

## How Absorptive Capacity Improves Green Innovation Performance in Small and Medium-sized Enterprises: A Study of the Mediating Role of Environmental Motivation and Organizational Learning

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### Abstract

Amid the global transition toward green and low-carbon development and China's commitment to its dual-carbon goals, small and medium-sized enterprises (SMEs) face increasing pressure to innovate sustainably despite limited resources. Drawing on Dynamic Capability Theory and the Resource-Based View, this study examines how absorptive capacity influences green innovation performance through the mediating roles of environmental motivation and organizational learning. Using survey data from 602 SMEs in Shanghai and applying partial least squares structural equation modeling (PLS-SEM), the results indicate that absorptive capacity has a significant positive effect on green product and process innovation. Environmental motivation and organizational learning partially mediate this relationship, and a sequential mediation effect from environmental motivation to organizational learning is also confirmed. The findings contribute to the green innovation literature by clarifying the internal mechanisms through which knowledge-related capabilities translate into sustainable innovation outcomes and offer practical implications for SME managers and policymakers.

**Keywords:** Absorptive Capacity, Environmental Motivation, Organizational Learning, Green Innovation Performance, SMEs

### Introduction

The global commitment to green and low-carbon growth, catalyzed by international efforts such as the Paris Agreement, has made green innovation a necessity for achieving both national competitiveness and environmental sustainability. This global trend provides the backdrop for China's strong commitment to its "dual carbon" goals (carbon peaking before 2030 and neutrality before 2060), supported by major policies like the 14th Five-Year Plan that encourage green technology investment and have driven a rapid increase in green patents since

2020 (China National Intellectual Property Administration, 2024; Huang et al., 2024). However, Small and Medium-sized Enterprises (SMEs), despite their significant economic role, face unique and greater challenges than larger firms; they are often constrained by limited financial, technical, and professional resources, making it difficult to meet stringent environmental standards and transition from passive compliance to proactive innovation (Shao, 2009; Zhao, 2011; Tripathi et al., 2023). This situation necessitates a focus on strengthening internal capabilities within SMEs to adapt to the fast-changing policy environment, exemplified by regions like Shanghai, which seeks to become an “international green finance hub.”

To address these limitations, this study highlights the importance of absorptive capacity a firm's ability to recognize, understand, and utilize external knowledge (Cohen & Levinthal, 1990; Zahra & George, 2002; Flatten et al., 2011; Du et al., 2019)—as a critical internal capability for green innovation success. However, absorptive capacity alone is insufficient; its impact is significantly mediated by environmental motivation (both intrinsic and extrinsic factors, driving willingness to engage in eco-friendly actions; Bansal & Roth, 2000; Zhu & Sarkis, 2006; Delmas & Toffel, 2008; Grewatsch & Kleindienst, 2017) and organizational learning (the systematic process of knowledge collection, sharing, and utilization to build a sustainable culture and lasting green practices, as framed by models like the 4I framework; Huber, 1991; Crossan et al., 1999; Marsick & Watkins, 2003; Wang & Ahmed, 2003; Albort-Morant et al., 2018). While studies suggest firms with stronger learning and policy absorption capabilities can convert environmental pressure into innovation opportunities (Zhao et al., 2015), many SMEs still lack systematic methods. Therefore, this research is crucial for systematically understanding how environmental motivation and organizational learning collectively help transform external policy and technological knowledge into effective green innovation activities for SMEs.

### Research Objective

1. To analyze how the four dimensions of absorptive capacity influence green product innovation and green process innovation among SMEs within China’s dynamic environmental policy context.
2. To examine how environmental motivation and organizational learning mediate the relationship between absorptive capacity and green innovation performance.
3. To develop and validate a chain mediation model linking absorptive capacity, environmental motivation, organizational learning, and green innovation, and to assess moderating factors such as enterprise size, industry type, and policy change through structural equation modeling.

### Literature Review

This research systematically reviews literature on green innovation and dynamic capability theory, focusing on the constructs of absorptive capacity, environmental motivation, and organizational learning, which shape green innovation performance. It then develops a theoretical framework linking absorptive capacity to green innovation performance through the mediating mechanisms of environmental motivation and organizational learning.

#### **1. Organizational Learning as a Transmission Mechanism**

Organizational learning transforms knowledge into innovative behavior (Li et al., 2019). Exploratory learning fosters breakthrough environmental technologies, while utilitarian learning is conducive to process optimization. The effectiveness of organizational learning is ultimately constrained by enterprises' knowledge absorptive capacity (Xu & Qian, 2010).

#### **2. The Dual Driving Effect of Environmental Motivation**

Environmental motivation has evolved from a narrow compliance-oriented view to a multidimensional framework (Shui et al., 2015). Intrinsic environmental motivation, arising from values and strategic vision (Hemingway, 2005), leads to radical, beyond-compliance innovations (Berchicci & King, 2007). Extrinsic environmental motivation, driven by policy and competitive pressures (Delmas & Toffel, 2008), tends to prompt incremental innovations (Rennings, 2000). A nuanced understanding of the interplay between the two is essential (Grewatsch & Kleindienst, 2017). In the Chinese context, policy-responsive motivation dominates (Gao & Tian, 2005), and there is a significant interaction effect between motivation intensity and absorptive capacity (Shehzad & Sherani, 2024).

#### **3. Absorptive Capacity and Green Innovation Performance**

Absorptive capacity, a core element of dynamic capabilities (Wen et al., 2024), is subject to higher demands in green innovation due to technological complexity and policy dependence. Existing research shows a significant positive correlation between improvements in absorptive capacity and green innovation output (Li et al., 2019). However, the link between absorptive capacity and innovation outcomes evolves dynamically under shifting regulatory pressures (Teece, 2007).

#### **4. Research Progress and Limitations**

Research focuses on multivariate synergistic mechanisms, finding that when environmental motivation and absorptive capacity are better matched, the speed of green product launches is significantly accelerated (Jia et al., 2018). Limitations include: 1) a scarcity of targeted studies on lightweight knowledge management models for SMEs (Massaro et al., 2016); 2) lack of systematic examination of China's dynamic regulatory influence; and 3) shortage of quantitative investigations into informal learning networks within SMEs.

## 5. Theoretical Positioning of This Study

This study aims to: 1) uncover the differentiated mechanisms of action across the dimensions of absorptive capacity (Ozgul, 2022), with emphasis on policy knowledge transformation (Todorova & Durisin, 2007); 2) test a dual-channel mediation model (Liu & Qin, 2016); 3) validate the unique policy-sensitive innovation pathways of Chinese SMEs; and 4) construct a tailored green innovation mechanism framework by integrating dynamic capability theory with the theory of planned behavior (Ajzen, 1991; Teece, 2007).

### Research Gaps and Theoretical Contributions

Despite many studies, important research gaps still exist, especially for small and medium-sized enterprises (SMEs) in emerging economies such as China.

#### 1. Limitations in the Contextualization of Absorptive Capacity

Most theories are based on research about large companies in Western countries (Bruton et al., 2010), so these frameworks may not fully explain the situation of Chinese SMEs, which face limited resources and strong dependence on government policies (Tsui, 2007). One major gap is the lack of attention to context when applying absorptive capacity theory. Only a few studies have examined how this capacity works under conditions of limited resources and policy sensitivity (Li et al., 2008).

#### 2. Lack of Integration Between Environmental Motivation and Absorptive Capacity

There is a lack of integration of environmental motivation into absorptive capacity frameworks (Chen & Cao, 2025). Many studies have treated motivation only as a background factor or a direct driver of innovation, rather than as a mediator or moderator in the process of knowledge absorption (Berrone et al., 2013). The absence of motivational mechanisms limits understanding of how external institutional pressures become internal drivers of learning and innovation (Aragón-Correa & Sharma, 2003).

#### 3. Insufficient Exploration of the Reciprocal Relationship Between Organizational Learning and Absorptive Capacity

There is limited research on the two-way relationship between organizational learning and absorptive capacity. Few studies have examined how learning can also strengthen absorptive capacity in return (Baker, Miner, & Eesley, 2003). Most existing models follow a linear view (Absorptive Capacity to Learning to Innovation), overlooking the feedback cycles that often occur in real innovation processes.

#### 4. Methodological Limitations in Prior Studies

Most work on green innovation relies on cross-sectional or qualitative designs (Wang & Zhang, 2024), which do not show how absorptive capacity, motivation, and learning change over time. Additionally, many studies overlook differences across industries and regions (Zhu & Geng,

2013). The shortage of longitudinal, multi-regional, and comparative research limits the generalizability and depth of current findings.

### Research Methodology

#### 1. Research Methodology

The methodological framework outlines the overarching research paradigm, which adopts a quantitative research approach based on survey data and statistical modeling, while also delineating the research design and contextual environment of the study. The quantitative component is elaborated in two phases, where the first phase details the identification of the study population and sampling framework, the sampling strategies and measurement instruments employed, procedures for data collection, methods for assessing reliability and validity, the selection process for the pre-test sample, and the analytical tools utilized. All procedures were quantitative, focusing on survey design, data collection, and statistical analysis. The objective is to provide a comprehensive and systematic presentation of the methodological framework, thereby offering a clear understanding of the research paradigm, design strategies, and implementation context.

#### 2. Research Steps

This study employed a quantitative cross-sectional research design to examine the relationships among absorptive capacity, environmental motivation, organizational learning, and green innovation performance in small and medium-sized enterprises (SMEs) in Shanghai. Data was collected through a structured questionnaire administered to managers, decision-makers, and employees across different industries and firm sizes. The survey design enabled the systematic measurement of latent constructs using established multi-item scales, ensuring both reliability and validity.

The quantitative design was selected because it allows for rigorous hypothesis testing and generalization across a large sample. Specifically, the study applied Partial Least Squares Structural Equation Modeling (PLS-SEM) as the primary analytical method. PLS-SEM is particularly suitable for complex conceptual models with multiple constructs and mediating variables, and it emphasizes prediction and variance explanation rather than strict model fit (Hair et al., 2019). This approach ensures the simultaneous assessment of measurement properties and structural relationships (direct, indirect, and chain mediation effects), making the findings both empirically rigorous and theoretically meaningful.

#### 3. Data Collection

Data were collected through a combination of online and offline methods to ensure broad accessibility and high response quality. The primary distribution channel was Wenjuanxing, an

online survey platform, while paper-based questionnaires were also provided. To enhance participation, the research team collaborated with local industrial parks, business associations, and SME service centers in five key districts of Shanghai. Recruitment focused on individuals in managerial, operational, or decision-making roles relevant to knowledge absorption, organizational learning, and green innovation practices. All participants were clearly informed of their right to anonymity, voluntary participation, and data confidentiality.

The data collection period lasted three months. A two-step validation process was applied: automated screening via the survey platform to identify incomplete or invalid responses, followed by manual review to ensure logical consistency and data integrity. After data cleaning, a total of 602 valid responses were retained for analysis. This rigorous procedure ensured the reliability and representativeness of the dataset.

#### 4. Data Analysis

##### 1) Measurement and Operationalization

This study employed four main structural constructs, which are operationalized through distinct dimensions:

Absorptive Capacity (AC) is measured by four dimensions: Acquisition, Assimilation, Transformation, and Exploitation.

Environmental Motivation (EM) is measured by two dimensions: Internal and External Motivation.

Organizational Learning (OL) is measured by three dimensions: Knowledge Transfer, Learning Culture, and Managerial Commitment.

Green Innovation Performance (GIP) is measured by two dimensions: Green Product Innovation and Green Process Innovation.

These abbreviations (AC, EM, OL, GIP) will be utilized to ensure clarity and facilitate the interpretation of structural relationships throughout the analytical process.

##### 2) Research Design and Sample Characteristics

The study employed a cross-sectional survey design. Data was collected from managers and employees of SMEs across five key industrial and commercial districts of Shanghai, China (Pudong, Jiading, Minhang, Songjiang, and Baoshan), between April and May 2025. The final data yielded 206 valid questionnaires.

This sample size aligns with recommended thresholds for structural equation modeling (PLS-SEM) analysis and provides sufficient statistical power to test the proposed hypotheses (Hair et al., 1998).

## Research Results

### 1. Measurement Model Assessment

#### 1) Reliability and Convergent Validity

The measurement model demonstrated strong internal consistency reliability and convergent validity at both the first-order and second-order levels.

Reliability: All first-order constructs showed exceptionally high reliability, with Cronbach's alpha coefficients ranging from 0.825 to 0.856 (exceeding 0.70) and Composite Reliability (CR) values ranging from 0.828 to 0.859 (exceeding 0.70).

Convergent Validity: Factor loadings for all items exceeded 0.70 (ranging from 0.766 to 0.931). Average Variance Explained (AVE) values ranged from 0.657 to 0.773, all surpassing the 0.50 threshold, thus establishing robust convergent validity.

#### 2) Discriminant Validity

Discriminant validity was confirmed through both the Fornell-Larcker criterion and the Heterotrait-Monotrait (HTMT) ratio analysis.

Fornell-Larcker: The square root of AVE for each construct consistently exceeded the inter-construct correlations, confirming empirical distinctiveness.

HTMT Analysis: All first-order construct HTMT values fell well below the conservative threshold of 0.85 (highest value was 0.756). For second-order constructs, the highest HTMT ratio was 0.805 (between Organizational Learning and Green Innovation Performance), which is below the more lenient 0.90 threshold, generally supporting adequate discriminant validity.

Cross-Loadings: The cross-load analysis further supported discriminant validity, as every measurement item exhibited substantially higher loading on its intended construct than on any other construct (meeting the 0.10 difference criterion).

### 2. Structural Model Assessment

#### 1) Model Quality and Robustness

The measurement model was confirmed to be highly reliable and valid.

Reliability & Validity: Constructs showed high internal consistency (Cronbach's  $\alpha$ : 0.825-0.856; CR: 0.828-0.859) and strong convergent validity (AVE: 0.657-0.773). Discriminant validity was established using the Fornell-Larcker and HTMT criteria (most HTMT values <0.85).

Model Fit & VIF: The model achieved acceptable fit (SRMR = 0.085) and was free from multicollinearity (all VIF < 2.428), confirming the robustness of the estimates.

#### 2) Hypothesis Testing: Direct and Indirect Effects

All hypothesized relationships were statistically significant ( $p < 0.001$ ), providing strong support for the conceptual framework.

Direct Effects: Absorptive Capacity (AC) had the strongest influence on Organizational Learning (OL) ( $\beta = 0.493$ ) and Environmental Motivation (EM) ( $\beta = 0.440$ ). AC ( $\beta = 0.299$ ), EM ( $\beta = 0.235$ ), and OL ( $\beta = 0.306$ ) all significantly and positively influenced Green Innovation Performance (GIP).

Mediating Effects: The analysis confirmed significant partial mediation. The indirect path AC  $\rightarrow$  OL  $\rightarrow$  GIP ( $\beta = 0.151$ ) showed the strongest mediating effect, accounting for 49.83% of the total effect of AC on GIP.

Total Effect: The total influence of AC on GIP was large ( $\beta_{\text{Total}} = 0.594$ ;  $f^2 = 0.371$  for AC  $\rightarrow$  OL).

### 3) Explanatory Power

The model successfully explained a large portion of the variance in the outcome variables:

Explanatory Power ( $R^2$ ): The model demonstrated strong explanatory power for GIP ( $R^2 = 0.490$ ) and OL ( $R^2 = 0.473$ ).

Predictive Power ( $Q^2$ ): All constructs exhibited sufficient predictive relevance ( $Q^2 > 0$ ), with GIP having the highest relevance ( $Q^2 = 0.297$ ), supporting the model's practical application value.

## Conclusion

This study analyzed how Absorptive Capacity (AC) influences the Green Innovation Performance of Small and Medium-sized Enterprises (SMEs) in Shanghai, confirming the significant roles of Environmental Motivation (EM) and Organizational Learning (OL) as mediating factors. Based on 602 valid responses, the findings provide strong empirical support for all proposed hypotheses, demonstrating that AC has both direct and indirect positive effects on green innovation outcomes. Firms that excel in acquiring, assimilating, transforming, and applying external knowledge are better positioned to generate green product and process innovations, thus confirming AC's status as a dynamic capability that translates external knowledge into concrete sustainable innovation results.

The results further confirmed that Environmental Motivation acts as a strategic driver, not only directly promoting green innovation but also strengthening the firm's commitment to green activities. This motivational force is effectively channeled and amplified through Organizational Learning, which functions as a performance conversion mechanism, turning acquired knowledge and motivational awareness into tangible innovation outputs. The study also validated a complex sequential double mediation effect: Absorptive Capacity enhances Environmental Motivation, which subsequently boosts Organizational Learning, ultimately leading to stronger Green

Innovation Performance. This capability–motivation–learning–performance chain offers a crucial, nuanced pathway for SMEs seeking to leverage knowledge resources for their green transformation journey.

The findings significantly enrich the theoretical understanding of sustainable innovation by demonstrating that knowledge-related capabilities alone are insufficient. Achieving impactful green innovation outcomes necessitates the combined presence of a robust Absorptive Capacity, strong Environmental Motivation, and effective Organizational Learning mechanisms. For SMEs undergoing green transformation, the practical implications are clear: developing the ability to absorb crucial policy and market knowledge, proactively fostering an environmental commitment throughout the organization, and institutionalizing learning practices are essential strategic conditions for securing long-term competitive advantages in the sustainability era.

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