close control of those metrics helps prevent the misalignment between internal and external goals and, thus, contributes to supply chain performance. The old adage, "You get what you inspect, not what you expect," summarizes this critical role of internal monitoring. Thus, ES initiative starts with establishing the relevant internal ES performance metrics, followed by tight monitoring of them. By doing so, a focal firm can continuously trace the changes in its ES metrics and raise warning and/or action signals when related metrics reach their limits or thresholds. As a governance mechanism, monitoring

also has been believed to reduce information asymmetry and the risk of opportunistic behaviors among relevant entities [39]. Klassen and Vachon [22] supported this view in the ES context by showing that tighter plant-level control and monitoring have positive impacts on the level of environmental investment, due to the decreased risk of opportunism.

Further, a close monitoring of ES initiative and corresponding metrics enables frequent measurement of a firm's ES performance and calls attention to better use of (or needs for) its limited (or more) resources. Nidumolu et al. [18] shares this view by describing ES as innovation's new frontier, in that a firm's ES performance contributes to fewer inputs, more revenues, and creation of new businesses. More recent studies are in line with this proposition. Narasimhan and Narayanan [44] found the efforts for waste reduction and operational efficiency frequently lead to product innovation, and studies by Pujari [14] and Hallstedt et al. [45] strongly recommended that ES managers conduct environmental assessments at every stage of their product innovation process.

Building on this logic, this study proposes that a firm's internal monitoring, as a governance mechanism for ES, promotes its product innovation. Thus, we put forward the following hypothesis:

**Hypothesis 1.** *Internal monitoring of ES metrics positively impacts product innovation capability.*

### 2.3.2. Supply Chain Collaboration for ES and Innovation

Firms can have an opportunity to learn how to improve their own performance through their involvement in buyer-supplier partnerships. Supply chain management literature indicates that focal firms collaborate with suppliers, as a formal governance arrangement, on strategic and tactical issues (e.g., [46]). When involved in such governance mechanisms, the focal firm and its suppliers are likely to develop structures and communication support systems that can enhance their mutual learning.

These efforts can be extended to leverage the environmental capabilities of the parties involved with the intent of improving ES performance ([47,48]). More recent studies also conceptually argue that sustainability initiatives involve close collaboration between relevant supply chain entities, rather than being entirely achieved by one focal company's leadership (e.g., [49,50]). This perspective recognizes sustainability as a supply-chain matter and underlines that firms must involve and collaborate with suppliers for successful implementation of a sustainability initiative [51,52]. The structures that focal firms establish during this process essentially afford them the opportunity to increase their knowledge of supplier operations, which can have a spillover effect on environmental practices.

Further, firms in a collaborative relationship set up joint problem-solving processes and systems that are known to improve their performance in the area of product innovation [53]. It is well-known that Toyota was able to create supplier development forums, whereby suppliers were encouraged to collaborate with one another in support of Toyota's desire to improve innovation performance [54]. A focal firm thus implements an inter-organizational knowledge-sharing routine with suppliers to help the suppliers improve their processes that may contribute a focal firm's innovation performance [55].

Building on this reasoning, we theorize that firms involved in supplier collaboration for ES will establish structures, systems, and/or processes that may lead to improvement in a focal firm's product innovation performance. Therefore:

**Hypothesis 2.** *Supplier collaboration for ES positively impacts product innovation capability.*

## 3. Research Method

### 3.1. Sample

Data were collected by members of the Global Manufacturing Research Group (GMRG), a multinational community of researchers studying manufacturing practices worldwide. Standardized survey instruments were administered by individual members of the group across 16 countries. These measures have been validated in many studies published in top journals and administered by leading

international academic researchers from over 20 countries. The unit of analysis for the survey is the manufacturing plant, and all data were collected from plant managers as key informants within those sites, who often consult with others in their firms. The data used in this paper is a sub-sample of the fifth round (GMRG V), consisting of five modules (core, culture, innovation, sustainability, and supply chain management). The core module containing the demographic data of 1089 participating companies is obligatory, while other modules are elective. Most questionnaires (43%) were completed during an on-site visit by the researcher, followed by Internet surveys (29%) and mail surveys (23%) [56]. The variables used for this study were pooled from the three elective modules (i.e., innovation, sustainability, and supply chain management). A total of 22 different industries were represented and grouped into the following seven categories, as suggested by Schoenherr et al. [57], that also used the GMRG V dataset: (1) computing, electronics, and related products (22.66%); (2) metal based products (21.14%); (3) food and related products (14.49%); (4) petro-chemicals and related products (14.02%); (5) timber and related products (10.63%); (6) miscellaneous manufacturing industries (9.81%); and, (7) textiles, clothing, and footwear (7.24%). Such breadth and depth of data allows for the generalizability of research findings, which has led to many studies, using this dataset, being published in top-tier journals. A more detailed overview of questionnaire development and evolution is provided in Whybark et al. [58].

### 3.2. Measures

Table 1 presents the questionnaire items and factor loadings for the variables used for this study. Given the ordinal nature of our variable, the polychoric correlation was used to construct the correlation matrix. The prime goal of factor analysis was to identify interpretable simple structure, and this was achieved in all items of the analysis. Factors were orthogonally rotated by means of the varimax method. In addition to the main variables, we controlled for size (*employee*; measured by the natural logarithm of total number of employees working at the plant), R&D budget (*rd*; measured by an ordinal scale of average R&D budget as a percentage of total plant sales: 0–0.25%, 0.26–0.50%, 0.51–0.75%, 0.76–1%, 1.1–2%, 2.1–4%, and more than 4%), and training budget (*edu*; measured on an ordinal scale of average training budget for education of employees as a percentage of total plant sales: 0–0.5%, 0.51–1%, 1.1–1.5%, 1.6–2%, 2.1–3%, 3.1–4%, and more than 4%).

**Table 1.** Variables and measurements.

Construct and Related Literature	Question and Measurement Items	Mean	Standard Deviation	Factor Loadings	Uniqueness
Product Innovation Capability [53,59] (N = 567; Eigenvalue = 3.87; Sig = 0.00)	<i>Please compare the levels of product innovation at this plant in the last two years to those of your major competitors.</i>				
	(1) Percentage of total sales stemming from new products	4.34	1.32	0.86	0.26
	(2) Percentage of market share stemming from new products	4.28	1.31	0.87	0.25
	(3) Number of new products	4.27	1.38	0.88	0.22
	(4) Speed of introducing new products	4.40	1.38	0.88	0.22
Internal Monitoring for ES [60] (N = 639; Eigenvalue = 1.65; Sig = 0.00)	<i>During the past two years, to what extent did you engage in the following activities?</i>				
	(1) We actively monitored energy usage in our facilities.	5.34	1.45	0.87	0.25
	(2) We actively monitored water usage in our facilities.	5.00	1.60	0.89	0.21
	(3) We actively monitored waste re-usage at our facilities.	4.78	1.71	0.79	0.37
	(4) We actively monitored carbon usage at our facilities.	4.17	1.92	0.69	0.52

Table 1. Cont.

Construct and Related Literature	Question and Measurement Items	Mean	Standard Deviation	Factor Loadings	Uniqueness
Supplier Collaboration for ES [61,62] (N = 691; Eigenvalue = 1.85; Sig = 0.00)	<i>During the past two years, to what extent were the following green collaborative practices performed among your plant's supply chain members?</i>				
	(1) The plant currently uses green vendor certification program to certify main suppliers' quality and operations.	3.59	1.94	0.74	0.45
	(2) The plant currently makes direct investments in main suppliers' green activities.	2.66	1.67	0.79	0.37
	(3) Joint green improvement work sessions between this plant and main suppliers are held regularly.	2.89	1.72	0.82	0.32

### 3.2.1. Dependent Variable

Product innovation capability (*innov*) was measured by five items (Cronbach's  $\alpha = 0.94$ ). Respondents were asked to compare the levels of product innovation at their plants in the past two years to those of their major competitors. Responses were recorded on a seven-point scale ranging from "much lower/far worse" to "much higher/far better" (factor score: average = 4.62, min = 1.07, max = 7.51).

### 3.2.2. Independent Variable

Internal monitoring on ES metrics (*monitor*) was captured by asking to what extent respondents engage in monitoring four ES metrics including energy usage, water usage, waste re-usage, and carbon usage. Responses were recorded on a seven-point scale ranging from "not at all" to "great extent" (factor score: average = 5.26, min = 1.07, max = 7.52) for four items (Cronbach's  $\alpha = 0.85$ ). Collaboration with suppliers for ES (*collabo*) was measured by three items (Cronbach's  $\alpha = 0.82$ ) using a seven-point scale ranging from "not at all" to "great extent" to capture the extent to which the respondent actively collaborates with other supply chain members (factor score: average = 3.03, min = 1.01, max = 7.09).

### 3.3. Econometric Approach

Holding control variables constant, *monitor* (i.e., control mechanism) and *collabo* (collaboration mechanism) are estimated to have positive impacts on product innovation capability. Standard errors were adjusted using robust variance estimation.

This study adopts Heckman's two-step estimation procedure [63] to preclude potential sample selection bias and to investigate the possible differences between our explanatory variables (i.e., internal monitoring and supplier collaboration) regarding product innovation capability. As noted earlier, first, our research proposition is tested using a subsample of large GMRG global survey data. Table 1 shows, for instance, 567 respondents answered the question about product innovation capability. Heckman's procedure enables us to deal with the possibility that some potential determinants affect our dependent variable and preclude the potential sample selection bias related to the traits used as our control variables (i.e., *employee*, *rd*, and *edu*). It consists of two equations: a substantive model and a selection model. The substantive model first estimates a model predicting dependent variable  $y_i$  as follows:

$$y_i = x_i\beta + \varepsilon_{1i} \quad (1)$$

where  $x_i$  is the vector of explanatory variables,  $\beta$  is the vector of coefficient parameters, and  $\varepsilon_{1i}$  is the vector of disturbance terms ( $\varepsilon_{1i} \sim N(0, \sigma)$ ). In this study, this was estimated with ordinary least squares (OLS) as follows:

$$innov = \beta_0 + \beta_1 monitor + \beta_2 collabo + \varepsilon_1 \quad (2)$$

Next step, the selective model detects selection bias and statistically corrects the substantive model for any selection bias. A dependent variable for observation  $j$  is observed only if:

$$z_i \gamma + \varepsilon_{2i} > 0 \quad (3)$$

where  $(\varepsilon_{2i} \sim N(0, 1))$ . In our model, the production innovation capability is observed if:

$$\gamma_0 + \gamma_1 employee + \gamma_2 rd + \gamma_3 edu + \gamma_4 monitor + \gamma_5 collabo + \varepsilon_2 > 0 \quad (4)$$

where  $\varepsilon_1$  and  $\varepsilon_2$  have correlation  $\rho$ .

Another reason for choosing Heckman's procedure is to examine the two ES governance mechanisms in the same model, while distinguishing their differences. Although control and collaboration mechanisms are not independent (rather coexist) [64], most of the extant research on the association between governance mechanism and innovation has investigated either internal monitoring or collaboration only. The present two-step procedure allows for the possibility that some firm-specific factors could potentially play different roles in the two governance mechanisms of our interest.

#### 4. Results and Implications

The descriptive statistics and bivariate correlations are shown in Table 2. No strong correlation higher than 0.6 was found, indicating little probability of multicollinearity.

**Table 2.** Correlations and descriptive statistics.

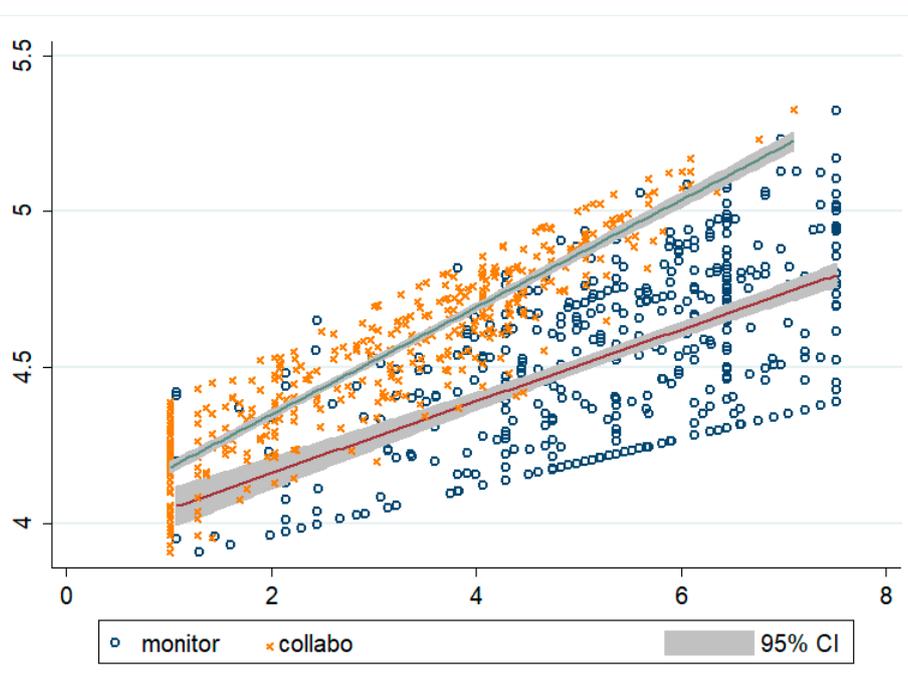
	(a)	(b)	(c)	(d)	(e)	(f)
(a) <i>innov</i>						
(b) <i>monitor</i>	0.187 *					
(c) <i>collabo</i>	0.275 *	0.238 *				
(d) <i>employee</i>	0.180 *	0.300 *	0.037			
(e) <i>rd</i>	0.258 *	−0.039	0.084	0.210 *		
(f) <i>edu</i>	0.205 *	−0.018	0.144 *	0.113 *	0.478 *	
Mean	4.616	5.256	3.035	4.990	3.221	2.781
Standard deviation	1.310	1.486	1.536	1.650	1.968	1.624

\*  $p < 0.05$ .

Table 3 presents our analysis results. The first column shows the results from using Heckman's two-step procedure estimations. The coefficient results indicate that both of our dependent variables have a positive relationship with product innovation capability. Results from the Heckman procedure can be compared with the OLS result in the second column to check the robustness of our findings. Results are consistent in terms of coefficient sign and statistical significance with the results from the OLS estimation. The Wald test clearly rejects the hypothesis of independent equations, which indicates that the Heckman approach of estimating both stages simultaneously is preferable. We can conclude, therefore, both internal monitoring and supplier collaboration for ES practice have positive impacts on a factory's product innovation capability. The scatter plot and fitted regression line with 95% confidence intervals in Figure 2 summarize the results.

**Table 3.** Estimation results: Coefficients and standard errors (in parentheses).

	Heckman	OLS
Constant	2.586 ** (0.777)	2.768 ** (0.291)
<i>monitor</i>	0.053 * (0.108)	0.095 * (0.042)
<i>collabo</i>	0.081 * (0.113)	0.131 ** (0.040)
<i>employee</i>	−0.038 (0.122)	0.064 (0.039)
<i>rd</i>	−0.168 * (0.077)	0.117 ** (0.037)
<i>edu</i>	−0.095 (0.113)	0.099 * (0.045)
$R^2$		0.142
F-statistic		12.38 **
Log likelihood	−670.228	
Wald $\chi^2$	20.21 **	
LR test of indep. eqns. ( $\rho = 0$ )	3.86 *	

\*  $p < 0.05$ ; \*\*  $p < 0.01$ .**Figure 2.** Scatter plot and fitted regression line with 95% confidence intervals.

Our study contributes substantially to the literature and practice of triple bottom line in multiple ways. First, we have proposed a theoretical interpretation of how firms can transform from practicing CSR to CSV in the context of innovation capability. Different from traditional CSR, with a value of just “doing good”, the CSV framework highlights a firm’s ability to address sustainable issues as an integral part of, not outside, its profit maximization model [4]. Although this view has drawn much support from both academic and business communities, its implementation process has remained unclear, with mixed or sometimes even contradictory findings. For instance, Hillman and Keim [65] found a negative association between a firm’s social issue participation and shareholder value. Many managers and executives who participated in Kiron et al.’s [66] global survey also expressed the view that increasing administrative costs for sustainability programs often hurt corporate profitability. Given such gaps in the available research of the CSV framework, this study was anchored on innovation management literature and proposed the firm’s innovation capability as the missing link that could connect sustainability initiative to firm performance.

This research provides early empirical evidence for KGA in an ES context in supporting the above theoretical line of argument. In doing so, we have contended that the impacts of a firm's sustainability initiatives on its innovation performance originated from the governance mechanism it uses for sustainability, not sustainability outcome per se, and provided empirical evidence. Despite its significance, there has been limited synthesis on the association between sustainability initiatives and firm performance [67]. Although a few studies such as Nidumolu et al., (2009) conceptually acknowledged the influence of sustainability on innovation, this view has been contradicted by some industry examples, and little empirical research has been done on them. This study attempted to fill this gap by using internal monitoring and supplier collaboration for ES as proxies of control and collaboration that have been regarded as two conflicting mechanisms in the literature [38]. These two governance mechanisms were tested simultaneously in our model, and the results confirmed the theoretical argument that the determinants of a firm's product innovation capability are embedded in the mechanisms governing its ES initiatives.

Last but not least, our study is a part of growing but minimal empirical work that focuses on the role of corporate governance mechanism in the context of corporate social responsibility. Most of the corporate efforts to incorporate ES initiatives were sporadic or one-time projects, that have remained confined to the domain of CSR. Despite the growing interest in CSV frameworks, the findings of a few early empirical works on this subject are still highly conceptual and not well grounded in practice. The measurement items used for our dependent variables can serve as meaningful plant-level action plans for manufacturing firms and managers to establish the ES governance mechanisms that can be converted into product innovation capability.

## 5. Conclusions and Future Directions

Relying on the theories of triple bottom line and corporate governance, this research empirically examined how a firm's governance mechanisms can be the source of corporate innovation in the context of ES. In particular, the impacts of internal monitoring and supplier collaboration for ES on product innovation capability have been found to be positively significant, and the results are robust across both Heckman's approach and the OLS model. These findings provide early empirical evidence on our two important theoretical arguments: (1) a firm's ES will be converted into an economic dimension through its innovation capabilities; and (2) such capabilities are not from its ES outcomes, but from the governance mechanisms established to achieve those outcomes.

Despite its contributions, our study is not without limitations that may raise interesting questions for future research. First, this research examined the impacts of two primary governance mechanisms. Although these are the two most widely-discussed ones in the literature, new types of governance mechanisms could be considered in future studies. One interesting candidate may be cooperation. As supply chains become more complex, firms often work not only with collaborators but also with competitors. Future research may benefit from considering this type of governance mechanism based on dyadic data from both partnering firms. Second, this study only considered product innovation, not other types of innovations such as processes, organization, etc. [68]. Future research should focus on how corporate governance mechanisms work differently for other innovation types. Third, some of the previous studies argued that the implementation stages of ES procedures or governance mechanisms could possibly impose differential impacts on firm performance (e.g., [69,70]). These could not be addressed with the available dataset. Although this study has attempted to control such effects, as far as possible, by using a two-year time frame in measuring all variables used (see Table 1), future research could fully investigate the impacts of ES or governance implementation stages on innovation outcome. Fourth, we focused only on ES, with no reference to social sustainability initiatives of a firm. Market- or consumer-driven innovation has gained a lot of attention, due to increasing uncertainties of corporate environment and technological innovation, and is the key to competitiveness of firms facing end customers [71]. Future researchers may find it interesting to explore how the governance mechanisms of such firms or industries are different from the ones of non-customer-facing firms. Last,

the dynamics of governance mechanism and innovation can be influenced by other contextual factors such as product or process complexity, stakeholders' sustainability pressure, and level of internal or inter-organizational integration. Future studies may be able to examine this interesting issue.

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