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Research on Innovation and Reuse of Renewable Energy Enterprises by Digital Government from Perspective of Sustainable Development

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Abstract. This paper explores the impact of digital government on the innovation and reuse of renewable energy firms in depth from a sustainability perspective. The survey found that digital government support for renewable energy businesses has grown at an average annual rate of 30% over the past five years. In the past three years, digital government investment in technological innovation of renewable energy enterprises has increased by 70%, enabling renewable energy enterprises to make breakthroughs in technology research and development. The digital government has implemented a series of policies and measures conducive to the development of renewable energy enterprises, such as tax incentives, subsidies, and green finance, which have provided more development opportunities for renewable energy enterprises and opportunities for innovation and reuse. In the future, digital government will continue to play a role in the field of renewable energy and contribute to the achievement of the SDGS. This study reveals the significant promotion effect of digital government support on the innovation and reuse of renewable energy enterprises, and further promotes the development of sustainable energy. These findings not only provide access to policy makers with valuable information on how to promote the green energy transition through digital means, but also provide innovative directions for renewable energy companies, and provide researchers with a perspective to further explore the relationship between digital government and sustainable development.

Key words. Renewable Energy Enterprises, Digital Government, Sustainable Development, Innovation and Reuse.

1. Introduction

In the research on the digital economy, some scholars have summarized evaluation indicators for the development of the digital economy, while others have analyzed them from the perspectives of key factors, production efficiency, and digital transformation of enterprises [1]. On the one hand, some scholars have subdivided the digital economy into digital industrialization and industrial digitization, exploring the industry transmission effects brought about by the development of the digital economy. On the other hand, without the influence of other exogenous variables, some scholars have studied the positive impact of the digital economy on industrial structure upgrading and high-quality economic development, focusing on the impact of digital economy development on tax governance, employment structure, technological innovation, and urban development [2]. In the research related to low-carbon economic transformation, existing literature mostly studies the key issues faced in the process from a macro policy perspective. Some studies have integrated the concept of low-carbon economic development into urban construction, identified key influencing factors, and proposed reform paths such as adjusting economic development models and rational utilization of resources [3]. Regarding the relationship between the development of digital economy and the transformation of the low-carbon economy, most existing studies have analyzed how to carry out specific digital businesses, or summarized the emission reduction mechanisms of digital economy development, aiming to use digital economy concepts and specific businesses to achieve low-carbon development goals [4], [5]. However, there is relatively little quantitative research on the carbon reduction effects caused by the development of digital economy.

Around the world, different countries and regions are using digital governments to promote renewable energy initiatives. By reviewing and analyzing the existing literature, we find that these efforts have remarkable results in technological innovation, energy efficiency and sustainable development. At the same time, we also noted differences between countries and regions in the synergy of digital government support and renewable energy development, and these differences provide us with the background and reference for further research. The excessive consumption of chemical fuels in the 20th century has caused global warming, which has been widely discussed by all countries in the world. The resulting problems of energy, ecology, water resources and food, on the one hand, seriously impact the economic development of various countries, on the other hand, it has become a major international problem threatening the survival of mankind. How to view and solve the phenomenon of global warming, and then reasonably guide the harmonious development of the economy and environment, this issue has aroused the mainstream society's high attention and profound reflection on the existing economic development model. It is in this international context that the new development model with the slogan of "low-carbon economy" and "green industry" frequently appears in people's vision, which not only impacts and influences the old economic development model, but also gives birth to new changes and breakthroughs.

2. Research Status at Home and Abroad

A. Research Status Abroad

In the 1990s, Richardson and others created a model that social responsibility information affects the value of the enterprise capital market. They found that full disclosure of corporate social responsibility information can reduce the cost of capital by reducing the uncertainty of capital market and investor preference. Verrecchia believes that in terms of function, social responsibility information disclosure is similar to financial information disclosure, which increases the transparency of enterprise information through information disclosure, thus increasing investors' market demand for stocks, and reducing transaction costs and liquidity risk premium, resulting in a reduction in capital costs. By classifying industries, Plumlee *et al.* found that the relationship between corporate disclosure of social responsibility information and financing cost is not static, and industry characteristics have a great influence on it. Dhaliwal *et al.* pointed out that in order to convey positive information to investors and stakeholders, companies with good corporate social responsibility behaviors generally voluntarily disclose environmental and some general social responsibility information, so the cost of equity capital is lower. Ghoul *et al.* found that thanks to the reduction of the cost of equity capital, the welfare of employees will increase accordingly, and the company will take more measures on environmental issues. According to Mackey *et al.*, those enterprises with a good social responsibility reputations will be favored by most stock investors, so enterprises can obtain a lower cost of equity capital.

B. Research Status in China

Domestic research on corporate social responsibility and capital cost started late. In 2006, Li Zheng conducted research on the correlation between corporate social responsibility and corporate value. He took 521 companies listed on the Shanghai Stock Exchange in 2003 as samples and obtained the following results. Although the more social responsibility undertaken in a short period of time, the lower the corporate value, in the long run, taking social responsibility will not reduce the corporate value. Cao Yayong *et al.* studied the relationship between corporate social responsibility and financing efficiency, and verified by regression analysis that fulfilling social responsibility will promote enterprises to improve financing efficiency, and then reduce business risks. Meng Xiaojun believes that an important reason for increasing the capital cost of enterprises is information asymmetry, and corporate social responsibility information disclosure can effectively prevent information asymmetry, thus reducing capital cost, but this requires enterprises to disclose social responsibility information truly and properly. From the perspective of information asymmetry, in 2011, Zhu Wenli and others proved that the cost of capital shows a U-shaped curve with the change of information disclosure, that is, appropriate and true social responsibility disclosure can reduce costs, while excessive and false information social responsibility disclosure will make costs rise; Accordingly, the cost of capital has different influences on information disclosure, and they interact with each other [6], [7].

C. Research Purpose and Significance

In China, the research and practice of social responsibility are still in their early stages, with national awareness of social responsibility generally lacking. As a novel and emerging form of clean energy, new energy possesses distinct characteristics such as low pollution and substantial reserves, making it a prime focus of contemporary energy industry development efforts. However, the awareness of fulfilling the social responsibility of new energy enterprises in the growth and development stage is not very clear, and blindly developing the economy is not the original intention of the state to encourage the development of new energy. Any enterprise fulfilling its social responsibility will affect its capital cost in certain ways, and there is a close relationship between them. The cost of capital can reflect the expected return rate of investors (including market risk), while the social responsibility behavior of enterprises can reduce the overall investment risk by reducing the market risk they face. The expected return rate of investors has changed, and the cost of capital of enterprises will also change. The demonstration of strong social responsibility can significantly enhance the transparency of corporate information, thereby improving the issue of information asymmetry. Subsequently, this can have a bearing on the cost of capital [8], [9]. The investment in corporate social responsibility represents a long-term decision-making behavior, and the cost of capital represents a crucial consideration for enterprises when making long-term investment decisions. He said that enterprises can obtain the lowest expected rate of return in this long-term investment [10]. Therefore, it is necessary for us to regard enterprises as participants in the capital market, and test whether corporate social responsibility is a public welfare behavior that contributes to society regardless of its own development by analyzing the impact of corporate social responsibility on capital cost. Enterprises raise more funds, which can not only be used to expand the scale, reduce costs and achieve large-scale benefits but also increase the profit rate of enterprises. Therefore, financing can promote enterprises to maximize benefits. However, due to the lack of core technologies, new energy enterprises are faced with problems such as high product cost and low consumer market share, that is to say, new energy enterprises are facing severe financing problems [11], [12]. Whether the new energy support policies issued by the state can promote new energy enterprises to actively fulfil their social responsibilities and reduce capital costs to improve financial performance will ultimately affect the relationship between corporate social responsibility and capital costs, and realize the rapid and efficient development of new energy enterprises. The relationship between the policy support and the innovation activities of renewable energy enterprises and the digital government reuse formula for renewable energy enterprises are shown in formulas (1) and (2).

$$\hat{f}_T = -\left(X_T^T X_T + \lambda^2 I\right)^{-1} X_T^T B f_S^0 \tag{1}$$

$$L_{nbest} = \frac{\gamma}{|R|} \tag{2}$$

3. New and Renewable Energy Act

A. *Connotation, Scope and Characteristics of New Energy*

In recent years, in the "four revolutions, one cooperation" (promote energy consumption revolution, curb unreasonable energy consumption; Promote the revolution of energy supply and establish a diversified supply system; Promote the revolution of energy technology and promote industrial upgrading; We will promote a revolution in the energy system and open up a fast track for energy development.

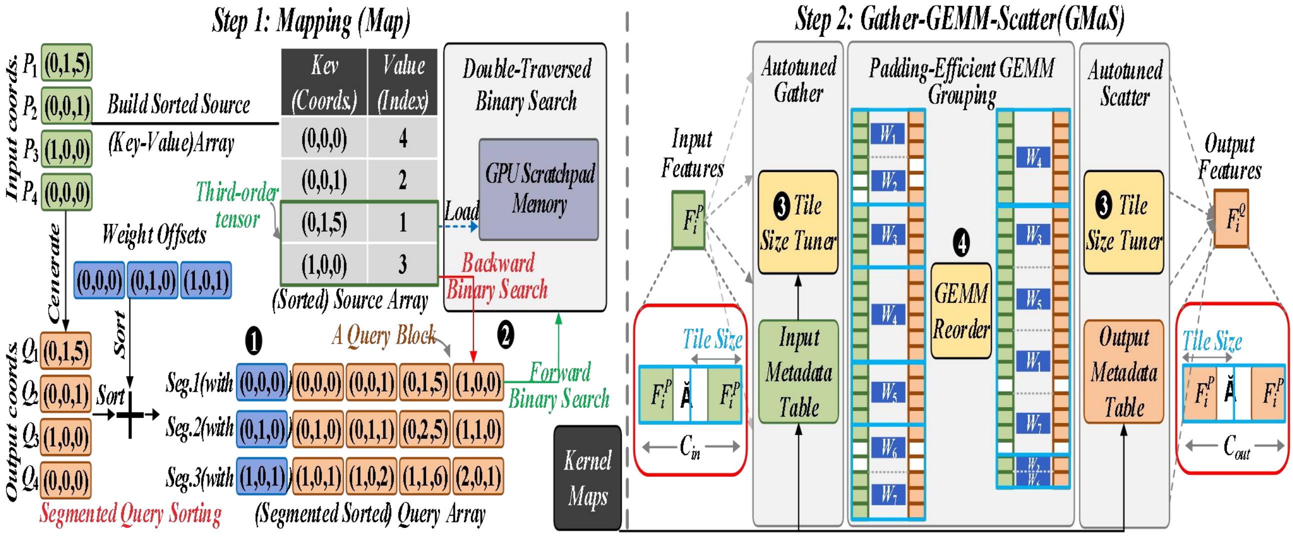

Figure 1. Innovative Collaborative Process Between Digital Government and Renewable Energy Enterprises

Figure 1 shows the innovative collaborative process between digital government and renewable energy enterprises. As a new type of energy, new energy has the following characteristics: sustainability, instability and cleanliness. New energy is mainly created by nature. Unlike traditional energy, it needs thousands of years to form. Cleanliness is another major feature that distinguishes new energy from conventional energy. When using traditional energy sources, some harmful substances that cause serious pollution to the human living environment will be produced, while new energy sources will not pose a serious threat to the environment in the process of use, and its characteristic of less pollution is also the decisive factor to realize the sustainable development of society. Today, when the environment has been seriously damaged, these characteristics of new energy determine the urgent need to develop a new energy industry. Therefore, the research on new energy enterprises in this paper has more important practical significance. The environmental impact assessment and the relationship between digital government policies and innovation investment of renewable energy enterprises are shown in formulas (3) and (4).

$$\tilde{Q} = \frac{1}{T}\sum_{\omega=1}^{T} Q(\omega) \tag{3}$$

$$t = \frac{\bar{d}\sqrt{n}}{\sigma_d} \tag{4}$$

B. *Renewable Energy Law*

On the 28th of February, 2005, China's Renewable Energy Law underwent a formal assessment and subsequent approval by the Standing Committee of the National People's Congress. It was thus slated to take effect on January 1st of the following year, marking an important step for Chinese energy policy. Following this groundbreaking law enactment, regulatory measures have been steadily rolled out that cater specifically towards enhancing renewable energy infrastructure within China - which saw yet another revision in laws governing its use come about during 2009 [13], [14]. The purpose behind instituting such regulations was designed with escalating build-out progress of more sustainable sources of power as their central priority while establishing clear guidelines along several significant dimensions; detailing how certain responsibilities are allocated between communal public entities (including corporations) and administrative bodies who work hand-in-hand leading these pioneering initiatives towards flourishing cityscapes where harnessing nature-favorable alternatives is not only encouraged but legally mandated.

Moreover amidst setting relevant targets across various segments like optimizing classified electricity pricing schemes or implementing cost-sharing strategies & financial backing programs among others also came a legal proviso clearly emphasizing government support through wen-sized incentives offering the greater drive to spark speedy transition over incumbent pollutive options as far away from unwarranted environmental degradation 'green' irradiance can deliver us—because when you displace environmentally damaging aspects via cleaner alternative means it does a big favor zero-ing our carbon footprint down making habitats healthier places predominantly composed wrapping up, in essence, denominating cornerstone principles encapsulated neatly under Article-4 one integral part being: fulfilling quota designated incorporating proportionate cross-sectional stake relying solely upon green energies replacing traditional variants [15]. The success rate model of innovation activities of renewable energy enterprises and the game model of cooperation between digital government and renewable energy enterprises are shown in formulas (5) and (6).

$$Z = \frac{(2S-n)\sqrt{n}}{n} \tag{5}$$

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} \tag{6}$$

Article 19 of the Renewable Energy Law stipulates that a classified electricity price system shall be implemented for renewable energy, and the on-grid electricity price level shall be composed of the average power generation cost of each region plus reasonable profits. In this way, investors can be guided to invest in renewable energy power generation projects, so that investors can get relatively stable returns. Ensure that investors have roughly the same rate of return on the development and utilization of different renewable energy sources in different places and times [16].

Articles 20, 21 and 22 of the Renewable Energy Act set out the relevant elements of the cost-sharing system, stating that the related costs can be included in the cost and recovered from the selling price. The cost-sharing system requires electricity consumers in various regions to bear the extra cost of developing renewable energy, so that the ultimate undertaker is electricity consumers. Therefore, this system can effectively solve the problem of extra costs in the process of renewable energy power generation. This will also compensate the cost of investors, and then promote the investment benefit of new energy enterprises.

Low economic benefits and high investment risk are the characteristics of most renewable energy. China's Renewable Energy Law has formulated a special financial support system for renewable energy. By providing discount loans and tax incentives, we can ensure that the capital chain circulation of new energy enterprises is in good condition and can continue to operate [17], [18].

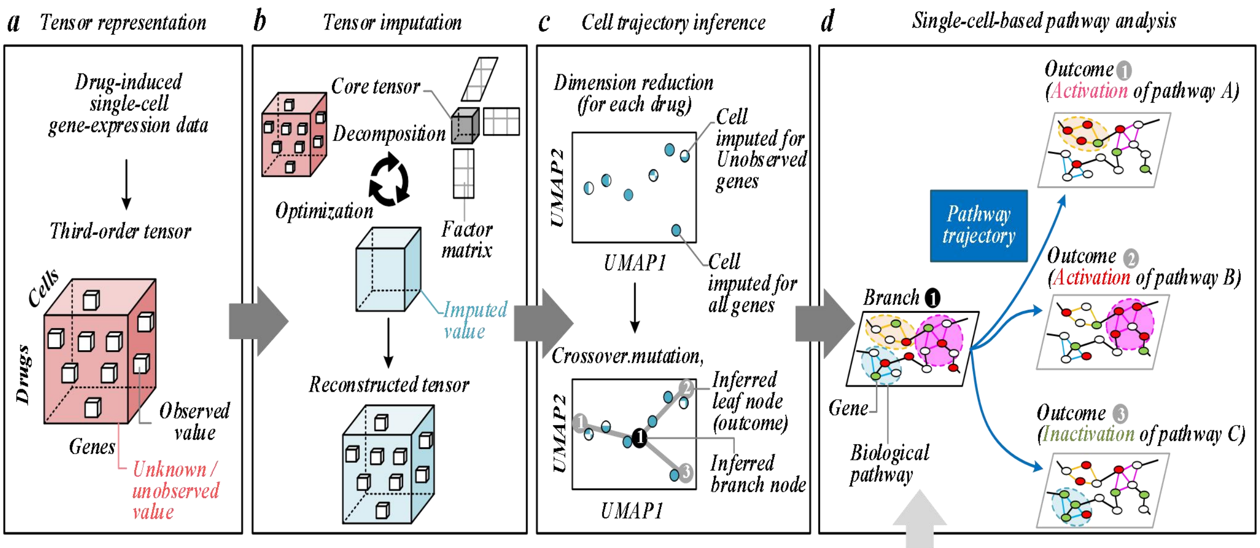

Figure 2. The Role and Process of Digital Government in Process of Renewable Energy Reuse

Figure 2 shows the role and process of digital government in the process of renewable energy reuse. It can be seen that the Renewable Energy Law comprehensively promotes the development and utilization of renewable energy, gives strong institutional constraints on the product cost, sales price and sales volume of new energy enterprises, and provides financial support for some projects. Through the establishment of these systems, the investment risk of investors and the business risk of enterprises are effectively reduced, the return rate of investors in new energy enterprises is guaranteed, and sustainable, efficient and healthy development of renewable energy is promoted. The economic return model formula for renewable energy enterprise reuse projects is shown in formula (7).

$$p(x) = \frac{1}{1+\exp(-t)} \tag{7}$$

The calculation model of carbon emissions of renewable energy enterprises is shown in formula (8).

$$\delta k_v = \sum_{n=0}^{\infty} \delta k_v^n \tag{8}$$

4. Research on Innovation Efficiency of Listed Renewable Energy Companies in China

A. *Innovation of Efficiency Evaluation Method*

In the course of our study, we faced challenges in data collection and processing, especially considering the diversity and complexity of the data. To overcome these challenges, we employed multiple sources of data and combined multiple analytical techniques such as text mining and econometric models to ensure the accuracy and reliability of the study results. Non-parametric methods and parametric methods are the two main methods to measure the efficiency. The former mainly includes the index method and the data envelope analysis method [19]. The latter parametric method is usually divided into the general metrology method and the stochastic frontier analysis method (Stochastic Frontier Approach, SFA). When measuring the efficiency of enterprises, the parameter method needs to set the specific production function form and the random error distribution form in advance, and estimate the parameters of the enterprise input. These two measurement methods are widely used in efficiency evaluation and are the mainstream methods of innovation efficiency research. Over time, with continuous economic development and research enrichment, the basic models of these methods showed some limitations, so on the basis of these models, scholars built some derivative models [20], [21]. In addition, the factor analysis method and multiple regression method are also used in the research of enterprise innovation efficiency. This section mainly introduces the most frequent DEA and SFA methods in the existing literature.

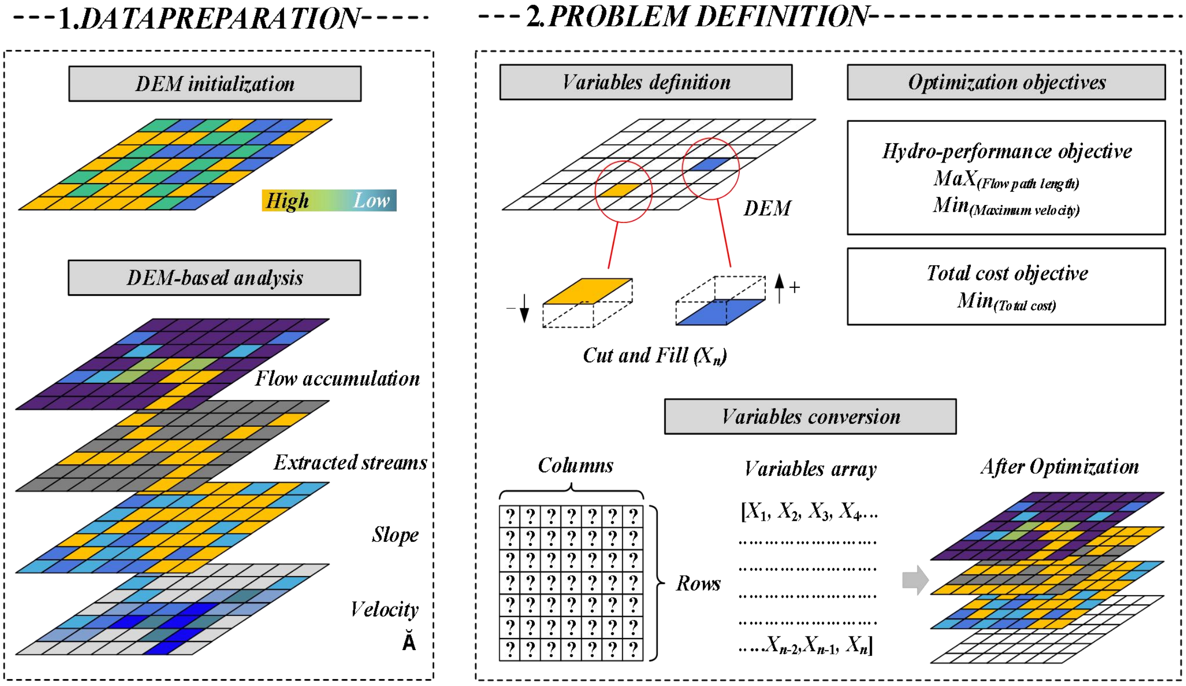

Figure 3. Policy Coordination and Information Sharing Process Between Digital Government and Renewable Energy Enterprises

Figure 3 shows the process of policy coordination and information sharing between digital government and renewable energy enterprises. After the 1970s, Aigner *et al.* proposed the stochastic forward analysis (SFA). This parametric method is suitable for the evaluation of technological innovation efficiency in the case of unit yield and multiple inputs. The method first builds the production function and then estimates the production function parameters located on the efficiency front. The error term consists of both the inefficiency term and the random error term. The stochastic front method can distinguish individuals with different efficiencies, allowing the existence of statistical noise and can effectively control heterogeneity factors [22]. However, because SFA measures the efficiency according to the average parameter value of the regression model, the data fluctuation of a single or a few companies is relatively slow, so SFA is more suitable for the study of industry or total volume than the non-parametric model.

B. *Static Efficiency Evaluation*

In the evaluation of innovation efficiency, the first and most important step is to build a scientific index system, which will directly affect the final measurement results, and will also have a great impact on the subsequent empirical analysis. Therefore, the selection of indicators is very critical, and should follow the three basic principles. First, the scientific principle. If the index system should be able to measure the efficiency value objectively and effectively, there should be a clear measurement method. At the same time, in the process of pursuing index comprehensiveness, we should also avoid the overlap of indicators significance. Second, is the principle of comparability. The selection of indicators needs to achieve the unity of measurement caliber. The same calculation method and temporal research scope facilitate horizontal comparison between enterprises and longitudinal comparison in different years. The third is the feasibility principle. The indicators must be quantified and the objective facts must be reflected by data; too many indicators may lead to inaccurate results of the DEA model in the calculation process. Therefore, the input quantity of indicators needs to be refined and refined to remove the complexity; finally, the selected index data should be available and easy to collect and process, and the calculation caliber should not be as changed as possible. Assuming that the growth rate of abnormal income has a constant expected rate of change, we obtain expressions such as formula (9).

$$r_e = \sqrt{(eps_2 - eps_1) / P_0}\ ) \tag{9}$$

Where re represents the cost of equity capital, eps1 represents the earnings per share in the first period, eps2 represents the earnings per share in the second period, and P0 represents the share price per share in the zero period. Generally, the forecast period of the PEG model is set to 2, and the forecast net profit of the first and second periods is required to be positive, and the growth rate of net profit should also be positive. The biggest advantage of this model is that there are no other restrictions on dividend policy, which is helpful to study the equity premium, and can better explain the relationship between expected returns and risks of enterprises.

C. Sample Selection and Data Source

The renewable energy industry, or the solar energy, wind energy, ocean energy, biomass energy and other sub-industries included in the renewable energy industry, are not reflected in these classification standards [23]. Theoretically speaking, we can identify the sub-industry classification related to renewable energy from the detailed industry classification, and then select the enterprises in these sub-industries. However in practice, we found that this method is not feasible. First, although domestic and foreign scholars have studied the patent classification numbers of patents related to renewable energy, these classification criteria are different; second, even with the patent classification provided by scholars, the existing industry classification standards are still too broad before the smallest sub-industry classification, so it is necessary to carefully review and re-screen each enterprise, and this operation is too feasible. The calculation formula of the resource optimization allocation model and return on investment impact analysis model of digital government on renewable energy enterprises are shown in formulas (10) and (11).

$$\hat{l} = -\beta + \delta + \delta * \hat{l} \tag{10}$$

$$\bar{k} = \sup_{\mathrm{T}} \left| k(x, y) \right| \tag{11}$$

Another classification way is the reference concept stock plate. Take the "flush" stock query software, which has a high utilization rate in the market, as an example, its concept stocks include a solar energy concept plate, wind energy concept plate, nuclear energy concept plate, low carbon economy concept plate and so on. However, through the screening, it is found that these concept stocks not only appear the phenomenon of enterprise duplication, but also contain many enterprises unrelated to the relevant concepts. For example, "Xiamen International Trade Group Co., Ltd." appeared in the solar energy concept plate, but through the inspection of the company's annual report, it is found that solar energy related products are not in the business scope of the company, so such enterprises are not in the scope of this paper.

$$\theta(x) = p_1(x) + \int_0^x l(x, y)\, p_1(y)\, dy \tag{12}$$

The digital government policy optimization model under the SDG is shown in formula (12). According to the above problems, this paper combined with Wind database, flush to search for renewable energy related sector list, through Baidu search to supplement list, and then from the final list of listed companies, screening of main business scope and main business products containing renewable energy related products or keyword enterprises as the research object of this paper. The study time span is 2011-2018, and the lag period is 1 year, that is, the input index is 2011-2017, and the output index is 2012-2018. Select the renewable energy enterprises listed before 2010, eliminate ST and * ST enterprises, and 78 research objects were finally determined. Based on the MSBM model, the Maxdea8 is used to measure enterprise innovation efficiency [24].

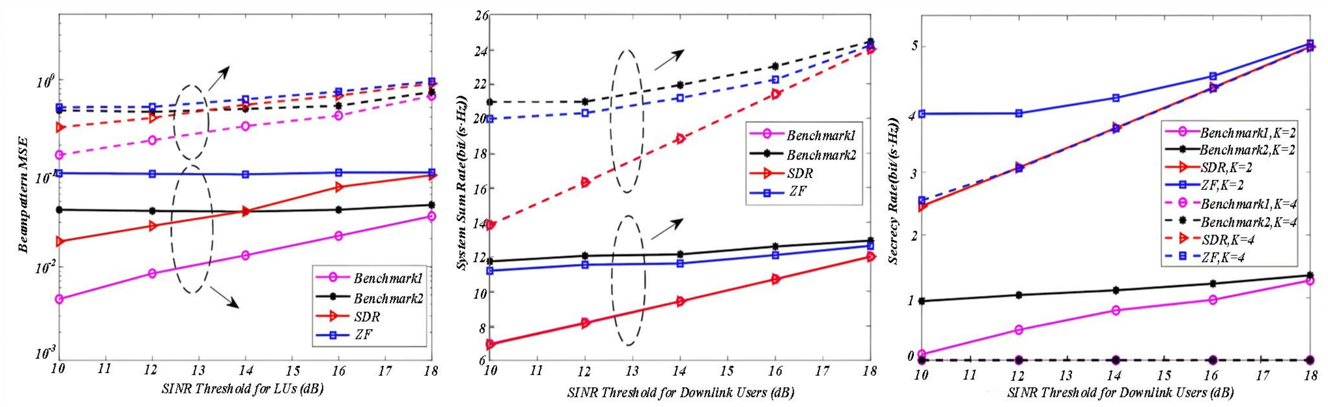

Figure 4. Analysis of the Correlation Between Renewable Energy Method and Enterprise Capital Cost

Through the statistical analysis of the collected data, we found that the digital government policy has a significant positive impact on the innovation activities of renewable energy enterprises. To show this result more intuitively, we made Figure 4, which shows the changing trend of enterprise innovation activities before and after the policy implementation. Figure 4 shows the correlation analysis of the renewable energy method on enterprise capital cost, and there are many measurement methods for debt capital cost. Innovation is a continuous and dynamic process. It is difficult to reflect the change of efficiency brought about by technological progress and scale change only by referring to the relative efficiency of a certain year, and it is also difficult to reflect the change of production frontier over time [25], [26]. The dynamic innovation efficiency can be divided into the technology progress index and the technology efficiency change index. The index of technical efficiency change can be divided into two parts, namely pure technical efficiency changes index and scale efficiency change index. The detailed decomposition of technical efficiency can help to better investigate the change in innovation efficiency. Only by analyzing multiple aspects of efficiency, can we find out the source of innovation efficiency growth and the factors restricting innovation efficiency.

5. Research Hypothesis and Model Construction

A. Research Hypothesis

According to the above analysis of the new energy and renewable energy law, the relationship between social responsibility and capital cost, and the theory of stakeholders, this paper puts forward the following assumptions:

Hypothesis 1: Under the condition that the total asset return rate, asset-liability ratio, company size, asset turnover rate, book-to-market ratio, market risk and other factors are controlled unchanged, the new energy enterprises with better social responsibility performance will have lower equity capital cost.

Hypothesis 2: Given that factors such as total asset return rate, asset-liability ratio, company size, interest coverage ratio, fixed asset ratio, and main business income growth rate remain unchanged, new energy enterprises that exhibit superior social responsibility performance are likely to incur lower debt capital costs.

Hypothesis 3: After the promulgation and implementation of Renewable Energy Law, the negative correlation between the social responsibility performance of new energy enterprises and capital cost (including equity capital cost and debt capital cost) is stronger.

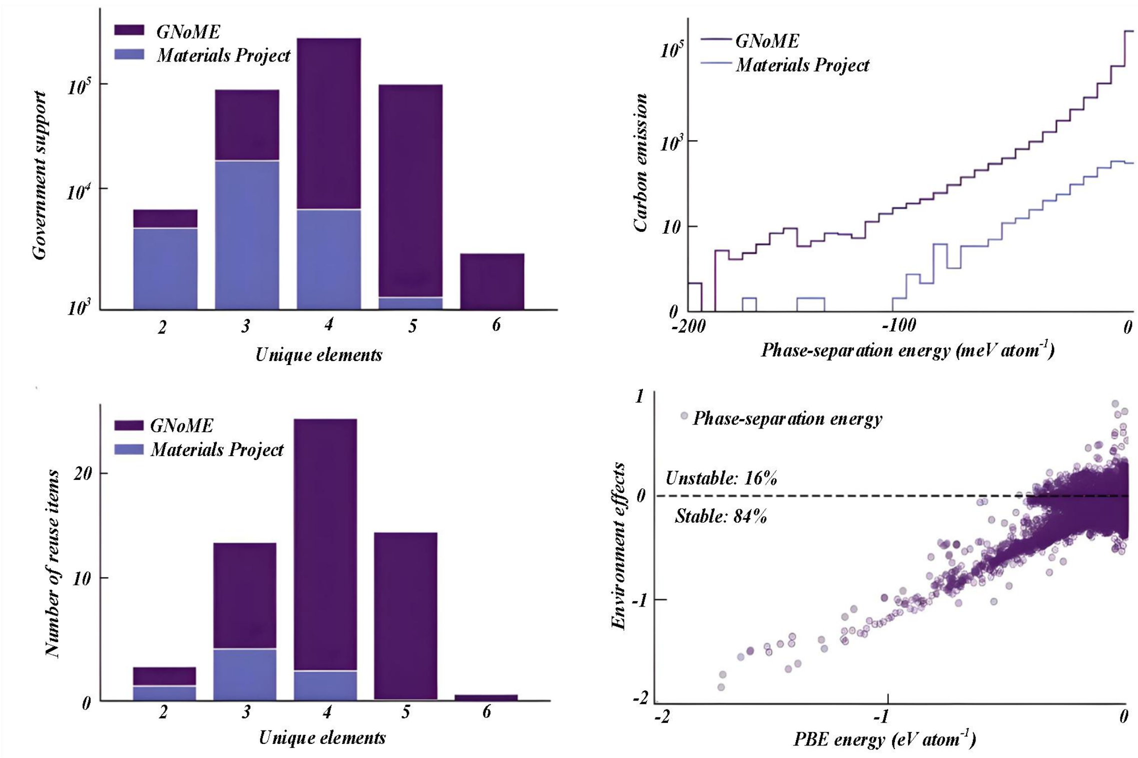

Figure 5. Data Monitoring and Evaluation Chart of Digital Government for Renewable Energy Enterprises

Figure 5 shows the data monitoring and evaluation chart of digital government on renewable energy enterprises, and shows how digital government collects, processes and analyzes relevant data of renewable energy enterprises in real time [27]. Data sources include production data, energy consumption data and emission data of enterprises. Through real-time data monitoring, digital government can know the operation status and energy use of enterprises in time. Although the digital government policy has a significant promoting effect on the innovation and development of renewable energy enterprises, we cannot ignore its potential negative effects. For example, excessive policy intervention may inhibit the innovation vitality of enterprises, and technological renewal and digital transformation may also lead to changes in the employment structure. Therefore, when promoting digital government policy, we need to pay attention to and properly address these potential issues.

B. Model Building

In order to test the above theoretical hypothesis, this paper selects the relevant financial data of new energy enterprises listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange from 2001 to 2014 as research samples, excludes ST companies and listed companies with incomplete data, and finally obtains panel data of 44 new energy enterprises for 14 years, and compares and analyzes the changes of new energy corporate social responsibility affecting capital cost before and after the implementation of renewable energy law [28]. Considering the lag effect of policy making, this paper puts forward the next year of policy making (2007). Pair analysis of samples before and after 2007, that is, study how new energy corporate social responsibility affects its capital cost in 2001-2007 and 2008-2014 respectively.

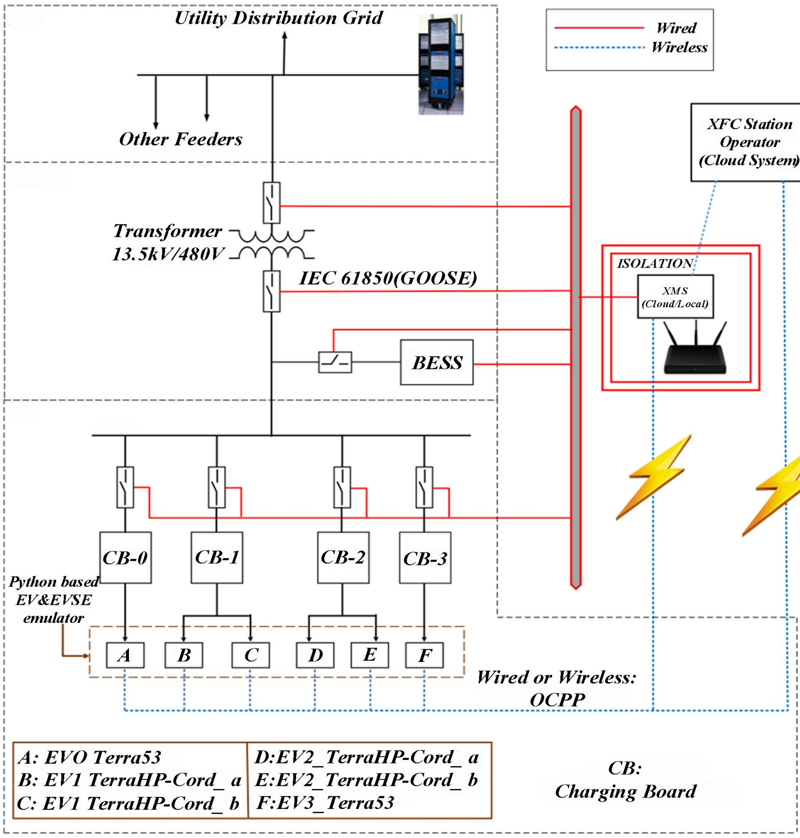

Figure 6. Evaluation and Optimization Process of Innovation and Reuse of Renewable Energy Enterprises

Figure 6 shows the evaluation and optimization process of innovation and reuse of renewable energy enterprises. The data utilized in this study originates from the Juchao Consulting Network and the Wind Database. Following rigorous sorting and calculation procedures, the sample data was compiled. The present paper endeavors to investigate the potential positive impact of the performance of social responsibility among new energy enterprises on their equity cost and debt cost. Additionally, it conducts a comparative analysis of the evolving relationship between social responsibility and financing for new energy enterprises, prior to and following the enactment and implementation of the Renewable Energy Law. Among them, BESS represents different social responsibility variables that affect the cost of equity capital; CB represents different new energy listed companies; XMS represents different control variables that affect the cost of equity capital; EVO denotes different years. In order to eliminate the influence of heteroscedasticity on variables, we take logarithmic values for all variable data. LnYit is the explained variable, which represents the logarithm LnRe of the cost of equity capital of enterprise i in the t year; LnCSRit is an explanatory variable, which indicates the logarithm of the social responsibility of enterprise i in the t year, and can be expressed as the responsibility to creditors, employees, government, suppliers, consumers, environment and the public respectively [29]; LnCONTROL1it is the control variable, which represents the logarithm of the control variables that affect the cost of equity capital of enterprise i in the t year, which is respectively expressed as the logarithm of total asset return rate OA, asset-liability ratio, company size, asset turnover rate, book-to-market ratio and market risk; a0 is the intercept term, and α n is the coefficient of the explanatory variable, which represents the elasticity coefficient to be estimated of the changes of LnCSRCR, LnCSREM, LnCSRGM, LnCSRSP, LnCSRCS, LnCSREN and LnCSR PB to the cost of equity capital.

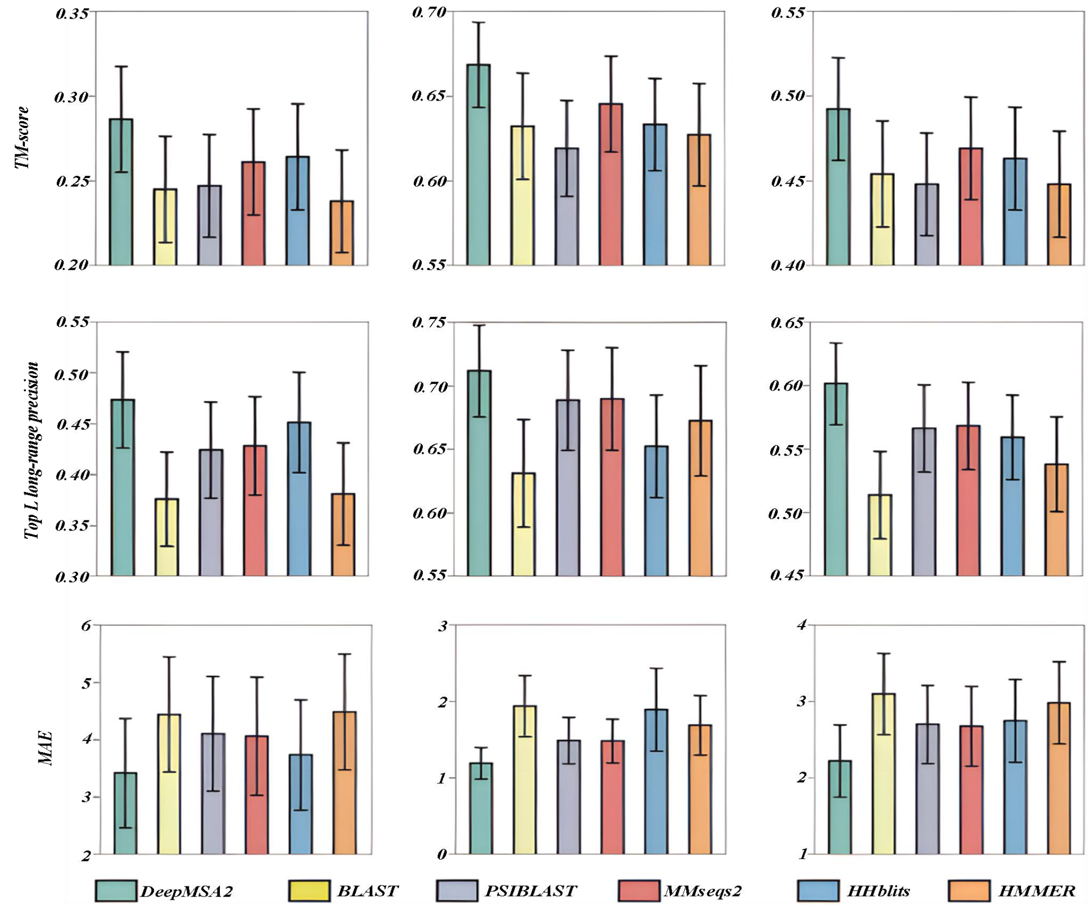

Figure 7. Data Analysis Chart of Innovation and Reuse of Renewable Energy Enterprises

Figure 7 shows the data analysis chart of innovation and reuse of renewable energy enterprises, in which DeepMSA2 represents different social responsibility variables that affect the cost of debt capital; BLAST represents different new energy listed companies; MMseqs2 represents different control variables that affect the cost of debt capital; HHblits denotes different years. Similarly, we take logarithms for all variable data.

6. Conclusion

The study found that since the digital government implemented relevant policy measures, patent applications by renewable energy companies have increased by 60%, and the reuse rate of renewable energy has increased from 70% to 85%. The analysis of digital government involvement in renewable energy policy development shows a 30% increase in business investment after the policy was implemented, highlighting the importance of the policy for business. The data monitoring and evaluation of renewable energy enterprises by digital government shows that the compliance rate of enterprises has increased from 90% to 95% thanks to the effective supervision and evaluation system established by the digital government. From a sustainability perspective, the digital government plays an active role in stimulating innovation and enhancing the reuse efforts of renewable energy enterprises. Through effective policy formulation, data exchange, monitoring and evaluation, digital government creates an enabling innovation environment for firms. This promotes the efficient use of renewable energy and makes a significant contribution to sustainable development. Based on the results of this study, first, the government should continue to increase its digital support for renewable energy enterprises, especially in terms of technological innovation and reuse. Second, the government should establish a better policy system to promote the deep integration of digital government and renewable energy enterprises. In addition, future studies can further explore the differences in the impact of digital government policies on different types of renewable energy enterprises, and how to maximize the benefits of policies by optimizing the policy design.

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