sustainability

MDPI

Article

Too Much Is as Bad as Too Little? Sources of the Intention-Achievement Gap in Sustainable Innovation

Daegyu Yang [1] and Sangchan Park [2,*]

[1] School of Management, Kyung Hee University, Seoul 02447, Korea; daegyu@khu.ac.kr
[2] Korea Advanced Institute of Science and Technology, College of Business, Seoul 02455, Korea
* Correspondence: sp@business.kaist.ac.kr; Tel.: +82-2-958-3318

Academic Editor: Beatriz Junquera
Received: 10 June 2016; Accepted: 21 July 2016; Published: 25 July 2016

Abstract: Prior work on innovation has generally emphasized the importance of an organization's exposure to external knowledge. This study, in contrast, redirects our attention toward conditions under which such exposure serves as constraints on organizational endeavors to achieve environmentally preferable innovation. We develop a two-stage model for sustainable innovation. A firm in the first stage explores a variety of alternatives and develops strategic intentions to address broader environmental concerns; thus, it may benefit from access to both diverse sources of external knowledge and network ties that enable an extensive search for new information. In the second stage, a firm exploits limited available options to achieve its strategic intentions. We suggest that dependence on external knowledge in the first stage makes the transition toward the second stage challenging, thereby reducing the probability that a firm's strategic intentions for sustainability result in actual innovation outcomes. We test our theory using the 2014 Korean Innovation Survey. Our results show that diverse sources of external knowledge through rich network ties, albeit the positive main effects on innovation outcomes, negatively moderate the relationship between a firm's intentions for environmental sustainability and its achievement of sustainable innovation. Several theoretical and practical implications are discussed.

Keywords: environmental sustainability; strategic intention-achievement gap; external knowledge; sustainable innovation; organizational learning; social network

1. Introduction

The strategic significance of environmental innovation has been well noted [1–3]. For instance, as consumers and other interested audiences increasingly consider environmental characteristics and performance, such as carbon offsets and energy efficiency, to be significant purchasing criteria, manufacturers with strong environmental innovation capabilities can gain sustainable competitive advantages by providing their products and services through new technologies that enable energy and pollution reduction [4]. The strategic significance of environmental innovation is also logically consistent with the natural resource-based view (NRBV), which suggests that firms can explore and exploit new business opportunities by applying environmental innovation to their products and services as a critical means to create and maintain sustainable competitive advantages [5–7]. Rooted in the resource-based view of the firm [8–10], Hart proposes a natural resource-based view that identifies primary characteristics of strategically important resources, such as tacitness, social complexity, and rarity—key factors that can contribute to pollution prevention, product stewardship, and sustainable development [5]. This perspective has been extended to provide a link between resources, innovation, and environmental performance [11].

A longstanding premise of innovation research is that external knowledge is critical to the generation and development of creative solutions within firms. For example, organizational learning

perspectives, a powerful tool in understanding organizational innovation and change, posit that as with individuals, organizations are often dependent on external sources of knowledge in their creativity and innovation processes [12–14]. The fundamental importance of external knowledge is exemplified by the increasing reliance on inter-organizational collaboration in various industries, including biotechnology, pharmaceuticals, and chemicals, among others [15–20]. Together, these studies confirm the strong positive influence of organizational exposure to a diverse set of novel ideas, both directly, through a firm's experience, and indirectly, through a firm's network contacts.

While the general significance of external knowledge in innovation is hardly disputable, it is not entirely clear whether such importance holds completely without any boundary conditions. Namely, scholars have tended to view organizational exposure to a diverse set of novel ideas and external relations as a natural given condition for innovation outcomes, ignoring the possibility that external sources of knowledge may serve as a liability. Studies have suggested that the mere presence of external knowledge per se does not guarantee the achievement of innovation; rather, knowledge absorption should be substantiated by internal capabilities to better utilize external knowledge, highlighting that external dependence has a boundary condition [21–24]. Additionally, scholars have provided direct evidence for the potential costs of external knowledge dependence. Firms access a knowledge pool via collaboration with external partners, yet such inter-organizational arrangements can become costly because of opportunism [25], the complexity and tacitness of new knowledge [26], or concerns about knowledge leakage [27].

This line of reasoning allows us to question the taken-for-granted assumption that external knowledge always has a positive impact on innovation outcomes. Scholars have yet to directly examine conditions under which external knowledge dependence serves as constraints on innovation outcomes. Our study aims to remedy this situation by resting on a more realistic premise that organizational exposure to a diverse set of novel ideas may entail both benefits and costs. Given that prior work has almost exclusively focused on the benefits, the current study focuses on the cost side and critically assesses whether external sources of environmental innovation always have a positive influence. In doing so, our paper stands to make significant contributions to extant research. First, this study contributes to the literature on competitive environmental strategy [28–31] by showing that environmental innovation, if well implemented with respect to external knowledge utilization, can serve as a source of sustained competitive advantage. Second, our paper makes a contribution to research on organization learning and technological innovation by highlighting the potential liability arising from external learning processes and thereby offering a more nuanced imagery of innovation dynamics for environmental sustainability.

2. Theory and Hypotheses

2.1. Strategic Search and Selection: A Two-Stage Model of Environmental Innovation

In organizational learning literature, James G. March's insightful work on exploration and exploitation suggests that a fundamental distinction between the two learning modes is relevant to understanding organizational innovation and change [32]. Exploration engages individuals and organizations in search, experimentation, and variation, whereas exploitation involves choice, execution, and variance reduction. Although both learning modes are important for organizational innovation, they are also characterized by inherent contradictions [33]. Exploring new technological capabilities is critical to long-term survival, and simultaneously, exploiting existing technological capabilities is also crucial for short-term efficiency. If a firm engages in exploitation to the exclusion of exploration, it maintains stable performance without realizing the maximum potential [34]. If it engages in exploration to the exclusion of exploitation, it will suffer the costs of experimentation without gaining the benefits associated with exploiting existing opportunities [32]. Thus, the issue of how a firm balances exploration and exploitation has drawn substantial interest from scholars of innovation and technology.

Prior work has introduced different approaches to balancing exploration and exploitation, including organizational separation, or separating units dedicated to either exploration or exploitation and coordinating them at the corporate level, as well as temporal separation, or sequential shifts over time from exploration to exploitation (see [35] for a more detailed review). According to the latter approach, temporal separation represents a time-paced sequence of exploration and exploitation that involves slow, gradual, and often challenging transitions between periods of exploitation and exploration [36–38].

Similarly, environmental innovation consists of temporal sequences of exploration and exploitation, reflected in the two modes of organizational activities: search-based strategic planning and selection-based organizational implementation. On the one hand, environmental innovation originates with recognizing the strategic importance of addressing environmental sustainability and considering environmental innovation a key driver that can meet strategic intention [2]. Without establishing such strategic intention, a firm cannot attempt to enhance its environmental performance via sustainable innovation. Organizational search helps a firm to scan its market and industries to gauge social and regulatory pressures on environmental sustainability, and to understand the strategic importance of sustainable innovation as a means to address these pressures. Thus, strategic planning, which a firm elects as a means to develop environmental innovation, can benefit from an extensive search for new sources of sustainable competitive advantages. As widely accepted information and data about new technologies to enhance environmental performance are not yet readily available, a firm engaging in a distant, broad search is better positioned to understand the strategic importance and commercial relevance of sustainable innovation. Organizational search is also useful in identifying external knowledge providers who have valuable information on innovation, as well as the capability and willingness to transfer it. In this regard, organizational search activities, and exploration in general, can enhance the likelihood that a firm will be exposed to a diverse set of novel ideas and external contacts for new knowledge. Consequently, the benefits of external knowledge are most salient in the first stage, that is, search-based planning to set a strategic intention for environmental innovation.

On the other hand, strategic intentions require organizational implementation to achieve innovation outcomes. While strategic intentions are construed as the most immediate predictor of goal attainment (i.e., achieving environmental innovation), intention and achievement are often loosely coupled. Gollwitzer, for example, noted the intention-behavior gap, suggesting that "intentions account for only 20% to 30% of the variance in behavior" [39] (p. 493). The weak relation between intentions and behavioral outcomes has also been well documented in many studies of social psychology [40–42]. Insofar as an organization, like an individual, exhibits a similar intention-to-behavior process, setting a strategic intention to pursue environmental sustainability does not guarantee its achievement. It is in this regard that we emphasize the importance of implementation as a building block for the second stage of environmental innovation. Exploitation-related activities, such as choice, execution, and variance reduction, can enable a firm to focus on a few manageable options for implementing environmental innovation. For example, as a firm has limited attention and capacity [43,44], too much information from external partners may prevent it from sorting through viable options to realize the potential of environmental innovation.

2.2. The Liability of External Knowledge in Environmental Innovation

We follow the aforementioned line of research and suggest that the transition between periods of strategic search and selection is challenging. Shifts between exploration and exploitation are not always smooth because temporal separation requires a firm to excel in managing contradictory activities [36,37]. Additionally, dominant activities at one point of time reinforce inertial pressures and make it difficult to counter the inherent nature of path dependence over time [35,45]. In the first stage of environmental innovation, extensive searching to explore diverse external sources of information represents a dominant activity. Reliance on external information and collaborative knowledge partners is therefore useful in this stage, yet such a dominant activity associated with external dependence can

serve as an inertial force that constrains necessary transitions toward the second stage where a firm should engage in selection and implementation. Consequently, the shift between search and selection will likely become more challenging when external dependence is stronger.

External dependence can be reflected on the quantity and diversity of external sources of information. A firm can be overwhelmed by too much search-identified information, especially if it cannot correctly assess its value for environmental innovation. In addition, it is less likely that all information is directly relevant to commercially viable innovation for sustainability. Mata and Woerter suggest that too much diversity among external knowledge sources may increase costs, by noting that "exceptionally valuable outcomes often come from cross-collaboration from different fields of science, but the chances of achieving a positive outcome and, indeed, the average gain from collaborations increase if both partners' knowledge is within the scope of the same specific domain" [46] (p. 497). Taken together, we suggest that a firm establishing a strategic intention for environmental sustainability via extensive search may generally achieve positive innovation outcomes, yet such a relationship will be negatively moderated by a degree of external dependence, captured by the number of external information sources as well as their degree of diversity. Thus, we propose:

Hypothesis 1: While a firm with stronger intentions toward sustainable innovation will be more likely to achieve innovation outcomes for enhancing environmental performance, the positive main effect will be negatively moderated by the number of external sources of information to which the firm is exposed.

Hypothesis 2: While a firm with stronger intentions toward sustainable innovation will be more likely to achieve innovation outcomes for enhancing environmental performance, the positive main effect will be negatively moderated by the degree of diversity in external sources of information to which the firm is exposed.

Network ties generally serve as an important conduit through which new knowledge and other valuable information flow, such as novel inventions, market demand, technological advances, competitive dynamics, and regulatory compliance issues [18,20]. Organizational scholars have widely acknowledged the difficulties in transferring new knowledge [47–49]. When the knowledge being transferred is new, complex, and tacit in nature and thus difficult to articulate, implementing the transfer will become increasingly problematic [26,50]. As the nature of new technologies associated with environmental innovation is complex and tacit, it is useful to probe how a focal firm is connected to external knowledge partners. For instance, prior research suggests that close, frequent relationships, or strong ties, are beneficial in resolving such difficulties, as a strong tie allows two parties to spend more time articulating new knowledge and seeking instruction and feedback through two-way interactions [51]. Additionally, knowledge transfer may require a focal firm to engage in collaborative processes in which to interact with its knowledge partners to shift and align socio-cognitive schemas for establishing common grounds, enabling inter-subjective understandings, and thereby enhancing inter-firm learning outcomes [16,52]. Therefore, knowledge transfer relationships are less likely to depend on a one-time interaction; actual transfer processes often require extended mutual involvement, such as follow-up meetings, renegotiations, and the subsequent adjustment of legal contracts [53].

As managing extended mutual involvement is costly, all connections to external partners established during the search stage cannot be easily maintained. As it is unlikely that all network connections are directly relevant to implementation for environmental innovation, a firm should sort through connections to external players whose knowledge fits well. Consequently, the selection process for innovation implementation becomes costly, and the external dependence constructed during the search stage is likely to serve as a hurdle preventing a firm from making continued knowledge transfer efforts with a few manageable relationships.

It is noteworthy that a firm depends on different types of external partners in environmental sustainability. Sustainable innovation, like other forms of general innovation, is often enabled by external operative partners such as suppliers, consultants, competitors, and universities, to name

a few. A firm's dependence of this type represents sources of new knowledge regarding environmental products and services. On the other hand, we also consider the significance of government and regulatory bodies in environmental sustainability. While government is relevant in virtually every business sector, such regulated industries as biotechnology, agriculture, energy, and electricity, in which environmental sustainability has begun to predominate, are particularly subject to regulatory intervention. For instance, government can dramatically influence a firm's innovation outcomes, performance, and survival, via the regulatory approval or disapproval of product and service offerings, product standards and production requirements, and market entry and exit rules. Governmental intervention in forms of facilitative support and policies may positively shape a firm's intention to pursue environmental innovation, but external intervention may also undermine its internal operative efficiency and business decision autonomy, which would otherwise enhance innovation outcomes. While the types of dependence on external players differ, it is likely that the negative influence of external dependence will arise for both cases of governmental and non-governmental partners. Thus, we predict that:

Hypothesis 3: While a firm with stronger intentions toward sustainable innovation will be more likely to achieve innovation outcomes for enhancing environmental performance, the positive main effect will be negatively moderated by the firm's dependence on its associated external partners.

Hypothesis 4: While a firm with stronger intentions toward sustainable innovation will be more likely to achieve innovation outcomes for enhancing environmental performance, the positive main effect will be negatively moderated by the firm's dependence on government support.

3. Methods

3.1. Data

We use the "Korean Innovation Survey (KIS) 2014: Manufacturing Industry" as our primary data source to test our hypotheses; this survey is biannually conducted by the Science and Technology Policy Institute (STEPI), a government-driven research institute in South Korea [54]. The KIS follows the OECD's *Oslo Manual* (third edition) to collect and interpret innovation data, and develops question items based on the Community Innovation Survey (CIS), which also follows *Oslo Manual*'s definition. As the CIS data is used as an official data source for the European Union to make innovation-related policies, the Korean government also adopted the KIS data as a crucial, reliable data source for its governmental policies for the innovative actions of companies. From 2002, STEPI began to collect this official survey to monitor Korean manufacturing firms' innovative actions and capabilities, and the 2014 survey is the most recent survey that is publically available. In summary, the KIS 2014 survey is well designed according to global standards and is systematically collected by a reliable research institute with careful consideration of data-collecting procedures. We find that, aside from the reliability aspect, the KIS 2014 survey is valuable for our research as it includes questions regarding not only the extent to which a company considers environmental issues in their product and process innovation, but also about the extent to which it achieves environmental innovation. Therefore, the KIS 2014 survey is suitable for testing our research hypotheses regarding companies' environmental innovation issues.

The population of the KIS 2014 survey is composed of all 46,101 Korean manufacturing companies that engaged in ongoing activities from 2011 to 2013, and that have at least 10 employees. The KIS 2014 survey sample is selected using a stratified random sampling strategy, which considers both the industry category and company size in the sampling process; the KIS 2014 survey's sample size is 4075. Among the companies in this sample, there exist companies that did not answer questions regarding environmental innovation. Therefore, the actual sample size of our analysis after excluding such missing observations is 1251.

3.2. Measurements

3.2.1. Dependent Variable

Our study's dependent variable is the extent to which a company achieves innovation outcomes toward environmental performance. We use the response to the KIS 2014 survey question, "During the three years from 2011 to 2013, how much did your company's product and process innovation activities influence energy-related cost reduction?" to measure the dependent variable. The response is constructed as an ordinal scale of "none (=0)", "low (=1)", "medium (=2)", and "high (=3)".

3.2.2. Independent and Moderating Variables

The independent variable used for the baseline model of our study is the extent to which a company considers environmental aspects in its innovation activities. By using this variable, we first investigate the effect of the first-stage of sustainable innovation, which we argue focuses on strategic planning. We use the KIS 2014 survey question, "During the three years from 2011 to 2013, how much did your company consider energy-related cost reduction as a goal of your product and process innovation activities?" to measure this variable. The respondent companies answer this question with a scale of "none (=0)", "low (=1)", "medium (=2)", and "high (=3)". Additionally, to investigate the liability effects of the external knowledge in environmental innovation proposed in our four hypotheses, we develop four moderating variables, as follows.

We generate a moderating variable to test Hypothesis 1 based on the KIS 2014 survey question, "During the three years from 2011 to 2013, did your company's innovation activities use the following information sources?" The survey provides eight different categories under this question for external sources of innovation-related information: "private sector clients or customers", "public sector clients or customers", "competitors or other companies in your industry", "consultants and commercial labs", "universities or other higher education institutes", "government, public, or private research institutes", "conferences, trade fares, exhibitions", "scientific journals and trade/technical publications", and "professional and industry associations". To each question, the respondent companies answer "used (=1)" or "not used (=0)". We construct the variable by counting the number of "used (=1)" answers; therefore, the variable is generated as a count variable that ranges from 0 to 9.

We construct a diversity measure based on a weighted Blau index [55] to test Hypothesis 2, in which we propose a moderating effect of the diversity of external sources of information on the relationships between an innovation intention toward environmental sustainability and actual environmental performance achievement. The KIS 2014 survey also asks, "During the three years from 2011 to 2013, how important were each of the following information sources to your company's innovation activities?" The same list of eight different external information source categories was used. The respondent companies noted each external information source using a scale of "not used (=0)", "low (=1)", "medium (=2)", and "high (=3)". Based on this, we construct the diversity of external information sources as follows:

$$\text{diversity of external information sources} = 1 - \sum_{\text{i}}^{9} p_i^2 \quad (1)$$

where i refers to each category of external information sources included in the KIS 2014 survey question, and p refers to the proportion of a weighted importance of an external information source to those of all external information sources.

We construct the variable to test Hypothesis 3 by measuring the extent to which a company depends upon its cooperating partners. The KIS 2014 survey asks, regarding cooperating partners, "During the three years from 2011 to 2013, which type of cooperating partner was helpful for your innovation activities?" Eight types of cooperating partners are presented under this question: "other companies within your company group", "suppliers of equipment, materials, components,

or software", "clients or customers from the private sector", "clients or customers from the public sector", "competitors or other companies in your sector", "consultants and commercial labs", "universities or other higher education institutes", and "government, public, or private research institutes". We construct a dummy variable based on this question's response, indicating whether the respondent company depends on a cooperating partner for its innovation activities, in which the dependence is coded as 1, and 0 otherwise. In the final sample, 449 companies (about 36%) answer that cooperating partners are crucial to their innovation activities.

We generate a variable to test Hypothesis 4, by which we can measure the extent to which a company finds government support helpful for their innovation activities. The KIS 2014 survey asks whether the respondent company uses the innovation-related support provided by the Korean government. Eight different types of government support for companies' innovation activities are presented in the questionnaire: "tax reduction for technology development", "financial support for technology development and commercialization", "participation in government-driven research and development projects", "provision of government-owned technology", "provision of technological information", "provision of technological workforce and education", "national product procurement", and "support for marketing activities". The respondent companies answer whether they use each type of governmental support for their innovation activities, and we code the variable as a count variable by summing the number of supports the companies use; namely, the variable ranges from 0 to 8.

3.2.3. Control Variables

We control for several factors that may influence the extent to which a company achieves its environmental performance in terms of innovation activities. First, we include the company's industry category, according to the Korean Standard Industry Code (KSIC) (10–33) in the analysis by including the dummy variable indicating each industry. Next, whether a company is an independently operating company or a part of a larger business group, such as a Chaebol (Korean business conglomerate) affiliate, is included as a dummy variable. Out of 1251 companies in our final sample, 1127 companies are categorized as independent (approximately 90%). Third, we control for the company type, which is legally categorized according to a Korean law of small- or medium-sized company supports, as the government attempts to balance small-, medium-, and large-sized companies in terms of competitive conditions. The dummy variables that indicate small- and medium-sized companies are included in the analysis. There are 559 small-sized companies in our sample (approximately 44.7%), and 523 medium-sized companies (approximately 41.8%). Finally, we control for companies' annual sales as of 2013. The KIS 2014 survey collects this information as a discrete scale, for example, "no sales", "smaller than 1 billion Korean won (KRW)", "1 to 5 billion KRW", "5 to 10 billion KRW", "10 to 50 billion KRW", "50 to 100 billion KRW", and "greater than 100 billion KRW" (1 billion KRW is approximately 800,000 USD). By using "no sales" as a baseline, we include six dummy variables that fall into each annual sales category in the analysis.

3.2.4. Model

As our dependent variable is an ordinal variable, in which four responses are presented as "none (=0)", "low (=1)", "medium (=2)", and "high (=3)", we test our hypotheses by using ordered logistic regression models. In each model, we include an interaction term for the independent variable and each moderating variable to individually test our hypotheses. We report the results of our analysis in the following sections.

4. Results

Table 1 reports the descriptive statistics of the variables used in our ordered logistic regression analysis, along with the pairwise correlations between the variables. As explained in Section 3.2.3, we also include industry dummy variables in our analysis, based on the Korean Standard Industry Code (KSIC), as well as dummy variables indicating different annual sales levels. However,

these two control variables are not reported in Table 1 due to space limitations. The pairwise correlation analysis indicates that independent companies and small/medium companies are negatively associated with the innovation outcomes for enhancing environmental performance in our Korean research context. In support of our baseline argument, which notes that stronger intentions toward sustainable innovation lead to better innovation outcomes for environmental performance, the correlations between these two variables are positively high and significant. The correlations among the independent and moderating variables in our analysis are not particularly strong. The variance inflation factors test confirms that the variables used in our analyses do not cause serious multicollinearity problems.

Table 1. Descriptive statistics and pairwise correlations.

Variables	Mean	S.D.	(1)	(2)	(3)	(4)
(1) Outcomes of sustainable innovation	0.73	1.10				
(2) Independent company	0.91	0.30	−0.16 *			
(3) Small company	0.45	0.50	−0.11 *	0.26 *		
(4) Medium company	0.42	0.50	−0.02	−0.01	−0.76 *	
(5) Intentions toward sustainable innovation	0.90	1.26	0.83 *	−0.17 *	−0.11 *	−0.06
(6) Number of external information sources	2.05	2.24	0.27 *	−0.09 *	−0.13 *	0.02
(7) Diversity of external information sources	0.32	0.35	0.21 *	−0.04	−0.12 *	0.04
(8) Cooperating partners	0.36	0.48	0.25 *	−0.14 *	−0.13 *	−0.01
(9) Government support	1.50	1.94	0.20 *	−0.04	−0.08 *	0.04
Variables *(continued)*			**(5)**	**(6)**	**(7)**	**(8)**
(6) Number of external information sources			0.28 *			
(7) Diversity of external information sources			0.22 *	0.90 *		
(8) Cooperating partners			0.28 *	0.36 *	0.31 *	
(9) Government supports			0.19 *	0.43 *	0.37 *	0.30 *

Notes: $N = 1251$; * $p < 0.05$; industry category and sales dummy variables are not reported due to space limitations.

Table 2 presents the results of ordered logistic regression analyses. Model 1 includes the variable of intention toward sustainable innovation, with all control variables. In support of our baseline argument, the coefficient of the sustainable innovation intentions is positive and highly significant.

In Model 2, we add the number of external information sources, and find that the number of external information sources has a positive effect. To test Hypothesis 1, Model 3 includes the interaction term of the intentions toward sustainable innovation, and the number of external information sources. The interaction term's coefficient is negative at a significant level, which is interpreted as an increase in external information sources leading to a decrease in the coefficient of intentions toward sustainable innovation. While the coefficient of the intentions toward sustainable innovation is 2.14 at approximately the mean of the number of external information sources (=2), this becomes 1.84 at the mean plus 1 standard deviation (=4). Thus, our hypothesis regarding the negative moderating effect of the number of external information sources is statistically supported.

Models 4 and 5 add the diversity of external information sources measured as the Blau index and its interaction term with intentions toward sustainable innovation, respectively. The interaction term's coefficient is negative at a significant level, which shows that an increase in diversity leads to a decrease in the effect of the intentions toward sustainable innovation. For example, while the coefficient of the innovation intentions is 2.44 at the median of diversity (=0), it becomes 1.83 at the third quartile level (=0.67). Therefore, Hypothesis 2 is supported by these findings.

Table 2. Results of ordered logistic regression.

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Intercept 1	3.87 **	3.99 **	4.82 **	3.94 **	4.69 **	3.92 **	4.16 **	4.01 **	4.38 **
	(0.77)	(0.77)	(0.81)	(0.77)	(0.81)	(0.77)	(0.78)	(0.78)	(0.80)
Intercept 2	4.65 **	4.77 **	5.62 **	4.72 **	5.48 **	4.69 **	4.94 **	4.80 **	5.17 **
	(0.78)	(0.78)	(0.81)	(0.78)	(0.82)	(0.78)	(0.79)	(0.78)	(0.81)
Intercept 3	7.10 **	7.21 **	8.05 **	7.17 **	7.92 **	7.14 **	7.38 **	7.25 **	7.61 **
	(0.79)	(0.80)	(0.83)	(0.80)	(0.83)	(0.79)	(0.81)	(0.80)	(0.82)
Independent company	−0.00	−0.03	−0.01	−0.05	−0.00	0.00	−0.01	−0.01	−0.02
	(0.27)	(0.27)	(0.27)	(0.27)	(0.27)	(0.27)	(0.27)	(0.27)	(0.27)
Small size company	0.30	0.33	0.26	0.31	0.26	0.32	0.24	0.35	0.37
	(0.43)	(0.43)	(0.43)	(0.43)	(0.42)	(0.43)	(0.43)	(0.43)	(0.43)
Medium size company	0.54	0.54	0.54	0.53	0.52	0.57	0.50	0.54	0.55
	(0.33)	(0.34)	(0.33)	(0.34)	(0.33)	(0.34)	(0.34)	(0.33)	(0.33)
Intentions of sustainable innovation	2.10 **	2.07 **	2.44 **	2.08 **	2.44 **	2.09 **	2.26 **	2.09 **	2.25 **
	(0.09)	(0.09)	(0.13)	(0.09)	(0.13)	(0.09)	(0.12)	(0.09)	(0.11)
External information sources		0.09 *	0.39 **						
		(0.03)	(0.07)						
(Intentions) × (Number of information sources)			−0.15 **						
			(0.03)						
Diversity of external information sources				0.51 *	2.33 **				
				(0.23)	(0.49)				
(Intentions) × (Diversity of information sources)					−0.91 **				
					(0.21)				
Cooperating partners						0.20	0.95 **		
						(0.17)	(0.32)		
(Intentions) × (Cooperating partners)							−0.40 **		
							(0.14)		
Government support								0.13 **	0.30 **
								(0.04)	(0.07)
(Intentions) × (Governmental supports)									−0.09 **
									(0.03)
pseudo R-square	0.45	0.46	0.47	0.46	0.46	0.45	0.46	0.46	0.46
Log likelihood	−663.44	−659.80	−648.12	−661.02	−651.5	−662.79	−695.09	−657.97	−654.38

Notes: $N = 1251$; * $p < 0.05$; ** $p < 0.01$; standard errors are in parentheses; industry category and sales dummy variables are included but not reported.

Models 6 and 7 test our hypothesis regarding cooperating partners' negative moderating effect on the positive relationship between the intention for sustainable innovation, and the innovation outcomes for enhancing environmental performance. This is accomplished by adding the variable of cooperating partners and its interaction term with the innovation intentions. The findings confirm the negative moderating effect of cooperating partners as the interaction term's coefficient is negative at a significant level. In Model 7, the coefficient of the intentions toward sustainable innovation drops from 2.26 to 1.86 when a company utilizes external cooperating partners. That is, the findings support Hypothesis 3 regarding the negative moderating effect of external partners.

Lastly, we test the proposed negative moderating effects of government support in Models 8 and 9. While government support has a positive independent effect, its interaction effect with good intentions toward sustainable innovation is negative. As the level of government support that a company relies on increases, the positive effect of the intentions toward sustainable innovation on the innovation outcomes for environmental performance is mitigated. In sum, these findings support Hypothesis 4.

Additionally, to strengthen our argument that the negative moderating effect of external knowledge is mostly due to the firm's limited ability to assess and modify external knowledge for internal use, we conduct separate analyses in which financial resources obtained from outside parties are tested for the negative moderating effects. Unlike knowledge resources, financial resources can be instantly used without additional modification, and therefore we expect that financial resources will not produce a negative moderating effect. In this additional robust check, we confirmed that financial resources acquired from outside parties did not negatively moderate the relationship between a firm's strategic intention for sustainable innovation and its actual outcomes. This additional robustness check provides stronger confidence in our results.

5. Discussion and Conclusions

While studies of organizational learning and innovation have typically assumed access to diverse sources of external knowledge through rich network ties as a key driver for innovation outcomes, our paper critically examines the taken-for-granted assumption by suggesting that organizational exposure may entail costs as well as benefits. Our key premise, in other words, is that organizational exposure to a diverse set of novel ideas does not always have a strong positive influence on the achievement of innovation outcomes; rather, we examine a boundary condition under which external knowledge may serve as constraints on organizational endeavors to achieve sustainable innovation.

Our main hypotheses, drawn from a conceptual model of two-stage innovation for environmental sustainability, predicts that dependence on external knowledge will disrupt a firm's endeavors to focus on strategic execution, and thereby undermine actual outcomes of sustainable innovation. The results of our empirical analyses provide strong support for the predictions. As Table 2 shows, diverse sources of external knowledge through rich network ties, albeit the positive main effects on innovation outcomes, negatively moderate the relationship between a firm's intentions for environmental sustainability and its actual achievement of sustainable innovations. More specifically, we find that the negative moderating effects arise from both the number and the diversity of external sources upon which a firm relies to acquire innovation-related information, while the main effects are all positive and significant. A firm gaining access to a greater amount of external information, in other words, is likely to achieve innovation outcomes, yet such positive influence of external exposure is reduced when the firm has already established its strategic intentions toward sustainable innovation. We find that network-based supports from external business and government actors have similar negative moderating effects.

We interpret these results to reflect the fact that environmental innovation consists of strategic search and selection, two modes of significantly different innovation activities. Although external knowledge may be useful in the first stage, in which a firm searches and explores diverse external sources of sustainable development to set innovation intentions, such resources can become a liability that serve as an inertial force against organizational selection for effective implementation. As Hypotheses 1 and 2 predict, a firm's implementation process can be interrupted by external sources

of new information acquired through an extensive search, as it is costly and challenging to assess their respective values for environmental innovation. The cost and challenge can become severe, not only because external information comes from many sources, but also because the sources are diverse. Likewise, Hypotheses 3 and 4 suggest that network ties, while an important conduit through which new knowledge and other valuable information flows, can serve as a hurdle to prevent a firm from implementing its innovation efforts via a few manageable relationships.

Our causal mechanism concentrates on a firm's limited ability to assess external knowledge, and in particular informational and relational resources from outside parties that require additional work for internal use. For instance, information regarding pollution prevention systems of external suppliers cannot be directly applied to the focal firm's manufacturing system without considerable modification. Financial resources, however, differ in that a firm can instantly use them without additional work, and if so, one should expect that a firm's external dependence on financial resources will not produce a negative moderating effect. As mentioned in the result section, our additional analysis has confirmed the difference in moderating effects.

5.1. Contributions and Practical Implications

This paper provides both theoretical and practical implications. First, our study contributes to the literature on competitive strategy and the environment by highlighting the importance of considering strategy implementation [7,28–30]. The primary theoretical driving force for the field of competitive strategy and the environment has been the natural resource-based view of the firm. For instance, studies guided by this view have generally emphasized the importance of acquiring strategically important resources, characterized by tacitness, social complexity, and rarity [5,11]. Environmental innovation, according to the natural resource-based view, can also be an important means for differentiation strategy which may help a firm to gain competitive advantages [1,31]. This line of work, however, has been criticized for its over-emphasis on strategy formulation, thereby calling for research on strategy implementation. As Russo and Minto highlight, "To understand more fully how competitive strategy unfolds within organizations, we need to flesh out issues of strategy implementation" [7] (p. 35). Our results suggest that a firm's environmental strategy, through sustainable innovation, cannot naturally lead to competitive advantages, if it fails to recognize the changing importance of external dependence over the implementation process of environmental innovation.

In relation, our findings are informed by an extensive body of social psychology research on the intention-behavior gap [39–42]. For instance, Gollwitzer suggests that an overflowing amount of external knowledge, although it seems useful at first glance, may hamper focused-attentions required for successful implementation of actions [41]. This line of work provides a micro-foundation for understanding the important role of firm-level implementation intentions, distinguished from goal intentions, in selecting an effective goal-directed behavior that is linked to specific opportunities to realize the resolutions originally set in the strategy formulation stage. Many scholars consider acquiring informational and relational resources of special qualities central to competitive advantage, but it may be preferable to ask where a firm acquires these resources, and how it utilizes them in its implementation process. Our paper sets a stage for future research by redirecting scholarly attention to the better research question.

Second, our findings suggest an urgent need for the further refinement of organizational innovation and learning theory. While the primary focus of organizational innovation and learning has been on the importance of organizational search to access external knowledge, a number of details are yet to be specified. Among them, this paper offers an initial step toward understanding sources of the potential liability from organizational exposure to external informational and relational resources. Future studies of innovation and learning should explore other factors that could explain whether and how organizational learning and innovation dynamics are reshaped by external sources of information and knowledge. Organizational internal capability to sort through external knowledge can be one

factor that can illuminate the boundary conditions. If a firm has strong internal capacity to discern the quality of external knowledge partners, for example, its innovation process is less likely to suffer from the mere number of external connections. In other words, those firms with the strong capability to address the challenge of moving from search to selection in their innovation process will be superior to those with weak capabilities in realizing environmental competitive advantages—an intriguing topic for future research.

Third, our paper provides useful implications for corporate managers. Managers and CEOs may wish to understand an ironic yet interesting consequence of excessive dependence on external knowledge for environmental innovation. This understanding is useful in formulating and implementing environmental strategy. For instance, as the effectiveness of R&D activities for sustainable innovation is most likely to differ according to the changing importance of external dependence, managers should avoid adopting a simple model that sets uniform dependence throughout the innovation process. They should instead monitor and control the varying amount and diversity of external information. Designing external relations to maintain an appropriate level of external exposure would also be a welcome improvement. In sum, managers should understand that an optimal balance between innovation sequences that maximizes the utility of external knowledge transfer is not static, but dynamic.

Fourth, policymakers may find our results unexpected, yet important, regarding government support's negative moderation. While government-business relations operate in virtually all sectors, environmental innovation in manufacturing sectors has been a central arena in which governmental bodies often play a critical role in encouraging firms to develop environmentally preferable products and services through regulatory mandates, technological support, or facilitative subsidies. Our results suggest that policymakers should not blindly provide government support with the simple assumption that greater support will always lead to greater outcomes. It is possible that the actual effectiveness of environmental innovation policies will depend on the type (e.g., financial vs. informational) and the pace (more information at the early stage of innovation vs. reduced information at a later stage of innovation) of government support.

5.2. Methodological Considerations

Although this study makes several contributions to the research of sustainable innovation in both theoretical improvements and practical implications, one may raise a question particularly about the dataset used in this study, as the dataset is constructed through survey methods. A survey method may be subject to some issues about the reliability of responses because it collects the data based on self-reports, which may lead to response biases such as self-enhancement bias. While KIS 2014 survey is systematically conducted by an authoritative and reliable research institute with supports of Korean government and used as a reliable data source by prior innovation studies [56–59], the use of the data collected through survey may be pointed out as a potential limitation of our study. In future studies, a more objective measure of sustainable innovation outcomes is recommended, if available, to rule out such restrictions (e.g., the actual decrease of energy-related costs in monetary unit).

5.3. Concluding Remark

Our paper examines organizational dependence on external knowledge as an understudied source of challenges relating to environmental innovation, thereby illuminating broader implications for business, management, and policy aspects of sustainability. While a firm's good intentions for sustainability may generally achieve good consequences, our study notes that the relationship between intention and achievement is more complex than prior work has usually described. In particular, excessive exposure to external knowledge can serve as a source of the intention-achievement gap in sustainable innovation, thus suggesting that too much is as bad as too little.

Acknowledgments: This work was supported by the National Research Foundation of Korea Grant funded by the Korean Government (NRF-2012S1A3A2033902).

Author Contributions: Daegyu Yang provided initial research ideas and analyzed the data. Sangchan Park designed the overall research model and developed theoretical arguments. Both authors wrote and approved the final manuscript.

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

References

1. Delmas, M.; Russo, M.V.; Montes-Sancho, M.J. Deregulation and environmental differentiation in the electric utility industry. *Strateg. Manag. J.* **2007**, *28*, 189–209.
2. Klassen, R.D.; Vachon, S. Green supply chain management. In *Oxford Handbook of Business and the Natural Environment*, 1st ed.; Bansal, P., Hoffman, A.J., Eds.; Oxford University Press: Oxford, UK, 2012; pp. 269–289.
3. Seuring, S.; Müller, M. Core issues in sustainable supply chain management—A Delphi study. *Bus. Strateg. Environ.* **2008**, *17*, 455–466.
4. Bansal, P.; Hoffman, A.J. Retrospective, perspective, and prospective: Introduction to the Oxford handbook on business and the natural environment. In *The Oxford Handbook of Business and the Natural Environment*, 1st ed.; Oxford University Press: Oxford, UK, 2012; pp. 3–25.
5. Hart, S.L. A natural-resource-based view of the firm. *Acad. Manag. Rev.* **1995**, *20*, 986–1014.
6. Roome, N. Looking back, thinking forward: Distinguishing between weak and strong sustainability. In *Oxford Handbook of Business and the Natural Environment*, 1st ed.; Bansal, P., Hoffman, A.J., Eds.; Oxford University Press: Oxford, UK, 2012; pp. 620–629.
7. Russo, M.V.; Minto, A. Competitive strategy and the environment: A field of inquiry emerges. In *Oxford Handbook of Business and the Natural Environment*, 1st ed.; Bansal, P., Hoffman, A.J., Eds.; Oxford University Press: Oxford, UK, 2012; pp. 29–49.
8. Barney, J. Firm resources and sustained competitive advantage. *J. Manag.* **1991**, *17*, 99–120.
9. Penrose, E.T. *The Theory of the Growth of the Firm*; Sharpe: New York, NY, USA, 1959.
10. Wernerfelt, B. A resource-based view of the firm. *Strateg. Manag. J.* **1984**, *5*, 171–180.
11. Russo, M.V.; Fouts, P.A. A resource-based perspective on corporate environmental performance and profitability. *Acad. Manag. J.* **1997**, *40*, 534–559.
12. Argote, L.; Ingram, P. Knowledge transfer: A basis for competitive advantage in firms. *Organ. Behav. Hum. Decis. Process.* **2000**, *82*, 150–169.
13. Kogut, B.; Zander, U. What firms do? Coordination, identity, and learning. *Organ. Sci.* **1996**, *7*, 502–518. [CrossRef]
14. Levitt, B.; March, J.G. Organizational learning. *Annu. Rev. Soc.* **1988**, *14*, 319–340.
15. Ahuja, G. Collaboration networks, structural holes, and innovation: A longitudinal study. *Adm. Sci. Q.* **2000**, *45*, 425–455.
16. Bouncken, R.B.; Peshe, R.; Reuschl, A. Copiesis: Mutual knowledge creation in alliances. *J. Innov. Knowl.* **2016**, *1*, 44–50.
17. Rosenkopf, L.; Almeida, P. Overcoming local search through alliances and mobility. *Manag. Sci.* **2003**, *49*, 751–766.
18. Owen-Smith, J.; Powell, W.W. Knowledge networks as channels and conduits: The effects of spillovers in the Boston biotechnology community. *Organ. Sci.* **2000**, *15*, 5–21.
19. Ozkan-Canbolat, E.; Beraha, A. Configuration and innovation related network topology. *J. Innov. Knowl.* **2016**, *1*, 91–98.
20. Powell, W.W.; Koput, K.W.; Smith-Doerr, L. Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology. *Adm. Sci. Q.* **1996**, *32*, 116–145. [CrossRef]
21. Cohen, W.M.; Levinthal, D.A. Absorptive capacity: A new perspective on learning and innovation. *Adm. Sci. Q.* **1990**, *35*, 128–152. [CrossRef]
22. Lane, P.J.; Koka, B.R.; Pathak, S. The reification of absorptive capacity: A critical review and rejuvenation of the construct. *Acad. Manag. Rev.* **2006**, *31*, 833–863.
23. Todorova, G.; Durisin, B. Absorptive capacity: Valuing a reconceptualization. *Acad. Manag. Rev.* **2007**, *32*, 774–786.
24. Zahra, S.A.; George, G. Absorptive capacity: A review, reconceptualization, and extension. *Acad. Manag. Rev.* **2002**, *27*, 185–203.

25. Williamson, O.E. *The Economic Institutions of Capitalism*; Free Press: New York, NY, USA, 1985.
26. Zander, U.; Kogut, B. Knowledge and the speed of the transfer and imitation of organizational capabilities: An empirical test. *Organ. Sci.* **1995**, *6*, 76–92.
27. Oxley, J.E.; Sampson, R.C. The scope and governance of international R&D alliances. *Strateg. Manag. J.* **2004**, *25*, 723–749.
28. Delmas, M. Stakeholders and competitive advantage: the case of ISO 14001. *Prod. Oper. Manag.* **2001**, *10*, 343–358.
29. López-Gamero, M.; Claver-Cortés, E.; Molina-Azorín, J.F. Complementary resources and capabilities for an ethical and environmental management: A qual/quan study. *J. Bus. Ethics* **2008**, *82*, 701–732.
30. Marcus, A.A.; Nichols, M.L. On the edge: Heeding the warnings of unusual events. *Organ. Sci.* **1999**, *10*, 482–499.
31. Reinhardt, F.L. Environmental product differentiation: Implications for corporate strategy. *Calif. Manag. Rev.* **1998**, *40*, 43–73. [CrossRef]
32. March, J.G. Exploration and exploitation in organizational learning. *Organ. Sci.* **1991**, *2*, 71–87.
33. Tushman, M.L.; O'Reilly, C.A. The ambidextrous organizations: Managing evolutionary and revolutionary change. *Calif. Manag. Rev.* **1996**, *38*, 8–30.
34. Levinthal, D.A.; March, J.G. The myopia of learning. *Strateg. Manag. J.* **1993**, *14*, 95–112.
35. Lavie, D.; Stettner, U.; Tushman, M.L. Exploration and exploitation within and across organizations. *Acad. Manag. Ann.* **2010**, *4*, 109–155. [CrossRef]
36. Lavie, D.; Rosenkopf, L. Balancing exploration and exploitation in alliance formation. *Acad. Manag. J.* **2006**, *49*, 797–818.
37. Rothaermel, F.T.; Deeds, D.L. Exploration and exploitation alliances in biotechnology: A system of new product development. *Strateg. Manag. J.* **2004**, *25*, 201–221.
38. Venkataramani, V.; Dalal, R.S. Who helps and harms whom? Relational antecedents of interpersonal helping and harming in organizations. *J. Appl. Psychol.* **2007**, *92*, 952–966.
39. Gollwitzer, P.M. Implementation intentions: Strong effects of simple plans. *Am. Psychol.* **1999**, *54*, 493–503.
40. Armitage, C.J.; Conner, M. Efficacy of the theory of planned behavior: A meta-analytic review. *Br. J. Soc. Psychol.* **2001**, *40*, 471–499.
41. Gollwitzer, P.M. Goal achievement: The role of intentions. In *European Review of Social Psychology*; Stroebe, W., Hewstone, M., Eds.; John Wiley & Sons: Hoboken, NJ, USA, 1993; Volume 4, pp. 141–185.
42. Gollwitzer, P.M.; Sheehan, P. Implementation intentions and goal achievement: A meta-analysis of effects and processes. *Adv. Exp. Soc. Psychol.* **2006**, *38*, 69–119.
43. Cyert, R.M.; March, J.G. *A Behavioral Theory of the Firm*; Blackwell Inc.: Englewood Cliffs, NJ, USA, 1963.
44. Ocasio, W. Towards an attention-based view of the firm. *Strateg. Manag. J.* **1997**, *18*, 187–206.
45. Helfat, C.; Peteraf, M. Understanding dynamic capabilities: Progress along a developmental path. *Strateg. Organ.* **2009**, *7*, 91–102.
46. Mata, J.; Woerter, M. Risky innovation: The impact of internal and external R&D strategies upon the distribution of returns. *Res. Policy* **2013**, *42*, 495–501.
47. Reagans, R.; McEvily, B. Network structure and knowledge transfer: The effect of cohesion and range. *Adm. Sci. Q.* **2003**, *48*, 240–267.
48. Szulanski, G. Exploring internal stickiness: Impediments to the transfer of best practice within the firm. *Strateg. Manag. J.* **1996**, *17*, 27–43.
49. Teece, D.J. Technology transfer by multinational firms: The resource cost of transferring technological know-how. *Econ. J.* **1977**, *87*, 242–261. [CrossRef]
50. Polyani, M. *The Tacit Dimension*; Anchor Day Books: New York, NY, USA, 1966.
51. Hansen, M.T. The search-transfer problem: The role of weak ties in sharing knowledge across organization subunits. *Adm. Sci. Q.* **1999**, *44*, 82–111. [CrossRef]
52. Dionysiou, D.D.; Tsoukas, H. Understanding the (re)creation of routines from within: A symbolic interactionist perspective. *Acad. Manag. Rev.* **2013**, *38*, 181–205.
53. Feldman, M.; Feller, I.; Bercovitz, J.; Burton, R. Equity and the technology transfer strategies of American research universities. *Manag. Sci.* **2002**, *48*, 105–121.
54. Korea Innovation Survey. Available online: http://kis.stepi.re.kr/kis_portal/service/sub02_data_application.do (accessed on 20 April 2016).
55. Blau, P.M. *Inequality and Heterogeneity: A primitive Theory of Social Structure*; Free Press: New York, NY, USA, 1977.

56. Chun, D.; Chung, Y.; Woo, C.; Seo, H.; Ko, H. Labor union effects on innovation and commercialization productivity; An integrated propensity score matching and two-stage data envelopment analysis. *Sustainability* **2015**, *7*, 5120–5138.
57. Seo, H.; Chung, Y.; Chun, D.; Woo, C. Value capture mechanism: R&D productivity comparison of SMEs. *Manag. Decis.* **2015**, *53*, 318–337.
58. Woo, C.; Chung, Y.; Chun, D.; Han, S.; Lee, D. Impact of green innovation on labor productivity and its determinants: An analysis of the Korean manufacturing industry. *Bus. Strateg. Environ.* **2014**, *23*, 567–765.
59. Woo, C.; Chung, Y.; Chun, D.; Seo, H. Exploring the impact of complementary assets on the environmental performance in manufacturing SMEs. *Sustainability* **2014**, *6*, 7412–7432.