

Can Entrepreneurship Promote Green Innovation of Enterprises?

- Based on the Empirical Analysis of Chinese Listed Companies

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Abstract: How entrepreneurship affects the modernization transformation of enterprises in the new era is of great research significance. This paper uses the panel data of China's A-share listed companies from 2015 to 2020 to analyze the relationship between entrepreneurship and corporate green innovation by constructing an indicator model of entrepreneurship. By constructing a multiple linear regression model, this paper analyzes how entrepreneurship affects corporate green innovation. The results show that entrepreneurship can positively affect corporate green innovation. This study is helpful for enterprises to analyze corporate culture and corporate behavior mechanism in the context of green development in the new era.

Keywords: entrepreneurship; Green innovation; Corporate culture; Internal behavior mechanism of enterprises.

1. Introduction

In recent years, the emphasis on environmental green innovation has gained particular importance among organizational decision makers. However, in many cases, despite the significance and advantages of green innovation, the participation of producers in green innovation does not meet expectations due to some problems (Abdullah et al. 2016). The most important factors affecting a company's adoption of green innovation are stakeholder pressure, environmental regulation, company size, characteristics of managers, human resources, and industrial sector (Gonzalez-Benito & Gonzalez-Benito 2006; Etzion 2007). The research on corporate green innovation is subdivided into two specific aspects. The first aspect of research focuses on the factors that contribute to green innovation. These factors include stakeholder pressure, government regulations, excess resources, expected economic benefits, and environmental awareness of managers and employees (Caputo 2014). Another aspect of the research focuses on the consequences of green innovation. This aspect mainly includes the relationship or mechanism between green innovation and firm performance. Although there is no consensus on the impact of corporate green innovation on business performance, existing empirical studies reveal a positive impact of corporate green innovation on business performance. However, the current barriers mainly stem from the fact that one of the barriers is the identification and classification of the green innovation activities of enterprises and the lack of correct understanding of green innovation measures in some enterprises.

Few studies have examined the factors affecting the implementation of green innovation in enterprises (Lin et al. 2011; Tseng 2013). Green innovation is the improvement of products or processes that can reduce environmental pressure and achieve sustainability (Rennings 2000). Green innovation can effectively reduce environmental pollution and its negative impact on the process of resource (and energy) use, thus creating sustainable development (Kemp & Pearson 2007).

Wang et al. (2010) pointed out that exploring the impact of entrepreneurs' personal characteristics, values and cognitive basis on corporate innovation will become an important development trend in this field. Sha Yanfei (2012) believed that strengthening the research on the relationship between entrepreneurs' green innovation and entrepreneurship and properly handling the relationship between the two are the current and future development direction of enterprises. In reality, entrepreneurship has an important impact on the practice of corporate green innovation. However, Daqiu Zhuang's operating creed is "only by looking at money can we look ahead". It should also be noted that different entrepreneurial leadership styles will play a certain role in the process of entrepreneurship influencing corporate behavior. In view of the above analysis, this study will examine the impact of entrepreneurship on corporate green innovation and further analyze the heterogeneity of corporate attributes.

The objective of this study is twofold. The first objective is to provide an integrated approach to assessing entrepreneurship. The second objective is to assess the impact of entrepreneurship on corporate green innovation. To achieve these two tasks, evaluating quantitative models with large-scale quantitative empirical evidence contributes to this study. In short, the main research question is: is there a significant relationship between entrepreneurship and corporate green innovation?

The main contributions of this study are as follows: 1. It helps to expand the quantitative methods of quantifying entrepreneurship from the perspective of corporate finance; 2. Expand and analyze how entrepreneurship, as a kind of corporate culture force, affects the green innovation behavior of enterprises in the new era, so as to analyze the mechanism and effect of entrepreneurship within enterprises.

2. Literature Review and Hypothesis Formulation

When analyzing green innovation, green product innovation and green process innovation (Chen, Lai & Wen 2006; Li et al. 2008; Chang 2011; Lin et al. 2014) and administrative innovation (Ndubisi & Iftikhar 2012) need to be distinguished. Green product innovation involves modifications to improve product design, quality, and safety. It also involves reducing the environmental impact of the entire product life cycle, such as reducing toxins during the production phase, using energy efficiently, and using biodegradable packaging (Kammerer 2009). The environmental impact of production can be mainly attributed to the use stage and the abandonment stage. In short, green product innovation emphasizes reducing the environmental impact of manufacturing, use, and disposal (Dangelico & Pontrandolfo 2010). Green innovation can promote green entrepreneurship and the creation of green enterprises. Green innovation includes behaviors that reduce damaging environmental impacts. For example, (Wong 2013; Zailani et al. 2014)). It should be noted that the enterprise green innovation defined in this paper refers to the improvement of enterprises' production process and technology, so as to promote the reduction of pollution emissions and reduce environmental damage.

Schumpeter first defined entrepreneurship as a combination of doing things in ways that others have not done before, including developing new products, using new production methods, opening up new markets, seeking new supply sources and realizing new organizational forms. Since then, many well-known foreign scholars have made insightful discussions on what entrepreneurship is, and most of them take innovation as the core. Drucker (1985) believed that entrepreneurship is an innovative behavior that uses existing resources to

create new wealth. Covin and Slevin (1991) pointed out that entrepreneurship can be defined from three aspects: innovation, active competitive attitude and risk taking. Sharma et al. (2001) argued that entrepreneurship includes innovative behaviors of internal and external changes or organizational restructuring and creation. Many domestic scholars also regard innovation, risk taking and the ability to acquire resources as the basic gist of entrepreneurship, such as Chen and Hao (2008).

Although most scholars recognized the view of Covin and Slevin (1991), entrepreneurship was defined from the three dimensions of innovation, active competition and risk taking. However, by reviewing the existing literature, we also found that some foreign scholars studied entrepreneurship from the perspectives of cooperative consciousness, helping the world spirit and sense of mission. North (1991) emphasized the importance of cooperation spirit in the new institutional economics and believed that it was an important source of entrepreneurship. Dolan and Garcia (2002) pointed out that in addition to creativity, ambition and energy, entrepreneurship should also contain a strong moral code. Mort et al. (2003) pointed out that entrepreneurship needs to create corporate benefits and social benefits. More and more scholars in China also analyze the connotation of entrepreneurship from the perspective of values and ethics. Li Jing (2004) pointed out that the paradigm reconstruction of entrepreneurship should be based on the ethical dimension of entrepreneurship. Wang Yanqiao (2004) believed that entrepreneurship is a kind of cultural quality that includes various characters such as belief, concept, will and quality, and integrates economic ethics, functional ability and way of thinking, which is in line with the requirements of social economy and modern development. Through empirical research, CAI Hua (2009) concluded that entrepreneurship includes five dimensions: innovation spirit, learning spirit, cooperation spirit, dedication spirit and responsibility spirit. Ding Donghong (2010) pointed out that entrepreneurship is a kind of psychological state, values, thinking paradigm or other spiritual characteristics formed under high pressure, which is closely related to the social and economic system at that time.

From the above review, it is not difficult to find that although scholars have not reached a consensus on the definition and expression of entrepreneurship, three inspirations can be obtained: (1) The classic definition of entrepreneurship takes innovation, active competition attitude and risk taking as the core, which are still important dimensions of modern entrepreneurship; (2) In recent years, the connotation of modern entrepreneurship has been expanded to a certain extent, which needs to be incorporated into the spirit of cooperation and the spirit of helping others; (3) The discussion on entrepreneurship belongs to the research category of entrepreneurial values, so it should be carried out more from the aspects of entrepreneurs' way of thinking and internal personality. Based on the above analysis, this paper holds that entrepreneurship should meet the requirements of the development of The Times.

Based on this, this paper puts forward the hypothesis:

H1: Entrepreneurship can promote corporate green innovation.

3. Empirical Analysis

3.1 Sample selection and data collection

The sample data come from A-share listed companies from 2015 to 2020, and the data source is CSMAR database. The R studio software was used for the empirical analysis.

3.2 Variable Definition

Explained variable: corporate green innovation. At present, the academia generally uses green patents to quantify green innovation. In recent years, there are more consistent quantitative methods for the quantification of green patents. In this paper, the selection criteria for green patents involved are: invention patents, utility

model patents and design patents with green technology as the theme of invention. Its goal is to reduce pollutant emissions and improve enterprise output. Its variable type is numeric. Since the existing quantitative methods of green patents have been very unified, there are thematic data sets in various databases. In this paper, the relevant green innovation data set from the CSMAR database is used as the quantitative data set of this paper.

Explanatory variable: entrepreneurship. As for entrepreneurship, there is no clear and unified definition at present. Among them, operating income, fixed assets and intangible assets can indicate the entrepreneur's operating ability, which can be regarded as the entrepreneur's ability to identify market opportunities; The independence of the board of directors considers whether the two positions of chairman and general manager are integrated, that is, whether the enterprise has self-employment, and shows the entrepreneurial ability of entrepreneurs. Innovativeness refers to the tendency to introduce new products (services), new technologies, build new production lines and seek new market opportunities, which is often manifested as the R&D investment of enterprises. The spirit of responsibility considers that when enterprises face economic difficulties and natural disasters in the country or society, entrepreneurs will respond in a timely manner and make charitable donations. The index composition of entrepreneurship is shown in Table 1.

Table 1 Construction of entrepreneurship

Type of evaluation	Measurement index
Business Capacity	Natural logarithm of operating income Natural logarithm of fixed assets Natural logarithm of intangible assets
Entrepreneurial Ability	Independence of the Board
Spirit of Innovation	R&d investment
Spirit of Responsibility	Socially responsible investment per share

In order to make the entrepreneurship index more objective, the entropy weight method is used to quantify the entrepreneurship variable for the above six indicators. R studio was used to standardize the indicators to measure entrepreneurship; Secondly, the information entropy of each index is calculated, and the weight of the index is determined according to the entropy value. Finally, the quantitative value of entrepreneurship is obtained by adding the weight of each indicator and the product of the standardized indicators. The annual weights of the entrepreneurship index are shown in Table 2.

Table 2 Weights of entrepreneurship index

Year	Operating Receipt	Fixed Assets	Intangible Assets	Board Independence	R & D Expenditure	Social Responsibility
2015	0.0964	0.1509	0.1617	0.1491	0.0275	0.4144
2016	0.0859	0.1194	0.1592	0.1498	0.0289	0.4568
2017	0.0828	0.1413	0.1444	0.1460	0.0318	0.4536
2018	0.1056	0.1438	0.1526	0.1280	0.0614	0.4086
2019	0.1134	0.1801	0.1859	0.1363	0.0632	0.3211
2020	0.0997	0.1565	0.1663	0.1422	0.0989	0.3363

Many studies have shown that the characteristics of a firm are also important variables that affect firm behavior and firm decisions. On this basis, we add seven control variables, including firm size and its age,

asset-liability ratio, ownership structure, ownership concentration, return on assets (ROA) and current ratio. Firm size is expressed as the natural logarithm of the firm's total assets. Age (Ages) is expressed as the difference from the year of establishment. The asset-liability ratio is expressed as total liabilities/total assets. Firm attributes are expressed as binary variables equal to 1 if state-owned shares are included and 0 otherwise. Ownership concentration is expressed as the proportion of the largest shareholder (%). Return on assets is expressed as net profit after tax divided by total assets. Current ratio is expressed as the ratio of current assets to current liabilities.

Table 3 Variable quantification table

Type	Index	Code	Varity
Variable explained	Innovation of enterprises	PRO	Number of green patents of enterprises in that year
Explanatory variables	Spirit of entrepreneurship	ACT	The measurement results are shown in Table 1
Variable of control	Size of company	PER	Natural logarithm of the firm's total assets
	Age of enterprise	AUT	And the enterprise listed year difference
	Asset-liability ratio	SPO	Total corporate liabilities/total corporate assets
	Enterprise asset attributes	PEO	It is equal to 1 if state-owned shares are included and 0 otherwise
	Concentration of ownership	NUM	Proportion of the largest shareholder
	Return on assets	PRI	Net profit after tax divided by total assets
	Current income ratio	SAL	Ratio of current assets to current liabilities

3.3 Model construction

This paper constructs the following model to quantify the research process:

$$PRO = \alpha_0 + \beta_1 ACT + \beta_i \text{control}_i + \varepsilon_i$$

Where control represents all control variables, α represents the constant term, β is the coefficient of each variable, and ε is the random error term. The above model is to explore the impact of entrepreneurship on corporate green innovation, so as to verify.

4. Analysis of Empirical Results

4.1 Descriptive statistics

Table 4 Descriptive statistics

Index	Min	Median	Mean	Max	SD.
PRO	4.32	111.91	392.94	11400.00	1256.18
AUT	2.31	6.89	7.53	17.20	3.39
PER	20.92	816.00	846.94	2836.00	442.42
NUM	14	41	18	61	14.674
SAL	0.02	2.00	3.68	31.15	5.02
PRI	3.17	102.88	206.81	6619.94	686.74

ACT	0.03	2.49	100.53	7444.53	762.13
SPO	1.17	114.33	307.33	7652.77	1020.72

This paper conducts descriptive statistics on all variables, and the descriptive statistics are shown in Table 4. The maximum value of corporate green innovation is 11400, and the minimum value is 4.32, indicating that the innovation patents of the samples are quite different, which may be affected by factors such as the industry and scale of the sample companies. The minimum value of entrepreneurship intensity is 0.03, and the maximum value is 7444.53, indicating that there are great differences in entrepreneurship among different sample individuals. The maximum and minimum values of the logarithm of sample firm size are 20.92 and 2836, respectively, showing a large difference among sample firm sizes. There is a large gap in the profitability of the sample enterprises, but the mean and median are both greater than 0, indicating that most of the sample enterprises are profitable.

4.2 Analysis of regression results

Table 5 Regression results

	Model 1
PRO	7.222** (2.724)
PER	-1.112 (-0.298)
AUT	7.480 (0.809)
NUM	-1.018 (-0.253)
SAL	1.788 (0.496)
PRI	6.377 (0.643)
SPO	3.660** (4.309)
F	14.74
Controls	YES
R ²	0.2317
VIF	FALSE

Note: The values in parentheses are t-values. ***, ** and * indicate significance at the confidence levels of 1%, 5% and 10% respectively, the same below.

It can be seen that the regression result of Model 1 is significant, and the regression coefficient of corporate green innovation is positive, which can verify the hypothesis of this paper. In other words, entrepreneurship can positively affect user perception.

4.3 Robustness test

Entrepreneurship is an important explanatory variable in this paper, and in order to further verify the

robustness of the empirical results, this paper adopts another method to construct entrepreneurship. According to Lin Yaopeng et al. (2022), entrepreneurship has at least two dimensions, namely, entrepreneurs' innovative spirit and entrepreneurs' entrepreneurial spirit. Therefore, the comprehensive variables of entrepreneurship are evaluated by the entropy method from the two dimensions of innovation and entrepreneurship. The number of patents accepted, the number of patents granted and the R&D expenditure are used as the proxy variables of entrepreneurs' innovation spirit. The total number of employees in private enterprises and individual enterprises is used as a proxy variable for entrepreneurs' innovative spirit. The author uses the above method to reconstruct the regression model, and the results are shown in Table 5. Although the regression coefficient has changed, the overall conclusion remains unchanged, and the research conclusion is still valid.

Table 6 Robustness test results

	Model 2
PRO	1.917*** (9.102)
PER	-0.997 (-0.264)
AUT	2.592* (2.616)
NUM	2.703 (0.053)
SAL	1.561** (5.048)
PRI	2.106*** (20.466)
SPO	4.721 (0.628)
F	15.63
Controls	YES
R ²	0.581
VIF	FALSE

5. Conclusions and implications

The lack of quantitative empirical evidence on the impact of entrepreneurship on corporate green innovation in the Chinese market is the motivation for this study.

In terms of the impact of entrepreneurship on corporate green innovation, the research results show that the influence coefficient of entrepreneurship and the increase of corporate green innovation is 7.22. Therefore, entrepreneurship has a strong positive impact on the increase of corporate green innovation. Therefore, due to the rapid change of green technology, the whole society has higher requirements for enterprises' green innovation, and enterprises must improve their entrepreneurship to promote their development. Therefore, it can be said that entrepreneurship can become a necessary element for companies to promote green development in the new era. In other words, the transition to a green economy depends to a large extent on the role of entrepreneurship in firms. Therefore, if entrepreneurship as a kind of corporate culture is properly applied in enterprises, managers of enterprises can increase the green innovation capability of enterprises under the turbulent conditions of the new era. Therefore, it is suggested that the managers of small and medium-sized

enterprises should put entrepreneurship on the agenda under the market conditions with higher and higher requirements for green in the new era, so as to increase the vitality of enterprise development. The government should also provide the context for creating an infrastructure to protect R&D. The OECD report on "Innovative Development for Green growth" makes some important recommendations. Some of these include:

1. The government should provide sufficient legal incentives to strengthen the market for green innovation results.
2. The government should provide appropriate policies to strengthen the cultivation of entrepreneurship.

The results also show that enterprises' own economic factors play a key role in entrepreneurs' investment in new businesses related to natural resources (Nikolaou, Ierapetritis & Tsagarakis 2011). Therefore, green innovation is considered as a profitable innovation activity with positive social, economic and environmental impacts. Among the own elements of the firm, firms with higher profitability can obtain higher liquidity, which directly supports green innovation and commercialization. Although low profitability limits the decision-making power of managers, it may interfere with the continuity of green innovation investment (Li et al. 2008).

Entrepreneurship plays an important role in green innovation. This is because it greatly affects the strategy and structure of the company. In addition, legal uncertainty and bureaucracy in the external environment may have prevented green innovators from operating effectively and limited the ambitions of these outcomes to create new industries. The creation of operational mechanisms for innovative results that are compatible with the development of enterprises is an issue that needs more research and investigation to provide the necessary facilities and apply the strategies of removing barriers. It is recommended that future researchers investigate the solutions, barriers and challenges that may arise in creating new mechanisms under green innovation and entrepreneurship. In addition, although this study provides a rich literature in the field of entrepreneurship and green innovation, further research can be conducted with new models to add other influencing variables. Other econometric models should be used for more accurate research in future studies.

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