

Energy Market Prediction and Risk Assessment Based on China's Rural Collective Economy

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Abstract

INTRODUCTION: Energy, as a core element supporting the functioning of modern society, is vital to the development of the rural collective economy. With the upgrading of the agrarian industrial structure and the improvement of rural electrification levels, the energy demand gradually increases. Therefore, for China's rural collective economy, an in-depth study of the forecasting and risk assessment of the energy market has essential theoretical and practical value for scientific planning of resource allocation and improving energy utilization efficiency.

OBJECTIVES: This study aims to reveal the development trend and key influencing factors through an in-depth analysis of China's rural collective economy's energy market and to make scientific forecasts of the future development of the energy market. At the same time, through risk assessment, it proposes risk prevention and resolution countermeasures of the energy market for the rural collective economy to provide decision support for rural energy security and sustainable development.

METHODS: This study adopts a comprehensive analysis approach, combining historical data, policy literature analysis, and expert interviews. First, a comprehensive analytical framework is established by combing the development history of the rural collective economy energy market over the past few years. Second, quantitative analysis models and numerical simulations are used to analyze the key factors affecting the energy market. Finally, expert interviews are conducted to obtain the views of experts in related fields on the future development and risks of the energy market to improve the research conclusions further.

RESULTS: The results of the study show that the energy market of China's rural collective economy will show a trend of gradual growth, but it also faces multiple risk challenges, including market price fluctuations, policy adjustments, and an imbalance between supply and demand. In the future, with the deepening of green energy policies, rural collective economies will pay more attention to the application of clean and renewable energy.

CONCLUSION: To summarize, this study provides a scientific reference for the energy strategy decision-making of rural collective economies by forecasting and assessing the risk of the energy market based on China's rural collaborative economies. In the future, it is necessary to pay more attention to the improvement of the policy system to promote the development of green energy, as well as the establishment of a sound market regulatory mechanism to reduce the uncertainty of the energy market and provide solid support for the sustainable development of the rural collective economy.

Keywords: rural China, collective economy, energy market, market forecasts

Received on 18 June 2023, accepted on 5 February 2024, published on 21 February 2024

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doi: 10.4108/ew.5173

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1. Introduction

With the vigorous development of China's rural collective economy, the smooth operation and sustainable development of the energy market has become a crucial guarantee to support agricultural production and rural revitalization(Wang & Pei, 2022). This study is dedicated to comprehensively exploring the impact of the energy market on the rural economy and the future development trend through an in-depth analysis of energy market forecasting and risk assessment based on China's rural collective economy(Ren-Wei et al., 2022). With the rapid rise of China's economy, the economic development of rural areas has gradually received widespread attention. The rural collective economy has formed a unique form of financial organization based on collective ownership, with rural collaborative economic organizations as the main body and the pursuit of the interests of rural cooperative members as the goal (Tuncel et al., 2022). As an indispensable basic resource for production and life in modern society, energy plays a crucial role in the sustainable development of the rural collective economy(Ashlyn et al., 2023). However, a severe imbalance between energy supply and demand in rural areas of China leads to confusion and uncertainty in the energy market. At the same time, the volatility of the energy market also brings many challenges to the rural collective economy, making it face a complex and volatile situation in the development process(Zijian, 2023). Therefore, a comprehensive prediction and risk assessment of the energy market based on China's rural collective economy has essential theoretical value and profound practical significance. This study helps to understand the role and influence mechanism of the energy market in the rural economy and provides a scientific basis for the future development of the rural collective economy.

Forecasting and risk assessment of energy markets are essential to support rural economic development. A thriving collective rural economy requires reliable energy support in agricultural production, transportation, or daily life. A stable and adequate energy supply is directly related to the growth rate and quality of the rural economy(Yuan, 2021). Forecasting and risk assessment of the energy market can help rural areas better plan the utilization of energy resources and promote the transformation and upgrading of agrarian energy structure. China is facing severe environmental pressure and resource constraints, so it is imperative to actively promote the development of an energy structure conducive to clean, low-carbon, and renewable energy(W. Huang, 2021). Predicting and risk-assessing the energy market of the rural collective economy can provide a scientific basis for the adjustment and optimization of the agrarian energy structure and promote the sustainable development of rural energy(Kashirina et al., 2021). In addition, instability and insufficient supply in the energy market may lead to chaos in the production and life order in rural areas and even trigger social instability. Therefore, forecasting the development trend and assessing

the risk of the energy market is crucial for taking timely measures and maintaining social stability in rural areas. Through the prediction and risk assessment of the energy market, potential problems and risks can be detected early, providing a scientific basis for the government to formulate corresponding policies and measures and effectively maintain social order. Finally, energy market prediction and risk assessment are also essential to promote the energy market's healthy development (Zhou & Zhang, 2022). At the same time, scientific forecasting and risk assessment can also help enhance the market's transparency and predictability, provide investors and enterprises with a more stable and reliable business environment, and promote the development of the energy market in a healthier and more sustainable direction.

Energy market forecasting and risk assessment based on China's rural collective economy are urgent needs in developing China's rural economy and a hot issue that has attracted much attention from academics at home and abroad. This study is of great theoretical and practical significance because it spans multiple disciplines, including energy economics, rural economics, and risk management(LIU Jian-po, WU Feng, 2022). Through the prediction and risk assessment of the energy market based on China's rural collective economy, the author can gain a deeper understanding of the operation mechanism and influencing factors of the rural energy market. It provides new ideas and methods for energy market theory research and helps to reveal the dynamic relationship between energy demand and supply in rural collective economies. At the same time, the study also provides strong decision-making support for rural energy restructuring and energy market reform, which helps the government promptly adjust and improve relevant policies and measures to promote the healthy development of the rural collective economy.

Forecasting energy market trends and assessing risks are significant to enterprises and decision-makers (Neema et al., 2021). This helps formulate strategic plans, reduce investment risks, improve competitiveness, and provide scientific guidance for production and business activities. An in-depth study of the energy market in China's rural collective economy can better understand energy use in this vast economic system, thereby optimizing energy allocation more effectively and promoting sustainable economic growth. As the world's largest developing country, the development of China's rural energy market is directly related to the global energy landscape and climate change. Therefore, an in-depth study of the energy market in China's rural collective economy is crucial to China's sustainable development and of great international significance on a global scale(Girardi et al., 2021). A deep understanding of the characteristics and challenges of China's rural energy market can provide useful experiences and insights for global energy governance and contribute to promoting sustainable international development. Therefore, developing energy market forecasting and risk assessment based on China's rural collective economy is of significant theoretical value and essential practical and policy

significance(Zhao, 2021). This study is expected to provide critical relevance to promoting the sustainable development of China's rural economy and global energy governance, thus creating a far-reaching impact in academia and practice.

2. Background of the study

In today's context of globalization, the study of the collective economy and energy market risks in rural China has become an important topic that has attracted widespread attention. China is the largest developing country in the world, and its rural areas occupy a vital position in the vast territory of the country, which is crucial to the sustainable development of the whole country(Zhang et al., 2021). In this context, developing the rural collective economy, as an essential part of China's rural economic system, is directly related to the energy market risks. China's rural collaborative economy has always undertaken the mission of promoting agricultural modernization and improving the living standards of farmers(Cumming, 2022). However, under the multiple pressures of global climate change, economic globalization, and the imbalance between energy supply and demand, China's rural collective economy faces unprecedented challenges and opportunities. As a core element supporting the functioning of modern society, the rational allocation and utilization of energy in the rural cooperative economy is crucial to ensuring sustainable rural development(Fang et al., 2023). Therefore, an in-depth study of the relationship between China's rural collaborative economy and energy market risks is of great theoretical and practical significance for understanding the development path of China's rural economy, optimizing the allocation of energy resources, and formulating effective policies to cope with the risks.

The collective economy has a unique organization and operating mechanism in the rural economy, covering a wide range of areas, including agriculture, rural industry, and pastoral services(Edwin et al., 2022). As China's agricultural modernization and urban-rural integration advance, the rural collective economy not only plays a key role in maintaining rural stability and raising farmers' incomes but also plays an essential role in energy demand and the energy market. There is a growing demand for energy in agricultural production, rural industry, and rural services, and changes in this demand are directly related to the volatility of global energy markets and the instability of energy supply chains, presenting a new set of risks and challenges. Risks in the energy market are severe and complex issues involving many aspects, such as macroeconomic policies, international market movements, climate change, and scientific and technological advances(Andrade et al., 2021). Due to its unique nature and geographical distribution, the energy market risks may be more diverse and specific in China's rural collective economy (Y. Huang & Luo, 2021). This includes, but is not limited to, the volatility of energy prices, the uncertainty of energy supply, and the upgrading of energy technology.

One of the current pressing issues is how to better understand and cope with energy market risks in rural collective economies in such a context.

In this context, this study aims to explore in depth the interrelationship between China's rural collective economy and energy market risks and to systematically analyze the current situation and trends of energy utilization in the rural collaborative economy through forecasting and risk assessment of the energy market(Fu, 2022). Through theoretical and empirical research, it will attempt to reveal the mechanism of energy market fluctuations on the rural collective economy and explore its potential impacts on agriculture, rural industries, and rural life to provide a scientific basis for governmental decision-making and formulate effective strategies for the sustainable development of the rural collective economy(Yuan et al., 2021). Studying China's rural collaborative economy and energy market risk has essential academic value and provides a valuable reference for practical policymaking. This study is expected to help promote the green development of Chinese rural areas, improve the adaptive capacity of the rural economy, and explore new paths and models for the sustainable development of rural regions worldwide.

3. Research methodology

3.1 Time-series analysis of the rural collective economy

To conduct energy market forecasts for China's rural collective economy, the time series analysis methodology provides a powerful tool. Further extending this methodology, the following steps can be taken to fully understand and forecast the future energy market dynamics of rural collective economies:

Data collection and organization: In the preliminary stages of the time series analysis, there is a need to collect extensive data on energy use in the rural collective economy over the past several years. This includes, but is not limited to, detailed information on energy consumption, energy prices, and energy demand in agriculture, industry, and services. A comprehensive database will be created by systematically organizing these data to provide a solid basis for subsequent analysis. **Trend, Seasonal, and Cyclical Analysis:** Utilizing time-series analysis methods, in-depth excavation of potential trends, seasonal variations, and other cyclical factors in the data is conducted. By identifying these factors, future energy market trends can be more accurately predicted. For example, it may be possible to identify certain seasonal factors that have a significant impact on the energy demand of a rural collective economy, and this information is valuable for rational planning of resources and market supply. Energy market forecasting flowchart, shown in Figure 1.

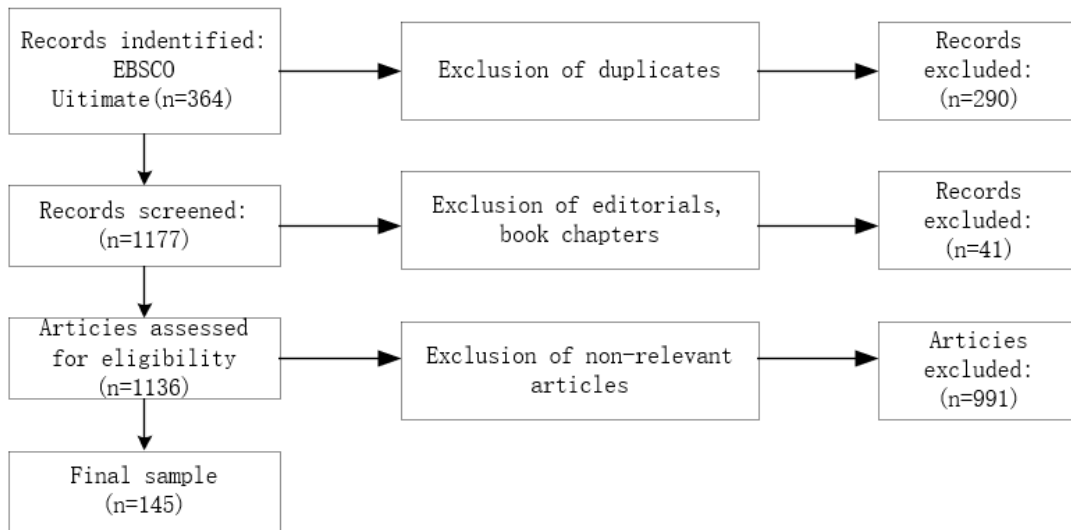


Figure 1. Energy market forecasting flowchart

Modeling the energy market: Based on an in-depth analysis of the time series, a comprehensive energy market model is constructed, considering multiple influencing factors. These factors may include macroeconomic policies, international market conditions, climate change, etc. The choice of a model may involve the VAR (vector autoregressive) model in econometrics or other relevant economics models to better understand the interrelationships among the factors. In Model Evaluation and Adjustment, the constructed model is evaluated to test its fit to the historical data and to make necessary adjustments to improve its accuracy. This may involve adjusting the model's parameters or introducing new variables to reflect better the complex relationship between the rural collective economy and the energy market. On future trend forecasting, based on the constructed model, forecasts of future energy market prices, supply and demand situations, etc., are carried out. This provides data support for the future energy market risks the rural collective economy faces and helps formulate corresponding risk management strategies and policy adjustments. The researcher can understand the relationship between China's rural collaborative economy and the energy market through the above methodology, providing a scientific basis for future decision-making and risk management.

3.2 Energy market modeling

When conducting an energy market risk assessment of China's rural collective economy, fully utilizing the risk assessment methodology in combination with scenario analysis can provide more comprehensive and in-depth insights into the future development of the rural collaborative economy. The following is a further expansion of the original article:

Clear definition of key risk factors It is crucial to define key risk factors precisely in the early stages of risk assessment. Factors such as technological developments, changes in government policies, market competition, etc., could be considered in addition to those already mentioned, such as fluctuations in energy prices, changes in international trade policies, and extreme climatic events. Such a comprehensive definition helps to form a more global framework for risk assessment. The deepening of data and literature collection is as follows: in the quantitative analysis stage, relevant data and literature are collected in depth to gain a more precise understanding of the historical fluctuations, probability distributions, and other characteristics of the risk factors. This may include historical transaction data in the energy market, the evolution of international trade agreements, past climate change events, etc. By digging deeper into this information, researchers can more accurately quantitatively characterize the impact of individual risk factors—energy market risk assessment, as shown in Figure 2.

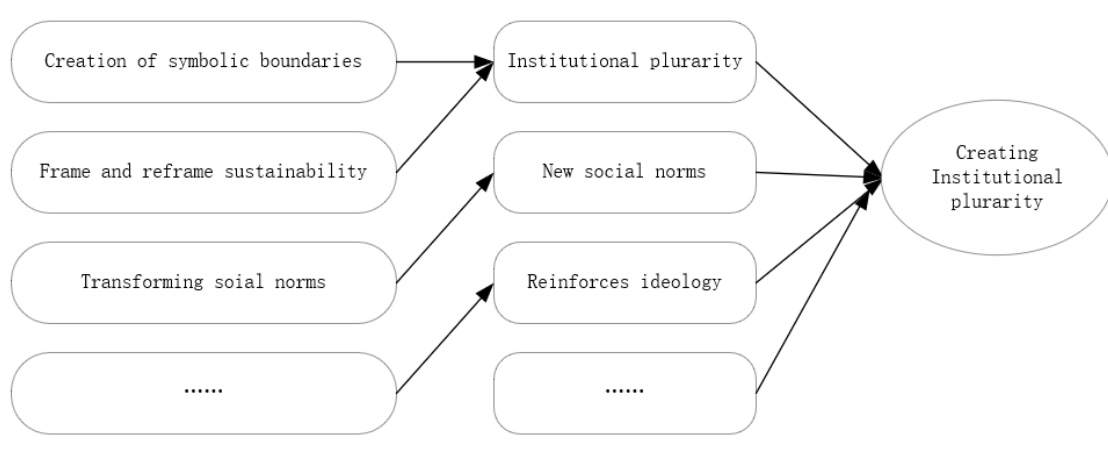


Figure 2. Energy market risk assessment

Flexible application of risk assessment tools: Monte Carlo simulation is a robust risk assessment tool that generates many possible future scenarios through thousands of simulations of individual risk factors. The model's parameters can be flexibly adjusted to simulate various possibilities and produce multiple outcomes. This facilitates a comprehensive understanding of the impact of different risk factors on the collective rural economy, considering their interrelationships. In scenario analysis, cross-cutting factors such as policy interactions, market volatility, etc., can be introduced in addition to future development scenarios considering different possibilities. The complex relationships among other factors can be better understood by conducting scenario analysis in multiple dimensions, and more comprehensive forecasts can be provided.

Integrated application and policy recommendations: Ultimately, the results of the risk assessment and scenario analysis will be integrated to provide a more comprehensive and in-depth forecast of energy market trends for the rural collective economy. This helps identify and assess potential risks in advance and provides a scientific basis for policy formulation. Rural economies can respond more flexibly to future energy market challenges by formulating appropriate strategies and policies for different scenarios. International experience and reference value: Applying these methods is essential for China's rural collective economy and provides some methodological references for research on similar problems faced by other countries or regions. The international experience can help localities cope with global energy market uncertainty more effectively and promote sustainable rural development.

The energy market forecasting model for China's rural collective economy is shown below:

$$\omega_k(C) = \sum_{i \in c} a_{ik} + \gamma_k \quad (1)$$

$$\mu(C) = \left\{ v \in \square \mid \exists (x^i)_{i \in c}, \text{ with } \sum_{i \in c} x^i \leq \omega(C), \text{ s.t. } v^i \leq u^i(x^i) \right\} \quad (2)$$

$$\sum_{\{B \in \varphi \mid i \in B\}} \lambda_B = 1 + \theta_0 \quad (3)$$

In Equation (1), $\omega_k(C)$ it is used to express the random error in the energy market; in Equation (2), $v \in \square$ it is used to specify the range of the function $\mu(C)$; and in Equation (3), the value of $\sum_{\{B \in \varphi \mid i \in B\}} \lambda_B$ is the essential sum term of least squares.

$$\sum_{B \in \varphi} \lambda_B = ((u^i(x^i))_{i \in b}, 0, \dots, 0) \in \varphi(I) \quad (4)$$

$$\sum_{B \in \varphi \mid i \in B} \lambda_B u \left(\frac{w(B)}{|B|} \right) \leq u \left(\frac{\omega(I)}{n} \right) \quad (5)$$

The $\varphi(I)$ in Equation (4) represents the partial sum of the sum of the λ -functions; the $u \left(\frac{\omega(I)}{n} \right)$ in Equation (5) is the maximum and minimum values in the pinch forcing theorem.

4. Results and discussion

4.1 Data Mining and Statistics

In-depth interviews and case studies are vital in studying China's rural collective economy and energy market risks. In-depth interviews are a research methodology based on open-ended dialogues, and by communicating with various stakeholders in the rural collaborative economy, it is possible to gain insights into

stakeholders' perceptions and awareness of the energy market, as well as the challenges and opportunities that stakeholders face in practice. For example, by conducting in-depth interviews with farmers, cooperative managers, and government officials, among others, researchers can learn about stakeholders' perceptions of factors such as energy price volatility, policy changes, and technological innovations, as well as the impacts of these factors on stakeholders' production and livelihoods. In-depth interviews can also provide the researcher with a wealth of case study information revealing rural collective economies' challenges and opportunities in the energy market. Through dialogues with various stakeholders, the researcher can learn about the functioning of different regions and types of rural cooperative economies in the energy market, thus providing essential references and guidance for subsequent case studies.

Meanwhile, the case study is another important research method. Selecting representative rural collective economic organizations and digging deeper into their operation history in the energy market can help researchers analyze their experiences and strategies in coping with energy market risks. For example, the researcher can select some rural cooperatives with outstanding performance in energy market fluctuations and summarize the successful experiences and lessons learned through in-depth investigation and analysis of their operation mode, energy procurement strategies, and measures to cope with market fluctuations. Synthesizing the findings of different cases can help researchers summarize general patterns and commonalities, which can provide a basis for formulating more targeted policy and management recommendations. For example, by comparing the practices of different rural collective economic organizations in coping with energy market risks, some common strategies and methods can be

identified, such as diversifying energy procurement channels and establishing long-term cooperative relationships, etc... These experiences can provide lessons and references for similar organizations. Therefore, in-depth interviews and case studies are essential for studying China's rural collective economy and energy market risks and can provide substantial theoretical and empirical support for policymaking and management practices.

It is of great theoretical and practical significance to conduct an in-depth study of China's rural collective economy and energy market risk using statistical analysis and data mining methods. First, extensive data collection is the basis for ensuring the comprehensiveness and reliability of the study. From a rural collective economy's perspective, collecting primary data such as economic indicators, demographic structure, and agricultural structure can provide detailed information about agricultural production, financial activities, and social structure. At the same time, data on the energy market, such as prices, supply and demand, and policy changes, provide the necessary basis for analyzing the operating conditions and trends of the energy market. In terms of statistical analysis, using regression analysis and correlation analysis can reveal the potential relationship between the rural collective economy and the energy market. By analyzing the interactions between the data, it is possible to determine the degree of influence of energy market factors on the rural collective economy, which provides a rational basis for decision-making by rural economic participants and policymakers. This approach helps to understand current correlations and provides trend forecasts for future policymaking, allowing interested parties to be more forward-looking in dealing with potential risks. The assessment of the collective economy (I) and (II) is shown in Figures 3 and 4.

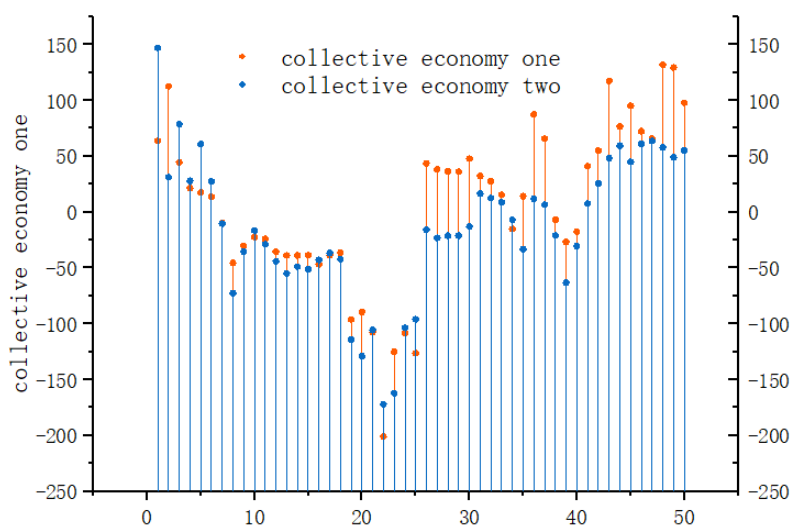


Figure 3. Assessment of the collective economy (I)

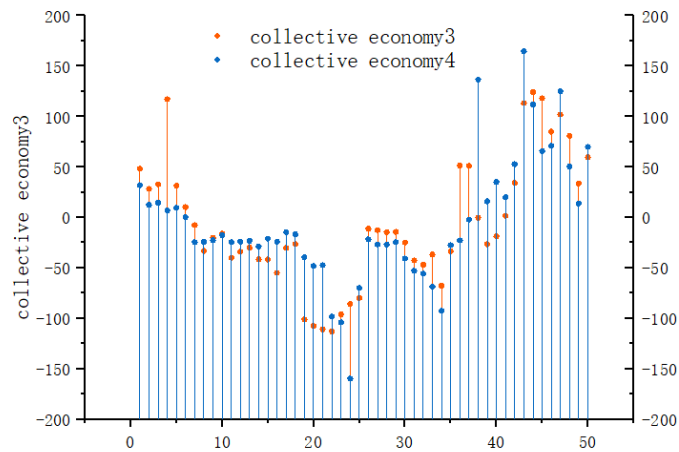


Figure 4. Assessment of the collective economy (II)

In addition, applying data mining techniques is even more uniquely suited to digging deeper into hidden patterns and regularities in large-scale data. By employing data mining algorithms, researchers can identify key factors that may have been overlooked, leading to a more comprehensive understanding of the underlying factors of energy market risk. The utility of this approach is that it can provide greater depth and breadth of analysis and more specific decision-making recommendations for participants and policymakers in the rural collective economy. Combining in-depth interviews and case studies with statistical analysis and data mining can comprehensively understand the complex relationship between rural collaborative economies and energy markets from multiple perspectives. This integrated research method provides detailed case information and gives researchers a more comprehensive and deeper understanding of big data through the analysis of big data. Ultimately, such research results can help provide more effective decision-making support for governments, enterprises, and farmers and provide a scientific basis for relevant policy formulation and risk management.

4.2 Discussion of experimental results

Statistical analysis shows a close correlation between the collective rural economy and the energy market. There is a specific positive correlation between economic indicators and energy prices, suggesting that the growth of the rural collaborative economy may be affected by fluctuations in the energy market. On the other hand, there is a potential negative correlation between demographics and energy demand, suggesting that demographic changes may have a specific mitigating effect on energy demand. The regression analysis results show that price changes in the energy market significantly impact the rural collective economy. Concerning policy changes, there is a complex relationship between government intervention in the energy market and the development of the rural collaborative

economy, and more in-depth research is needed to analyze the causal relationship.

The results of data mining not only demonstrate the cyclical pattern of energy market fluctuations, but a more in-depth analysis reveals the underlying factors behind these fluctuations. First, cyclical fluctuations in energy market prices are observed, which may be closely related to seasonal demand, changes in international markets, and policy adjustments. Such cyclical patterns provide a valuable reference for future market forecasts, enabling policymakers to formulate better supply plans and pricing strategies to adapt to market changes. Second, data mining also reveals some implied risk factors that may negatively affect the stability of the collective rural economy. Abnormal fluctuations in energy market prices may lead to unstable production costs for rural enterprises, affecting their profitability and development prospects.

Meanwhile, policy uncertainty is also a significant risk factor, as government policy adjustments may directly impact the energy market, thereby affecting the path and pace of development of the rural collective economy. This uncertainty makes it difficult for rural enterprises to formulate long-term development plans and investment decisions, increasing business risks and uncertainty. In response to these risk factors, rural collective economy participants must adopt a series of effective countermeasures. First, they can reduce the impact of market fluctuations by establishing flexible supply chain management systems and price risk management mechanisms. Second, communication and coordination with government departments should be strengthened to keep abreast of policy developments and make corresponding adjustments. In addition, maintains the cooperation and communication between industry associations and enterprises to jointly deal with market risks, share resources and information, and improve the ability and efficiency to deal with risks. Assessment of energy efficiency (i); economic efficiency of rural markets (i), (ii); as shown in Figures 5, 6, 7 and 8.

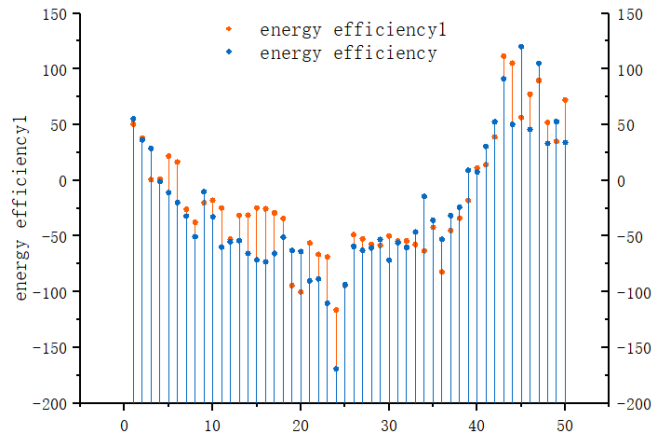


Figure 5. Assessment of energy efficiency (i)

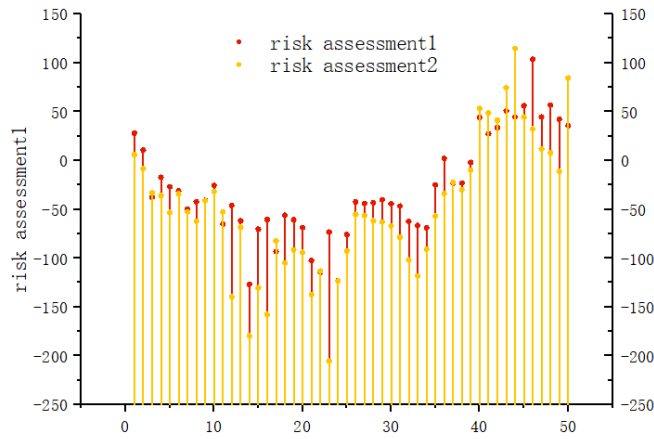


Figure 6. Assessment of energy efficiency (II)

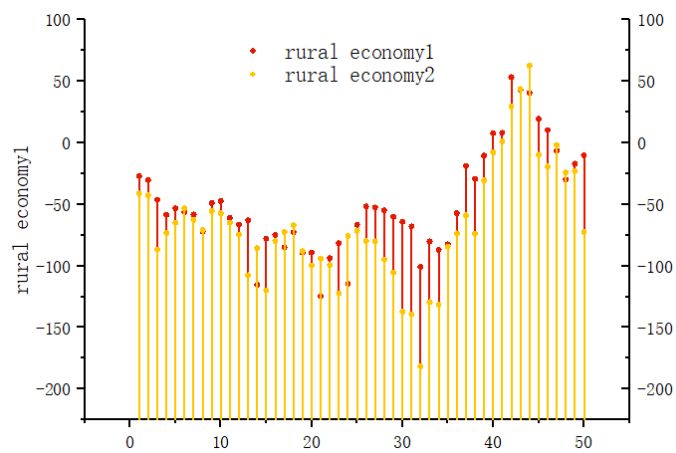


Figure 7. Economic efficiency of rural markets (I)

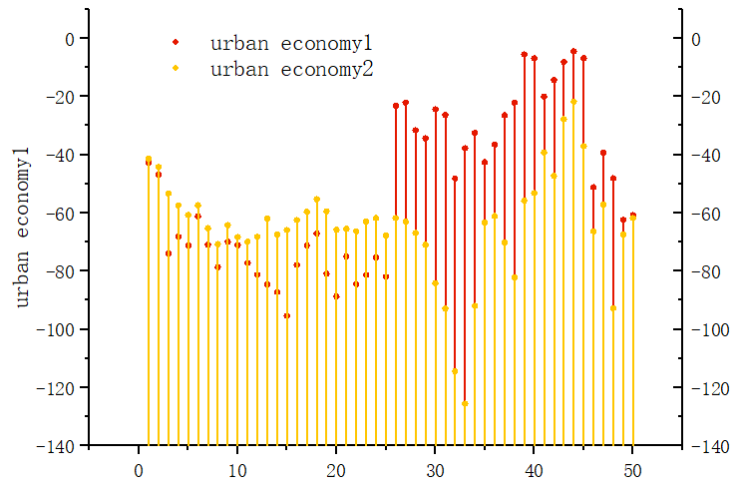


Figure 8. Economic efficiency of rural markets (II)

In summary, data mining provides an in-depth understanding of energy market volatility and risk factors, which provides an essential reference for the stable development of collective rural economies. Based on these findings, rural economic participants should take adequate measures to cope with market challenges and achieve sustainable development and long-term growth. Synthesizing the results of statistical analysis and data mining, it is argued that more attention should be paid to forecasting and risk assessment of the energy market in developing China's rural collective economy. To respond effectively to the challenges posed by market fluctuations and policy changes, the government, enterprises, and farmers can make use of the forecasting model and risk assessment tools proposed in this study for decision-making. In addition, it is recommended that future research strengthen the study of the micro-level relationship between the rural collective economy and the energy market to gain a more comprehensive understanding of the complex interactions between the various factors. At the same time, in-depth interviews and case studies with rural economic participants should be strengthened to better understand their challenges and needs in actual decision-making. Overall, this study provides in-depth analysis and insights for understanding the relationship between China's rural collective economy and the energy market and provides a scientific basis for decision-making by relevant policymakers. In the future, the research methodology needs to be further improved to better adapt to the changing market environment.

5. Conclusion

Through an in-depth study of the forecasting and risk assessment of the energy market based on China's rural collective economy, the researchers have drawn a series of important conclusions, which provide not only scientific references for the energy strategy decision-making of the rural collaborative economy but also provide valuable

insights for future research and policy formulation. First, the researchers deeply recognize that the energy market of China's rural collective economy has made remarkable development in the past few years. With the upgrading of the rustic industrial structure and the increase in electrification level, the rural energy demand has gradually increased. This poses new challenges for the sustainable development of the rural collective economy and lays the foundation for further prosperity of the energy market. Second, by analyzing the key influencing factors, the researchers identified some potential risks in the development of the energy market. Issues such as market price fluctuations, policy adjustments, and supply-demand imbalances may have specific impacts on rural collective economies' energy supply and economic growth. Therefore, there is an urgent need for researchers to establish flexible management mechanisms to cope with these potential uncertainties. In the future, green energy policies will be a crucial driver for developing energy markets in rural collective economies. Researchers note that using clean, renewable energy will gradually become the preferred choice for rural collaborative economies, closely related to society's growing concern for sustainable development. More emphasis should be placed on supporting and promoting green energy when formulating policies and planning future energy layouts. In the conclusion, the researchers also emphasize the future focus. To better cope with market risks, a sound policy system must be established to ensure the long-term stability of policies and reduce market uncertainty. At the same time, establishing market regulatory mechanisms is crucial to ensuring energy markets' fair, transparent, and efficient operation. Overall, energy market forecasting and risk assessment based on China's rural collective economy are complex and vital. The researchers' study provides insights for understanding the current and future state of the energy market in rural collaborative economies and offers strong support for related decision-making. In the future, it is necessary to continue to strengthen the research and optimize the policy

measures to promote the development of China's rural collective economy's energy market in a more sustainable and stable direction.

Acknowledgements.

This work is supported by Key Scientific Research Project of Xi'an Traffic Engineering Institute in 2024 (Grant No.: 2024 KY-33). Xi'an Traffic Engineering Institute 2022 Young and Middle-aged Fund Project (Grant No.: 2022 KY-75).

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