



# A Choice on the Wind: A Study on the Impact of the Development Direction of New Energy Products on Market Investment Decisions

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**Abstract.** With the global “dual carbon” green energy transition, green finance is advocated worldwide. As a core sector of new energy, the photovoltaic industry's development has also drawn much attention in the capital market. This article systematically studies the impact of the photovoltaic industry on investment decisions from three dimensions: enterprises, governments, and consumers respectively. By using the panel regression model and based on literature reviews and empirical data analysis, questions are raised around three core aspects: the total revenue structure of enterprises, policy density, and the proportion of revenue from product spending. This article finds that all three core dimensions have a certain positive impact on investment decisions to a certain extent. Among them, while policy density amplifies investment willingness, it may also generate phased investment risks. In terms of policy recommendations, this article suggests that a policy optimization system with high orientation, high transparency, high supervision and high controllability can be established to reduce the negative impacts brought about by market instability. In addition, this article also refines the scope of considerations for green finance in the market from a micro perspective, providing referenceable suggestions for policy optimization and market investment strategies.

**Keywords:** Photovoltaic Industry, Policy Density, R&D Ratio, ESG Performance, Panel Regression.

## 1 Introduction

### 1.1 Research Background and Topic

Since the late 20th century, the world has proposed energy structure transformation to address issues such as energy security, climate change, and high pollution, low efficiency, and carbon emissions from oil-based energy sources. With the accelerated transformation of the global energy structure, the new energy industry has become an important force driving global green transformation and technological innovation and has also promoted rapid commercial development in a short period of time. Among them, China's photovoltaic industry, as the most dynamic sub-sector of the new energy industry. Driven by the transformation towards green finance for carbon peaking and

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carbon neutrality, it not only enriches the global development path but also significantly influences investment decisions in the capital market.

## **1.2 Research Objectives and Significance**

In view of the trend of energy transition and the increasing development of new energy products, this article will systematically explore the decision-making impact of different orientations of photovoltaic on investment behavior. For this reason, this article focuses on the research based on the following three core issues. Specifically, does the total revenue structure of new energy photovoltaic product enterprises drive market investors' expectations for photovoltaic products to have a differentiated impact? Furthermore, does the proportion of revenue spent on photovoltaic products reflect changes in affordability and thereby enhance long-term investment behavior in the capital market? On the basis of these two issues, there is another extremely crucial one that needs to be paid attention to and explored. Does the density of government policies act as a magnifying glass for investment decisions in the photovoltaic industry?

## **1.3 Research Methods and Structure**

To answer the above questions, this research conducted literature review, digital regression model analysis (panel VAR), and data analysis. This research also extends based on the above issues, taking into account aspects such as investors' orientation towards high-R&D photovoltaic enterprises, the intensity of capital investment in high-R&D enterprises, and the scope of the industry's capacity to bear.

The main contribution of this article lies in its distinction from traditional research that focuses on macro policies or a single technical variable. Based on the previous macro energy analysis, this research attempts to systematically reveal how it simultaneously affects market investment behavior through three main micro levels. In addition, this research aims to clarify the development path of the new energy photovoltaic industry through empirical data results and panel regression. On this basis, an attempt is made to provide empirical references for the investment decision-making strategies in the capital market of the new energy photovoltaic industry. In this regard, this paper conducts a detailed Analysis in Data Analysis & Discussion and summarizes several conclusions and suggestions that may conform to the development direction based on the analysis results.

# **2 Literature Review**

## **2.1 Views on new energy products**

Amid the intensifying pressure of global economic changes, new energy products have become an important strategic pillar for sustainable living. New energy products have gained mainstream recognition from society and the market [1]. Enterprises have also gained trust in the hierarchy, which is widely regarded as the "legitimate solution" to climate and energy issues, including the interaction among multiple entities such as consumers, enterprises, policymakers and financial markets [1, 2]. Moreover, the growth in green product consumption has driven capital to increase investment in green

innovation. New energy products have been endowed with added value by society, and green innovation has become a "symbolic signal" for enterprises to demonstrate their environmental commitment. It is not only a moral proposition, but also a behavior with market returns [3]. However, surveys show that although the majority of people recognize the environmental attributes of new energy, they still have reservations about its safety and stability, especially among the middle-aged and elderly. For the public, there is still a phenomenon of "overestimating economic benefits and underestimating environmental value" in the perception of photovoltaic and wind power [2].

## **2.2 Relationship Between Investment and Industry Trends**

Investment in new energy products is currently in a market-oriented transformation period. While reflecting the advancement of the green development concept, it also exhibits dual characteristics of structure and periodicity. Among them, as a technology innovation-intensive industry, new energy has stronger growth elasticity in the early stage of economic expansion and the recovery period. Investment performance is also greatly influenced by cyclical factors [4]. From the perspective of refining the structure, investment in new energy has become a key approach to enhancing opportunity efficiency and promoting structural transformation. Constructing a "cyclical response graph" helps to represent the relationship between macroeconomic cycles and green industries and identify the dynamic performance patterns of different assets [5]. Based on the data of listed companies in the United States, it is found that green innovation is positively correlated with enterprise performance, which is conducive to the demonstration and enhancement of sustainable competitive advantages. In addition, new energy innovation not only reduces the financial performance problems of enterprises but also has the ability to hedge risks. Hedging risks at the enterprise level refers to the financial measures and strategies formulated and adopted by enterprises to deal with potential losses brought about by uncertainties in the market, policies, technologies. It reflects its strategic value [6].

## **2.3 Impact of Development Paths on Investment**

The government and the market pay particular attention to its development path. When new energy products shift from policy-driven to "core value" transformation, a positive interactive relationship emerges between green innovation practices (in the new energy industry) and enterprise investment behaviors. Among them, green innovation and effective investment enhance the financial performance of enterprises and alleviate multi-dimensional risks, making it easier to reduce exposure to policy and market uncertainties. Incentive policies drive new energy enterprises to obtain stable capital investment [6]. On this basis, it is pointed out that innovation-intensive industries such as new energy exhibit strong cyclical response capabilities during the economic recovery period [3]. From the perspective of financing, green innovation reduces the cost of equity financing for enterprises and gives them an advantage in carbon-intensive industries [7]. Furthermore, research shows that investors' self-efficacy in investment reflects the increasing sensitivity of the market to the sustainable development of new energy [8]. Strengthening environmental strategies and governance structures in the new energy industry can help enterprises avoid many inefficient investments caused by climate change [9]. Meanwhile, enterprises with outstanding carbon performance usually

achieve better financial returns, demonstrating that the capital market places greater emphasis on environmental transparency and the sustainability of green enterprise value [10].

## 2.4 Hypothesis

From a policy perspective, data analysis indicates that energy policy intervention has a considerable impact on investment sentiment in the new energy industry. The asynchronous release rhythm further leads to phased deviations [11]. The certainty and continuity of policies stated in the Inflation Reduction Act have enhanced market confidence and raised product expectations in the short term [12]. The above indicates that government policies play a key role in market investment, but literature and data show that the impact of policies has phased volatility. Thus, this article will make an assumption regarding this: In the process of the development direction of new energy, will the government's policy inclination enhance the investment orientation of market investors towards specific new energy?

## 3 Research Methods & Data Sources

### 3.1 Methodology

This research employed a panel regression model to explore the statistical relationship between the development direction of new energy and investment performance. Equation 1 presents this model.

$$Invest_{it} = TechDirection_{it} + Policy_{it} + R\&D\ Ratio_{it} + ESG\ Score_{it} + \mu_i + \tau_t + \varepsilon_{it} \quad (1)$$

$Invest_{it}$  is the investment performance of the enterprise in time  $t$ ,  $TechDirection_{it}$  is the degree of focus of enterprises in the new energy photovoltaic industry,  $Policy_{it}$  represents the intensity variable of policies in the field of new energy, also reflects the level of government policy support for the new energy photovoltaic industry at  $t$  time,  $R\&D\ Ratio_{it}$  is the proportion of R&D investment of enterprise  $i$  in time  $t$ ,  $ESG\ Score_{it}$  is the ESG comprehensive sustainable development score of photovoltaic enterprise  $i$  at time  $t$ ,  $\mu_i$  is the fixed effect of photovoltaic enterprise  $i$ . The fixed efficiency of an enterprise refers to the unobservable heterogeneity of enterprise  $i$ ,  $\tau_t$  is the fixed effect of time  $t$ . The fixed effect of time refers to whether there is an economic change in the market within time  $t$ . Rather  $\varepsilon_{it}$  is the random error term of photovoltaic enterprise  $i$  at time  $t$ .

### 3.2 Data Source

This research collected seven new energy photovoltaic data points from both the enterprise level and the industry and society level, namely, the proportion of R&D expenditure of enterprises, volatility (daily rate of return), cost expenditure of the new energy industry, inventory turnover rate, policy density of new energy, ESG performance, and subsidy rate of new energy. The observation period was from 2003 to 2023, and most

of the data were sourced from the CSSAR database. This is a widely used economic data resource. Table 1 presents the summary statistics of the data. These relevant data reflect the degree of attention each enterprise attaches to the future level of technological development and whether they have good expectations. And take into account the preferences of investors, whether they support the development of green industries, and whether their investment goals are to make profits. Finally, it is about whether there is support in terms of policies and regulations.

**Table 1.** Summary Statistics.

Variable	Mean	Media	Max	Min	Std
Unit cost of photovoltaic (USD/W)	2.140476	1.9	4.5	0.4	1.394329503
the proportion of R&D expenditure of enterprises	6.85864826	5.394753522	12.20218501	3.956074078	2.738930241
Inventory turnover rate	6.150594773	5.793008525	6.150594773	4.0376625	1.918000459
volatility (daily rate of return)	1.814391458	1.357162577	4.540689975	0.330308921	1.166076958
ESG performance	72.99671149	72.96485981	74.25478827	72.14049751	0.550677857
Subsidy rate	0.796222184	0.837689915	1.463873783	0.668878011	0.442387942

## 4 Data Analysis & Discussion

### 4.1 Enterprise Investment Orientation

**Cost of new energy resources.** Based on the above phenomena, the production costs of photovoltaic and battery modules have become an important factor influencing market investment decisions. From 2003 to 2023, the unit cost of photovoltaic power generation has shown a significant and continuous downward trend. This trend enables enterprises to no longer face the predicament of "excessively high costs and losses" when undertaking projects, and also effectively alleviates the pressure of elimination of marginal enterprises in the industry caused by fierce competition.

Furthermore, the steady growth of key costs reflects the maturity and commercial feasibility of the photovoltaic technology path, significantly reducing the technological uncertainty and risk premium faced by investors. Enterprises with cost advantages have more pricing power. Especially during periods of phased overcapacity or price fluctuations, the survival flexibility and profitability of low-cost enterprises should be highlighted. On the contrary, it may face strategic adjustments such as "transition" or exit from the market.

From the perspective of investors, the economy and sustainability of the project have become the focus of decision-making. Photovoltaic projects with a good cost structure

and large-scale capabilities have greater long-term investment value and risk resistance and are more likely to attract capital attention. For instance, Three Gorges Energy takes into account the electricity price level and power usage conditions comprehensively to ensure that the project has a good rate of return and sustainability.

**Daily return rate and R&D Ratio.** The daily rate of return can be understood as the average daily revenue of a unit photovoltaic project. It can be seen from the statistical chart that there was a slow upward trend from 2003 to 2010. The power generation efficiency is relatively low, and most of the initial profits come from government subsidies. From 2011 to 2015, it rose due to the improvement of power generation efficiency and the stability of electricity prices. From 2016 to 2023, there were fluctuations or even significant differences due to regional disparities and the implementation of grid parity. During this process, photovoltaic projects have shifted from initial government support to value expectations driven by two major variables: cost and market preference.

Overall, this trend directly reflects profitability. A higher daily yield rate means that the project has sufficient cash flow in the short term. It helps enhance market competitiveness and investment confidence in the photovoltaic industry. After 2016, with the changes in supply and demand and the timely adjustment and upgrading of technology, more opportunities were gained. Returns vary by region. Negative electricity prices may occur in the northwest region. Most investors tend to prefer projects with short cycles and quick returns. However, some investors prefer non-profit, highly challenging or projects with high difficulty in capital return.

From the perspective of investors, the R&D Ratio is one of the important indicators for measuring the cost reduction, efficiency improvement and technological leadership capabilities of photovoltaic enterprises. From 2003 to 2023, the proportion of investment in photovoltaic projects has been increasing year by year. From 2021 to 2023, some leading enterprises adopted diversified technical routes such as heterojunctions, with an R&D Ratio as high as 5% to 7.3%. A high proportion of R&D investment can not only meet the diverse consumer preferences in the short term. It also helps to adapt to changes in market trends in advance, enhance the technological adaptability of enterprises, and is of greater strategic significance against the backdrop of the accelerated global energy transition.

## 4.2 Government Orientation

**Density of New Energy Policies and Subsidy Rate.** Policy density refers to the frequency and extent of influence of formal policy documents issued by the government or regulatory authorities regarding the photovoltaic industry within a specific time unit. As can be seen from the chart, in the early stage, the policy density was relatively low, mainly relying on fiscal subsidies and project demonstrations. After 2010, with the establishment of the grid connection mechanism and the expansion of its scale, the government's policy density for the photovoltaic industry has increased. In China, the average number of policies issued annually has reached as high as 20, covering multiple

dimensions. In recent years, the policy density has relatively decreased, but the institutional nature has become stronger, mainly focusing on energy digitalization, emphasizing green finance, and providing route guidance.

From the perspective of investment, in the first stage, the subsidy policy, as the driving force for the early stage of the photovoltaic industry, reduces the initial investment cost, significantly increases investors' returns, and enhances their willingness to invest. In addition, high-density policies and continuous support can encourage enterprises to increase research and development innovation and investment in photovoltaic technology. Strong guiding policies help enterprises identify backward photovoltaic industries, optimize investment directions in a timely manner, eliminate backward production capacity, and avoid resource waste. And enhance industrial competitiveness. On the other hand, policy density also affects the financing environment. When the policy density is stable, some financial institutions have more confidence in photovoltaic projects and the difficulty of financing decreases. Meanwhile, the policy of reducing direct taxes has increased the net income of photovoltaic enterprises. When the production cost of photovoltaic products remains unchanged, high-profit industries have also strengthened development expectations and investment willingness.

However, a high policy density does not necessarily bring about positive impacts. Insufficient coordination between local and government policies and information failure are common problems of government failure, which lead to differences in the consumption of photovoltaic projects and further affect the judgment of enterprises and financial institutions on photovoltaic projects. In some cases, phenomena such as premium pricing may occur. Additionally, the demand for photovoltaic products is limited, which may lead to overcapacity.

**ESG performance.** With the continuous development of the global green energy transition, ESG performance has become an important criterion for evaluating whether the new energy photovoltaic industry has the ability for sustainable development. Based on the above phenomena, ESG performance is constantly on the rise. From 2003 to 2010, the development of green energy was in its infancy. During the financing period, enterprises all ignored actual emissions and governance standards. And there is a lack of relevant information disclosure. Since 2015, with the strengthening of the green development concept in the capital market, enterprises have gradually established more complete ESG rating systems. In 2021, driven by the reform of the implementation system for the dual carbon goals in China, the ESG performance was further provided with the opportunity to rise rapidly. The photovoltaic industry is also significantly higher than the traditional energy industry.

The continuous improvement of ESG performance in the new energy photovoltaic industry has a positive impact on the market from three dimensions. Firstly, good environmental protection activities enable enterprises to avoid the risks of legal proceedings and reputational damage. The photovoltaic industry with excellent environmental management, such as incorporating the logistics link into the carbon emission calculation, thereby reducing the financing risks faced due to uncertainties. In addition, excellent environmental performance means maximizing energy utilization, which is in line with the global trend towards a low-carbon economy. The life cycle of photovoltaic

modules is long, and photovoltaic products with strong competitiveness are more attractive, but at the same time, there will be inventory management issues. Secondly, at the social level, the improvement of ESG standards for photovoltaic products among midstream and downstream customers has prompted some enterprises to enhance their sense of responsibility, making it easier for them to stabilize customer relationships. However, the contributions of photovoltaic enterprises to the community and the protection of consumers' rights and interests have enhanced their brand image and customer loyalty. Finally, on the basis of the first two directions, the optimization of governance has led financial institutions to lower the interest rate level of photovoltaic investment loans and reduce financing costs at the same time. Complete governance helps to make the equity structure more reasonable and prevent internal manipulation within the enterprise. Enhancing information transparency enables investors to have a clearer understanding of the development direction of enterprises, thereby increasing decision-making efficiency and further enhancing the appeal of photovoltaic enterprises.

### 4.3 Consumer Orientation

**Proportion of New Energy Revenue in Income.** The changes in new energy photovoltaic products from 2003 to 2023 reflect the transformation of the entire new energy industry from a peripheral business to a core pillar, which has certain impacts on enterprise valuations and investor preferences. It also reflects the affordability and popularization potential of photovoltaic products. According to statistics, with the technological advancement of the photovoltaic industry and the continuous expansion of market demand, the proportion of photovoltaic products in the total revenue of enterprises is on the rise. On the contrary, for consumers, due to the continuous decline in the cost of photovoltaic modules and system integration and the growth of residents' income levels, the proportion of the trend has significantly decreased. When the market makes investment decisions from two perspectives, different directions of consideration will emerge in the market.

From the perspective of enterprises, in line with the development direction of The Times and in response to government dividends, some leading enterprises have increased the proportion of photovoltaic products. In the short term, it has a stable cash flow and risk resistance capacity, and also serves as a buffer for other businesses. A high proportion also implies a high reliance on policy and technological updates. Once technology lags behind market innovation iterations or policy adjustments, enterprises will face the risks of being replaced and having a low rate of return. Investors will reconsider their investment intentions.

Conversely, from the perspective of consumers, when the proportion of photovoltaic product spending in income decreases, it means that more families have the ability to use photovoltaic products. To enhance the living standards, the user penetration rate has risen, the fluctuations on the demand side have decreased, and consumption has driven the market. Consumers are more willing to further understand photovoltaic projects in the early stage of purchase. On this basis, the threshold for promotion has significantly dropped. For enterprises, the early promotion costs have decreased, the capital recovery cycle has shortened, and in the terminal market, the investment return rate

limit for entering the market is relatively high. It has enhanced the capital market's favor for the photovoltaic industry.

**Per Capita Utilization Rate and Inventory Carry Rate.** The per capita utilization rate of new energy photovoltaic products refers to the installed capacity of photovoltaic power per unit of population, reflecting the popularity of photovoltaic power in society. Inventory turnover rate, on the other hand, is used to measure the efficiency of the entire process of a company's products from procurement to sales. As can be seen from the chart, the per capita usage rate is on a continuous upward trend. This might be due to the cost reduction of technology, the accelerated popularization in various countries, and consumers' more explicit preferences. The inventory turnover rate, on the other hand, first declines and then rises. When it reaches a certain level, it tends to stabilize. This also indicates that in the early days of the photovoltaic industry, consumers had very little knowledge of photovoltaic products, and production and sales were not smooth. The raw materials fluctuate greatly. Subsequently, various enterprises gradually formed optimized management systems. As the supply chain accelerates, the inventory cycle rises accordingly.

From the perspective of investors, regions with a higher per capita usage rate tend to have more intense market competition. Investors can identify their own market advantages based on the existing photovoltaic products in the market, such as design and appearance. Decide whether to make the next investment. Conversely, in new regions and markets with low per capita utilization rates, investors can enter the market in advance to adapt and leverage their advantages. In addition, the per capita usage rate also reflects the society's acceptance of photovoltaic products. A higher per capita usage rate means that there are not too many social obstacles after investors choose to raise funds. A high inventory turnover rate usually indicates that the operational efficiency and profitability of the photovoltaic industry are both at the top level. The cost of occupying a large amount of capital is low, and the pressure of capital turnover is small. There will be no situation of insufficient supply or excessive supply. When evaluating enterprises, investors will also take into account the current situation of other industries in the market and choose industries with flexible capital turnover and large net profit margins for investment.

Above two trends jointly indicate that the photovoltaic industry has entered a new stage driven by efficiency and demand. For investors, the mature industrial process has further enhanced their interest and confidence in innovation in the photovoltaic industry, enabling them to make decisions more quickly.

## 5 Conclusion

The development of new energy is an important part of the energy transition and a significant means to address climate change and achieve sustainable development goals. Photovoltaic power generation, as the leading force of new energy. Whether its three main factors play a key role in investment decisions in the capital market is worth

in-depth analysis. This paper, through a literature review of the new energy photovoltaic industry, panel regression models and data analysis, draws the following main conclusions:

- 1) The increase in the daily return rate and the proportion of R&D investment of photovoltaic enterprises has driven the market's expectations for the long-term value of products.
- 2) When the proportion of photovoltaic product revenue declines and its affordability increases, photovoltaic products are shifting towards a market-driven model, and their resistance to changes in the investment cycle is enhanced.
- 3) The high attention from the state will lower the threshold for initial investment. The lack of coordination between the government and local authorities, as well as the frequent implementation of policies, will still disrupt the market rhythm and cause additional losses.

Based on the above analysis results, this paper puts forward two suggestions worth practical reference: 1) The market should enhance consumers' response capabilities and encourage local residents to apply for green credit. 2) Governments of all countries should also enhance the transparency and quality of their policies to avoid market conflicts.

This paper empirically studies the impact of photovoltaic industry development on market investment decisions from three main investment dimensions, but there are still deficiencies. Firstly, although the face data model used in this paper can directly reflect the investment efficiency of investment performance under different investor orientations, it does not fully consider the possible nonlinear relationships among variables. Secondly, the main data comes from low-frequency data such as CSMAR, which limits the timeliness and authenticity of the data. Finally, at present, the photovoltaic industry mainly focuses on the Chinese market. However, this article takes a global perspective and does not fully explore the investment characteristics of the photovoltaic industry in the Chinese market. This may lead to certain deviations in the understanding of market demand and the development of the photovoltaic industry. For this reason, in the subsequent exploration, it is planned to use high-frequency data and conduct an in-depth analysis of the current situation of investment decisions in the photovoltaic industry in the Chinese market and incorporate the factors of nonlinear relationships into the special consideration range.

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