

The Role of Information Technology in Promoting the Green Development of Agricultural Economy ——From the Perspective of Green Innovation of Listed Agricultural Companies in China

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Abstract. Nowadays, green development and information development have become a trend, computer technology and other high-tech to promote agriculture to break through the limitations of the natural environment, realize agricultural mechanization, establish information platforms, etc., to promote the unity of economic benefits and ecological benefits. Listed agricultural companies, which are important driving forces for the development of agricultural economy, are also affected by advances in information technology. Information technology is widely used in financial management, human resource management, production management and other aspects of agricultural listed companies. Information technology helps enterprises to achieve information management, thereby positively affecting enterprise performance. This paper takes listed agricultural companies as the research object and deeply explores the impact of green innovation and technological innovation on the financial performance of agricultural listed companies in China. The empirical results show that (green innovation has a significant positive effect on listed agricultural companies; (Increasing investment in research and development to promote the advancement of information technology has a positive effect on enterprise performance.) (Green innovation promotes the performance of all types of listed agricultural companies.) The study provides ideas and paths for agricultural economy and agricultural listed companies to realize the unification of ecological benefits and economic benefits.

Keywords: Information Technology Application, Green Innovation, Agricultural Economy, Listed Agricultural Companies

1 Introduction

Since the implementation of China's reform and opening up for more than 40 years, despite rapid economic growth, various environmental problems have also arisen. The coordination and integration of economic benefits and ecological benefits has aroused extensive discussion and research. At the same time, the rapid development of interconnected high-tech provides the possibility to realize the unification of economic benefits and ecological benefits. The development of agricultural economy is related to people's lives and national development, and it is imperative to achieve green development, while the rapid development of information technology and computer technology help the green development of agricultural economy. Computer technology is widely used in agricultural machinery, improving the efficiency of agricultural mechanization, such as the application of "CAD software technology" to China's

modern agricultural machinery and equipment, the use of "CAD" to better achieve paperless design and manufacturing. Designing through computer software not only reduces the design cost, but also avoids unnecessary waste of resources in the design. At the same time, information technology is used to build an information platform, timely publicize the latest policies, forecast weather, etc., and improve agricultural production efficiency. In addition, the application of computer technology to marketing and sales. It can build an efficient and reasonable network sales platform, and at the same time expand the market scale of agricultural products. The application of computer technology can increase the publicity of agricultural products through the establishment of websites, network publicity and other methods, improve the popularity of brands, and further improve the industrial sales chain of agricultural products. One of the important ways to achieve green development of the agricultural economy is for listed agricultural companies to promote green innovation through information technology and realize the coordination of corporate economic benefits and environmental optimization. Similarly, computer technology is widely used in listed companies. For example, computer technology and information technology are applied to the strategy formulation of enterprises, through the collection and analysis of big data, improve the accuracy of enterprise decision-making and reduce risks. In addition, information technology is applied to enterprise financial management system, human resource management system, etc., which is very good to improve the work efficiency of enterprises, which is conducive to improving the quality of internal control and improving performance appraisal methods. To this end, the wide application of computer technology and information technology promotes the green development of agricultural economy and enterprise performance. Taking enterprise green innovation and information technology progress as the starting point, this paper constructs a moderating effect model, deeply studies the impact of green innovation and information technology on the financial performance of listed agriculture, and explores the path of green development of agricultural economy.

2 Review of the literature

2.1 The use of information technology and agricultural economics and business performance

Scientific and technological innovation can significantly contribute to the growth of agricultural economy in the region ^[1]. The most prominent application of computer technology in agriculture is the combination with agricultural machinery, which plays a promoting role in the development process of China's agricultural machinery modernization, continuously promotes the improvement of agricultural development level, improves ecological benefits, and helps the green development of agricultural economy ^[2]. There is a positive correlation between IT investments such as Bharadwa ^[3] and business performance. Li Jixue ^[3] and other studies believe that information technology investment can optimize and upgrade the information technology infrastructure of enterprises. Investments in information technology software can significantly improve business performance. The effective application of computer technology in enterprise economic management can ensure better results in economic management, promote the effective improvement of the quality and efficiency of enterprise economic management, and provide support for enterprises to obtain more true, objective and accurate economic activity information.

2.2 Green innovation and firm performance

Green innovation refers to the creation of new technologies, products, etc. that can reduce energy and natural resource consumption, reduce or avoid environmental pollution, and thus achieve a combination of economic and environmental benefits. A review of the existing literature reveals that there is a degree of disagreement in the conclusions of the current research on the relationship between green innovation and financial performance. For example, Liu Mingguang^{[4][5]} found that there is a significant positive relationship between the green innovation model and each of its sub-level dimensions and enterprise performance, which can be divided into green product innovation, green process innovation and green organisational innovation according to the strength of the relationship, all of which have a significant positive relationship with economic performance. Zhu^[6] demonstrated that enterprises can effectively reduce their investment in environmental management by using new green technologies. Zhao Shukuan^[4] found that green innovation can positively drive the growth of financial performance. Green innovation plays an important role in a firm's development strategy, and firms actively engage in green innovation can help them achieve long-term sustainable growth in future performance. For example, Chiou^[8] argue that green innovation can help firms build industry barriers against potential entrants. Sun Liwen^[9] conclude that strengthening green innovation can curb the problem of declining performance contribution due to excessive strategic flexibility. Zhang Xiu'e^[10] conclude that a green entrepreneurial orientation can improve the performance of agricultural start-ups and help them to innovate their business models. They also study the positive impact of green entrepreneurial orientation on agribusiness performance under environmental uncertainty and the moderating effect of strategic flexibility. Geng, Yunjiang^[12] used a sample of heavily polluting firms and concluded that green innovation has a catalytic effect on the performance of heavily polluting firms. However, existing studies have also found that green innovation can have a negative impact on financial performance in some specific cases. Driessen^[9] suggest that green innovation can increase R&D costs and thus have a negative impact on financial performance. Li Man^[14], through research and analysis of data from listed manufacturing enterprises in Jiangsu Province, concluded that green innovation has different effects on the performance of enterprises with different levels of innovation. In summary, But the current study mainly focuses on manufacturing and heavy pollution enterprises, lacking research on listed agricultural companies.

3 Research hypothesis and design

3.1 Research hypothesis

The theory of natural resource-based view points out that under the continuous change of natural environment, the material materials and innovation ability accumulated continuously by enterprises to enhance the ability to resist risks and achieve the long-term and sustainable development of enterprises can bring long-term competitive advantage to enterprises. listed agricultural companies must have the ability to resist the risk of changes in the natural environment. The effective application of computer technology in enterprise economic management can ensure better results in economic management, promote the effective improvement of the quality and efficiency of enterprise economic management, and provide

support for enterprises to obtain more true, accurate economic activity information. To this end this paper combs through the relevant literature to propose hypothesis 1 and 2.

H1: Green innovation has a positive impact on the corporate performance of listed agricultural companies.

H2: The higher the R&D investment of enterprises, the stronger the impact of green innovation on enterprise performance.

At the same time, agriculture as a broad concept can be subdivided. Different agricultural sectors have different degrees of reliance on the natural environment. For this reason this paper innovatively classifies listed agricultural companies according to their main business and divides the 75 agricultural companies listed on A-shares (with anomalies excluded) into four categories, 37 in agricultural and by-product processing, 22 in farming, 14 in planting and 2 in forestry. Also considering the sample size, the hypotheses were formulated.

H3: Green innovation has a positive effect on the corporate performance of listed agricultural companies in the agri-food category

H4: Green innovation has a positive effect on the corporate performance of listed agricultural companies in the farming sector

H5: Green innovation has a positive effect on the corporate performance of listed agricultural companies in the plantation sector

Due to the small number of listed companies in the forestry category, this paper does not examine them separately for the time being.

3.2 Sample selection and data sources

Agricultural companies listed on A-shares in Shanghai and Shenzhen from 2018 to 2020 were selected for the study. To ensure the validity and accuracy of the data, listed companies in ST, *ST and PT during the study period were excluded, and some companies that did not disclose relevant data were excluded. Data for 75 listed agricultural companies were finally obtained. The data were mainly sourced from the Guotaian database, the China Research Data Service Platform and Sina Finance.

3.3 Variable definitions

(1) Explanatory variables

Corporate performance is the explanatory variable and is measured in this paper using return on assets (ROA). ROA measures how much net profit is generated per unit of assets.

(2) Explanatory variables

The explanatory variable in this paper is green innovation (GI), and a compilation of existing literature reveals that there are different methods of measuring green innovation. Many studies use questionnaires for data collection, however, the data obtained using this method is influenced by the subjectivity of the respondents and lacks a certain degree of objectivity. For example, Liu Mingguang ^[15] used the ratio of new product sales revenue to energy consumption power for measurement. And Gu Feng ^[16] use R&D investment to be measured

by taking the logarithm. This paper draws on the research methods of Zhao Shukuan^[7] and Geng Yunjiang^[12], and makes changes to the original one by using the logarithm of the number of green invention patents independently applied by enterprises to measure.

(3) Moderating variables

For the moderating variable information technology investment (YF), this paper selects the logarithm of R&D investment of listed agricultural companies.

(4) Control variables

Factors that affect the financial performance of a firm, such as: gearing, firm growth, equity concentration, etc., were selected and the specific variables used in this paper are detailed in Table 1.

Table 1. Definition of variables

Type	Name	Code	Variable Description
Explained variables	Return on assets	<i>ROA</i>	Net profit after tax / Total assets
Explanatory variables	Green Innovation Investment	<i>GI</i>	$\ln(1 + \text{Number of independently filed green invention patents})$
Adjustment variables	in information technology	<i>YF</i>	$\ln(\text{R\&D investment})$
	Gearing ratio	<i>Lev</i>	Total liabilities/total assets
	Business Growth	<i>Growth</i>	(Main operating revenue for the year - Main operating revenue for the previous year)/Main operating revenue for the previous year
Control variables	Concentration of shareholding	<i>Top1</i>	Shareholding of the first largest shareholder as a proportion of all shares
	Size of business	<i>Size</i>	Natural logarithm of the total assets of the business
	Age of business	<i>ListAge</i>	Natural logarithm of the actual number of years the business has been in existence

3.4 Model construction

To test the hypothesis in this paper, a multiple regression linear model was constructed by referring to the study of Li Xiudong^[16] as follows

$$ROA_{i,t} = \alpha_0 + \alpha_1 GI_{i,t} + \alpha_n \text{Controls}_{i,t} + \text{Firm} + \text{Year} + \varepsilon_{i,t} \quad (1)$$

Model (1) is used to verify the impact of green innovation on the financial performance of listed agricultural companies in China, where α is a constant term and ε is the disturbance term, and when α_1 is significantly positive, indicating that green innovation promotes higher levels of performance, hypothesis 1 is tested. The same applies to hypotheses 3, 4 and 5.

$$ROA_{i,t} = \beta_0 + \beta_1 GI_{i,t} \times YF_{i,t} + \beta_2 GI_{i,t} + \beta_3 YF_{i,t} + \beta_n \text{Controls}_{i,t} + \text{Firm} + \text{Year} + \varepsilon_{i,t} \quad (2)$$

Hypothesis 2 was tested by constructing model (2) with the inclusion of the moderating variable IC and the IC and GI multiplier terms, where β is the constant term and ε is the

disturbance term, and if β_1 is significantly positive, then Hypothesis 2 is tested.

4 Results of the empirical study

4.1 Descriptive statistics

The results of the descriptive statistics are detailed in Table 2, There is a significant difference in the financial performance of listed agricultural companies, and that the overall mean value of return on assets is 0.046, indicating that there are certain problems in the level of development of listed agricultural companies as a whole and that there is a need to explore ways to improve corporate performance. There is also a significant difference in the level of green innovation among listed agricultural companies, with a maximum value of 3.401 for green innovation and a minimum value of 0. Similarly there is a significant difference in the level of Investment in information technology. Industry segmentation is conducted to study the impact of green innovation and internal control on the performance of listed agricultural companies The impact of internal control on corporate performance is of great practical significance.

Table 2. Descriptive statistics

Variables	N	Minimum value	Maximum value	Average	Standard deviation
ROA	225	-0.258	0.675	0.046	0.088
GI	225	0	3.401	0.669	0.857
YF	225	1.85	20.33	16.61	3.67
Lev	225	0.048	0.938	0.401	0.176
Growth	225	-0.652	33.072	0.308	2.226
Top1	225	0.041	0.703	0.336	0.143
Size	225	20.336	25.532	22.207	1.028
ListAge	225	0.693	3.367	2.378	0.689

4.2 Correlation analysis

Green innovation has a significant positive correlation effect on corporate performance. R&D investment has a significant positive relationship on the performance of listed agricultural companies. The correlation coefficient between green innovation and internal control was 0.209, significant at the 1% level, indicating that R&D investment has a positive effect on green innovation.

Table 3. Correlation analysis

Variables	ROA	GI	YF	Lev	Growth	Top1	Size	ListAge
ROA	1							
GI	0.467**	1						
YF	0.327**	0.152*	1					
Lev	-0.219**	0.104	-0.027	1				

Growth	0.084	0.11	0.003	0.005	1			
Top1	0.024	-0.07	0.029	-0.045	0.143*	1		
Size	0.135*	0.121	0.312**	0.327**	0.065	0.004	1	
ListAge	-0.051	-0.048	0.097	0.017	0.061	-0.052	0.099	1

Note: **, *, indicate significant at 1%, 5% level respectively

4.3 Multiple regression analysis

The results of the multiple regression analysis using model (1) and model (2) with the overall listed agricultural companies as a sample are detailed in Table 4. the correlation coefficient between financial performance and green innovation is 0.047, which is significant at the 1% level, indicating that hypothesis 1 is correct. The cross product term of green innovation and internal control (GI * YF) and corporate performance is 0.075, which is significant at the 5% level, indicating that high-quality internal control can well contribute to the positive effect of green innovation on corporate performance, and hypothesis 2 is proved.

Table 4. Multiple regression analysis

Variables	Model 1 ROA	Model 2 ROA
GI	0.047** (0.000)	0.023* (0.026)
GI*YF		0.075* (0.026)
YF		0.120** (0.000)
Lev	-0.101** (0.001)	-0.171** (0.000)
Growth	0.001 (0.721)	0.001 (0.567)
Top1	0.025 (0.484)	0.042 (0.357)
Size	0.013* (0.018)	0.011* (0.022)
ListAge	-0.005 (0.498)	-0.017 (0.0678)

Note: **, *, indicate significant at 1%, 5% level respectively

4.4 Classification studies

In this paper, listed agricultural companies are divided into four categories, agricultural and sideline products, farming, plantation and forestry. The results are detailed in Table 5. The level of information technology investment of various types of agricultural listed companies varies greatly. while in terms of green innovation, the p-value is less than 0.05, indicating that there is a significant difference in the level of green innovation between the individual samples. And for this reason it is meaningful to classify the overall listed agricultural companies in this paper.

Table 5. One-way ANOVA test

Variables	Square and	Mean Square	F	Significance
ROA	0.228	0.057	8.352	< 0.001
GI	10.395	2.599	3.705	0.006
YF	1.450	0.008	14.496	0.009
Growth	7.682	1.921	0.383	0.820
Top1	0.290	0.073	3.696	0.006
Size	35.148	8.787	9.580	< 0.001
ListAge	5.253	1.313	2.854	0.025

The results of the test using model (1) for the three groups of samples are detailed in Table 6. The analysis shows that the correlation coefficient of green innovation for listed agricultural companies whose main business is processing agricultural products is 0.044, which is significant at the 1% level. The correlation coefficient of green innovation for listed agricultural companies whose main business is animal farming is 0.042, which is significant at the 5% level. The coefficient of green innovation for listed agricultural companies in the plantation category was 0.053, which was significant at the 5% level. The results indicate that hypotheses 3, 4 and 5 are correct.

Table 6. Results of regression analysis of data for various types of listed agricultural companies

Variables	Agricultural and sideline products processing	Farming	Planting
	0.044**	0.042*	0.053*
GI	(0.000)	(0.017)	(0.000)
Lev	-0.152**	-0.450**	-0.233**
	(0.000)	(0.000)	(0.000)
Growth	0.001	0.145**	-0.023
	(0.942)	(0.000)	(0.358)
Top1	0.013	0.282*	0.008
	(0.693)	(0.025)	(0.831)
Size	0.035**	0.022	0.000
	(0.000)	(0.090)	(0.956)
ListAge	-0.002	-0.009	0.012
	(0.727)	(0.645)	(0.232)

Note: **, *, indicate significant at 1%, 5% level respectively

4.5 Robustness tests

(1) Substitution of variables method

To enhance the accuracy of the research results, this paper uses the method of replacing the explanatory variables for testing. The firm's performance was measured by replacing the return on net assets with return on net assets (ROE) = net profit/net assets. The regression results obtained were consistent with the above results.

(2) Time lag test

Considering that there is a lagged effect on company performance after R&D generates green

patents, this paper lags both the explanatory and dependent variables by one to two periods for regression analysis, and the regression results obtained are consistent with the above results.

5 Conclusions and insights

Based on the above empirical analysis, some of the following conclusions are drawn: ①Green innovation plays a significant positive role in listed agricultural companies; ②Increasing investment in research and development to promote the progress of information technology has a positive role in promoting enterprise performance. ③Green innovation promotes the performance of all kinds of agricultural listed companies. The present empirical results provide ideas and insights for listed agricultural companies seeking to:

Firstly: listed agricultural companies can appropriately strengthen their investment in research and development of new green invention patents, achieve energy saving and emission reduction with new technologies, take up the social responsibility of promoting ecological civilization in the new era, and at the same time develop new products and markets to improve their profitability. Agriculture is an industry related to people's livelihood. Although the scale of development of listed companies is relatively small compared to manufacturing and other industries, they need to face huge operational risks and have a high dependence on natural conditions, so green innovation is of great help in improving the anti-risk ability of agricultural companies. Achieving the unity of ecological and economic benefits for companies.

Second: Listed agricultural companies need to increase investment in research and development, improve the level of enterprise information technology, and promote the level of green innovation of enterprises. At the same time, it is necessary to control the amount invested to avoid financial risks. Science and technology is the primary productive force, the development of agricultural economy is inseparable from the promotion of science and technology, in order to achieve green agricultural development, it is necessary to use all kinds of information technology to improve ecological effects.

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