sustainability

Article

Diffusing Environmental Management Practices within the Firm: The Role of Information Provision

Michael J. Lenox [1,*] and Michael W. Toffel [2]

1 Darden School of Business, University of Virginia, Charlottesville, VA 22903, USA
2 Harvard Business School, Harvard University, Boston, MA 02163, USA; mtoffel@hbs.edu
* Correspondence: lenoxm@darden.virginia.edu

Abstract: Why are some firms more successful in adopting profitable environmental management practices than others? A key role of corporate managers is to encourage subsidiaries to adopt innovative practices. We examine the conditions under which corporate managers use information provision to encourage subsidiaries to adopt advanced environmental management practices. Focusing on the distribution of expertise across subsidiaries, we propose that corporate managers are more likely to elect an information provision strategy when subsidiaries (i) possess moderate levels of related expertise, (ii) exhibit significant heterogeneity in this expertise, and (iii) are more diversified and less concentrated. We study the diffusion of pollution prevention practices by firms in the information and communication technology sector in the United States and find empirical support for our four hypotheses. These findings promote a greater understanding of which firms adopt advanced environmental management practices and when firms adopt information provision strategies to encourage knowledge transfer within the organization.

Keywords: information provision; knowledge diffusion; environmental management; environmental strategy

check for updates

Citation: Lenox, M.J.; Toffel, M.W. Diffusing Environmental Management Practices within the Firm: The Role of Information Provision. *Sustainability* **2022**, *14*, 5911. https://doi.org/10.3390/su14105911

Academic Editors: Clyde Eiríkur Hull and Andrea Pérez

Received: 9 March 2022
Accepted: 10 May 2022
Published: 13 May 2022

1. Introduction

In the 1970′s, 3M launched its famous pollution prevention pays (3P) program that demonstrated that proactive management to mitigate environmental impacts could generate positive financial returns by reducing risk, eliminating waste, and improving efficiency. The success of the 3P program helped launch the U.S. Pollution Prevention Act of 1990, which declared that the national policy of the United States would be to prevent or reduce waste at the source when feasible. The subsequent decade saw a flurry of activity by corporations looking to capitalize on evolving pollution prevention practices, but the adoption of pollution prevention practices was uneven both across firms *and* within firms. Why were some firms more successful in diffusing seemingly favorable environmental management practices within their organization than others?

This question has taken on added importance as calls for improved environmental, social, and governance (ESG) performance by firms grows louder. These calls have migrated from communities and policy makers to consumers and employees and increasingly to investors who demand superior ESG performance as a condition for investing. The interest in ESG has energized long-running debates on the conditions under which superior environmental performance improves profitability [1]. Understanding the micro-conditions under which some firms are able to successfully diffuse superior environmental management practices throughout their organization is paramount in a world awash with interest in ESG.

At the most basic level, the ability to recognize and adopt profitable practices and technologies is central to a firm's competitive success. Although this notion is well established in the strategy literature, cautionary tales abound of units within a firm that were successful at recognizing or discovering the value of some new technology or practice but failed to communicate that information to other units of the organization [2]. Gupta and Govindarajan [3] caution that despite multinational corporations' very existence being predicated on their superior ability to transfer and exploit knowledge more effectively and efficiently within their organizational boundaries versus external markets, this "does not in any way imply that such knowledge transfers actually take place effectively and efficiently on a routine basis" (pp. 473–474).

This potential failure of knowledge to diffuse across subsidiaries creates opportunities for corporate management to intervene. Several studies have found that the strategies, policies, and tools that the corporate headquarters employ are critical to successfully disseminating valuable new technologies and practices as they arise across their organizations' business units [4,5]. Indeed, Gupta and Govindarajan [3] found that "the parent corporation continues to serve as the most active creator and diffuser of knowledge within the corporation" (p. 490). In this paper, we focus on one managerial strategy that some parent companies employ to diffuse practices throughout the organization: information provision.

We define "information provision" as the transfer of practice-specific information from a knowledgeable principal to subsidiaries that decide which management practices to adopt. Information providers utilize a variety of mechanisms including internal seminars, peer to peer demonstrations, knowledge management systems, and promotional brochures. Modern enterprise resource planning (ERP) systems are powerful conduits for information provision throughout the organization. Our focus is less on the efficiency of such systems as information processors and more on the efficacy of information provision to change the expectations and ultimately the behavior of information receiving agents.

Lenox and King [6] found that headquarters' promotion of new management practices through information provision can significantly increase the adoption rates of those practices by subsidiaries, especially among those with limited prior experience with such practices. Our work builds on this by examining the antecedent decision. Specifically, we ask: *Under what circumstances do corporate managers use information provision to encourage subsidiaries to adopt environmental management practices*? This is an important question as corporate managers can pursue several other approaches, such as using various carrots (incentives) and sticks (punishments) to drive adoption. Information provision differs from those approaches because it seeks to change agents' behaviors by shaping their expectations given established incentives.

We propose that a firm's organizational structure and the dispersion of knowledge across subsidiaries plays a central role in shaping managerial strategies for diffusing technologies and practices within a firm. We assume that top managers are thoughtful in the selection of management strategies for how best to encourage adoption of advanced management practices within their firms but are constrained by the current organizational structure. Implicitly, we assume that organizational structures emerge from the accumulation of past decisions and actions, and remains, by and large, exogenous to and unaffected by decisions regarding information disclosure. We propose that the efficacy, and hence, use of information provision by corporate managers is contingent on the distribution of existing knowledge and expertise across subsidiaries. We hypothesize that corporate managers will rely to a greater extent on information provision when their subsidiaries have moderate levels of prior related knowledge. Too little prior related knowledge prevents subsidiaries from being able to competently evaluate the technology touted by corporate staff, whereas too much reduces the likelihood that the knowledge provided will be novel. We further hypothesize that a firm's investment in information provision is contingent on the diversification of its subsidiaries' activities as well as the concentration of employees and variation in the stock of related knowledge across the facilities.

To test our hypotheses, we studied the diffusion of pollution prevention practices among firms in the information and communication technology industry in the early 1990s. Pollution prevention, the reduction in pollution through the design or redesign of products and/or manufacturing processes, began to be embraced in the 1990s in response to mounting environmental liabilities. We combine archival data with a survey of corporate environmental managers to construct a panel of firms, some of which attempted to diffuse pollution prevention practices across their facilities. Examining the circumstances under which corporate managers rely on information provision strategies to encourage their manufacturing facilities to adopt pollution prevention practices, we find evidence to support the four hypotheses we develop.

This paper helps advance our understanding of the drivers of heterogeneity among firms' environment/sustainability practices. Over the past thirty years, there has been an active debate in the literature about why firms fail to adopt seemingly profitable environmental management practices [7,8]. Recent work focuses on the adoption of circular economy business strategies where firms look to "close material loops, reduce raw material use, reuse or remanufacture products, and recycle products and material" [9]. Information provision is both a potential solution to information asymmetries that plague efforts to diffuse sustainability practices and an explanation for lingering heterogeneity among firm adoption.

In addition, this work has important implications for our general understanding of the diffusion of practices within firms. Our results suggest that efforts to diffuse practices or technologies through information provision will be constrained by the dispersion of expertise in an organization. We expect choices in whether and how to diffuse practices to vary between firms because firms face difference costs and benefits of information provision and other diffusion strategies. This work supports a long line of research in strategy that proposes that firms are subject to path dependencies that constrain and enable competitive advantage.

2. Theory and Hypotheses

Information provision has a long history as a strategy for diffusing valuable practices and technologies throughout firms, especially large multidivisional organizations [5,6]. Information provision may provide significant economies of scale in encouraging adoption across subsidiaries of the firm. For example, a corporate human resources department could leverage its investment in understanding employment law by providing a central service to subsidiaries. Corporate environmental affairs departments can develop and test various pollution prevention techniques and disseminate the results to subsidiaries, sparing them from conducting duplicative tests. Corporate functional departments can also serve as information clearinghouses, identifying best practices among subsidiaries and disseminating this knowledge to the others.

Recognizing that knowledge acquired in specific activities can yield important new insights in entirely different contexts [10,11], corporate managers can attempt to disseminate these best practices across a much wider range of activities. During site visits to manufacturing facilities, for example, corporate environmental affairs personnel observe a wide range of environmental management practices including procedures, training programs, and audit checklists that might be beneficial to other facilities. Corporate staff who attend conferences with other firms and regulators can accumulate knowledge about other organizations' environmental management policies, procedures, programs, and tools, some of which might be beneficial to their own facilities. Many corporate environmental managers thus have an opportunity to provide valuable information to their own facilities about the value of specific technologies and practices developed or customized elsewhere.

Previous research has found that information provision can be an effective management strategy for encouraging the adoption of advanced management practices in subsidiaries. Björkman et al. [5] and Gupta and Govindarajan [3] find that subsidiary managers who participate in cross-divisional training programs, committees, and task forces are more likely to succeed in transferring knowledge. Lenox and King [6] find that information provision is most effective when potential adopters lack experience with the given practice or technology but possess sufficient experience with related practices or technologies to be able to effectively internalize the information being provided.

There remains, however, the question of under what conditions do managers adopt an information provision strategy? We propose that firms' organizational structures influence the extent to which their corporate managers use information provision to encourage subsidiaries to adopt novel practices and technologies. We focus on the heterogeneity of firms' business activities and the extent to which they are concentrated within specific facilities or dispersed across multiple facilities. We further propose that the distribution of existing knowledge and expertise across subsidiaries conditions the potential efficacy and, hence, the use of information provision.

A corporate manager's decision to adopt an information provision strategy is influenced, in part, by the absorptive capacity of individual units within the firm. Absorptive capacity is defined by Cohen and Levinthal [12] as the "ability to recognize the value of new information, assimilate it, and apply it to commercial ends" (p. 128); they hypothesize that the presence of prior related knowledge that enables a unit to make better resource and capability decisions about novel external technologies and practices is central to absorptive capacity. At the firm level, absorptive capacity is determined by the stock of prior related knowledge and its distribution across, and flow between, subsidiaries [6,12,13].

At the subsidiary level, limited prior related knowledge impedes the ability to accurately assess the value of adopting a new technology or management practice. Further, it limits the desire and ability of subsidiary management to receive information about such practices. Absent of the requisite knowledge base, information provision efforts might fall on deaf ears. An employee of a subsidiary with limited related knowledge, for example, might return confused and unconvinced of the value of practices expounded at a corporate "dog and pony" show. Subsidiaries with more prior related knowledge will make better resource and capability decisions about novel, corporate-recommended technologies and practices and will be more receptive to information provision attempts by corporate management.

However, they might also be less in need of such information. In other words, while subsidiaries must have sufficient related knowledge to competently evaluate new technologies, little learning occurs when two agents become so closely aligned in their knowledge sets that their knowledge becomes redundant [14,15]. Subsidiaries that possess high levels of knowledge related to a touted practice are thus more likely to have already adopted a comparable practice based on the same knowledge. Such subsidiaries would stand to gain little from an information provision strategy. Given that corporate managers' information provision attempts are unlikely to be understood and internalized in subsidiaries with low levels of prior related knowledge and are likely to be redundant and unnecessary in subsidiaries with high levels of prior related knowledge, we expect corporate managers to be more inclined to use information provision with subsidiaries that possess moderate levels of prior related knowledge.

Hypothesis 1. *The average prior related knowledge across an organization's subsidiaries will be concavely related (inverted U) to the extent to which corporate management relies on information provision.*

Of course, the amount of prior related knowledge is likely to vary across a firm's subsidiaries. Because of their deeper contextual knowledge, subsidiary managers are particularly well suited to decide how applicable new practices and technologies are to their specific situations and locations [16] and to decide whether the value they bring warrants adoption or replication, adaptation to a different context, or rejection. Corporate managers who choose an information provision strategy rather than mandate adoption expect subsidiaries' managers to use their private information to assess, within the context of their needs, whether a practice is worthwhile and whether it will need to be customized. To achieve this under a mandate would require that corporate managers distinguish between subsidiaries for which the practice would add value and those for which it would not, which would require deep contextual knowledge that the subsidiaries' managers already possess.

Lacking this idiosyncratic information, corporate managers might choose to implement a uniform mandate based on the average value of adoption across all agents. Clearly, this would be less than ideal, as adoption by units in which it is redundant would be wasteful, and adoption by units for which it is inappropriate might be damaging. As implied by Holmstrom and Milgrom [17], a corporate mandate followed up with monitoring is more problematic when potential adopters vary greatly in their activities. Firms with more diverse productive activities across subsidiaries are particularly susceptible to this problem. In diversified firms, subsidiary activities vary greatly, and the returns to adopting a novel technology or practice will likely vary greatly as well. Inevitably, technologies or initiatives promoted by corporate managers of diversified firms will be more likely to be adopted by some subsidiaries than by others. Managers of subsidiaries engaged in activities like those of the unit in which a corporate-touted practice was developed might readily recognize its value and adopt it, but managers of subsidiaries engaged in other activities would likely need to carefully assess its potential costs and benefits, and possibly even invest more just to simply understand it.

Hypothesis 2. *The more diversified an organization's subsidiaries, the more corporate management will rely on information provision.*

Variance may be introduced not only by kind, but by size. Corporate managers of companies whose employees are widely dispersed face more difficulty replicating their facilities' deep contextual knowledge that is needed to understand which facilities would benefit from adopting a particular practice. Thus, corporate managers are less able to accurately gauge which practices ought to be mandated across all subsidiaries. In addition, corporate managers face higher costs in monitoring dispersed subsidiaries, and thus face greater uncertainty regarding compliance to such mandates. As such, geographically distributed organizations are more likely to use information provision, which relies on the judgment of local managers to decide which specific practices to adopt. In contrast, when activities are concentrated in a few subsidiaries, corporate managers can more easily assess their prior related knowledge and more easily monitor corporate mandates. Therefore, we expect corporate departments in organizations in which employees are less concentrated in specific facilities to be more likely to rely on information provision.

Hypothesis 3. *The less concentrated an organization's employees, the more corporate management will rely on information provision.*

Even subsidiaries of similar scale that provide similar goods and services may possess widely varying knowledge sets. Differing levels of expectation and knowledge of individual practices and technologies on the part of managers in subsidiaries engaged in similar activities can variously be driven by experience with past improvement efforts, changes in the management team, and other path dependent changes in practices. Information provision by corporate managers touting "best practices" throughout the organization is more likely to provide useful insights to subsidiary facilities when they vary widely in their knowledge levels. Corporate managers must thus consider not only the average amount of related prior knowledge across subsidiaries (as proposed in Hypothesis 1), but also how evenly, or unevenly, this knowledge is distributed.

Hypothesis 4. *The greater the variance in related prior knowledge across an organization's subsidiaries, the more its corporate management will rely on information provision.*

3. Data and Method

To test our hypotheses, we collected data on the diffusion of pollution prevention practices within firms in the information and communication technology (ICT) industry. Adoption of pollution prevention practices is an opportune setting in which to study intra-organizational knowledge transfer. Corporate environmental management departments possess unique information that enables them to transfer knowledge to facilities to spur manufacturing process improvements [18–20]. Such departments' focus on "discarded material, byproducts of the operation, [and] mistakes and waste" provides a broader perspective on production and yield, and their technical capabilities enable them to diagnose some production problems by analyzing waste characteristics [18]. Compared to production staff, environmental management departments tap information from a broader set of sources including vendor technical staff, environmental staff in other operations and at competing firms, and regulatory agency inspectors and technical assistants [18,20]. Their ability to analyze and recommend production changes based on this broader information set can yield important insights for production managers. Environmental staff in printed circuit board factories, for example, identified problems in material handling, maintenance, and water usage and helped to develop solutions that both improved yields and reduced waste [19].

Indeed, many process changes initiated by environmental management staff elicit benefits beyond pollution prevention including cost reduction, quality improvement, and extensions of production capabilities [18,19,21]. As a result, some process engineers rate environmental management staff as being just as important as quality management staff in helping initiate process changes, and in some cases, even more important than engineering staff [18]. Environmental management staff have been characterized by some process engineers as a "second pair of eyes and ears" that help to identify process improvement opportunities [19].

3.1. Setting

Field studies in the information and communication technology industry revealed vast differences in knowledge of pollution prevention practices between corporate managers and facility-level decision makers [22,23]. The industry is broad, including manufacturers of computers, servers, storage devices, telecommunications equipment, semiconductors, and printed circuit boards. Although generally perceived as a "clean" industry, it faces several environmental challenges that span the entire product life cycle including high levels of water and energy use, reliance on toxic chemicals in manufacturing, the phase-out of CFCs in manufacturing cleaning processes, use and reuse of lead solder, energy efficiency during product use, and recycling of metals and plastics at the end of product life [24].

When it first appeared, pollution prevention was a new practice of uncertain value. Most companies in the information and communication technology industry have a corporate environmental affairs department that develops policies, provides technical assistance, and monitors performance, often via environmental audits. Often, a major task of this function is to convince reluctant facility managers and staff to adopt environmental programs, the benefits of which are often uncertain and corporate-wide (e.g., mitigating risk to brand reputation arising from accidents or non-compliance). Because insufficient technical expertise can limit subsidiary facilities' engagement in environmental programs being promoted by the corporate environmental affairs department, many environmental affairs departments also provide technical training to their facilities.

Pollution prevention emerged among a set of leading firms and industry groups to limit environmental impacts through the design or redesign of products and/or manufacturing processes. As early as 1990, the American Electronics Association, a professional organization for the ICT industry, began convening task groups to formalize and standardize pollution prevention practice. In general, pollution prevention is a set of management practices and tools that facilitate the consideration of environmental issues during design. Pollution prevention is related to and builds upon other innovations in operations management including total quality management, design for manufacturing, and design for serviceability.

By 1991, pollution prevention was beginning to diffuse throughout the ICT industry, but early research revealed strong resistance by facility-level managers who were reluctant to dedicate valuable time to the consideration of environmental issues and adopt pollution prevention practices without a clear indication of their value [25,26]. Because impacts on the natural environment of individual design choices were often difficult to assess, and the returns to firms from pro-environment decisions even more so, diffusion of pollution prevention at the facility level was uneven and strongly influenced by the diverse expectations of individual managers.

Corporate environmental managers in several firms responded by establishing company-wide programs to encourage the adoption of pollution prevention practices [26]. Several firms adopted policy statements asserting their commitment to pollution prevention, and a few firms established incentive programs that made pollution prevention a criterion in performance reviews. Teams established by other firms to promote pollution prevention internally typically developed pamphlets and held seminars touting its benefits [26]. Even after IBM's CEO signed an executive order requesting that all design teams adopt pollution prevention practices, implementation varied widely across the firm [23].

3.2. Sample

For our analysis, we collected data on pollution prevention practices for the period 1990–1996, when pollution prevention practices were initially diffusing through the US information and communication technology industry. We identified an initial population of 221 publicly traded firms included in Standard & Poor's Compustat Annual Database that had US manufacturing facilities in the ICT industry. We defined the ICT industry as including the following 4-digit Standard Industrial Classification (SIC) codes: semiconductors (3674), printed circuit boards (3672), components and peripherals (3577 and 3679), storage (3572 and 3695), computers (3571 and 3575), imaging technology (3579), and telecommunications equipment (3661, 3663, and 3669).

We collected data in two phases: firm attribute data were collected from Compustat and other archival sources in phase one; data on management strategies were collected via a survey of the sample firms' corporate environmental managers in phase two. A field study indicated that corporate environmental managers were generally best suited to reflect on corporate pollution prevention efforts. Although they might or might not be responsible for administering pollution prevention programs, corporate environmental managers were found to be extremely knowledgeable of such efforts given the relationship between pollution prevention and their designated responsibilities.

We constructed the survey instrument using insights from a field study of four firms' attempts to diffuse pollution prevention practices. The firms were selected because of their status as widely recognized leaders in pollution prevention practice [22]. Four corporate environmental managers and ten product managers reviewed the survey items, and pilot testing demonstrated that the measures were consistently well understood. Approximately one half-dozen open-ended interviews were conducted in each firm over a three-month period. Interviewees included corporate-level environmental managers as well as designers and product managers at the establishment level. Additional information was gathered from company publications, journal articles, and news releases.

The company-level survey was mailed to all 221 firms identified in phase one. Two follow-up mailings were administered. Seventy-two responses were received from corporate environmental managers, a response rate of 33%. Because some firms entered or exited the industry (due to closure or sale) during 1990–1996, our final sample consists of an unbalanced panel of 473 firm-year observations for the 72 respondent firms. Using archival data collected for all 221 firms, we found that the final sample did not differ significantly from the initial population in terms of facility concentration, firm growth, leverage, R&D intensity, foreign ownership, past negative environmental events, or emissions. Larger firms (as measured by assets) were found to be more likely to respond to the survey. The test for respondent bias was conducted using a Probit model with archival data as independent variables and the dependent variable indicating whether a firm was a respondent.

3.3. Measures

Dependent Variables. Our primary dependent variable is the level of information provision used by top management to promote adoption of pollution prevention practices within their facilities. We created two alternative measures of information provision. *Information Provision* is the number of corporate, full-time equivalent (FTE) employees providing information on pollution prevention, which we log (to reduce the impact of outliers) after adding one (to accommodate zero values). *Relative Information Provision* is the percentage of the total corporate effort advocating adoption of pollution prevention spent providing pollution prevention information to facilities. Total effort beyond information provision includes time spent monitoring the adoption of pollution prevention measures and providing technical support.

These data were gathered via the survey, in which we defined pollution prevention as "the prevention of pollution through the design or redesign of products and/or manufacturing processes." Respondents were asked to indicate the number of corporate employees (in FTEs) dedicated to promoting pollution prevention practices within the company for each year from 1990 through 1996. Questions were then asked about information provision. To prime respondents on the types of activities that might constitute information provision, we asked a series of questions concerning the degree to which they engaged in specific information provision activities. Activities include communicating past successes, providing information on future regulation or customer demand, using demonstration projects, and distributing brochures. Respondents were asked to judge their firm's use of each activity on a scale of 1 (not at all) to 7 (very much).

Respondents were then asked to indicate for each year from 1990 through 1996 what percent of total corporate effort promoting pollution prevention was spent communicating the value of pollution prevention within the firm. The Cronbach alpha among the responses to the list of common mechanisms and number of FTEs performing information provision is 0.87, which indicates strong inter-item correlation and increases our confidence that the number of FTEs is an accurate gauge of information provision. *Relative Information Provision* captures these annual percentages. We calculated *Information Provision* for each year by multiplying these percentages by the total number of corporate employees dedicated to promoting pollution prevention practices.

Independent Variables. To test Hypothesis 1, we measure the average level of pollution prevention expertise across a firm's facilities (*Average Expertise*). To measure the pollution prevention expertise of individual facilities, we adopt King and Lenox's [27] approach and calculate the difference between a facility's expected and actual waste generation given its industry segment and size. This measure has the desirable property of reflecting a facility's expertise in reducing waste at the source rather than using end-of-pipe pollution control technology.

Following King and Lenox [27], we first measure the total toxic waste generated by a facility each year by calculating the sum of 246 toxic chemicals that have been released into the environment, treated onsite, and transferred offsite, while weighting each chemical by its toxicity using the Reportable Quantities (RQ) list in the CERCLA statute. Data for this calculation were collected from the US EPA's Toxic Release Inventory (TRI). Since 1987, all US manufacturing facilities that manufacture or process 25,000 pounds of any listed chemical during a calendar year, use more than 10,000 pounds, and employ ten or more full-time people are required to complete TRI reports. All the firms in our sample have facilities listed with the TRI.

We next estimate for each year, for each 4-digit Standard Industry Classification (SIC) code, a quadratic function between facility size and total waste generation using standard OLS regression.

$$W_{it} = e^{\alpha jt}\, s_{it}^{\beta 1jt}\, s_{it}^{ln(s)*\,\beta 2jt}\, e^{\varepsilon jt} \quad (1)$$

$$\ln W_{it} = \alpha_{jt} + \beta_{1jt}\,(\ln s_{it}) + \beta_{2jt}\,(\ln s_{it})^2 + \varepsilon_{jt} \quad (2)$$

where W_{it} is aggregate waste generated for facility *i* in year *t*, s_{it} is facility size, α_{jt}, β_{1jt}, and β_{2jt} are the estimated coefficients for sector *j* in year *t*, and ε_{jt} is the residual. We use the estimated function to predict the amount of waste each facility would generate given its size, industry, and year.

$$W^*_{it} = e^{\alpha jt}\, s_{it}{}^{\beta 1jt}\, s_{it}{}^{ln(s)*\,\beta 2jt} \quad (3)$$

$$RW_{it} = -e^{\varepsilon jt/\sigma \varepsilon jt} \quad (4)$$

where W^*_{it} is predicted waste generation for facility *i* in year *t*, RW_{it} is the standardized relative performance for facility *i* in year *t*, and $\sigma_{\varepsilon jt}$ is the standard error of the residual for the SIC and year pair. We change the sign of the residual so that positive scores indicate more pollution prevention expertise.

To test Hypotheses 2 and 3, we measure the degree to which facilities' output is diversified into various lines of business (*Diversification*) and the degree to which the company's production is concentrated in a few facilities (*Concentration*). *Diversification* is measured as one minus the sum, across all a firm's manufacturing facilities, of the squares of the percent of the facilities' employees in each industry segment as specified by the facilities' 4-digit SIC codes. *Concentration* is calculated as the sum across all a firm's manufacturing facilities, of the squares of the percent of total firm employees in each facility. In both cases, facility employee data were gathered from the Dun & Bradstreet Million-Dollar Database.

To test Hypothesis 4, we measure the variation in pollution prevention expertise across each firm's facilities. *Expertise Variance* is the standard deviation of pollution prevention expertise across a firm's facilities. Pollution prevention expertise in an individual facility is measured using our variable RW_{it} (Equation (4)), defined as the standardized relative previous waste generation for facility *i* in year *t*.

Control Variables. Because we are interested ultimately in why managers use information provision versus other options, we control for other types of managerial intervention. *Total PP Effort* reflects the log of total full-time equivalents dedicated to promoting pollution prevention activity in the firm divided by the number of facilities. As described earlier, this measure reflects not only effort devoted to information provision, but also time spent monitoring adoption and providing technical support. We tease this out further by including a measure of monitoring activity. *PP Monitoring* reflects the degree to which pollution prevention adoption has been rewarded or required. This was measured by including in the survey a seven-item scale on which respondents indicated that pollution prevention adoption is rewarded "not at all" and seven indicates that it is rewarded "very much." In our analysis, we rescale this variable to a maximum of one.

Several factors beyond managerial intervention might influence the extent of information provision within firms. Larger firms with more facilities that might realize economies of scale in information provision, for example, might be more inclined to use it. We measure *Firm Size* as the log of employees, and *Firm Facilities* as the log of the number of manufacturing facilities owned by each firm. R&D intensive firms might realize economies of scale to the extent that information provision enables them to generate greater amounts of useful information about individual practices and technologies. We measure *R&D Intensity* as the ratio of research expenditures to total firm assets. We obtained data on employment, assets, and research expenditures from Compustat and on numbers of facilities from the US EPA's Toxic Release Inventory.

As a greater proportion of a firm's facilities adopt pollution prevention practices, the marginal return from information provision decreases. This occurs not only because there are fewer potential adopters, but also because facilities are more likely to receive value-revealing information from other facilities rather than corporate managers. First, there is a greater likelihood that a facility will have heard of a practice the more others have adopted [28,29]. Second, previous adopters may provide information about the costs and benefits of engaging in the practice [30,31]. Wider spread adoption of a practice among a firm's facilities may also provide an incentive for a given facility to also adopt the practice if its adoption comes to be viewed as requisite to maintaining legitimacy [32]. To capture these effects, the percent of all facilities within a firm adopting pollution prevention practices was calculated for each year (*% of Facilities Adopting PP*). To construct this measure, we code a facility as having adopted pollution prevention practices when it indicates that it has reduced pollution through a product or process modification. We obtained these data from the Source Reduction Activity fields of the Toxic Release Inventory. The Source Reduction Activity fields list several practices in which facilities might engage to reduce pollution. "Process Modifications" (elements W51, W52, W53, W54, W55, W58) and "Product Modifications" (elements W81, W82, W83, W89) represent the subset of practices we used to construct this variable.

Summary statistics and pair-wise correlations are provided in Tables 1 and 2, respectively.

Table 1. Descriptive statistics (ICT industry: 1990–1996).

Variable	Description	Mean	Standard Deviation	Min.	Max.
Information Provision	Log (+1) of pollution prevention information disseminated by headquarters (full-time equivalent employees)	0.106	0.273	0.000	1.792
Relative Information Provision	Ratio of headquarters' information dissemination effort to total pollution prevention advocacy effort	0.361	0.254	0.000	1.000
Concentration	Degree to which production is concentrated in a few facilities, calculated as the sum, across all of a firm's manufacturing facilities, of the squares of the percent of the firm's total employees in each facility	0.708	0.334	0.019	1.000
Diversification	Degree to which the firm's output is diversified into various lines of business, calculated as one minus the sum, across all of a firm's manufacturing facilities, of the squares of the percent of the facility's employees in each industry segment as specified by the facilities' 4-digit SIC codes	0.142	0.241	0.000	0.850
Average Expertise	Average difference between facilities' actual and "expected" waste generation (positive values indicate less waste)	−0.041	0.798	-2.289	2.266
Expertise Variance	Standard deviation of differences between facilities' actual and "expected" waste generation	0.426	0.541	0.000	2.541
Total PP Effort	Log (+1) of total effort (full-time equivalent employees) per facility put forth by headquarters to encourage adoption of pollution prevention practices	0.121	0.358	0.000	2.398
PP Monitoring	Degree of pollution prevention monitoring (seven-point scale rescaled to 0 to 1)	0.203	0.160	0.143	1.000
Firm Size	Log of employees	6.901	2.052	2.303	12.569
Firm Facilities	Log of plants	0.825	1.038	0.000	4.913
R&D Intensity	Research expenditures/total assets	0.044	0.048	0.000	0.219
% of Facilities Adopting PP	% of firm's facilities adopting pollution prevention practices	0.446	0.421	0.000	1.000

Note: n = 473 except for *Relative Information Provision*, for which n = 119.

Table 2. Correlations (ICT industry: 1990–1996).

	1	2	3	4	5	6	7	8	9	10	11	12
1. Information Provision	1.00											
2. Relative Information Provision	0.49 *	1.00										
3. Concentration	−0.12 *	0.04	1.00									
4. Diversification	0.14 *	0.10	−0.76 *	1.00								
5. Average Expertise	−0.16 *	−0.20 *	0.01	−0.05	1.00							
6. Expertise Variance	0.15 *	0.06	−0.66 *	0.50 *	0.04	1.00						
7. Total PP Effort	0.82 *	0.02	0.09	−0.06	−0.13 *	−0.04	1.00					
8. PP Monitoring	0.25 *	−0.19 *	−0.23 *	0.18 *	−0.01	0.14 *	0.20 *	1.00				
9. Firm Size	0.15 *	−0.23 *	−0.68 *	0.64 *	−0.02	0.54 *	0.05	0.20 *	1.00			
10. Firm Facilities	0.09	−0.10	−0.89 *	0.82 *	−0.03	0.63 *	−0.08	0.20 *	0.79 *	1.00		
11. R&D Intensity	0.03	−0.22 *	−0.18 *	0.15 *	0.10	0.20 *	0.07	−0.07	0.31 *	0.18 *	1.00	
12. % of Facilities Adopting PP	0.06	0.01	0.12	−0.05	0.03	0.03	0.02	0.12 *	0.07	−0.05	0.05	1.00

Note: n = 473 except for *Relative Information Provision*, for which n = 119, * $p < 0.01$.

4. Analysis and Results

Descriptive data from our survey of managerial activity reveals that firms increasingly advocated the use of pollution prevention during the time frame of the study. In 1990, more than 60% of the firms in our sample had implemented a policy advocating the adoption of pollution prevention techniques (see Figure 1). However, fewer than 10% had made any effort to promote compliance with the policy through information provision, implementation support, or by monitoring adoption. By 1996, nearly all the firms in our sample had a pollution prevention policy, and almost half had made some effort, three-fourths of these through information provision, to encourage its adoption by their manufacturing facilities.

"Policy" refers to whether the firm had a policy advocating the adoption of pollution prevention practices. "Effort" refers to whether the firm put forth any effort to promote adoption, specifically, whether it dedicated person-hours to provide information, support implementation, or monitor adoption. "Information provision" refers to whether the firm engaged in any information provision. Sample is 72 US public firms in the information and communication technology sector.

To test our hypotheses, we begin with a series of models that use *Information Provision* as the dependent variable. This being an absolute level measure, to control for the overriding incentives to adopt pollution prevention practices that might otherwise affect the overall level of information provision, we include our measure for the overall level of promotional effort firms put forth (*Total PP Effort*). We estimate our model using ordinary least squares. We begin by estimating a pooled model in which we cluster standard errors to accommodate multiple observations from facilities (Model 1, Table 3). We then estimate a more conservative model by including fixed effects at the facility level to control for stable sources of unobserved heterogeneity (Model 2, Table 3). Below, we describe the magnitude of coefficient estimates from the fixed effects model.

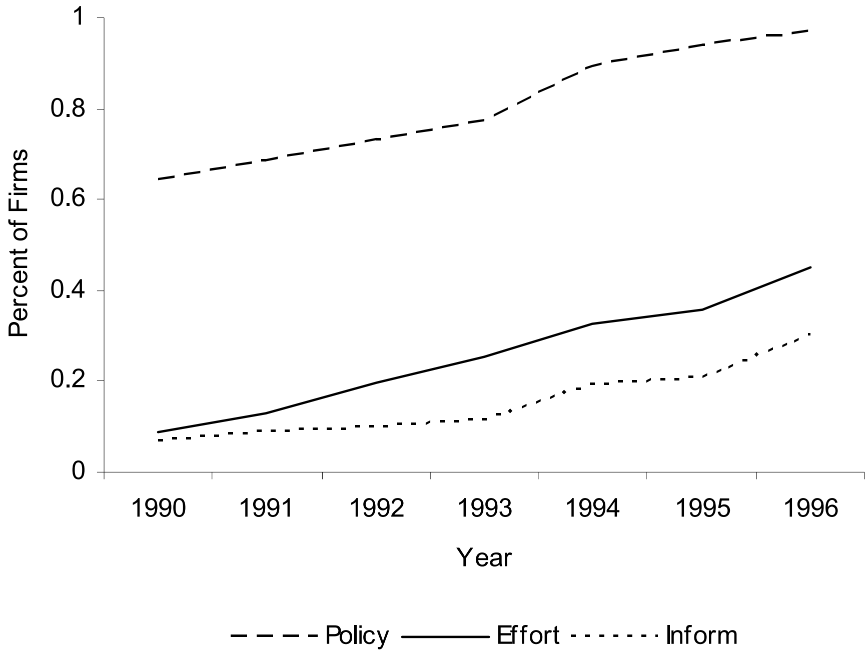

Figure 1. Growth in pollution prevention advocacy over time.

Table 3. The extent of information provision by firms to encourage pollution prevention within their facilities (ICT industry: 1990–1996).

	Specification	OLS [a]	OLS with Fixed Effects	OLS with Fixed Effects [b]	Tobit	Heckman Selection [c]
	Dependent Variable	Information Provision	Information Provision	Information Provision	Information Provision	Relative Information Provision
	Model	1	2	3	4	5
H1	Average Expertise	−0.022 (0.012) *	−0.014 (0.008) *	−0.041 (0.019) **	−0.112 (0.034) ***	−0.063 (0.031) **
H1	Average Expertise squared	−0.019 (0.011) *	−0.011 (0.006) *	−0.030 (0.017) *	−0.060 (0.033) *	−0.057 (0.032) *
H2	Diversification	0.176 (0.102) *	0.091 (0.053) *	0.092 (0.104)	0.314 (0.143) **	0.614 (0.127) ***
H3	Concentration	−0.133 (0.099)	−0.146 (0.055) ***	−0.327 (0.124) ***	−0.547 (0.151) ***	−0.245 (0.143) *
H4	Expertise Variance	0.068 (0.027) **	0.027 (0.013) **	0.050 (0.031)	0.196 (0.050) ***	0.035 (0.047)
	Total PP Effort	0.638 (0.091) ***	0.398 (0.023) ***	0.411 (0.039) ***	0.967 (0.053) ***	
	PP Monitoring	0.058 (0.100)	0.375 (0.043) ***	0.320 (0.068) ***	0.456 (0.113) ***	−0.275 (0.090) ***
	Firm Size	−0.010 (0.008)	0.011 (0.009)	0.018 (0.023)	0.039 (0.022) *	0.043 (0.035)
	Facilities within Firm	−0.029 (0.039)	−0.074 (0.029) **	−0.099 (0.069)	−0.135 (0.057) **	−0.198 (0.067) ***
	R&D Intensity	−0.322 (0.233)	0.168 (0.186)	0.159 (0.526)	−0.687 (0.548)	−0.906 (0.569)
	% of Facilities Adopting PP	0.054 (0.033)	0.029 (0.016) *	0.084 (0.043) *	0.043 (0.071)	0.099 (0.061) *
	Year Fixed Effects	Included	Included	Included	Included	Included
	Firm Fixed Effects		Included	Included		
	Mill's Ratio					0.283 (0.109) ***

Table 3. *Cont.*

Specification	OLS [a]	OLS with Fixed Effects	OLS with Fixed Effects [b]	Tobit	Heckman Selection [c]
Dependent Variable	Information Provision	Information Provision	Information Provision	Information Provision	Relative Information Provision
Model	1	2	3	4	5
N	473	473	203	473	473 [d]
Firms	72	72	30	72	72
F-stat (Wald χ^2 in Models 1 & 5)	18.3 ***	45.1 ***	23.1 ***	378.4 ***	113.7 ***
R^2 (Pseudo R^2 in Model 1)	0.742	0.937	0.933	0.682	

Standard errors in brackets; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; [a] Standard errors are clustered by firm; [b] Model 3 omits facilities that invested no corporate effort to advocate pollution prevention in any year during our sample (i.e., firms for which Total PP Effort is zero in all sample years); [c] the first stage of the selection model uses a probit specification where the dependent variable is whether or not a firm puts forth any effort to advocate pollution prevention. The coefficients and standard errors for our independent variables in the probit model are: relative waste generated (0.119, 0.158); total permits (0.075, 0.036); sector emissions (−2.598, 1.249); compliance costs (0.001, 0.003); firm facilities (−0.063, 0.026); and firm size (0.372, 0.091). Wald χ^2 = 22.80 ***. Pseudo R^2 = 0.1691; [d] 119 uncensored and 354 censored observations.

Corporate managers rely on information provision most when average subsidiary expertise is modest. Too little expertise in the subsidiaries risks the information being insufficiently absorbed; too much expertise risks the information being redundant. The concave relationship depicted in this graph is consistent with our hypothesis. Predicted values of *Information Provision* were calculated based on coefficients from Model 2, holding all variables (other than Average Expertise) at their sample means.

Our results yield significant, negative coefficients on both average expertise and its square. Graphing the combined effect of these two estimates reveals a concave curvilinear relationship between expertise and information provision (see Figure 2). Consistent with Hypothesis 1, we find that firms increase their use of information provision as the average expertise in their facilities rises until an inflection point at which further increases in expertise are associated with declining use of information provision.

Our results also yield a weakly significant, positive coefficient for *Diversification*, which provides some support for Hypothesis 2. To investigate the marginal effect, we calculated the following equation: β of *Diversity* × SD of *Diversity* divided by the mean of *Information Provision* = (0.091 × 0.241)/0.106 = 21%. The coefficient estimate implies that a firm dedicates 21% more effort to information provision when its diversification increases one standard deviation from the sample average.

Support for Hypothesis 3 is provided by the significant, negative coefficient on *Concentration*. To investigate the marginal effect, we calculated the following equation: β of *Concentration* × SD of *Concentration* divided by the mean of *Information Provision* = (−0.158 × 0.334)/0.106 = 49%. The magnitude of the coefficient estimate implies that a firm increases its information provision by 49% when its concentration decreases by one standard deviation from the sample average.

Consistent with Hypothesis 4, we find a significant positive coefficient on expertise variance. To investigate the marginal effect, we calculated the following equation: β of *PP Expertise-Variance* × SD of *PP Expertise-Variance* divided by the mean of *Information Provision* = (0.027 × 0.541)/0.106 = 14%. Our estimates imply that when expertise variance increases one standard deviation from the sample average, a firm increases information provision by 14%.

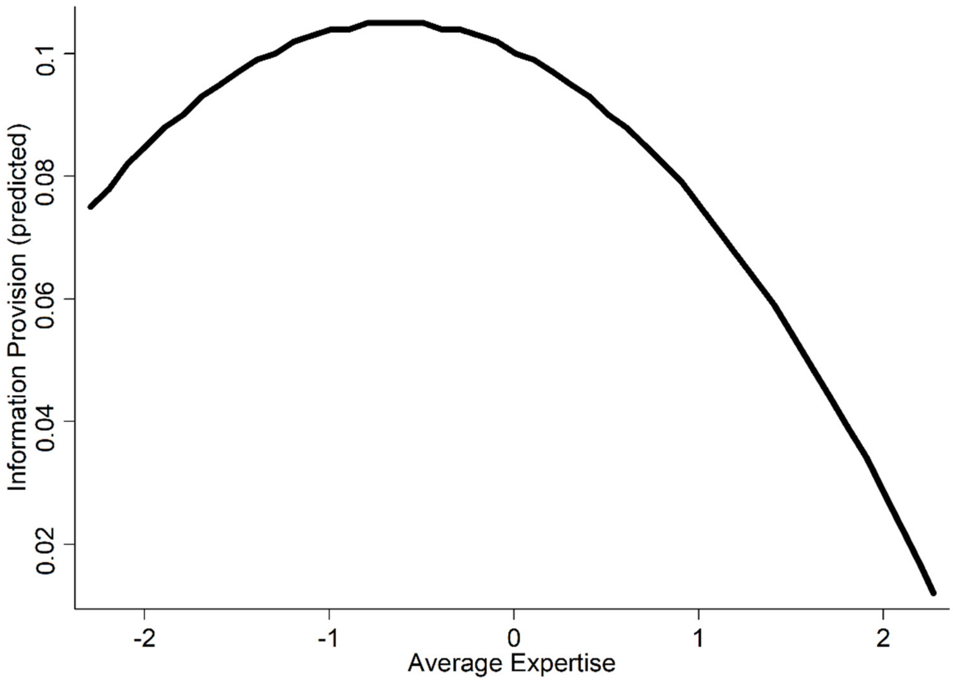

Figure 2. Marginal effect of expertise on the use of information provision.

We estimate several additional models as robustness tests. Because our dependent variable has many zero values, we re-estimate the fixed effects model after omitting facilities that invested no corporate effort to advocate pollution prevention (Model 3, Table 3). The resulting coefficients on the hypothesized variables are of larger magnitude than our main results, suggesting stronger effects, although the smaller sample sizes reduce the precision of some of the estimates. We also re-estimate the model using a Tobit specification in which we indicate the dependent variable is bottom censored at zero (Model 4, Table 3). These estimates also bolster our main results: all the coefficients are of larger magnitude and are at least as statistically significant as our main results.

As another robustness test, we make use of our second measure of information provision, *Relative Information Provision*. Recall that this is the ratio of information provision to total effort (*Information Provision/Total PP Effort*). This measure factors out the incentives to promote pollution prevention directly rather than through the inclusion of *Total PP Effort* as a control. A disadvantage of this measure is that it removes from our sample all firms that put forth no effort to promote the adoption of pollution prevention practices (due to the zero in the denominator). To address this sample selection bias, we adopt a two-stage Heckman selection model [33]. In the first stage, we estimate, using a Probit model, the likelihood that a firm puts forth any effort to promote pollution prevention. In the second stage, we regress our independent variables and controls on *Relative Information Provision* correcting for the first-stage selection.

For our first stage model, we include a series of regressors that attempt to capture private incentives a firm might have to reduce pollution. These include the relative waste generated across all a firm's facilities, the total number of regulatory permits received, the average industry toxic emissions for the firm's primary industry classification, and the firm's average industry compliance cost estimated using the US Census Bureau's pollution abatement cost and expenditure (PACE) data. In addition, we include firm size (log employees) and number of facilities to capture scale effects that might drive action (e.g., larger firms are more visible and might find themselves under greater scrutiny from environmental activists and consumers).

In estimating this pooled model, we cluster standard errors by facility. The results are largely consistent with our main results: all coefficients are of the same sign as those from our main results, but their magnitude is larger, indicating stronger effects. All these estimates are statistically significant except one: we are no longer confident that our estimate of *Expertise Variance* is different from zero, although the magnitude of the coefficient remains consistent with previous models. However, we should not mistake lack of significance for disconfirming evidence, given the constraints of this specification. In addition, Model 4 yields a significant, negative coefficient on *PP Monitoring*. This is not surprising because our dependent variable is the *relative* use of information provision. Greater use of monitoring reduces the relative use of information provision, holding the absolute level of information provision constant.

5. Discussion

In summary, we find support for each of our hypotheses. Corporate management relies more heavily on information provision to promote diffusion of management practices in firms that are less concentrated, more highly diversified, and exhibit greater variation in expertise across facilities. We observe a concave relationship between the average expertise of facilities and the use of information provision. Information provision is also used more often by firms with facilities that possess sufficient expertise to be receptive to the information but not with so much expertise that the information adds little value. Our findings are robust to several specifications and controls including models that employ firm fixed effects and a two-stage model to address selection issues. That we find only weak significance ($p < 0.10$) for some of our variables of interest might be, in part, a function of our use of firm fixed effects in a relatively wide (number of firms) but short (number of years) panel.

Our hypotheses are built on the assumption that corporate managers believe adoption of pollution prevention practices to be, at least on average, valuable for units of the firm (else they would be unlikely to advocate adoption). Whether corporate managers are sometimes likely to have better information than lower-level decision makers within organizations remains an open question, but we believe this to be a reasonable assumption given the nature of hierarchy in organizations, top managers are likely to be privy to information that others in the organization are not. Whether corporate managers' beliefs are correct is largely irrelevant to the question of the actions they might take based on those beliefs and should not affect our hypotheses or results. The possibility of corporate manager error, in fact, increases the value of information provision vis-à-vis alternative strategies such as fiat and monitoring.

While we have sought to control for alternative explanations of our results, we recognize that potential endogeneity between organization structure and information provision may remain. We assume that organization structures (e.g., subsidiary diversification, employee concentration) and the distribution of knowledge among subsidiaries are largely established before corporate managers decide how much to engage in information provision. We cannot rule out the possibility that organization structure and information provision strategies coevolve as the provision of information impacts the distribution of knowledge within the organization causing further refinement of information provision strategies. For example, it may be the case that unobserved characteristics of senior leaders play a role in both the distribution of knowledge and the adoption of information provision strategies [34,35].

Although our hypotheses center on the costs and benefits of information provision relative to other advocacy strategies, it is important to recognize that these strategies need not be pure substitutes. We present evidence that information provision and monitoring might be correlated and even complementary at some level (Models 1–3). Monitoring, for example, might make potential adopters more attentive to information provision. Most of the firms in our sample employ a mixture of information provision and managerial oversight (monitoring). At the margin, however, we believe that firms are deciding the relative use of one strategy versus another. The significant negative coefficient between monitoring and the relative use of information provision (Model 4) supports this notion. In summary, we believe that firm strategies might evolve over time and reflect differences in the likelihood of organizational units to adopt. We leave exploration of this to future research.

6. Conclusions

In this paper, we present evidence that organization structure influences corporate managers' strategic choice to use information provision to encourage organizational subsidiaries to adopt practices and technologies. We find the use of information provision to encourage the adoption of advanced environmental management practices across manufacturing facilities to be influenced by the distribution of expertise across organizational units. We find evidence that an information provision strategy is more likely to be pursued by corporate managers in less concentrated, more diversified firms that face greater variance in environmental management expertise and when the level of environmental management expertise across facilities is moderate.

This work has important implications for understanding variance in the adoption of advanced environmental management practices such as pollution prevention. Our research lends support to previous findings that internal management diffusion strategies are important drivers of the adoption of advanced environmental management practices within firms. We find evidence that the current organizational structure—the division and allocation of productive effort and expertise—affects the adoption of information provision, which previous research shows ultimately affects the adoption of advanced environmental management practices [6]. This, in turn, has important implications for our understanding of the relationship between ESG practices more broadly and corporate profitability, and suggests that variance across organizations in their ability to diffuse valuable practices may obscure a relationship between environmental management practices and profitability.

Our research also contributes more broadly to our understanding of intra-organizational knowledge transfer. Our research addresses Battisti and Stoneman's [36] call for "much greater emphasis [to] be placed on intra-firm issues" in diffusion research because of its crucial role in the understanding of overall technology diffusion patterns and because prior empirical research on the subject has "severe limitations" (p. 1641). We build on prior research that explores why some subsidiaries are more likely than others to adopt corporate initiatives and engage in knowledge transfer efforts [3,16,37,38]. Whereas previous research has focused on subsidiaries, our research highlights the role of corporate managers in the knowledge transfer process. Corporate managers' use of information provision might have a significant impact on subsidiaries' adoption of novel practices [6], but we find that attempts to diffuse valuable practices and technologies within organizations are constrained by the distribution of current expertise and knowledge. In conclusion, managers' active use of information provision might help to diffuse rent-producing practices and technologies central to competitive success, but only if the knowledge accumulated over time and distributed across subsidiaries is sufficient to make the provided information comprehensible and not so great as to render it redundant.

Author Contributions: Writing—original draft, M.J.L.; Writing—review & editing, M.W.T. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Provided by the authors upon request.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Kim, S.; Li, Z. Understanding the Impact of ESG Practices in Corporate Finance. *Sustainability* **2021**, *13*, 3746. [CrossRef]
2. Szulanski, G. Exploring internal stickiness: Impediments to the transfer of best practice within the firm. *Strateg. Manag. J.* **1996**, *17*, 27–43. [CrossRef]
3. Gupta, A.; Govindarajan, V. Knowledge flows within multinational corporations. *Strateg. Manag. J.* **2000**, *21*, 473–496. [CrossRef]
4. Adenfelta, M.; Lagerströmb, K. Knowledge development and sharing in multinational corporations: The case of a centre of excellence and a transnational team. *Int. Bus. Rev.* **2006**, *15*, 381–400. [CrossRef]
5. Björkman, I.; Barner-Rasmussen, W.; Li, L. Managing knowledge transfer in MNCs: The impact of headquarters control mechanisms. *J. Int. Bus. Stud.* **2004**, *35*, 443–455. [CrossRef]
6. Lenox, M.; King, A. Prospects for developing absorptive capacity through internal information provision. *Strateg. Manag. J.* **2004**, *25*, 331–345. [CrossRef]
7. Kahupi, I.; Hull, C.; Okoriec, O.; Milletted, S. Building competitive advantage with sustainable products—A case study perspective of stakeholders. *J. Clean. Prod.* **2021**, *296*, 125699. [CrossRef]
8. Lenox, M.; Chatterji, A. *Can Business Save the Earth? Innovating Our Way to Sustainability*; Stanford University Press: Palo Alto, CA, USA, 2018.
9. Hull, C.E.; Millette, S.; Williams, E. Challenges and opportunities in building circular-economy incubators: Stakeholder perspectives in Trinidad and Tobago. *J. Clean. Prod.* **2021**, *296*, 126412. [CrossRef]
10. Simon, H.A. What we know about the creative process. In *Frontiers in Creative and Innovative Management*; Kuhn, R.L., Ed.; Ballinger: Cambridge, MA, USA, 1985; pp. 3–20.
11. Lakhani, K.R.; Jeppesen, L.B.; Lohse, P.A.; Panetta, J.A. *The Value of Openness in Scientific Problem Solving*; Working Paper; Harvard Business School: Boston, MA, USA, 2007.
12. Cohen, W.M.; Levinthal, D.A. Absorptive capacity: A new perspective on learning and innovation. *Adm. Sci. Q.* **1990**, *35*, 128–152. [CrossRef]
13. Van den Bosch, F.; Volberda, H.; de Boer, M. Coevolution of firm absorptive capacity and knowledge environment: Organizational forms and combinative capabilities. *Organ. Sci.* **1999**, *10*, 551–568. [CrossRef]
14. Mowery, D.M.; Oxley, J.E.; Silverman, B.S. Strategic alliances and inter-firm knowledge transfer. *Strateg. Manag. J.* **1996**, *17*, 77–91. [CrossRef]
15. Ahuja, G.; Katila, R. Technological acquisitions and the innovation performance of acquiring firms: A longitudinal study. *Strateg. Manag. J.* **2001**, *22*, 197–220. [CrossRef]
16. Kostova, T.; Roth, K. Adoption of an organizational practice by subsidiaries of multinational corporations: Institutional and relational effects. *Acad. Manag. J.* **2002**, *45*, 215–233.
17. Holmstrom, B.; Milgrom, P. Multitask Principal-Agent Analyses: Incentive Contracts, Asset Ownership, and Job Design. *J. Law, Econ. Organ.* **1991**, *7*, 24–52. [CrossRef]
18. King, A. Innovation from differentiation: Pollution control departments and innovation in the printed circuit industry. *IEEE Trans. Eng. Manag.* **1995**, *42*, 270–277. [CrossRef]
19. King, A. Retrieving and transferring embodied data: Implications for the management of interdependence within organizations. *Manag. Sci.* **1999**, *45*, 918–935. [CrossRef]
20. Rothenberg, S. Knowledge Content and Worker Participation in Environmental Management at NUMMI. *J. Manag. Stud.* **2003**, *40*, 1783–1802. [CrossRef]
21. Klassen, R.D.; Whybark, D.C. The impact of environmental technologies on manufacturing performance. *Acad. Manag. J. 1999. 42*, 599–615.
22. Lenox, M. Agency and Information Costs in the Intra-Firm Diffusion of Practice. Unpublished Ph.D. dissertation, Massachusetts Institute of Technology, Cambridge, MA, USA, 1999.
23. Lenox, M.; King, A.; Ehrenfeld, J. Incorporating environmental concerns into product design decisions. *Interfaces* **2000**, *30*, 83–94. [CrossRef]
24. Frankel, C. Desperately seeking environment-ability. *Tomorrow Sept.* **1998**, 8–14.
25. Shelton, R. Hitting the green wall: Why corporate programs get stalled. *Corp. Environ. Strategy* **1994**, *2*, 5–11.
26. Lenox, M.; Ehrenfeld, J. Organizing for effective environmental design. *Bus. Strateg. Environ.* **1997**, *6*, 187–196. [CrossRef]
27. King, A.; Lenox, M. Exploring the Locus of Profitable Pollution Reduction. *Manag. Sci.* **2002**, *48*, 289–299. [CrossRef]
28. Ryan, B.; Gross, N. The diffusion of hybrid seed corn in two Iowa communities. *Rural. Sociol.* **1943**, *8*, 15–24.
29. Rogers, E.M. *Diffusion of Innovations*, 4th ed.; Free Press: New York NY, USA, 1995.
30. Mansfield, E. *The Economics of Technological Change*; Norton: New York, NY, USA, 1968.
31. Griliches, Z. Hybrid Corn: An Exploration in the Economics of Technological Change. *Econom. J. Econom. Soc.* **1957**, *25*, 501–522. [CrossRef]
32. Tolbert, P.S.; Zucker, L.G. Institutional Sources of Change in the Formal Structure of Organizations: The Diffusion of Civil Service Reform, 1880–1935. *Adm. Sci. Q.* **1983**, *32*, 590–607. [CrossRef]
33. Heckman, J.J. Sample Selection Bias as a Specification Error. *Econometrica* **1979**, *47*, 153–162. [CrossRef]
34. Coles, J.; Li, Z. Managerial attributes, incentives, and performance. *Rev. Corp. Financ.Stud* **2020**, *9*, 256–301. [CrossRef]

35. Coles, J.; Li, Z. An empirical assessment of empirical corporate finance. *J. Financ. Quant. Anal.* **2022**. Available online: https://jfqa.org/2022/01/11/an-empirical-assessment-of-empirical-corporate-finance/ (accessed on 23 April 2022). [CrossRef]
36. Battisti, G.; Stoneman, P. Inter- and intra-firm effects in the diffusion of new process technology. *Res. Policy* **2003**, *32*, 1641–1655. [CrossRef]
37. Tsai, W.; Ghoshal, S. Social capital and value creation: The role of intrafirm networks. *Acad. Manag. J.* **1998**, *41*, 464–476.
38. Szulanski, G.; Cappetta, R.; Jensen, R.J. When and How Trustworthiness Matters: Knowledge Transfer and the Moderating Effect of Causal Ambiguity. *Organ. Sci.* **2004**, *15*, 600–613. [CrossRef]