

1 Article

2 Green Innovation, Green Entrepreneurial Orientation 3 and Supply Chain Learning: Evidence from 4 Manufacturing Firms in China.

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10 **Abstract:** As a combination of both concepts of innovation and environmental development, green
11 innovation is of great significance to the sustainable development of the country and industry.
12 Previous literatures have found the separate roles of green entrepreneurial orientation and inter-
13 organizational learning in understanding green innovation issues. However, few studies have done
14 a comprehensive analysis of integrating three streams of research: green entrepreneurial orientation,
15 green innovation and supply chain learning capability. Based on the resource-based view and
16 dynamic capability theory, we examine the direct of green entrepreneurial orientation on green
17 innovation as well as indirect effect through the mediation of supply chain learning capability.
18 Meanwhile, an empirical data set of 228 manufacturing companies in China (Shaanxi, Guangdong,
19 Hebei, Jiangsu, and Shandong) was used to test our hypotheses. Findings from our empirical study
20 suggest that supply chain learning capability partially mediates the positive relationships between
21 green entrepreneurial orientation and its two consequences—green incremental innovation and
22 green radical innovation. In addition, this research implies that when enterprise has a strong green
23 entrepreneurial orientation, the enterprise should make an effort to enhance the level of supply chain
24 learning capability so as to fully develop their green innovation.

25 **Keywords:** green entrepreneurial orientation; green innovation entrepreneurship; supply chain
26 learning; inter-organizational learning; learning capacity; technology innovation

28 1. Introduction

29 The global environmental degradation, is a constantly increasing concern for public makers,
30 people and various countries[1]. As a result, pursuing green economic growth and development has
31 become a new global economic development trend [2,3]. As a combination of both concepts of
32 innovation and environmental development, green innovation involves dual externalities that
33 traditional innovation does not have [4]. Green innovation can improve production efficiency, save
34 resources and reduce environmental pollution by learning advanced green technology, becoming an
35 effective way to promote green economic growth, which has more significance than ever before[5].
36 Under this situation, it is essential for enterprises to integrate environmental ideas with innovation.
37 On the one hand, enterprises need to face powerful pressure from the set of environmental norms
38 and regulations by the government. On the other hand, greening innovation process is becoming a
39 strategic business opportunity for enterprises to cope with the market requirements that are more
40 environmentally friendly [6]. Thus, enterprises which drive growth by green innovation strategy
41 might have unprecedented opportunities for the development of green by leaps and bounds. In view
42 of this, successful green innovation enable enterprises to respond to the environmental tendency as
43 well as improve their green image and achieve competitive advantages [1,7,8].

44 Previous research on the determinants of green innovation is vast, such as government
45 environmental regulations, consumer demand and factors from competitors [3,7,9–11]. Meanwhile,

46 a growing literature analyzed the antecedents of green innovation from the inter-organizational
47 perspective, such as senior managers' environmental awareness[12], green shared vision[13],
48 cooperation with competitors[14] and environmental managerial concern [15]. In particular, some
49 empirical studies showed that the enterprise's green innovation is influenced by the path of
50 innovation, the accumulation of knowledge, the capabilities of organization and the learning of
51 organization [14,16–18]. However, little empirical research addressed the question of how green
52 entrepreneurial orientation as an antecedent, affects the improvement of green innovation. In this
53 respect, Mengucu Auh & Ozanne believed that organizational capabilities such as learning and
54 continuous innovation may appear when entrepreneurial orientation is strong enough, promoting
55 the environmental strategic initiatives [19]. Nevertheless, some scholars demonstrated that
56 entrepreneurial orientation has no significant effect on corporate innovation [20]. Consider the above,
57 the findings of the relationship between entrepreneurial orientation and corporate innovation are
58 controversial and need further exploration.

59 In this article, we intend to extend this line of analyzing how green entrepreneurial orientation
60 affects green innovation. More precisely, we fill a gap in the previous research by developing theory
61 and present empirical evidence to identify supply chain learning as a mediate variable between green
62 entrepreneurial orientation and green innovation. Few studies analyzed entrepreneurial orientation
63 in context of supply chain management [21,22], especially for the green entrepreneurial orientation,
64 which is different from general entrepreneurial orientation for it also improves environment quality.
65 Besides, scant research examined how green entrepreneurial orientation as a strategic posture, affects
66 the improvement of green innovation, especially in the supply chain context. Based on the resource-
67 based view and dynamic capability theory [23], we examine the relationship among green
68 entrepreneurial orientation, supply chain learning and green innovation in order to develop a better
69 understanding of the mechanism through which green entrepreneurial orientation can efficiently and
70 effectively influence companies' innovation outcomes. Our study focus on the following research
71 questions: (1) Does a company's green entrepreneurial orientation motivate it to develop supply
72 chain learning capability? (2) Dose a company's supply chain learning capability affect the company's
73 green innovation? (3) Would the relationship between green entrepreneurial orientation and green
74 innovation be mediated by supply chain learning?

75 To achieve our goals, the remainder of the study as follows. The next section presents the
76 literature review and hypothesis. Section 3 describes the research methodology, followed by the data
77 analysis and results in section 4. Finally, in section 5, the paper presents the conclusion, implications,
78 limitations of this study and suggestion for future research.

79 **2. Literary review and hypothesis development**

80 *2.1. Green entrepreneurial orientation and green innovation*

81 Over the years many researchers indicated that entrepreneurial orientation can help in a general
82 improvement of corporation performance [24]. As a strategic orientation, entrepreneurial orientation
83 affects enterprise innovation directly or indirectly [22,25–27], however, some scholars found that
84 entrepreneurial orientation has no significant effect on corporate innovation [20]. Consider the above,
85 though there are some studies on the relationship between entrepreneurial orientation and corporate
86 innovation, the results are controversial and need further exploration. Furthermore, the research of
87 the impact of the green entrepreneurial orientation on green innovation are less well established,
88 which our study intend to explore.

89 Green entrepreneurial orientation research was originated from the combination of theories of
90 entrepreneurial orientation and green entrepreneurship. For the component dimension of green
91 entrepreneurship orientation, Arruda [28] believed that green entrepreneurship consists of
92 proactivity and environmental orientation while Becker [29] divided green entrepreneurship into
93 innovativeness and social orientation. Cohen et al. [30] argued that sustainable entrepreneurship has
94 two significant characteristics: social orientation and environmental orientation. In line with the
95 recent work of li and Chen [31], in our research green entrepreneurial orientation refers to an

96 independent system, which is treated as a unique pattern of organizational operation and strategic
97 decision-making.

98 For green innovation, which is first mentioned by Fussler and James [32], refer to develop and
99 apply new products, new process and new services to achieve improvements in overall
100 environmental performance, including innovations in product innovation, process innovation and
101 project innovation [33]. According to different levels of technology innovation, green innovation
102 consists of either green radical innovation or green incremental innovation [13]. Based on previous
103 research [37], this study gives a definition to “green radical innovation” as ‘a novel, unique and
104 artistic creation caused by fundamental changes of existing green products, processes or services’.
105 Meanwhile, we refer to the definition of previous researchers [13,34,35], and state the term “green
106 incremental innovation” as ‘the minor improvements and enhancements to make existing green
107 products, processes or services enhance or expand by means of environmental technology’.

108 2.2. *Supply chain learning*

109 Supply chain learning originates from inter-organizational learning and involves how members
110 of the organization jointly create collective knowledge [36]. Bessant and Tsekouras [37] are the first
111 to study learning at the network level and view supply chain as one of these networks. Then, O’Keeffe
112 et al. [38] further found that supply chain possess “knowledge flow”, which can be fully utilized
113 among upstream and downstream enterprises, and multi-win cooperation can be realized through
114 inter-organization learning. Later, New, S. J et al. [39] defined “supply chain learning” as a learning
115 behavior in an inter-organizational context, and identified three different stages of supply chain
116 learning. Furthermore, Flint et al. [40] provided a formal definition of supply chain learning:
117 “interaction and learning among diversified supply chain partners on supply chain problems and
118 solutions”. In our study, based on the dynamic capability theory, we regard supply chain learning
119 capabilities as a dynamic capability which is a key component of supply chain management, because
120 the transformation of knowledge can encourage enterprises to share their experiences and to learn
121 from the cooperation with upstream and downstream customers, which can greatly reduce the
122 potential probability of making mistakes.

123 2.3. *The influence of green entrepreneurial orientation on supply chain learning capability*

124 New et al. revealed six pre-dependent variables of supply chain learning capability: trust and
125 commitment, communication, types of relationships among supply chain members, decision-making
126 styles, and company culture [39]. Besides, previous research summarized four antecedents of supply
127 chain learning in the context of supply management: team-oriented, system-oriented, learning-
128 oriented and memory-oriented [40,41]. In recent years, some literature find a direct link between
129 entrepreneurial orientation and organizational learning [24,25,40]. For example, based on learning
130 theory and behavioral science theory, Lambrechts et al. [42] discussed the mechanisms of
131 entrepreneurial orientation affect organizational learning. Moreover, it is concluded that enterprises
132 with entrepreneurial orientation tend to form learning atmosphere, promote learning behavior and
133 provide direction and scope of enterprise learning [43]. In addition, entrepreneurial orientation
134 provides management support for the learning process of supply chain [44]. Furthermore, green
135 entrepreneurial companies generally encourage organizational structures which can promote
136 creativity and collaboration [45], result in developing supply chain learning capability. Therefore,
137 green entrepreneurial orientation which possess a combination of entrepreneurship and
138 environmentally friendly features can lighten the psychological burden of supply chain members,
139 enhancing information and knowledge flows among organizations and thereby have a positive
140 impact on supply chain learning. Hence, we propose the following hypothesis:

141 *H1: Green entrepreneurial orientation has a positive influence on green supply chain learning capability.*

142 2.4. *The influence of supply chain learning on green innovation*

143 Recently, Jean et al. indicated a potential positive impact of joint learning capacity among supply
144 chain partners on relationship innovation [34]. Learning among supply chain members can be seen
145 as a strategic resource that contribute to performance of the supply chain [13,41], meanwhile, supply
146 chain learning capability can be seen as a dynamic capability based on dynamic theory. Furthermore,
147 five outcomes of supply chain learning were summarized and supply chain learning was defined as
148 “a process through which participants can learn together about how to rethink and update their
149 supply chain framework to develop a new knowledge Infrastructure” [42]. From the perspective of
150 dynamic capability, learning among alliance partners improve the technology information and
151 knowledge base and thus become a powerful stimulus to green technology innovation in alliance
152 products [43]. In this sense, supply chain learning emphasizes interaction among organizations so
153 that green technology information and knowledge such as green experience of the organization can
154 be shared and innovated. In other word, by learning and mastering partners' green technology
155 resources, a company can generate new ideas which enable the company's green technology to be
156 innovated. More specifically, there exist differences in the supply chain partners' resources and
157 capabilities for green technology, and to the fact that their green innovation outcomes can be
158 complementary by supply chain learning. Hence, green technology acquired from their supply chain
159 partners can be expected to help enterprises overcome their limited green knowledge and be able to
160 make better programs regarding green technology, which finally result in higher level green
161 innovation. Thus, green innovation can be regarded as a process of inter-organizational learning and
162 we argue that supply chain learning capability promote the effectiveness and efficiency of green
163 innovation. Consider the above:

164 *H2: Green supply chain learning is positively associated with green innovation*

165 *H2a: Green supply chain learning is positively associated with green radical innovation*

166 *H2b: Green supply chain learning is positively associated with green incremental innovation.*

167 2.5. The influence of green entrepreneurial orientation on green innovation

168 Some experts pointed out that entrepreneurial orientation has a direct or indirect impact on
169 enterprise innovation [24,44]. Some studies regarded technological innovation results as an indicator
170 of entrepreneurship [45] or the practice of innovation [46], reflecting the view of Drucker, who
171 claimed the importance of entrepreneurial function on firm's innovation [47]. In fact, firms with green
172 entrepreneurial orientation may tend to achieve green innovation more easily than those which strive
173 merely for economic interests [48]. Besides, executive teams which emphasize environmental
174 orientation may set an example for their subordinates by shaping their behavior, thereby promoting
175 firm's green technological innovation come from their employees [49]. Green entrepreneurial
176 orientation, which is regarded as a strategic resource can increase firms' proactivity and their
177 willingness to take risks of green technology, making it possible for firms to achieve higher green
178 innovation. Hence, based on the resource-based theory, this paper argues that green entrepreneurial
179 orientation could be considered as a major factor of green innovation.

180 We therefore put forward the following hypotheses:

181 *H3: Green entrepreneurial orientation is positively associated with green innovation.*

182 *H3a: Green entrepreneurial orientation is positively associated with green radical innovation.*

183 *H3b: Green entrepreneurial orientation is positively associated with green incremental innovation.*

184 2.6. The mediating influence of supply chain learning

185 In the academic circles, great attention should be paid to the basic process of clarifying the
186 contribution of entrepreneurial orientation to the company innovation, and it is particularly
187 necessary to explore a complete analytical framework of entrepreneurial orientation and enterprise
188 innovation. The relationship between entrepreneurial orientation and innovation was empirical
189 examined in previous studies [50], however, most studies focused on a direct link between
190 entrepreneurial orientation and innovation[27,51], while few studies examined the mechanism that
191 mediate the entrepreneurial orientation-to-innovation link, especially in the contextual of
192 environment. To address this gap, we focus on supply chain learning as a key determinant of green

193 innovation. As a strategic gesture, green entrepreneurial orientation enables enterprise to form an
194 internal organizational strength, which can not only support enterprises to produce as many green
195 innovative products as possible, but also helps the green technology content of products. In fact, the
196 influence of green entrepreneurial orientation on green innovation should not be separated from
197 organizational factors [22,25], especially the inter-organizational learning, such as supply chain
198 learning, which perform a vital role in the influence of green entrepreneurial orientation on green
199 innovation. Specifically, one of the significant roles of green entrepreneurship orientation might be
200 its association with supply chain learning, which would facilitate company's ability to provide
201 innovative proposals for new environmental product development. According to the dynamic
202 capability theory, supply chain learning capability is regarded as a dynamic capability involves
203 company strategic activities which are critical to the impact of green entrepreneurship orientation on
204 green innovation. Therefore, we propose that supply chain learning capability can enhance the
205 impact of green entrepreneurial orientation on green innovation. In other word, when possess strong
206 green entrepreneurial orientation, enterprises will attempt to enhance their supply chain learning
207 capability to develop green innovation. These lines of argument lead us to the following hypothesis:

208 *H4: Supply chain learning acts as a mediating variable between green entrepreneurial orientation and*
209 *green innovation.*

210 *H4a: Supply chain learning acts as a mediating variable between green entrepreneurial orientation and*
211 *green radical innovation.*

212 *H4b: Supply chain learning acts as a mediating variable between green entrepreneurial orientation and*
213 *green incremental innovation.*

214 3. Method

215 3.1. Variable measurement and questionnaire design

216 The survey questionnaire was structured into three sections, namely, green entrepreneurial
217 orientation, supply chain learning and green innovation. All measurements used a seven-point Likert
218 scale. In order to ensure the reliability and validity, we assembled our questionnaire utilizing
219 established survey items to fit our research context. The research questionnaire was first compiled in
220 English and then translated into Chinese. A preliminary questionnaire was pretested by firm's mid-
221 level or senior-level managers, graduate students, and three business management professors. They
222 hold sufficient knowledge about the innovation management and then made some minor
223 modifications to the questionnaire before a formal investigation. The Chinese questionnaire with
224 such alterations was subsequently back-translated into English by a third party to ensure that the
225 items included accurately reflect the original meanings in the Chinese context. We reviewed carefully
226 these two English versions, and were satisfied that there were no substantial differences between the
227 two versions in the meanings of the scales. First, entrepreneur orientation were measured by five
228 items adapted from Naman and Slevin [52]. Next, five items for measuring supply chain learning
229 capability were adopted from the study of Quan Zhu et al [41] and Flint et al.[40]. Finally, we
230 measured green innovation. Four items measured green incremental innovation, all adopted from
231 Jing Dai et al. [35], Yuan Li [53]. Four items measured green radical innovation, all adopted from Jing
232 Dai et al. [35]. For details of variable measurements, see the Appendix.

233 3.2. Sample and data collection

234 Using the questionnaire, we sought responses from top executives of the firms in our study
235 sample. We used the EMBA/MBA/IE graduates lists in our school. To avoid the biases, we randomly
236 selected sample graduates from the list. The sample firms are of all sizes in a broad range of
237 manufacturing industries (such as electronic, transportation equipment, and chemical), located in
238 five provinces (Shaanxi, Guangdong, Hebei, Jiangsu, and Shandong), which cover Western, Central,
239 and Eastern areas of China.

240 We phoned that randomly selected graduates who were at least R&D or general managers in
241 manufacturing firms to join the project. If these graduates we selected happened not to be the best

242 informants to answer the questionnaires, we requested them to help us pass the questions to the very
 243 respondents in their companies, or introduce the most appropriate answers to us, to finish this survey.
 244 The questions were all mailed with a cover letter which highlight the survey's background and goals.
 245 Follow-up calls were made by our research team to improve the response rate.

246 We issued a total of 728 questionnaires and 270 questionnaires were returned, which yield a
 247 response rate of 37.08%. We excluded 42 questionnaires due to incomplete database, thus 228 valid
 248 questionnaires were utilized for analyzing. Details of the companies and respondents are given in
 249 Table 1.

250 **Table 1.** Respondent profile information (N=228).

Information	Characteristics	Samples	Percent (%)
Size (Employee)	Less than 50	23	10.01
	50-100	20	8.77
	101-300	33	14.50
	301-500	39	17.1
	501-1000	37	16.4
	1001-2000	16	7.02
	2001-5000	38	16.67
	More than 5000	22	9.65
Sales revenue (RMB)	Less than 5 million	16	7.02
	5-10 million	19	8.33
	10-20 million	36	11
	20-50 million	31	15.79
	50-100 million	49	21.49
	More than 100 million	77	33.77
Industry	Textiles & Apparel	8	3.51
	Food, beverage, alcohol and cigars	13	5.70
	Chemicals and petrochemicals	28	12.28
	Furniture, wood and concrete products	6	2.63
	Electronics & Appliances	78	32.89
	Fabricated metal product & Machinery	32	14.04
	Transportation equipment	27	6.15
	Rubber & Plastics	6	2.69
	Pharmaceutical and medical	12	5.26
	Others	18	7.89
Type of firm	State-owned enterprise	83	36.40
	Collective enterprise	21	9.21
	Private enterprise	32	14.04
	Foreign-funded enterprise	40	17.51
	Joint venture	27	11.84
	Others	25	10.96
Job position of respondent	President/CEO	103	45.18
	Vice President	57	25.00
	R&D/General manager	50	21.93
	Others	18	7.89

251 Table 1 indicates the distribution of the respondent companies in terms of industry, company's
 252 size using employment levels, company's type and annual revenue. We can notice that respondents
 253 are mainly from foreign-funded companies and state-owned companies. Firm's size ranged from
 254 under 50 to over 500 employees with nearly half of companies belonging to the relatively large
 255 company classification of over 500 employees. Moreover, firms above 100 million in annual revenue
 256

257 make up one-third of the samples. Hence, the data is relatively mature and has enough capability to
258 implement green innovation.

259 **4. Data analysis and results**

260 *4.1. Tests for potential bias in survey data*

261 Two issues commonly raised in the literature concern with survey methodology are non-
262 response bias and common method variance bias.

263 4.1.1. Non-response bias

264 To evaluate non-response bias (the difference between the answers of respondents and non-
265 respondents) [54], the final sample was divided into two: 121 responses received at the beginning of
266 data collection process and the remaining 107 responses received in the middle and latter of the data
267 collection period. We compared the early (121 responses) and late data (107 responses) [54,55] to
268 examine if they differed in their questionnaire responses. The t-test results performed no statistically
269 significant differences on demographic characteristics at $p \leq 0.05$, indicating that the data was
270 relatively free from non-response bias issues.

271 4.1.2. Common method bias

272 We mitigated the potential dangers of common method variance bias. First, we surveyed two
273 informants to assess all the variables for each firm, in accord with the study of Podsakoff and Organ
274 [56]. Second, we surveyed top managers who are knowledgeable about the firms' green innovation
275 management. These individuals are considered to provide accurate and reliable information [57].
276 Finally, we examined the potential of common method variance based on Harman's single factor test
277 for all variables in the study [56]. The un-rotated factor analysis shows that no single factor occupies
278 the majority of the variance, and even the first factor captures only 25% of the overall variance.
279 Besides, the dependent variables and independent variables loading on different factors. The above
280 findings show that the data was unlikely affected by common method variance in our study.

281 *4.2. The result of the measurement model*

282 We adopt the two-step approach from Gerbing and Anderson [76] to examine the reliability and
283 validity of constructs.

284 4.2.1. Reliability analysis

285 The reliability of the data was indicated by Cronbach's α . If construct's reliability coefficient turns
286 out to be 0.7 or greater, it can be considered reliable [58]. Table 2 lists the scale's Cronbach's α
287 calculated using SPSS. Because it can be observed that the reliability of each construct is higher than
288 the threshold value 0.7, thereby we suggest that the theoretical constructs in this paper exhibit good
289 internal consistency.

290 4.2.2. Content validity

291 The validity of the data was tested by the structural validity and the content validity. Instructions
292 on the cover of our questionnaires make informants knowledgeable about the purpose of this
293 research was to examine firms' green innovation practices and outcomes. Confidentiality nature is
294 also ensured. In addition, we design in-depth managerial interviews and a preliminary test to modify
295 our measurement items so as to ensure they actually capture constructs of interests. Thus the scale of
296 this study has a good content validity.

297 4.2.3. Construct validity

298 Construct validity includes convergent validity and discriminant validity. This research verify
 299 the construct validity through confirmatory factor analysis by using AMOS. Convergent validity is
 300 "the degree to which multiple attempts to measure the same concept by different methods are in
 301 agreement" [59]. We use AMOS to calculate the average variance extracted (AVE). Table2 indicates
 302 that average variance extracted is more than 0.6, the composite reliability (CR) for each scale is well
 303 above 0.7 and all factor loadings are greater than 0.5. It suggests the acceptability of convergent
 304 validity of all constructs.

305 **Table 2.** Convergent validity and reliability.

construct	label	convergent validity			Reliability
		Standardized loading	CR	AVE	cronbach's a
Green entrepreneur orientation	GEO1	0.825	0.882	0.677	0.873
	GEO2	0.892			
	GEO3	0.853			
	GEO4	0.815			
	GEO5	0.806			
Supply chain learning	SCL1	0.822	0.824	0.635	0.861
	SCL2	0.861			
	SCL3	0.798			
	SCL4	0.803			
	SCL5	0.785			
Green incremental innovation	GII1	0.718	0.738	0.592	0.775
	GII2	0.801			
	GII3	0.797			
	GII4	0.832			
Green radical innovation	GRI1	0.826	0.750	0.608	0.821
	GRI2	0.813			
	GRI3	0.809			
	GRI4	0.729			

306 For discriminant validity, table 3 indicates that the diagonal elements in bold representing the
 307 square roots of the AVE for constructs are significantly higher than the off-diagonal elements,
 308 satisfying Fornell and Larcker's [60] criterion for discriminant validity.
 309

310 **Table 3.** Descriptive statistics and correlations matrix.

Constructs	Descriptive statistics		Correlations matrix			
	Mean	SD	1	2	3	4
1Green entrepreneur orientation	3.292	1.043	0.823			
2Supply chain learning	4.027	0.897	0.59***	0.797		
3Green incremental innovation	3.715	0.938	0.55***	0.48**	0.769	
4Green radical innovation	3.640	0.951	0.51**	0.63***	0.57***	0.866

311 Note: (a) The diagonal elements in bold are square roots of average variance extracted and (b) the off-diagonal
 312 elements represent correlations between constructs. ***p < 0.001, **p < 0.01, *p < 0.05.

313 4. 3.The result of the Structural model

314 4.3.1. The goodness of fit test of the model

315 We tested our hypotheses using structural equation model (SEM), and draw the results of the
 316 overall analysis of the model (see Table 4).The goodness of fit indices meet the evaluation criterion
 317 suggested by Hu and Bentler [61] ($\chi^2/df=1.28$, GFI=0.912,AGFI=0.835,NFI=0.912,IFI=0.923,CFI=0.922
 318 and RMSEA=0.037). So it suggests that the model has consistency with the actual survey data and
 319 this model has good fitness.

320 **Table 4.** The fitness of the model.

Fitting index	χ^2/df	GFI	AGFI	NFI	IFI	CFI	RMSEA
Test value	1.28	0.912	0.835	0.912	0.923	0.922	0.037

321 4.3.2. The results of hypothesis tests

322 To examine the model structure, we first assess multi-collinearity using SPSS for the predicting
 323 constructs. All constructs in this paper indicate to have an acceptable level of above 0.2 and VIF below
 324 5, suggesting non-collinearity. The structural equation model (SEM) and all standardized coefficients
 325 of the path are revealed in Fig.1. The statistical results show that the p-values of H1, H2a, H2b, H3a
 326 and H3b are all significant, thus all hypotheses of this study are supported. As indicated in table 5
 327 and figure 1, the green entrepreneurial orientation is positively related to supply chain learning
 328 capability. Thus, H1 received support. Supply chain learning capability is positively related to both
 329 green radical innovation and green incremental innovation, H2a, H2b were supported. Green
 330 entrepreneurial orientation is positively related to the green incremental innovation as well as the
 331 green radical innovation, providing support for H3. In addition, the results prove that supply chain
 332 learning capability partially mediates the positive relationships between green entrepreneurial
 333 orientation and its two consequences—green incremental innovation and green radical innovation. It
 334 means that green entrepreneurial orientation can not only directly affect green incremental
 335 innovation and green radical innovation, but also indirectly affect them positively via supply chain
 336 learning capability. Figure 1 presents the model results.

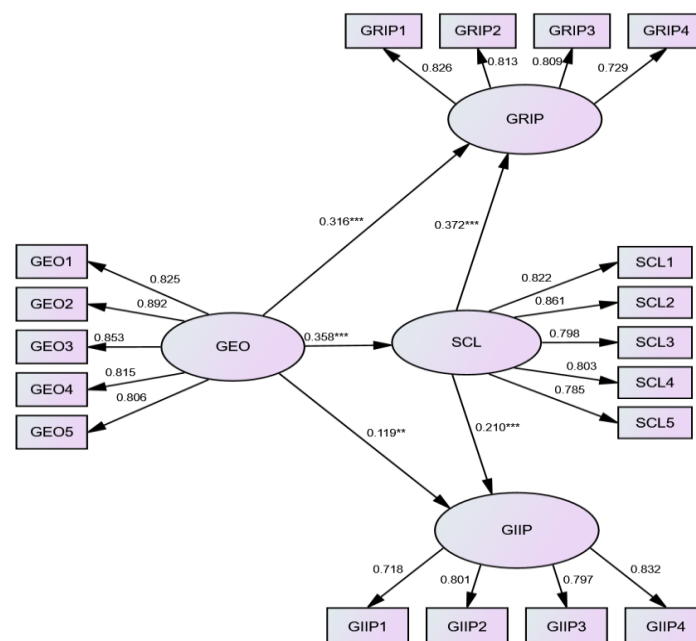


Figure 1. The result of the model

Table 5. The fitness of the model.

Hypothesis	Path coefficient	Proposed effect	P	Result
H1	0.358	+	***	Support
H2a	0.372	+	***	Support
H2b	0.210	+	***	Support
H3a	0.316	+	***	Support
H3b	0.119	+	**	Support

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

5. Discussion and conclusions

Our study demonstrates that supply chain learning play a mediating role: the green entrepreneurial orientation enhance the supply chain learning capability, which in turn benefit the green innovation outcome, including green radical innovation and green incremental innovation. These results make an important contribution to extend the recent research stream focusing on the mechanism of the green entrepreneurial orientation-green innovation relationship as well as the supply chain research in the environmental context. Our study indicates that higher supply chain learning capability can be reinforced with a higher green entrepreneurial orientation and as a consequence green innovation is also increased. In this regard, our results could answer the question why a company get a low development of green innovation even though its management show a higher green entrepreneurial orientation: the inter-organizational learning capability such as supply chain learning links would be missing.

5.1. Theoretical contributions

This research has the following theoretical contributions. Firstly, we contribute to the green

355 innovation research by extending the research beyond the conventional antecedents to demonstrate
356 the importance of the two factors: green entrepreneurial orientation and supply chain learning.
357 Specifically, on the one hand, results of entrepreneurial orientation-innovation relationship in
358 previous research are controversial, and studies in the environmental contextual are less well
359 established. On the other hand, there are few empirical studies about the association between supply
360 chain learning and green innovation. We examine green innovation by focusing on supply chain
361 learning capability, an inter-organizational variable that foster the increase of the company's green
362 innovation, providing a unique perspective. Secondly, our research broaden the current literature of
363 the contextual analysis of green entrepreneurial orientation [62] to supply chain management by
364 exploring the supply chain learning factor links the relationship between green entrepreneurial
365 orientation and green innovation. We claim that the relationship between green entrepreneurial
366 orientation and green innovation cannot be addressed as a simply direct relationship and the effect
367 of green entrepreneurial orientation on green innovation in the supply chain context may be
368 conditional or dependent on the capability of supply chain learning.

369 *5.2. Implications for practitioners*

370 Managerial implications represented by this research point to the important factors that
371 companies should make an effort to promote not only within their organization, but also extend to
372 their supply chain organizations in order to increase their green innovation. Our findings strengthen
373 such a belief that a firm with a higher green entrepreneurial orientation could show a better
374 development of their supply chain learning, and combine this opportunity to develop their green
375 innovation.

376 When initially enhancing their green innovation, management should first focus on enhancing
377 their management green entrepreneurial orientation. This research contributes to the implications for
378 practitioners by suggesting the importance of management as well as their posture and attitude so as
379 to effectively and efficiently implement the conditions to learn among different organizations.
380 Therefore, as a company seeks to achieve a high level green innovation, the management need to take
381 green entrepreneurial orientation into their strategies and develop it. At the same time, the
382 government especially in developing countries should encourage and advocate companies' green
383 entrepreneurial orientation by setting up a set of policies for graduating and training programs.

384 It is difficult to achieve green innovation within a single organization and it requires
385 complementary collaboration with their relevant organizations to create valuable green products and
386 services continually [63]. We conduct our research in the supply chain context, which can make a
387 contribution for managers to understand how to conduct their green entrepreneurial action in the
388 development of their green innovation. We suggest enhancing supply chain learning capability when
389 senior management attempt to follow a higher green entrepreneurial orientation. Moreover, supply
390 chain learning capability may be necessary for every company, especially these companies with high
391 green entrepreneurial orientation to achieve green innovation because the different ideas,
392 information and resources provided by supply chain partners are crucial for companies to solidify
393 their green entrepreneurial orientation. Our study implies that companies should enhance the level
394 of their supply chain learning capability. For example, they can try to emerge their atmosphere of
395 supply chain learning, encourage more investments and strengthen their relationships with their
396 supply chain partners, which may be more important in developing countries such as China. As a

397 result, green innovation may be enhanced by a high level of supply chain learning capability, which
 398 provides a better condition under which companies can make the best of green entrepreneurial
 399 orientation in the supply chain context.

400 5.3. Limitations and future research directions

401 Our study is subject to several limitations that make opportunities for future research. First,
 402 because this study take supplier learning and customer learning together to value the supply chain
 403 learning scale, it is important for additional research to recognize the individual effects of each
 404 dimension. More precisely, future research should address the impact of different supply chain
 405 learning dimensions, explore how each dimension operate independently, making a deeply
 406 understanding of the relationship between green entrepreneurial orientation and green innovation
 407 in supply chain context.

408 Second, from the variable point of view, we only examined the supply chain learning as a
 409 mediator between green entrepreneurial orientation-green innovation relationship and didn't
 410 explore the possible moderating roles of environmental conditions. However, other organizational
 411 issues which related to organizational learning and innovation, are not considered in our study, such
 412 as collaborative commitment [14], supply chain integration [41], technological resources [64] and
 413 information technology [65] may also likely to have effects in our conceptual model. Future research
 414 should explore the impacts of these variables on the green entrepreneurial orientation -green
 415 innovation relationship.

416 Third, as a cross-sectional research, our study is based on just a snapshot data of ongoing time
 417 and we can't exactly assess the future implication of green entrepreneurial orientation on green
 418 innovation. Future longitudinal research should try to replicate this study to examine the dynamics
 419 of the relations established in the theoretical model. Furthermore, our results is based on the
 420 information from just one company of a partnership, which may reduce the robustness. We are aware
 421 of the difficulties of obtaining data from all relevant companies in supply chain. Future research
 422 relied on data from all supply chain partners is going to be a meaningful extension.

423 **Author Contributions:** Ying Guo initiated the project, designed the article framework and wrote the paper.
 424 Lifang Wang made contributions in data collection and then analyzed the data. Yan Xie designed the
 425 questionnaire and reviewed the paper.

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

427 Appendix A

428 Construct items

Constructs	Label	Measurement items	Sources
Green entreprene ur orientation	GEO1	A strong tendency for high-risk environmental projects (with chances of very high returns)	Naman & Slevin (1993), Hult et al.(2007) and Gima(2
	GEO2	In dealing with its competitors, my firm typically initiates actions that competitors respond to.	
	GEO3	To seek environmental development, my firm typically adopts a very competitive, "undo-the-competitor" posture.	
	GEO4	Changes in environmental product or service lines have been quite dramatic.	

	GEO5	A strong emphasis on environmental R&D, environmental technological leadership and environmental innovations.	001)
Supply chain learning capability	SCL1	we ensure that our employees and managers change their behaviors and processes appropriately as they gain new knowledge from our key suppliers	Quan Zhu et al. (2017) and Flint et al. (2008)
	SCL2	we ensure that our employees and managers change their attitudes about our market situation as they gain new knowledge from our key supply chain partners	
	SCL3	we ensure that managers in our key suppliers learn better ways to manage their business and work with us	
	SCL4	we ensure that managers in our key suppliers are learning better ways to operate and serve us	
	SCL5	we ensure that our employees and managers change their attitudes when needed about customers and sending customers as they gain new new knowledge about customers	Flint et al. (2008)
Green incremental innovation	GII1	We often improve an existing product to make it more environmentally friendly	Jing Dai et al.(2015) and Yuan Li(2007)
	GII2	We often improve existing processes to make them more environmentally friendly	
	GII3	We often exploit existing technologies to make processes more environmentally friendly.	
	GII4	We often exploit existing technologies to make products more environmentally friendly	
Green radical innovation	GRI1	We often introduce radically new concept innovations to make products more environmentally friendly	Jing Dai et al.(2015) and Yuan Li(2007)
	GRI2	We often develop and introduce radically new environmentally friendly technologies intothe industry	
	GRI3	We often create radically new environmentally friendly products.	
	GRI4	We often introduce radical innovations to make processes more environmentally friendly	

430 Note: All items were of 7-level Likert scale in the questionnaire.

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