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The Mediating Role of Environmental Innovation on Knowledge Acquisition and Corporate Performance Relationship—A Study of SMEs in China

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Abstract: Open innovation theory believes that external knowledge acquisition is the key to gaining competitive advantage. This research aimed to examine the relationship between external knowledge acquisition, environmental innovation, and performance of small and medium-sized enterprises (SMEs). This study divides the external knowledge acquisition of enterprises into external technical knowledge acquisition and external market knowledge acquisition, and examines this theoretical framework with environmental innovation as a mediator. Using a sample of 416 Chinese SMEs, empirical results revealed that high levels of technical knowledge acquisition and market knowledge acquisition were positively related to SMEs' performance. The positive impact of technical knowledge acquisition is mainly embodied through economic performance; the positive impact of market knowledge acquisition is mainly embodied through environment performance. Meanwhile, environmental innovation plays a significant mediating role in the relationship between external knowledge acquisition and enterprise performance; environmental performance plays a significant mediating role in the relationship between environmental innovation and economic performance. This paper provides several managerial implications for managers and policy makers to improve SMEs' performance.

Keywords: technical knowledge acquisition; market knowledge acquisition; environmental innovation; environmental performance; economic performance

1. Introduction

With the increasingly heated competition in the international market, knowledge resource in the age of knowledge economy is increasingly important; lack of knowledge is one important obstacle for enterprises in coping with environmental challenges [1]. Enterprises will miss important innovation opportunities if they lack knowledge resource. However, one enterprise cannot bear the technical innovations of all the fields merely on its own, so it must gain the valuable knowledge and skills from the outside. Open innovation research has clarified that external knowledge acquisition has a significant positive impact on corporate performance [2], and some scholars brought possible intervening variables to the relationship between the two. For example, Lee et al. brought organizational creativity into the relationship between knowledge and corporate performance [3]; Ahn et al. regarded product innovation and process innovation as the intermediary, so as to evaluate the influence of knowledge on corporate performance [4]; some scholars regarded new product development as the intermediary, so as to analyze the influence mechanism of external knowledge acquisition on corporate performance. However, few researches analyze the influence process of external knowledge acquisition on corporate performance from the perspective of environmental innovation. In addition, the existing researches about external

knowledge focus on technical knowledge, neglecting the importance of market knowledge; the corporate performance they pay attention to is mainly financial performance, while they neglect the non-financial performances that are very important such as environmental performance.

Economic growth and natural environment are considered as a pair of contradictory concepts [5]. In this view, a higher economic growth rate may lead to a higher level of environmental degradation [6]; enterprises' investment to environmental management will result in profit reduction. However, recent researches have begun to pay attention to enterprises' environmental management related to sustainable development and economic performance. At the same time, as the public's attention to the environment is increasing, consumers' demand for corporate social responsibility (CSR) is increasing, and governmental environmental regulation widening, more and more small and medium-sized enterprises (SMEs) have recognized the importance of environmental issues and regarded environmental management as part of corporate goals and strategies [7]. It is worth noting that innovation is increasingly deemed as the most cutting-edge approach to the success of environmental management cases of enterprises [8]. Ecological Modernization Theory believes that corporate environmental management is an innovative mechanism for enterprises to integrate environmental concerns into their operations [9]. This may be due to the fact that the key point of environmental management is to consider how enterprises improve their competitiveness and profitability on the basis of reducing environmental burden [10,11]. Innovation exactly helps support these needs, with the goal of developing new products and processes through various knowledge, skills, and resources [12]. Further, environmental innovation expands the scope of achieving a more sustainable development, and its results should benefit the environment in addition to its innovative trait [13]. Therefore, unlike traditional innovation, environmental innovation not only achieves innovation in terms of products, processes and management, but also guides enterprises to obtain sustainable competitive advantage in an environmentally-friendly and effective way [14]. In addition, environmental innovation may increase market share and create higher economic profits by shaping green image and product differentiation [15,16], thus becoming a strategic way to achieve a win–win situation for environmental and financial performance [17].

Environmental innovation researches often focus on the external factors of enterprises. For example, in order to meet environmental regulations [18], catch up with the technical level of the industry [19], meet the expectations of society and the community [20], deal with pressure from competitors [16] and consumer pressure [15], etc., enterprises have to implement environmental innovation. It is not until recently that focus has been put on the different types of resources, capability, and knowledge that firms develop/acquire to promote environmental innovation [21–25]. Compared with traditional innovation, environmental innovation is more complicated and has higher demands for knowledge resource. As was indicated by De Marchi [21], an important difference between general innovation and environmental innovation is that environmental innovation requires more R&D cooperation. In addition to the limited resources and low technical level of SMEs, external knowledge acquisition enables SMEs to remain creative and flexible and accelerate capacity development [26], thus being the key factor in promoting SMEs' environmental innovation. However, to the authors' knowledge, none of the studies has empirically tested a model including the two types of external knowledge acquisition (technical knowledge acquisition and market knowledge acquisition) and their impact on environmental innovation. Furthermore, the previous studies, apart from a few exceptions [27], only involve the internal and external knowledge assets, and overlook the different types of external knowledge acquisition.

To fill such gaps, this research combines technical knowledge acquisition and market knowledge acquisition into the same framework. It takes the emerging economic market of developing countries (namely China) as the research background. Moreover, this paper constructs theoretical models of external knowledge acquisition, environmental innovation, environmental performance, and economic performance, then further discloses the influence mechanism of external knowledge acquisition on corporate environmental performance and economic performance. Specifically, it explores the following

research questions: (1) Do the two types of external knowledge acquisition (market knowledge acquisition and technical knowledge acquisition) of enterprises help promote the environmental innovation of enterprises? What is the difference in their influence on environmental performance and economic performance? (2) Does environmental innovation have a positive impact on corporate environmental performance and economic performance? Does environmental performance play a mediating role in the relationship between environmental innovation and economic performance?

The remainder of this paper is structured as follows: the next section introduces a literature review and hypotheses; Section 3 describes the research methodology, followed by data analysis and results in Section 4; and finally in Section 5, the paper presents the conclusions of this study, the practical significance, the limitations, and the recommendations for future research.

2. Research Hypothesis

2.1. External Knowledge Acquisition and Corporate Performance

External knowledge acquisition is the activity where enterprises recognize the external environment and gain knowledge from it [28]; it is an important mode for enterprises to renovate technical ability. In addition to their own research and development, enterprises generally acquire external sources of knowledge by outsourcing R&D, licensing, and attracting R&D talent [29]. This paper emphasizes procedural knowledge, namely the knowledge in the operating activity of enterprises, which includes how enterprises work and how they better execute some tasks [30]. It has important influence on enterprises' creating competitive advantages, as well as discovering and using new opportunities. According to the different natures of knowledge, external knowledge acquisition may be divided into technical knowledge acquisition and market knowledge acquisition. According to the latest research, the procedural knowledge based on design or production is defined as technical knowledge; the procedural knowledge based on sales is defined as market knowledge [31]. Technical knowledge is mainly acquired through advanced equipment introduction, R&D cooperation, and R&D outsourcing. Market knowledge is mainly acquired through cooperation with stakeholders, such as suppliers, clients, and universities.

The Knowledge-Based View holds that knowledge is the most valuable resource for enterprises to maintain competitive advantage; enterprises' acquisition, absorption, use and diffusion of knowledge resource determine their performance level [2]. Enterprises obtain market and technical knowledge from other organizations, update the knowledge resource combination, and enrich their solutions for specific innovation challenges [32], which may help reduce their operational risks and improve financial performance. For SMEs, there is a big gap in knowledge resource and skill level, so effective external knowledge acquisition is very important in improving their operating ability and management level. In addition, knowledge acquisition is an important approach for enterprises to overcome organizational inertia [2] and take the initiative to seek for new product development, which may satisfy the environment-friendly demands of the market, improve their environmental performance, enhance their green image, and increase profit. As was indicated by Ortiz et al. [33], enterprises must strengthen knowledge acquisition, so as to rapidly respond to and timely update technical change, competition, and client demand in the dynamic environment. Studies show that enterprises' understanding of market and technical knowledge may increase their potential for discovering new opportunities and effectively using them [34,35]. Therefore, this paper proposes the following hypotheses:

Hypothesis 1 (H1a). *Technical knowledge acquisition has a positive impact on environmental performance.*

Hypothesis 1 (H1b). *Technical knowledge acquisition has a positive impact on economic performance.*

Hypothesis 1 (H1c). *Market knowledge acquisition has a positive impact on environmental performance.*

Hypothesis 1 (H1d). *Market knowledge acquisition has a positive impact on economic performance.*

2.2. Environmental Innovation, Environmental Performance and Economic Performance

Concepts similar to environmental innovation also include "green innovation", "ecological innovation", and "sustainable innovation". Although their focuses are slightly different, yet they all indicate that enterprises reduce the negative impact on the environment by improving product, technique and management. Compared with traditional innovation, the biggest difference in environmental innovation lies in its dual externality, namely the innovation spillover effect in the R&D stage, and the environment spillover effect in the diffusion stage. Scholars give different definitions of environmental innovation, but this paper adopts the definition of the OECD [13]: whether it is done purposefully or not, the development of product (or service), process, marketing method, organizational structure, new or improved institutional arrangement may help reduce the negative impact on the environment, compared with other practices.

Most of the research results indicate that environmental innovation has a positive impact on environmental performance and economic performance [36,37]. Ecological Modernization Theory indicates that the environmental innovation strategy may improve both the environmental performance and economic performance simultaneously, and lead to an environment-friendly society [9]. Under the increasing pressure of environmental ethics and struggle for life, enterprises have to reduce their impact on the environment and maintain their advantages, which forces them to inevitably improve the complexity of their innovation. Furthermore, in the internal and external decision of enterprises, environmental innovation integrates the methods favorable for the environment and applies the methods in a systematic, conscious and strategic way, which is a strategic way of obtaining win–win of environmental performance and economic performance [17]. First of all, the basic principle of environmental innovation is to reduce the environmental influence [38]; it may replace the current products with more environment-friendly products and produce environmental spillover, thus reducing the negative impact on the environment [15], and decreasing the environmental cost of enterprises [39]. Therefore, environmental innovation has a positive impact on environmental performance. Second, environmental innovation may effectively improve the internal efficiency and operating ability of enterprises, thus promoting economic performance. According to the Porter Hypothesis, environmental practice may encourage enterprises to carry out technical innovation activities, reduce operating cost and decrease waste, thus improving economic performance for some time in the future [14]. Researches also find that technological eco-innovation reduces environmental impact and improves business performance, which proves that environmental innovation simultaneously contributes to environmental performance and economic performance of sustainable development [40]. Therefore, this paper proposes the following hypotheses:

Hypothesis 2 (H2a). *Environmental innovation has a positive impact on environmental performance.*

Hypothesis 2 (H2b). *Environmental innovation has a positive impact on economic performance.*

Some empirical results show that high-level environmental performance helps improve economic performance [41–43], and recent researches have found that environmental innovation helps indirectly improve economic performance by improving environmental performance [15,16]. This may be reflected in two aspects: on the one hand, enterprises improve the production, process and technology on the basis of environmental protection and sustainable development, which may help build a better environmental reputation and produce differentiated environmental innovation products, increase the market share, and gain extra profit [15]. On the other hand, environmental innovation may help gain social legal income, such as lower cost of violation punishment and breakdown expense, and reduce the cost [44]. In turn, environmental innovation increases the sales revenue of enterprises and improves their economic performance. It can be seen that enterprises improve environmental

performance through environmental innovation, and meanwhile improve economic performance. Therefore, by improving product or process, environmental innovation realizes the ideas that may help reduce environmental burden, which becomes an important way for enterprises to realize "low pollution-high performance" and improve economic performance by improving environmental performance. Therefore, the paper proposes the following hypotheses:

Hypothesis 3 (H3). *Environmental performance has a positive impact on economic performance.*

Hypothesis 4 (H4). *Environmental performance positively mediates the relationship between environmental innovation and economic performance.*

2.3. External Knowledge Acquisition and Environmental Innovation

Studies have confirmed that external knowledge acquisition is positively related to innovation [45–47] and may lead to environmental innovation [48]. However, some studies have found that the impact of external knowledge acquisition on innovation is not significant [49], and it even has a negative impact. Differences in research conclusions may be influenced by the size of the research object, the industry, and the region. SMEs' access to knowledge from outside may compensate for the inherent shortcoming of their small size, namely the lack of opportunities to explore and develop new resources [50]. According to the research of Andreeva et al. [51], the knowledge process and knowledge intensity have a positive impact on innovation. Research of Papa et al. [52] proves that external knowledge acquisition has a positive impact on innovation performance in the context of open innovation.

2.3.1. Technical Knowledge Acquisition and Environmental Innovation

If an enterprise adopts effective acquisition of external technical knowledge, its impact on environmental innovation will be more significant than general innovation. First of all, the design and production of environmentally friendly products have high complexity and difficulty. Technological assets identify new sources of organizational innovation by improving knowledge capacity in the company [53]. The technical knowledge obtained by enterprises from the outside may strengthen the diversity of their knowledge base and supplement the existing knowledge foundation. This complementation is exactly the foundation for improving the level of environmental innovation [54]. External technical knowledge acquisition may also promote the transfer and interaction of internal knowledge required for environmental innovation, and may create technological breakthroughs in the process of integration and interaction [34], thereby creating opportunities of environmental innovation for enterprises. Second, external technical knowledge acquisition can promote the optimization of processes, costs and functions of new/existing products/services, avoiding the obstacles caused by the inherent uncertainty and complexity of the environmental innovation process. In this process, it may also help enterprises identify and utilize more opportunities of environmental innovation [55], thereby increasing the efficiency in developing environment innovation opportunities [35]. It can be seen that technical knowledge acquisition helps enterprises recognize and use more innovation opportunities and has a positive impact on environmental innovation. Finally, from the perspective of resource, external technology knowledge acquisition emphasizes the new resources or develops the new uses of existing resources. By improving the flexibility of resource allocation, it solves the problems such as limited resource and knowledge and low ability level in SMEs' environmental innovation [56], thus creating conditions for environmental innovation. Research of Sullivan et al. [57] on the basis of knowledge-based view and social network theory finds that technical knowledge acquisition is closely related to corporate innovation of developing product/service. Therefore, the paper proposes the following hypotheses:

Hypothesis 5 (H5a). *Technical knowledge acquisition has a positive impact on environmental innovation.*

2.3.2. Market Technical Knowledge Acquisition and Environmental Innovation

The market is characterized by openness, unpredictability, and information asymmetry. Market knowledge reflects relevant business knowledge about potential customers and marketing channels. Market knowledge acquisition is an external integration mechanism, which helps enterprises expand the scope of information search outside the current clients or market [58]. The market environment faced by enterprises in the transitional economy of China is characterized by fast pace, dynamics and destructiveness, so enterprises have to carry out environmental innovation and to respond timely to market demand. Market knowledge acquisition may enhance enterprises' perception of market imbalance and is an important source of enterprises' access to innovation opportunities [35]. First, understanding customers' problems and needs helps enterprises accurately grasp information of the market and customers, and promote the discovery and capture of business opportunities [55]. Since customers often have difficulty in clarifying their own needs, enterprises must take the initiative to understand the tacit knowledge about customers' problems, so as to identify and gain insight into customers' preferences [35], thereby adopting effective production and sales solutions [59]. It is conducive to the effective implementation of environmental innovation. Second, since the level of risk related to entering the target market (such as "environmental market") is high, enterprises need to acquire any available information on the given market [60]. Maintaining close contact with customers may ensure that companies gain new market information and may become an important information source for new environmental products and services [35], and improve the R&D speed of new environmental products and commercialization [61], which is conducive to environmental innovation. Finally, enterprises' understanding of market knowledge may increase their potential to discover new opportunities and effectively use them. Market knowledge acquisition is a necessary condition for enterprises to identify and develop new opportunities [34]. Market knowledge acquisition may also broaden the horizons of SEMs, help them develop competitive capacity, and reduce the uncertainty of environmental innovation to a certain degree. It not only arouses SMEs' will of environmental innovation, but also has a positive impact on the efficiency of environmental innovation. As is indicated by scholars, market knowledge injects the new information from the emerging market into enterprises, provides new ideas for radical innovation [62], and thus has a positive impact on environmental innovation. Therefore, the paper proposes the following hypotheses:

Hypothesis 5 (H5b). *Market knowledge acquisition has a positive impact on environmental innovation.*

2.4. Mediating Role of Environmental Innovation

Through the above analysis, external knowledge acquisition provides a wide knowledge basis and technical premise for environmental innovation. Environmental innovation is also an important strategic mode for enterprises to improve the environmental performance and economic performance. Enterprises integrate the production, process, and operation, and realize the environmental innovation of product, technique, and management, thus reducing environmental pollution, improving economic performance and bringing financial income [14]. It means that with the support of market knowledge acquisition and technical knowledge acquisition, environmental innovation realizes enterprises' objectives of environmental performance and economic performance. The more market knowledge and technical knowledge that enterprises gain from the outside, the more favorable it is for enterprises to realize environmental innovation, so as to improve corporate environmental performance and economic performance. Therefore, market knowledge acquisition and technical knowledge acquisition may have a positive impact on corporate performance by promoting enterprises' environmental innovation. Therefore, the paper proposes the following hypotheses:

Hypothesis 6 (H6a). *Environmental innovation plays a mediating role between market knowledge acquisition and corporate environmental performance.*

Hypothesis 6 (H6b). *Environmental innovation plays a mediating role between technical knowledge acquisition and corporate environmental performance.*

Hypothesis 6 (H6c). *Environmental innovation plays a mediating role between market knowledge acquisition and corporate economic performance.*

Hypothesis 6 (H6d). *Environmental innovation plays a mediating role between technical knowledge acquisition and corporate economic performance.*

Based on the above analysis, the theoretical model set up by the paper is shown in Figure 1:

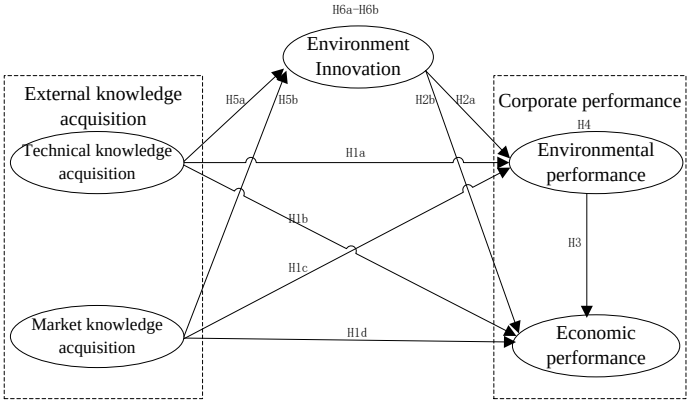

Figure 1. The Research Model. Source: own elaboration.

3. Research Design

3.1. Sample Selection and Data Collection

The interviewers of this research are the middle and senior managers, who are confirmed to be familiar with corporate environmental innovation and provide reliable and accurate information. Data collection is divided into three steps. (1) Initial questionnaire. Through field interview and literature study, the most appropriate questionnaire was selected, which was revised through the actual interview with entrepreneurs, thus making the questions more accurate and forming the initial questionnaire. (2) Preliminary investigation. Preliminary investigation was conducted with 33 interviewers, including the enterprise managers, school postgraduates, and six pioneering management professors; the questionnaire reliability and validity were analyzed and the improper questions were revised or deleted. (3) Formal investigation. Our sample is representative of the Chinese SMEs registered with the local government. From the China SME Directory, we obtained a random sampling pool that included 784 firms, which was generated by a stratified random sampling process based on firm size and industry. Then, we distributed questionnaires to these 784 firms in our sampling pool. In order to ensure the recovery rate of these questionnaires, we handed out the questionnaires through two approaches, including university resources and personal relationships of our team. First of all, a semi-structured interview was conducted to the enterprise managers in MBA and EMBA classes of five universities in Xi'an, thus completing the questionnaire. Second, the questionnaire was sent by colleagues and friends to enterprise managers through field interview, email, and network. The time of formal investigation ranged from January 2018 to September 2018. A number of 784 questionnaires in total were handed out and 480 were taken back, with the retrieving rate of 61.2%. A number of 39 incomplete questionnaires and 25 wrong questionnaires were removed, so the number of final valid questionnaire was 416.

In China, there is no generally accepted definition of SMEs (small and medium-sized enterprises). At present, the definition provided by the American Small Business Administration (SBA) is the

most widely used [63], suggesting SMEs as stand-alone enterprises with fewer than 500 employees. This standard is often applied to the field of innovation research, so this paper also selects this standard. This is consistent with recent researches, such as that of GUO et al. [64], who studied the innovation and performance of Chinese SMEs. The sample enterprises are mainly selected from industries such as bio-pharmaceuticals, electronic information, equipment manufacturing, and new material. The corporate ownership types include state-owned enterprises, limited liability companies, and private enterprises. The selected enterprises are from Shaanxi, Guangzhou, Shenzhen, and Shanghai. As for the respondents, the positions of respondents include: top managers (28.8%), heads of R&D departments (32.7%), and innovation directors (39.1%). About 4.1% of the respondents had business tenure of less than 4 years, 16.6% between 4 and 6 years, 52.9% between 6 and 8 years, 22.8% between 8 and 10 years, and 3.6% more than 10 years. On average, the business tenure of respondents within these enterprises was 7.5 years.

In order to evaluate the deviation between question respondents and non-respondents, we compared the difference between the 216 questionnaires selected in the early stage and the 200 questionnaires selected in the mid- and later stages [65]. Test result of t indicates that when $p \leq 0.05$, there is no significant difference in terms of characteristics of population statistics. Therefore, non-response bias will not influence the analysis of the paper.

3.2. Variable Measurement

In order to ensure both reliability and validity, all the items refer to the mature scale and are properly improved. All the items use Likert 7-point scale. The measurement items for variables are listed in Appendix A.

The measurement of technical knowledge acquisition (TKA) refers to the research of Cassiman and Veugelers [66]. The scale has been cited multiple times, including four items, such as "our firm acquire technology through licensing". The measurement of market knowledge acquisition (MKA) refers to the questionnaire of Zhou and Li [58], which has high reliability and validity, including three items, like "our firm has processes for continuously collecting information from customers".

The measurement of environmental innovation (EIN) refers to the research of Cai et al. [15], including five items, such as "the manufacturing process of our firm reduces the use of raw material".

The measurement of environmental performance (EP) and economic performance (FP) refer to the questionnaire of Li et al. [67]. The scale is highly related to the research of the paper. The measurement of environmental performance (EP) including four items, such as "our firm has reduced energy use in our facilities". The measurement of economic performance includes three items, such as "total sales of goods and services".

4. Research Results

This paper processed the data through statistical software including AMOS and SPSS22.0. The concrete mode of data analysis is shown as follows: it adopted SPSS22.0 to conduct reliability and validity test of samples, used AMOS22.0 to conduct the confirmatory factor analysis (CFA) of the measurement model of structural equation model, then made path analysis of the structural model and tested the proposed research hypotheses.

4.1. Test of Measurement Model

Based on 416 samples, we conducted an exploratory factor analysis (EFA) to assess the underlying factor structure of the scale items. The initial factor solution resulted in five factors with eigenvalues higher than unity. The five-factor solution for the 19 items accounted for 74.5% of the total variance explained. Table 1 shows a purified list of 19 items with a clear factor structure in five factors from the results of EFA.

Table 1. Results of exploratory factor analysis.

Items	Factor Loading				
EIN3	**0.854**	0.221	0.080	0.152	0.155
EIN4	**0.838**	0.116	0.085	0.084	0.102
EIN2	**0.790**	0.138	0.176	0.138	0.104
EIN1	**0.777**	0.228	0.115	0.159	0.212
EIN5	**0.753**	0.306	0.147	0.209	0.130
EP3	0.199	**0.821**	0.157	0.155	0.181
EP1	0.181	**0.815**	0.166	0.117	0.190
EP4	0.226	**0.806**	0.115	0.174	0.138
EP2	0.269	**0.773**	0.191	0.138	0.088
TKA3	0.153	0.113	**0.810**	0.087	0.122
TKA4	0.105	0.126	**0.806**	0.138	0.105
TKA1	0.072	0.154	**0.803**	0.151	0.085
TKA2	0.144	0.156	**0.761**	0.142	0.160
FP1	0.158	0.178	0.156	**0.820**	0.151
FP2	0.191	0.143	0.188	**0.818**	0.114
FP3	0.208	0.178	0.165	**0.802**	0.168
MKA1	0.180	0.099	0.209	0.115	**0.798**
MKA2	0.215	0.211	0.093	0.162	**0.793**
MKA3	0.124	0.188	0.141	0.141	**0.789**

Note: Extraction method: principal component analysis. Rotation method: Varimax with Kaiser normalization. Underline indicates the highest loading. *a* Rotation converged in 6 iterations.

The common index for testing reliability is Cronbach's *a* coefficient [68]. This paper tests it through SPSS22.0. The result indicates that Cronbach's *a* of various dimensions is higher than the standard value 0.7 (see Table 2), which shows that the variables of this study are highly internally consistent. As to the content validity, first of all, the research subject is based on the researches of domestic and foreign scholars, and is checked and revised by experts of related fields. Second, the items are revised through interview and preliminary investigation; and the cover of the questionnaire reminds the interviewees that the questionnaire does not involve any commercial privacy and it adopts an anonymous mode, so it is safe to say that variables have high content validity. The structural validity includes convergent validity and discriminant validity. This paper adopts AMOS22.0 and tests the convergent validity through CFA. Results in Table 2 indicate that the average variance is above 0.5; the composite reliability (CR) of the variables is higher than 0.7. All the normalization factor loads are above 0.7, indicating that all the variables have high convergent validity. The diagonal element shown in boldface in Table 3 represents the square root of average variance extracted (AVE); the square root of AVE of each dimension is higher than the correlation coefficient of the paired variables, which keeps in line with the standard of discriminant validity.

Table 2. Convergent validity and reliability.

Variables	Index	Convergent Validity			Reliability
		Factor Loadings (> 0.7)	C.R (> 0.7)	AVE (> 0.5)	Cronbach's *a* (> 0.7)
TKA	TKA1	0.770	0.855	0.596	0.853
	TKA2	0.762			
	TKA3	0.778			
	TKA4	0.777			
MKA	MKA1	0.760	0.855	0.596	0.853
	MKA2	0.817			
	MKA3	0.735			

Table 2. *Cont.*

Variables	Index	Convergent Validity			Reliability
		Factor Loadings (> 0.7)	C.R (> 0.7)	AVE (> 0.5)	Cronbach's *a* (> 0.7)
EIN	EIN1	0.823	0.914	0.681	0.912
	EIN2	0.774			
	EIN3	0.902			
	EIN4	0.790			
	EIN5	0.830			
EP	EP1	0.831	0.897	0.686	0.897
	EP2	0.796			
	EP3	0.861			
	EP4	0.823			
FP	FP1	0.809	0.854	0.661	0.854
	FP2	0.802			
	FP3	0.828			

Table 3. Test result of measurement model.

Variables	Mean	S.D.	TKA	MKA	EIN	EP	FP
TKA	4.945	1.419	**0.772**				
MKA	4.775	1.495	0.382 **	**0.771**			
EIN	4.161	1.709	0.354 **	0.437 **	**0.825**		
EP	4.651	1.590	0.408 **	0.447 **	0.529 **	**0.828**	
FP	4.753	1.466	0.411 **	0.415 **	0.453 **	0.444 **	**0.812**

Note: (1) the diagonal element in boldface is the square root of variance of mean; (2) the off-diagonal element refers to the correlation among variables. ** indicates that $p < 0.01$.

4.2. Result of Structural Model

This paper proves the relationship among the potential variables in the theoretical framework through the analysis software of the AMOS structural equation model, and calculates the fix index. The absolute goodness-of-fit index X2/df = 1.141 (below 3), GFI = 0.962 (above 0.9); the relative goodness-of-fit index NFI = 0.966, CFI = 0.996 (all above 0.9); approximation error root RMSEA = 0.018 (below 0.08). The fix indexes of models all keep in line with the evaluation standard, which indicates that the theoretical model proposed by the research accords with the actual investigation data, which are highly adaptive.

4.2.1. Main Effect

For the test of the main effect, Table 4 shows the normalization coefficient of the path and its significance. The hypotheses of the main effect are all supported.

H1a and H1b show that technical knowledge acquisition has a significant positive impact both on environmental performance ($\beta = 0.206$, $p < 0.001$) and on economic performance ($\beta = 0.227$, $p < 0.001$). Additionally, the results of H1a and H1b indicate that the effect of technical knowledge acquisition on economic performance is greater than the effect on environmental performance. The positive influence of technical knowledge acquisition on enterprises' performance is mainly embodied through economic performance.

H1c and H1d show that market knowledge acquisition has a significant positive impact both on environmental performance ($\beta = 0.241$, $p < 0.001$) and on economic performance ($\beta = 0.193$, $p < 0.01$). Additionally, the results of H1c and H1d indicate that the effect of market knowledge acquisition on environmental performance is greater than the effect on economic performance. The positive influence of market knowledge acquisition on enterprises' performance is mainly embodied through environmental performance.

Moreover, if we compare the results of H1a and H1c, the improvement of environmental performance is more likely to be influenced by market knowledge acquisition compared with technical

knowledge acquisition. Meanwhile, if we compare the results of H1b and H1d, the improvement of economic performance is more likely to be influenced by technical knowledge acquisition compared to market knowledge acquisition.

H2a and H2b show that environmental innovation has a significant positive impact both on environmental performance (β = 0.378, $p < 0.001$) and on environmental performance (β = 0.225, $p < 0.001$). The results also indicate that the effect of environmental innovation on environmental performance is greater than the effect on economic performance.

H3 shows that environmental performance has a significant positive impact on economic performance (β = 0.171, $p < 0.05$). H5a and H5b show that both technical knowledge acquisition (β = 0.201, $p < 0.001$) and market knowledge acquisition (β = 0.420, $p < 0.001$) have a significant positive impact on environmental innovation. Additionally, the effect of market knowledge acquisition is greater than technical knowledge acquisition.

Table 4. Model results.

Hypothesis Path	Standardized	Unstandardized	S.E.	C.R.	P
H1a: EP ← TKA	0.206	0.218	0.057	3.828	***
H1b: FP ← TKA	0.227	0.214	0.056	3.846	***
H1c: EP ← MKA	0.241	0.267	0.067	3.983	***
H1d: FP ← MKA	0.193	0.191	0.065	2.916	**
H2a: EP ← EIN	0.378	0.338	0.050	6.760	***
H2b: FP ← EIN	0.225	0.180	0.050	3.593	***
H3: FP ← EP	0.171	0.153	0.059	2.590	*
H5a: EIN ← TKA	0.201	0.237	0.068	3.488	***
H5b: EIN ← MKA	0.420	0.521	0.077	6.753	***

Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

4.2.2. Mediational Analyses

The paper tests the intermediate effect through bootstrapping. It adopts AMOS22.0 software, sets the sample size as 5000, and confidence interval as 95%. The test results are shown in Table 5. Confidence intervals do not include zero, indicating that the mediating effect tested by the paper is significant. The intermediaries Hypothesis H4, H6a, H6b, H6c, and H6d in the research are all supported.

Table 5. Bootstrapping analysis of intermediate effect.

Path	Bootstrap Estimated Value and Confidence Interval			Pass or Not
	Direct Effect	Indirect Effect	Total Effect	
H4 EIN—EP—FP	0.225 [0.100–0.354]	0.065 [0.006–0.146]	0.289 [0.146–0.424]	Pass
H6a TKA—EIN—EP	0.206 [0.074–0.351]	0.076 [0.028–0.142]	0.282 [0.126–0.444]	Pass
H6b MKA—EIN—EP	0.241 [0.066–0.410]	0.159 [0.098–0.244]	0.400 [0.226–0.552]	Pass
H6c TKA—EIN—FP	0.227 [0.070–0.380]	0.093 [0.036–0.176]	0.320 [0.162–0.468]	Pass
H6d MKA—EIN—FP	0.193 [0.022–0.371]	0.163 [0.084–0.265]	0.355 [0.210–0.506]	Pass

H4 suggests that environmental performance plays a mediating role in the relationship between environmental innovation and economic performance (β = 0.065, 95% BC CI = [0.006, 0.146]). This indicates that the practice of environmental innovation not only directly influences economic

performance, but also indirectly influences economic performance through the role of environmental performance, thus realizing win–win situation.

H6a and H6b show that environmental innovation plays a mediating role in the relationship between technical knowledge acquisition and corporate environmental performance (β = 0.076, 95% BC CI = [0.028, 0.142]), as well as that between market knowledge and corporate environmental performance (β = 0.159, 95% BC CI = [0.098, 0.244]). This shows that technical knowledge acquisition and market knowledge acquisition not only have a direct positive impact on corporate environmental performance, but also indirectly improve corporate environmental performance through environmental innovation.

H6c and H6d show that environmental innovation plays a mediating role in the relationship between technical knowledge acquisition and the corporate economic performance (β = 0.093, 95% BC CI= [0.036, 0.176]), as well as that between market knowledge and corporate economic performance (β = 0.159, 95% BC CI = [0.098, 0.244]). This shows that technical knowledge acquisition and market knowledge acquisition not only have a direct positive impact on corporate economic performance, but also indirectly improve corporate economic performance through environmental innovation.

5. Conclusions and Implications

5.1. Theoretical Contribution

First of all, the research of external knowledge acquisition in existing literature mainly emphasizes technical knowledge, but neglects the important role of market knowledge. This research gap is in line with recent research of Burak Erkut [69], who integrated market knowledge into innovation and enterprise success by focusing on the evolution process of the enterprise resource planning (ERP) market. In addition, Alexander McKelvie et al. [70] also studied it by combining external market knowledge acquisition and innovation, and found that the intensity of external market knowledge acquisition was related to new ventures' risk innovation. However, they rarely explored the different roles of two types of external knowledge acquisition in improving the performance of SMEs, especially in the context of the emerging economy. This paper combines market knowledge acquisition and technical knowledge acquisition into the same framework, analyzes the relationship between external knowledge acquisition, environmental innovation, and corporate performance. In addition, we find different types of knowledge acquisition have different effects on corporate environmental performance and economic performance.

Second, this paper adds related researches of open innovation. We prove the positive influence of external knowledge acquisition on economic performance of enterprises. This result is consistent with the observation by Yong Sauk Hau [71]. Specifically, he considered that external technology collaboration network had a positive effect on SMEs' production process improvement and may contribute to SMEs' cost reduction. This paper also verifies the positive influence of external knowledge acquisition on environmental performance. This result is in line with that of Ghisetti et al. [24], who showed that external knowledge source of enterprises could be helpful to the development of environmental innovation. Although existing researches discuss the influence of external knowledge acquisition on corporate performance, the influence mechanism of external knowledge acquisition on corporate environmental performance and economic performance is still not clear. We prove the important mediating role of environmental innovation and analyze the influence mechanism of the two types of external knowledge acquisition on corporate environmental performance and economic performance. In addition, the research of open innovation emphasizes that enterprises may improve their innovation ability by interacting with other organizations [72], and makes clear that SMEs' external technology R&D cooperation is one of the determining factors to promote innovation performance [73]. Nevertheless, there still lack empirical tests on how external knowledge acquisition affects environmental innovation in the context of sustainable development. For performance, the research on open innovation of SMEs focuses on the economic performance of enterprises, while ignoring the impact of environmental performance such as greenhouse gas emission reduction

and energy conservation. By incorporating environmental innovation into corporate knowledge acquisition activities, this study combines the research of open innovation and sustainable development, and examines the impact of external knowledge acquisition of enterprises on environmental performance, thus providing theoretical reference of how enterprises should improve corporate performance through external knowledge acquisition.

Finally, the research of this paper promotes the development of environmental innovation theory. Existing researches mostly discuss the influence factors of environmental innovation from aspects like law and regulation, organization factor and external pressure, but seldom involve the information and knowledge issue of enterprises [74]. This paper proves the important role that external knowledge acquisition plays in corporate environmental innovation, and supplements the empirical research of environmental innovation. The research results show that environmental innovation has a positive impact on both economic performance and environmental performance. These results are in line with previous findings [9,17,40]. In addition, Porter Hypothesis and Ecological Modernization Theory have been enriched and deepened through the empirical research of SMEs in the context of China's transitional economy [9,14]. Therefore, the research of this paper has contributed to the environmental and economic pillars of sustainable development. In addition, we have contributed to related researches of corporate social responsibility. The results of this paper show how environmental innovation, as a corporate social responsibility activity, can improve corporate economic performance. This result not only supplements the study of the combination of CSR and corporate competitive strategy, but also further strengthens the neoclassical economic viewpoint, that is, CSR is reasonable if the social responsibility activities of enterprises do not reduce the profitability of enterprises [8].

5.2. Research Implications

This paper has certain implications for the survival and development of enterprises in competition in the context of sustainable development.

Our results indicate that environmental innovation may improve environmental performance and economic performance simultaneously. So, environmental innovation should not be seen merely as a reactive behavior imposed by government but a proactive strategy for enterprises to sustain competitive advantage and improve business performance [75]. So, enterprise managers should be aware of the opportunities that environmental innovation brings and make environmental innovation a key component of enterprise strategy. Enterprise managers should also be kept informed of the potential value of environmental innovation and make a commitment to carry out environmental innovation throughout the enterprise. Besides, managers may make efforts to convey the importance of environmental innovation to all stakeholders, thus promoting corporate environmental innovation, and then improving corporate performance. For government agencies and decision makers, they should encourage these practices of enterprises. Government policies may encourage environmental innovation through incentive policies such as grants and rebates or disincentive measures such as tariffs and quotas. Governments may also strengthen the promotion of environmental perceptions through different channels, such as media and education, so to create market attractiveness, and help enterprises achieve corporate performance through environmental innovation.

In addition, this study verifies that the two types of external knowledge acquisition are the drivers of environmental innovation. Enterprises in a transitional economy may have relatively low knowledge resource and technical level. In order to sustain the competition advantage in the international competition market, the enterprise managers must seek market knowledge and technical knowledge from the outside, strengthen widespread cooperation, and communicate with external stakeholders. For example, they may gain advanced knowledge and skills from suppliers, consumers, universities, scientific research units to make up the internal defects. As for technical knowledge, enterprises may obtain a series of external technical knowledge through licensing, R&D contracting, taking over and hiring technical personnel. As for market knowledge, enterprises may develop specific processes for continuously collecting information from customers, competitors, and suppliers [58], thus promoting

their environmental innovation, and further improving the environmental performance and economic performance of the enterprises. Policy makers should help enterprises develop and expand more channels, such as increasing industry exchanges, sharing market information, and enlarging capital support, so as to promote enterprises to effectively gain external knowledge, improve corporate performance, and strengthen the competitiveness of enterprises in the international market.

5.3. Limitation and Future Research

The paper expands the previous researches, but it also has some limitations. First of all, the research uses cross-section data and there may be differences in the long-term effect. Future researches should conduct long-term follow-up and study long-term conditions through vertical data. Second, the samples of this paper are only taken from SMEs with less than 500 employees, as China has not formed a unified definition of SMEs. Although the research samples are selected from different regions and different industries, it still needs to be further tested whether the investigation results are suitable for other countries and a wider background. Finally, out of limited length, the study does not consider whether environmental innovation and corporate performance are influenced by the moderating factor. Future researches may explore this, so as to improve and expand the current model.

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Appendix A Measurement Items

Technical knowledge acquisition [66]

Our firm acquires technology through licensing (TKA1).
Our firm acquires technology through R&D contracting (TKA2).
Our firm acquires technology through take-over (TKA3).
Our firm acquires technology through hiring away personnel (TKA4).

Market knowledge acquisition [58]

Our firm has processes for continuously collecting information from customers (MKA1).
Our firm has processes for continuously collecting information about competitor activities (MKA2).
Our firm has processes for continuously collecting information from our suppliers (MKA3).

Environmental innovation [15]

Low energy consumption such as water, electricity, gas, and petrol during production/use/disposal (EIN1).
Recycle, reuse, and remanufacture material (EIN2).
Use of cleaner technology to create savings and prevent pollution (EIN3).
The manufacturing process of our firm effectively reduces the emissions of hazardous substances and waste (EIN4).
The manufacturing process of our firm reduces the use of raw material (EIN5).

Environmental performance [67]

Our firm has reduced energy use in our facilities (EP1).
Our firm has reduced water use in our facilities (EP2).
Our firm has reduced waste at our facilities (EP3).

Our firm has reduced emissions at our facilities (EP4).

Financial performance [67]

Total sales of goods and services (FP1).
Profitability (FP2).
Market share (FP3).

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