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Research on the Motivation and Performance of Green Investment by Listed Companies in Shaanxi Province

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Abstract: China actively advocates the construction of an ecological civilization. As one of the key instruments for promoting ecological civilization, green investment plays a vital role in solving resource and environmental problems and in building an energy-saving, emissions-reducing, clean and low-carbon production and living system[1]. As an important energy base of China, Shaanxi Province's exploration and practice of green investment by its listed companies is not only related to the green transformation of the regional economy, but also plays an exemplary role in green development nationwide[2]. This study focuses on the green investment behavior of listed companies in Shaanxi and aims to reveal the motivations behind it and its performance effects. The paper reviews the background and significance of green investment research, integrates domestic and international research results, introduces the current situation of green investment development of listed companies in Shaanxi, and analyzes in depth the key factors affecting green investment decisions, such as market competition pressure, environmental regulation policies, and corporate social responsibility[3]. Through empirical research methods, the paper not only tests the direct impact of green investment on the economic performance of enterprises, but also explores its long-term impact on environmental performance[4]. Finally, based on the empirical results, targeted green investment strategy suggestions are put forward for listed companies in Shaanxi Province[5].

Keywords: Green Investment; Investment Motivation; Enterprise Performance; Financial Performance; Environmental Performance

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1. Introduction

1.1 Research Background and Significance

1.1.1 Research Background

Under the pressure of the global energy crisis and public concern over environmental protection, green investment has become an important issue on the agenda of the Chinese government[6]. Since the reform and opening up, China's economy has achieved remarkable successes, with its industrial scale and output value ranking among the forefront of the world. At the same time, however, environmental pollution has become increasingly serious, imposing considerable pressure on economic development[7]. In response to this challenge, the government has incorporated environmental protection into the evaluation system of economic and social development and actively promoted a series of concepts centered on green development[8]. The "Two Mountains Theory" emphasizes the coordination between economic development and environmental protection,

providing strong guidance for the construction of a "Beautiful China"[9]. The listed companies of Shaanxi Province are facing pressure to transform from traditional energy and chemical industries to green development[10]. With the improvement of environmental awareness and the rise of the green consumer market, these enterprises have begun to actively explore the path of green investment so as to respond to national policies, seize market opportunities, and fulfill social responsibilities[11]. Compared with other regions in China, although listed companies in Shaanxi still lag behind to some extent in green investment, they are actively seeking opportunities for transformation to achieve a win-win situation of economic and social benefits[12].

When measuring the effectiveness of green investment, we need to pay attention to its multi-dimensional performance, including economic benefits, environmental benefits and social benefits[13]. Green investment can bring long-term cost savings, improve resource utilization efficiency, reduce pollution emissions and win social recognition, creating favorable conditions for the sustainable development of enterprises[14]. This study will conduct an in-depth exploration of the motivations and performance of green investment by listed companies in Shaanxi, so as to provide useful references for the promotion of green investment[15].

1.1.2 Research Significance

In theory, this study enriches the research on the motivations and performance effects of green investment from the perspective of a specific energy province, providing empirical evidence for the green development theory of enterprises[16]. In practice, it summarizes the green investment experience of listed companies in Shaanxi, which is of reference value for the green transformation of energy enterprises in similar regions and for the realization of the "dual carbon" goal[17].

1.2 Literature Review

Scholars at home and abroad have carried out extensive research on green investment, mainly focusing on its motivations, effects and influencing factors[18]. In terms of foreign research, since the 1990s scholars have focused on the long-term impact of green investment on financial and environmental performance. Porter (1991) emphasizes that environmental regulations drive enterprises to carry out environmental protection innovation, thereby improving environmental performance and expecting the improvement of financial performance in the future[19]. However, some scholars such as Islam (2010) point out that environmental governance investment may increase operating costs and have a negative impact on financial performance[20]. Recent studies further examine green investment in the context of sustainable development and institutional investors (Abdou et al., 2022; Peshkov, 2021), showing that green investment has become an important carrier for enterprises to fulfill environmental responsibilities and enhance brand value[21][22]. In terms of domestic research, Zhao Lingdi and Wang Xiaofei (2022) further verify that green investment can significantly reduce the stock price volatility of enterprises[23], and Ma Yanbo (2021) systematically studies the green investment behavior of Chinese listed companies from the perspectives of motivations, performance and mechanisms[24].

To sum up, the existing literature provides a rich basis for this study, but there are still two gaps: first, most studies take the whole country as the sample, while studies specifically on an energy province such as Shaanxi are relatively scarce; second, few studies systematically combine the motivations of green investment with the dual performance of economy and environment[25]. This paper takes the listed companies in Shaanxi Province as the research object to fill these gaps[26].

1.3 Research Content and Methods

This paper first reviews the current situation of green investment of listed companies in Shaanxi Province, then analyzes the motivations of green investment from four aspects: market competition, environmental regulation, green policy incentives and social responsibility[27]. On this basis, using the panel data of listed companies in Shaanxi from 2010 to 2022, it empirically tests the impact of green investment on corporate financial performance and environmental performance[28]. The research methods mainly include literature research, theoretical analysis and empirical analysis (descriptive statistics, multicollinearity test, fixed-effects regression and robustness tests)[29].

2. Concept Definition and Theoretical Basis

2.1 Concept Definition

2.1.1 Green Investment

Green investment refers to the investment behavior of economic entities in the fields of environmental protection, energy conservation and emission reduction, clean energy and circular economy, so as to achieve the coordination of economic, social and environmental benefits[30]. In this paper, following the practice of Zhao Lingdi and Wang Xiaofei, green investment is measured by the environmental capital expenditure of enterprises deflated by total assets, covering expenditure on environmental protection technological transformation and R&D, treatment of pollutants, purchase of desulfurization and denitrification equipment, construction of clean and renewable projects, and restoration of mine ecological environment.

2.1.2 Enterprise Performance

Enterprise performance refers to the overall results of an enterprise in multiple key areas such as finance, market operations, customer satisfaction, employee development, innovation capability and social responsibility[31]. It not only focuses on short-term financial returns, but also on long-term sustainable development and market competitiveness. In this paper, enterprise performance includes financial performance and environmental performance: financial performance is measured by the return on total assets (ROA), and environmental performance is measured by the comprehensive scoring method based on the ENV database of CSMAR, with the Environmental, Social and Governance (ESG) evaluation system used as a supplement for qualitative discussion[32].

2.2 Theoretical Basis

2.2.1 Green Investment Theory

The steam technology revolution, the electrical technology revolution and the information technology revolution significantly promoted the development of productive forces, but also brought serious ecological and environmental problems[33]. In response to this challenge, the United Nations Conference on the Human Environment put forward the concept of sustainable development in 1972[34]. The green investment theory of enterprises, as a positive response to the concept of sustainable development, not only reflects the social responsibility of enterprises, but also provides an action guide for the green development of enterprises[35]. Compared with traditional investment, green investment pays more attention to environmental issues while taking into account resource utilization and economic benefits, and encourages the adoption of strategies of energy saving, consumption reduction and pollution recovery in the whole production and consumption chain[36].

2.2.2 Sustainable Development Theory

Sustainable development theory requires meeting the needs of the present without compromising the ability of future generations to meet their own needs. For enterprises, sustainable development means that while pursuing economic benefits, they must assume corresponding environmental and social responsibilities. Green investment is the concrete manifestation of this theory in enterprise behavior: through investment in environmental protection and clean production, enterprises can reduce the negative impact on the ecological environment and realize the coordinated development of economy, society and environment[37].

2.2.3 Technological Innovation Theory

The technological innovation theory holds that technological progress is the fundamental driving force of economic growth and enterprise competitiveness[38]. Green technology innovation can not only reduce the pollution emission of enterprises and lower the cost of environmental governance, but also create competitive advantages through differentiated products and processes[39]. Green investment provides financial support for technological innovation, and technological innovation in turn improves the efficiency and effect of green investment, forming a virtuous circle[40].

2.2.4 Stakeholder Theory

The stakeholder theory holds that the development of an enterprise depends on the support of various stakeholders such as shareholders, employees, consumers, the government and the community, and the enterprise should balance the interests of all parties[41]. Green investment is an important way for enterprises to respond to the environmental demands of stakeholders: it not only satisfies the government's environmental regulation requirements and consumers' preference for green products, but also shapes a responsible corporate image, thereby gaining the trust and support of stakeholders[42].

2.3 Mechanism Analysis

Green investment affects enterprise performance through multiple channels. In the short term, green investment requires

enterprises to invest a large amount of funds in technology R&D, equipment purchase and process improvement, which increases operating costs and may inhibit financial performance[43]. In the long term, green investment promotes technological innovation, reduces energy consumption and pollution treatment costs, improves resource utilization efficiency and corporate image, and is conducive to the improvement of financial performance[44]. As far as environmental performance is concerned, in the early stage of green investment, due to the high treatment cost and the immature technology, the improvement of environmental performance may not be obvious; with the maturity of technology and the emergence of economies of scale, environmental performance will improve significantly, showing a U-shaped relationship between green investment and environmental performance[45].

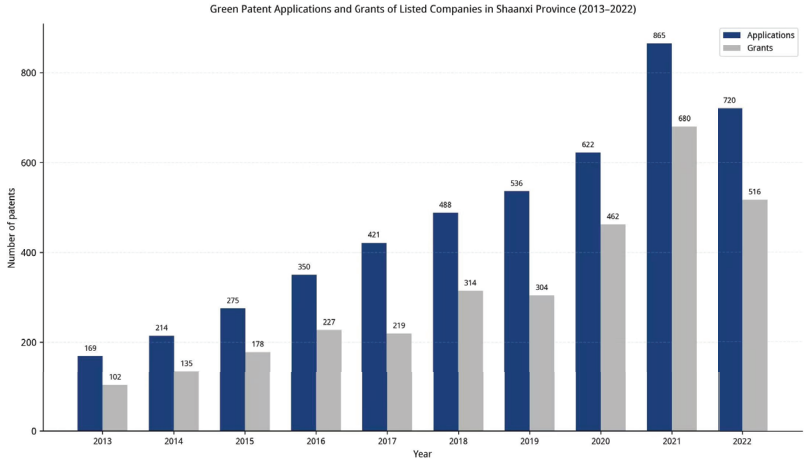
3. Current Situation and Motivations of Green Investment by Listed Companies in Shaanxi

3.1 Current Situation of Green Investment

3.1.1 Remarkable Achievements in Green Technology Innovation

Green technology is crucial for preventing and controlling environmental pollution and improving the quality of the ecological environment[46]. Listed companies in Shaanxi Province have made remarkable progress in green technology innovation in recent years, with the number of green patent applications and grants continuously rising[47].

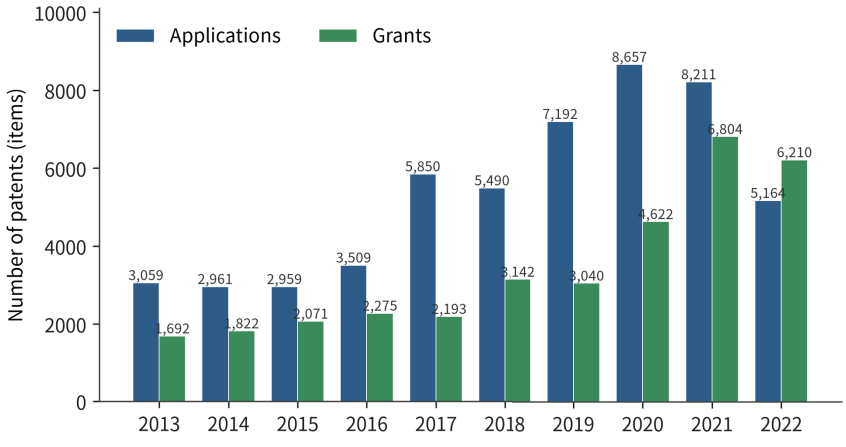
Figure 1 Green Patent Applications and Grants of Listed Companies in Shaanxi Province (2013-2022)



3.1.2 Steady Growth in Green Investment Scale

From 2016 to 2021, the scale of green investment by listed companies in Shaanxi Province showed a steady growth trend[48]. With the proposal of the national "dual carbon" goal and the support of green financial policies, listed companies in Shaanxi Province have increased their investment in clean energy, energy conservation and environmental protection, and circular economy[49].

Figure 2 Total Green Investment of Listed Companies in Shaanxi Province (2016-2021)



3.1.3 Accelerating Green Transformation

Driven by the wave of green investment, the green transformation actions of listed companies in Shaanxi Province have been increasing[50]. Leading enterprises represented by Shaanxi Coal and LONGi Green Energy have achieved leapfrog development from traditional energy to clean energy through large-scale green investment[51][52].

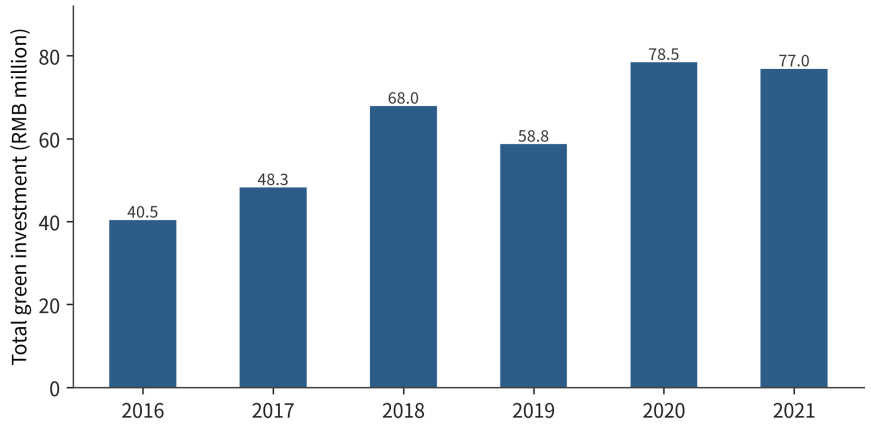
3.2 Motivations of Green Investment by Listed Companies in Shaanxi

The motivations for green investment by listed companies in Shaanxi Province are multi-dimensional: they stem not only from the urgent need for enterprises' own transformation and upgrading, but also from the promotion of external policy environment and market competition. The specific manifestations are in the following four aspects.

3.2.1 Market Competition

The green industry is currently in a golden period of vigorous development, with increasing industrial concentration and a stable market competition pattern gradually taking shape. As a dominant industry in Shaanxi Province, the photovoltaic industry has seen rapid growth in the number of newly registered enterprises and patent applications, and market competition is becoming increasingly fierce. Facing fierce market competition, listed companies in Shaanxi Province must enhance their competitiveness through green investment to seize the green market share[53].

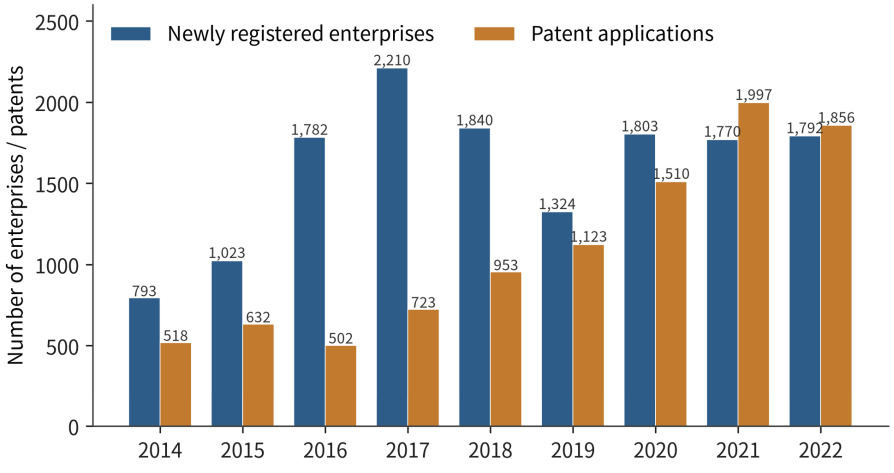
Figure 3 Newly Registered Enterprises and Patent Applications in Shaanxi's Photovoltaic Industry (2014-2022)



3.2.2 Environmental Regulation

At present, the state supervises corporate behavior through environmental laws and regulations to reduce its negative environmental impact[54]. With the implementation of environmental regulation policies such as ultra-low emission transformation and carbon emissions trading, highly polluting enterprises are facing increasing pressure to transform[55]. The environmental protection department of Shaanxi Province has increased penalties for enterprises with excessive emissions, forcing listed companies to increase green investment[56].

Figure 4 Environmental Fines of Shaanxi Coal Industry (2018-2025)



3.2.3 Green Policy Incentives

Under the guidance of the national "dual carbon" goal, it has become an inevitable trend for listed companies in Shaanxi Province to take the path of green development[57]. The state and local governments have introduced a series of green policy incentives, including special funds for the transformation of high-tech achievements and tax credits for investment in environmental protection equipment, which have effectively reduced the cost of green investment for enterprises[58][59].

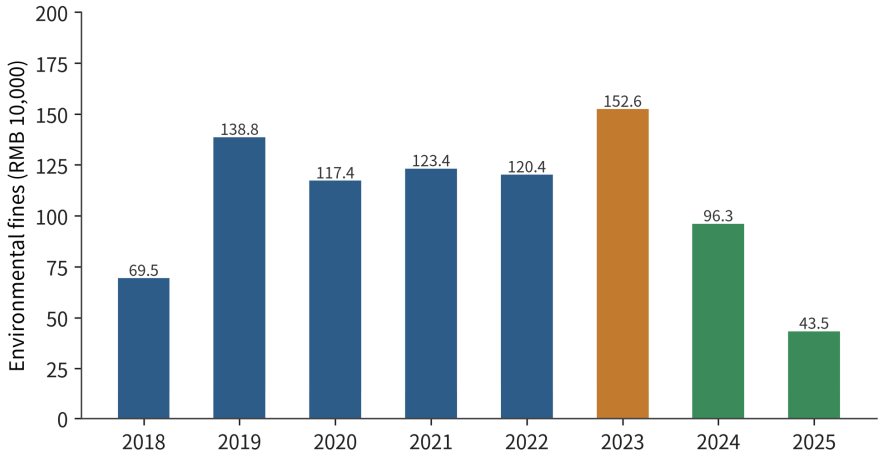
Table 1 Green-Related Government Subsidies Received by Shaanxi Coal (Unit: 100 million yuan)

Item	2018	2019	2020	2021	2022
Special Fund for High-Tech Achievement Transformation	0.82	1.48	1.27	1.14	1.36
Tax Credit for Special Equipment Investment	0.05	0.03	0.08	0.10	0.075

3.2.4 Social Responsibility

From the perspective of corporate social responsibility, listed companies in Shaanxi Province must comprehensively consider economic, environmental and social benefits in their growth process[60]. With the increasing social attention to environmental protection, listed companies are facing environmental pressure from investors, consumers and all sectors of society[61]. Through green investment, enterprises can establish a good social image and enhance brand value and market competitiveness[62].

Figure 5 Energy Consumption Structure of Shaanxi Province (2016-2022)



4. Research on the Performance of Green Investment

4.1 Theoretical Analysis and Research Hypotheses

4.1.1 Financial Performance of Corporate Green Investment

For enterprises, the ideal goal is to achieve dual improvement in environmental performance and financial performance[63]. However, due to the irreversible and long-term characteristics of green investment, enterprises need to bear high transformation costs in the short term. Green investment will increase capital expenditure and operating costs in the initial stage, leading to a decline in financial performance in the short term. With the maturity of technology and the emergence of scale effects, green investment will improve financial performance by reducing energy consumption, improving efficiency and developing green markets. Therefore, this paper proposes Hypothesis H1: Green investment has a negative impact on financial performance in the initial stage.

4.1.2 Environmental Performance of Corporate Green Investment

As a cutting-edge corporate resource allocation strategy, green investment focuses on green technology and renewable energy investment, and is an important way to achieve low-carbon transformation[64]. Green investment can directly reduce corporate pollution emissions by adopting clean production technologies, purchasing environmental protection equipment and

carrying out pollution control. However, the improvement of environmental performance is not a linear process: in the early stage of investment, due to immature technology and high treatment costs, the improvement of environmental performance may not be obvious; with the increase of investment intensity and the maturity of technology, environmental performance will improve significantly. Therefore, this paper proposes Hypothesis H2: There is a U-shaped relationship between green investment and environmental performance.

4.2 Empirical Research Design

4.2.1 Research Variable Design

The variable definitions in this paper are shown in Table 2[65]. The dependent variables include financial performance (ROA) and environmental performance (EP); the core independent variable is green investment (Ginvest), measured by the ratio of environmental protection capital expenditure to total assets; the control variables include firm size, leverage ratio, fixed asset ratio, whether in loss, proportion of independent directors, duality of CEO and chairman, shareholding ratio of the largest shareholder, and firm age.

Table 2 Variable Definitions

Variable Type	Variable Name	Variable Description
Dependent	Financial Performance (ROA)	Net profit at period-end / Total assets at period-end
	Environmental Performance (EP)	Constructed by comprehensive scoring method based on CSMAR-ENV database
Independent	Green Investment (Ginvest)	Green investment / Total assets
Control	Firm Size (Size)	Natural logarithm of total assets
	Leverage Ratio (Lev)	Total liabilities / Total assets
	Fixed Asset Ratio (FIXED)	Fixed assets at period-end / Total assets
	Loss (Loss)	1 if net profit is negative, 0 otherwise
	Duality (Dual)	1 if CEO and chairman are the same person, 0 otherwise
	Independent Director Ratio (Indep)	Number of independent directors / Board size
	Ownership Concentration (Top1)	Shareholding ratio of the largest shareholder
	Firm Age (FirmAge)	Current year - Year of establishment

4.2.2 Sample Selection and Data Sources

This study selects all A-share listed companies in Shaanxi Province from 2010 to 2022 as the initial research sample. Based on the initial sample, financial industry firms, ST firms, and samples with serious missing data are excluded, resulting in 524 firm-year observations[66]. Financial data are obtained from the CSMAR database, and environmental performance data are obtained from the CSMAR-ENV database.

4.2.3 Model Design

This paper adopts the following models to test the impact of green investment on financial performance and environmental performance:

Model 4-1 tests the impact of corporate green investment on financial performance:

$$ROAit = a + b1*Ginvestit + g1*Controlsit + di + qt + uit \quad (4\text{-}1)$$

Model 4-2 tests the impact of corporate green investment on environmental performance:

$$EPit = a + b3*Ginvestit + b4*Ginvest2it + g2*Controlsit + di + qt + uit \quad (4\text{-}2)$$

In the above models, i represents the firm, t represents the year, di represents firm fixed effects, qt represents time fixed effects, Controls is the set of control variables, and u is the random disturbance term.

4.3 Empirical Testing

4.3.1 Descriptive Statistics

The descriptive statistics of the relevant variables are shown in Table 3. The mean of green investment is 0.1144, with

a standard deviation of 0.1640, indicating that there is a large difference in the level of green investment among listed companies in Shaanxi Province. The mean of financial performance (ROA) is 0.0288, and the mean of environmental performance (EP) is 1.8492.

Table 3 Descriptive Statistics of Main Variables

Variable	N	Mean	Std. Dev.	Min	Median	Max
ROA	524	0.0288	0.0606	-0.3530	0.0291	0.2384
EP	524	1.8492	2.2094	0.0000	1.0000	9.0000
Ginvest	524	0.1144	0.1640	0.0000	0.0530	1.2209
Size	524	22.1723	1.3446	20.0634	21.9212	26.4260
Lev	524	0.4290	0.1891	0.0463	0.4332	0.9268
FIXED	524	0.2544	0.1683	0.0101	0.2072	0.7364
Loss	524	0.1469	0.3544	0.0000	0.0000	1.0000
Indep	524	0.3737	0.0488	0.3333	0.3636	0.5714
Dual	524	0.1775	0.3824	0.0000	0.0000	1.0000
Top1	524	0.3552	0.1531	0.1125	0.3141	0.7418
FirmAge	524	2.8821	0.3708	1.0986	2.9444	3.6109

4.3.2 Multicollinearity Test

To ensure that there is no multicollinearity problem, this paper adopts the variance inflation factor (VIF) diagnostic method[67]. The VIF values of all variables are less than 10, with a mean VIF of 1.21, indicating that there is no serious multicollinearity problem[68].

Table 4 Multicollinearity Test Results

Variable	VIF	1/VIF
Lev	1.46	0.6846
Size	1.44	0.6945
Top1	1.35	0.7395
FirmAge	1.30	0.7682
Dual	1.11	0.8993
Loss	1.11	0.9026
FIXED	1.06	0.9402
Ginvest	1.05	0.9536
Indep	1.03	0.9702
Mean VIF	1.21	

4.3.3 Baseline Regression Analysis

This paper uses stepwise regression for estimation. Table 5 reports the regression results of the impact of green investment on corporate financial performance and environmental performance. In columns (1) and (2), the regression coefficient of green investment is negative and passes the significance test at the 1% level, preliminarily indicating that green investment has a negative impact on corporate financial performance. In columns (3) and (4), the coefficient of the linear term of green investment is negative and the coefficient of the quadratic term is positive, both passing the significance test, indicating that there is a U-shaped relationship between green investment and environmental performance.

Table 5 Baseline Regression Results

	(1) ROA	(2) ROA	(3) EP	(4) EP
Ginvest	-0.0589***	-0.0417***	-1.6048**	-1.5862*
	(-2.6924)	(-2.9055)	(-2.0388)	(-1.9572)
Size		0.0108***		0.2702**
		(2.7160)		(1.9758)
Lev		-0.1182***		-0.4254
		(-5.8276)		(-0.7781)
FIXED		-0.0422*		0.4987
		(-1.7643)		(0.7372)
Loss		-0.0852***		-0.2758
		(-12.6976)		(-1.4633)
Indep		0.0594		1.6916
		(1.2005)		(1.0098)
Dual		0.0145**		-0.0929
		(2.1306)		(-0.4218)
Top1		0.0474*		-1.2185
		(1.9084)		(-1.0897)
FirmAge		0.0313*		0.4143
		(1.7023)		(0.4390)
Ginvest2			1.7898**	1.8536**
			(2.0255)	(2.0189)
Constant	0.0758***	-0.2107**	0.4850	-6.9002*
	(3.8821)	(-2.0349)	(1.3369)	(-1.6576)
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
N	524	524	524	524
R2	0.4805	0.7726	0.7449	0.7511

Note: t-values are in parentheses; *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

4.4 Empirical Result Analysis

The research results show that in the initial stage of corporate green investment, as green investment increases, corporate financial performance declines in the short term. This is mainly because green investment requires a large amount of capital injection in the initial stage, which increases the operating costs of enterprises. However, with the expansion of investment scale and the maturity of technology, the effect of green investment on environmental performance improvement gradually emerges.

4.5 Social Performance of Green Investment

A large number of studies have proven that through green investment, enterprises can develop and produce high-quality green products[69]. This can not only deepen the relationship between enterprises and stakeholders, but also enhance the social reputation and brand value of enterprises. Through fulfilling social responsibility and meeting consumers' green needs, green investment has won good social recognition for enterprises.

5. Conclusions and Suggestions

5.1 Research Conclusions

Through an in-depth discussion of the motivations and performance of green investment by listed companies in Shaanxi Province, this paper draws the following conclusions: First, the motivations for green investment by listed companies in Shaanxi Province include four aspects: market competition, environmental regulation, green policy incentives and social responsibility. Second, green investment increases corporate costs in the short term and has a negative impact on financial performance. Third, there is a U-shaped relationship between green investment and environmental performance, with a turning point of 0.43. When the intensity of green investment exceeds this turning point, environmental performance begins to improve significantly.

5.2 Policy Suggestions

Through an in-depth analysis of the green investment process of listed companies in Shaanxi Province, this paper puts forward the following suggestions: First, enterprises should persist in green technology R&D investment and reduce the cost of green investment through technological innovation. Second, enterprises should integrate green and low-carbon concepts into the entire process of production and operation to achieve coordinated development of economic and environmental benefits. Third, the government should further improve the green policy incentive system and reduce the cost of green investment for enterprises through fiscal subsidies, tax incentives and green finance. Fourth, enterprises should rationally plan the scale and pace of green investment to avoid giving up long-term green development goals due to short-term cost pressure.

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No

Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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