



An Economic-Resilience-Lean Evaluation Model for Coal Traders Serving Chinese Power Plants: A DEMATEL-SWARA-RPN Approach

Huiqiao Liu^{1,*}

¹ Yinchuan University of Energy, Ningxia, 750000, China

SUMMARY: *For the fuel procurement scenario of China's power plants, this paper takes the coal traders serving the power plant procurement system as the evaluation object, and constructs an evaluation model that takes into account cost constraints, supply stability and execution coordination. The research combines transaction, quality inspection, logistics, settlement and expert judgment into the same trader unit to form a three-level indicator structure covering economic performance, resilience capability and lean fulfillment, including three first-level dimensions and 15 second-level indicators. In terms of method, DEMATEL is used to identify the direction of action and key positions among the indicators, and then swara is used to form the order weight. Then RPN is introduced to deal with the potential vulnerability of trader separately, and on this basis, the final ranking after risk correction is formed. The results show that the stability of continuous performance, the response time of emergency supplementary supply, the redundancy ability of route and port, the quality consistency and the punctuality rate of arrival are in a more critical position, which are the main sources of the difference between traders. The comprehensive ranking shows that the objects with higher basic scores do not necessarily remain in the forefront after risk reduction; Although some traders are superior in terms of cost or trading conditions, they are moved backward due to flexibility and short board at the execution end; The objects with more balanced ability structure and lower risk exposure showed higher stability in multi scenario comparison. Further scenario comparison and weight disturbance results show that the front structure is generally stable under small disturbance, but different management preferences will change the local ranking order. The evaluation results formed in this paper can be directly used to support traders' reservation, replacement and combination configuration, and provide a quantitative basis for power plants to optimize the core guaranteed supply list, reduce the continuous fluctuation and the risk at the execution end.*

KEYWORDS: *coal trader evaluation; Chinese power plants; supply resilience; DEMATEL; SWARA-RPN*

1 Introduction

The purchase of coal for power plants in China is not simply a matter of price comparison. For the operation side, whether the trading partner can stably organize the supply of goods, connect the port and railway transportation, control the arrival rhythm, buffer the batch fluctuation and cooperate with the settlement arrangement will directly affect the fuel cost, inventory safety line and unit operation continuity. In recent years, supply chain research has extended "resilience" to more front-end capabilities such as interruption absorption, disturbance

*liuhuiqiao0875@163.com

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conduction suppression and operation continuity maintenance; In response, relevant work has also begun to discuss the identification of vulnerable links in complex supply systems from the perspective of network structure and linkage impact [1-2].

In the coal electricity scenario, this change is more obvious. The research on China's coal industry chain and coal power supply chain shows that when market fluctuations, policy constraints and transportation disturbances coexist, the evaluation focus of coal supply system has shifted from single supply capacity to collaborative stability and chain toughness; The quantitative research on coal power supply chain also further points out that adaptation, absorption and recovery are not isolated attributes, but will affect the final supply stability through a variety of factors coupling [3-4]. This means that when selecting coal trading partners, if power plants still only look at the low price, calorific value or short-term performance records, it is often difficult to identify those objects with "low nominal cost but weak disturbance tolerance".

The existing literature has begun to touch on this issue, but most of the work is still at the level of coal supply chain risk identification or general supplier evaluation. Studies have identified key factors such as transportation process risk, supply fluctuation risk and insufficient flexibility from the operation process of the hot coal supply chain, indicating that the risk is not concentrated in a certain link, but will continue to transmit along the chain of procurement, transportation and use [5]; There are also studies using AHP and fuzzy comprehensive evaluation to build a coal supply chain risk assessment framework, which shows that the stability of coal supply has a systematic evaluation basis [6]; The empirical study on thermal coal suppliers attempts to use the improved critical method to deal with the index weight, so that the supplier evaluation is closer to the transaction reality [7]. These works provide a direct reference, but their evaluation objects are mostly coal mining enterprises, general suppliers or regional supply chain nodes, and do not really fall into the decision-making unit of "coal traders from the perspective of power plants".

This object difference determines that this paper cannot directly copy the existing model. For power plants, the role of coal traders is not only to organize coal sources, but also to integrate multi-point resources, coordinate multi-channel transportation, cover the replenishment demand during the inventory warning period, and provide a buffer between quality fluctuations and settlement friction. Therefore, the evaluation model needs to answer three questions at the same time: first, whether the trading partner has acceptable economy; Second, whether it has enough elasticity under sudden disturbance; Third, whether the delivery and performance can be completed with low waste and high coordination efficiency. This multi-objective constraint is consistent with the multi-dimensional collaborative evaluation emphasized by the supplier selection Institute in recent years. Relevant studies have incorporated the dimensions of lean, agile, resilient, green and sustainable into the unified decision-making framework, and began to pay attention to the interaction and weight linkage between indicators [8-10]. However, the application scenarios of these studies are mainly focused on manufacturing, pharmaceutical or general industrial procurement, and their index connotation is not exactly the same as that of power plant coal procurement. The "lean" in the context of power plant is closer to the arrival rhythm, batch consistency, coal unloading coordination and loss control; "Resilience" is also more specifically manifested in multiple sources of goods, path redundancy, temporary supply speed and impact tolerance. If these differences are not written into the index system, even if the evaluation results are complete, it is difficult to really use them in power plant procurement decision-making.

The existing research still has two deficiencies to be filled. First, many models put cost, performance, synergy and risk together in the same scoring table, but did not further identify who was at the driving end and who was closer to the result end between these indicators.

Although the ranking obtained in this way is intuitive, its explanatory power is limited, and it is difficult to explain why some traders are dominant in price, but continue to lose points in stability and flexibility. Second, many studies can give comprehensive scores, but do not separate the risk penalty from the total score. As a result, it is easy to overestimate the objects with better short-term performance but higher vulnerability. For Chinese power plants, such deviations will directly affect the combination of traders, contract boundaries and safety stock arrangements, and will also weaken the availability of the evaluation results under the supply guarantee scenario.

Accordingly, the question this paper constructs is: how to build a coal trader evaluation model that can simultaneously describe economy, flexibility and lean in the scenario of fuel procurement for power plants in China, and take into account the index function structure, management preference and risk correction in the ranking process. Around this problem, based on the relevant data of power plant procurement, quality inspection, performance and risk management, this paper limits the evaluation object to the coal traders serving for power plant fuel procurement, establishes an economic elastic lean three-dimensional evaluation system under the unified index caliber, and uses dematel-swara-rpn to form a continuous decision-making chain. Here, DEMATEL is used to identify the causal relationship and action position between indicators, swara is used to reflect the order preference of the management side of the power plant, and RPN is used to recalibrate the objects with high scores but high risks. After this processing, the evaluation output is no longer just a static ranking, but can further answer the key factors that affect the ranking, the position of risk exposure and the degree of stability under different scenarios.

The work of this paper mainly falls into three aspects. First, the research object is further restricted from general suppliers to Chinese power plant coal traders, so that the evaluation boundary is consistent with the fuel procurement practice. Second, put economy, flexibility and lean into the same indicator framework to avoid splitting price, performance, synergy and risk into disjointed segments. Third, dematel-swara-rpn is used to connect causal identification, weight formation and risk correction, providing a unified basis for subsequent ranking comparison, scenario test and management interpretation. What this paper hopes to promote is not a simple comparison of "who is cheaper", but to judge "who is more stable, who is more balanced, and who is more suitable to enter the power plant trader portfolio" in a complex supply environment.

2 Methods

2.1 Data sources, trader sample construction, and indicator preprocessing

The data organization of this paper adopts the two-tier structure of "open background data calibration+self built trader sample library at the power plant side". The public part is used to describe the external constraints of coal supply, import substitution, power generation demand and port transportation conditions during the study period; The sample part directly corresponds to the procurement decision-making unit of the power plant, which is used to form a comparable evaluation object for coal traders. This processing method is consistent with a common orientation of supplier evaluation research in recent years, that is, first lock the evaluation boundary to the specific business scenario, and then put the operation records, expert judgment and environment variables under the same object level for unified organization, instead of directly splicing the data from heterogeneous sources into the same scoring table [11]. Combined with the research task of this paper, the public data is mainly used to identify the

market fluctuations and transportation environment, and the power plant side sample bears the main functions of trader evaluation, ranking and risk correction [12].

The sample construction takes the coal traders in the fuel procurement scenario of China's power plants as the evaluation object. Considering that open sources can obtain more stable information about coal production, import, power and port throughput at the national level, but it is difficult to directly provide the row level decision-making unit of "power plant trader batch to plant", this paper does not directly generate trader rankings with open data, but establishes a self built sample database at the power plant side on the basis of open data. The inclusion of the sample follows four conditions: first, the traders continuously serve the sample power plants during the study period, and there are traceable contracts and arrival records; Second, core fields such as price, calorific value, sulfur, moisture, ash, time of arrival, supplementary supply response and settlement accuracy can be obtained under the same caliber; Third, there is no abnormal lack of long-term supply suspension or unavailability of verification for trading partners during the study period; Fourth, procurement, fuel, quality inspection, transportation and finance positions can form a consistent business identification for the same trader. The final evaluation unit is defined as "coal traders who continuously serve the fuel procurement system of power plants during the study period", and organizes the original data in the form of monthly records, quarterly reviews, and full-term summaries to ensure that the samples can retain process differences and will not be enlarged by a single disturbance [13]. In order to bring the evaluation object, the scope of the research period and the judgment caliber of experts to the same level, this paper further lists the sample composition and expert group configuration, as shown in Table 1.

Table 1: Sample composition and expert panel configuration

Item	Content	Value	Note
Study period	Observation window	Jan 2023-Dec 2025	36 months
Evaluation objects	Coal traders	T1-T12	Continuously serving sample power plants
Sampling rule 1	Continuous service	≥ 24 months	Inclusion criterion
Sampling rule 2	Data completeness	Core fields available	Price, quality, delivery, settlement, emergency supply
Sampling rule 3	Exclusion rule	Unverifiable conflict records or continuous missingness	Excluded from final sample
Record organization	Data granularity	Monthly records + quarterly review + full-period aggregation	Used for unified trader-level evaluation
Expert panel	Procurement management	4 experts	Used for DEMATEL and SWARA judgments
Expert panel	Fuel management	3 experts	Used for DEMATEL and SWARA judgments
Expert panel	Quality inspection	2 experts	Used for DEMATEL and SWARA judgments
Expert panel	Dispatch	2 experts	Used for DEMATEL and SWARA judgments
Expert panel	Finance	2 experts	Used for DEMATEL and SWARA judgments

Data sources are divided into five categories. The first is the transaction and settlement record, which mainly corresponds to the contract unit price, quantity to factory, settlement cycle, claim feedback and price difference adjustment response. The second is the quality inspection record, which mainly corresponds to the low calorific value, sulfur, moisture, ash and batch dispersion. The third is the logistics and performance record, which mainly corresponds to the on-time rate, average delay, transportation path, alternative channel and the replenishment duration of inventory warning period. The fourth is operation coordination record, which

mainly corresponds to coal unloading coordination, coal blending control, loss control and document accuracy. The fifth is the expert judgment data, which is jointly completed by the procurement management, fuel management, quality inspection, transportation and finance positions, and is used for subsequent DEMATEL relationship identification and swara sequence weighting. This organization mode retains multi-source information, but does not change the level of evaluation objects; Each record will eventually fall back to the trader object, and then enter the subsequent calculation [14]. After the sample object and data source are fixed, the original business fields are merged into a computable trader evaluation index. The definition, attribute direction and data correspondence are shown in Table 2.

Table 2: Economic-resilience-lean evaluation criteria and measurement definitions for coal traders

First-level dimension	Code	Indicator	Measurement definition	Attribute	Data source
Economic performance	C11	Delivered calorific cost	Cost per unit of delivered effective heat value (RMB/GJ)	Cost	Transaction and settlement records
Economic performance	C12	Price fluctuation controllability	Ability to keep transaction price within an acceptable fluctuation range	Cost	Transaction and settlement records
Economic performance	C13	Settlement flexibility	Adaptability of settlement cycle, payment terms, and reconciliation arrangement	Benefit	Transaction and settlement records
Economic performance	C14	Transport organization economy	Economic efficiency of the selected transport combination and routing	Cost	Logistics and delivery performance
Economic performance	C15	Claim and price adjustment response efficiency	Response speed and completion quality in claim handling and price adjustment	Benefit	Transaction and settlement records
Resilience capability	C21	Source diversification	Degree of diversification in coal source organization and upstream channel coverage	Benefit	Logistics and delivery performance
Resilience capability	C22	Route and port redundancy	Availability of alternative ports, routes, and transfer channels	Benefit	Logistics and delivery performance
Resilience capability	C23	Emergency resupply response time	Time required to complete emergency replenishment after inventory alert	Cost	Inventory warning and emergency supply logs
Resilience capability	C24	Continuous fulfillment stability	Stability of continuous contract execution under normal and disturbed conditions	Benefit	Logistics and delivery performance
Resilience capability	C25	Shock tolerance to policy and market change	Capacity to absorb policy shifts, market fluctuation, and transport disturbance	Benefit	Inventory warning and emergency supply logs
Lean fulfillment	C31	On-time delivery rate	Proportion of deliveries arriving within the agreed time window	Benefit	Logistics and delivery performance
Lean fulfillment	C32	Quality consistency	Stability of calorific value, sulfur, moisture, and ash across batches	Benefit	Coal quality inspection records
Lean fulfillment	C33	Unloading and handover coordination efficiency	Coordination efficiency during arrival, unloading, handover, and plant-side reception	Benefit	Logistics and delivery performance
Lean fulfillment	C34	Document and settlement accuracy	Accuracy of delivery documents, invoices, and settlement records	Benefit	Transaction and settlement records
Lean fulfillment	C35	Loss and coal blending control	Ability to control transport loss, blending deviation, and process fluctuation	Benefit	Coal quality inspection records

The indicator preprocessing is completed before the weight recognition. The processing sequence is fixed as follows: field cleaning, unified caliber, missing verification, direction determination and dimensionless. First, merge the names of records from different sources that point to the same trader and align them with time to delete the duplicate items and obvious conflict items that cannot be verified. Secondly, it has the unique meaning of unifying the direction of price, quality, performance and coordination indicators and ensuring whether a larger value represents a better performance. Thirdly, for a small number of missing values, the verifiable records of adjacent periods are preferred; If the same trader is continuously missing on key fields, it will not be included in the evaluation sample. Finally, the benefit based and cost-based indicators are standardized to reduce the interference of dimensional differences on subsequent weights and ranking results. In recent years, two-stage supplier selection research and multi criteria review both emphasize that if the object boundary, indicator direction and original field mapping are not locked in the pre-processing stage, subsequent weighting and sorting will weaken the stability of the results even if the form is complete [15-16]. In order to eliminate the dimensional differences of different indicators and maintain the consistent direction of "the larger the value, the better the performance" of benefit indicators, this paper adopts standardized treatment as shown in formula (1):

$$z_{ij}^{(+)} = \frac{x_{ij} - \min_i x_{ij}}{\max_i x_{ij} - \min_i x_{ij}} \quad (1)$$

For cost type indicators, dimensionless is completed in the opposite direction to ensure that the standardized results can be shown in formula (2) under the same caliber:

$$z_{ij}^{(-)} = \frac{\max_i x_{ij} - x_{ij}}{\max_i x_{ij} - \min_i x_{ij}} \quad (2)$$

where x_{ij} represents the original observation value of the i th trader on the j th indicator, $z_{ij}^{(+)}$ represents the standardization result of benefit indicators, $z_{ij}^{(-)}$ represents the standardization result of cost indicators, and $\max_i x_{ij}$ and $\min_i x_{ij}$ respectively represent the maximum and minimum values of the same indicator among all traders. After the above processing, the trader by indicator evaluation matrix can be obtained to provide unified input for subsequent relationship identification, weighting and risk correction. In order to ensure that the evaluation objects, transaction records and expert judgments of coal traders come from the same decision caliber, this paper first unifies the sample organization, data cleaning and indicator generation process, as shown in Figure 1.

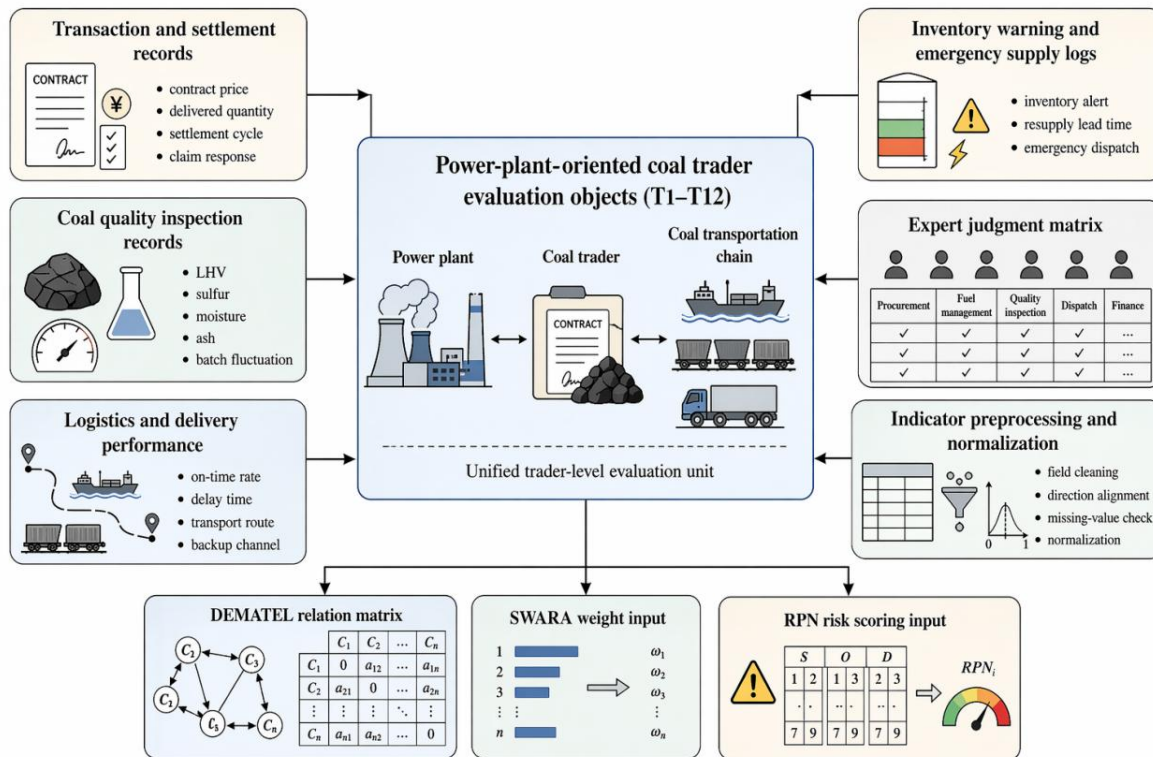


Figure 1: Data organization and sample construction for coal trader evaluation in Chinese power plants

2.2 Discourse Pattern Mining and Feature Engineering

The evaluation of coal traders should first put the business judgment in the power plant procurement scenario into a stable and comparable indicator caliber. In recent years, research on resilient supplier selection has put costs, supply recovery, collaborative execution and risk exposure into the same evaluation framework, indicating that the comparison of Complex procurement objects can no longer be based on single price or single performance record [17]. Further, the research on the supply chain risk assessment framework also points out that if the evaluation object, index boundary and judgment level are not fixed first, even if the data from different sources enter the same model, it is difficult to form a stable interpretation of the results [18]. Based on this, this paper classifies the judgment basis of power plants on coal traders into three first-class dimensions, namely, economic performance, resilience capability and lean fulfillment.

Economic performance is used to describe the direct impact of traders on the cost of arriving at the plant and transaction flexibility, including the cost of arriving at the plant calorific value, controllability of price fluctuation, settlement flexibility, economy of transportation organization, and response efficiency of claim and price difference adjustment. Resilience capability is used to describe the trade's ability to maintain supply under external disturbances, including the degree of diversification of supply sources, the redundancy of routes and ports, the response time of emergency supply, the stability of continuous performance, and the ability to withstand policy and market shocks. Lean fulfillment corresponds to the fluctuation control and collaborative quality during the implementation of coal supply, including the punctuality rate of arrival, quality consistency, collaborative efficiency of coal unloading and receiving, accuracy rate of documents and settlement, and loss and coal blending control ability. After this sorting, the purchase, quality inspection, transportation and financial records are all pressed into

the same trader unit, and subsequent comparisons are no longer disturbed by position dimension differences.

Only the indicator set is not enough to form a credible weight. For coal traders, supply diversification will affect the speed of replenishment, path redundancy will affect the stability of performance, and quality consistency will affect coal unloading coordination and loss control. If these indicators are regarded as independent scoring items, the ranking results tend to overestimate the surface performance and underestimate the factors that really play a driving role. The research around the risk priority of enterprise supply chain has shown that if the dependence between factors is ignored, the weight result will tend to static representation, and it is difficult to explain the object difference under the disturbance condition [19-20]. Therefore, this paper first uses DEMATEL to identify the function position of each index in the system, and then introduces swara to form the order weight. After the index boundary and variable caliber are locked, this paper further incorporates economic performance, resilience capability and lean fulfillment into the unified action network, and puts causal identification and sequential weighting into the same analysis framework, as shown in Figure 2.

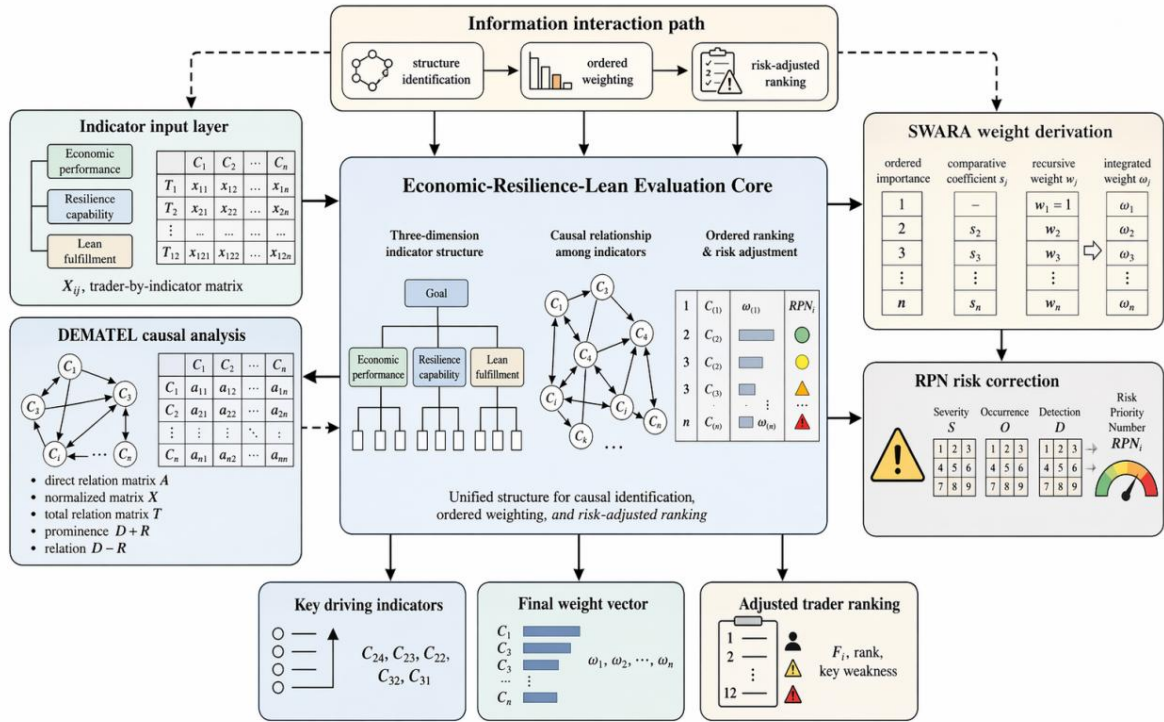


Figure 2: Architecture of the economic-resilience-lean DEMATEL-SWARA-RPN evaluation model

Let $\mathbf{A} = [a_{jm}]_{n \times n}$ be the expert direct relationship matrix. After the expert direct relationship matrix is formed, this paper first completes the normalization of the matrix, and further calculates the total relationship matrix between indicators, as shown in formula (3):

$$\mathbf{X} = s\mathbf{A} \quad (3a)$$

$$s = \frac{1}{\max_j \sum_{m=1}^n a_{jm}} \quad (3b)$$

$$\mathbf{T} = \mathbf{X}(\mathbf{I} - \mathbf{X})^{-1} \quad (3c)$$

where, $\mathbf{A} = [a_{jm}]_{n \times n}$ represents the direct relationship matrix of experts, and a_{jm} represents the direct impact intensity of index j on index m . n is the total number of indicators; s is the normalization coefficient, which is used to compress the direct relationship matrix to a computable interval; \mathbf{X} is the normalized direct relation matrix; \mathbf{I} is the identity matrix; \mathbf{T} is the total relationship matrix, which is used to describe the overall action structure after the superposition of direct and indirect impacts between indicators. \mathbf{T} can further identify the degree of participation and direction of each indicator in the overall network.

After the total relationship matrix is obtained, the significance and causality are further used to identify the role of each indicator in the overall network. For any indicator j , D_j is the sum of the elements in row j of \mathbf{T} , and R_j is the sum of the elements in column j , then the significance P_j and causality C_j are defined as shown in formula (4):

$$P_j = D_j + R_j \quad (4a)$$

$$C_j = D_j - R_j \quad (4b)$$

where, D_j represents the sum of the elements in row j of the total relationship matrix \mathbf{T} , which is used to describe the total impact of indicator j on other indicators; R_j is the sum of the elements in column j , which is used to describe the total impact of other indicators on index j ; P_j is the significance, which is used to measure the participation of index j in the overall network; C_j is the causal degree, which is used to distinguish whether the index j is closer to the influence end or the result end. When $C_j > 0$, the index j is closer to the driver; When $C_j < 0$, the index j is closer to the undertaking item.

The larger the P_j , the higher the participation of the index in the overall network; $C_j > 0$ means the index is closer to the influence end, and $C_j < 0$ means the index is closer to the result end. Research on supply chain disturbance has noted that chain fluctuations are usually not triggered by a single factor, but are formed by the continuous conduction of several high impact factors. Therefore, it is necessary to distinguish between drivers and takeovers before empowerment [21].

After obtaining the structure information of DEMATEL, this paper implements swara recursion according to the importance order of the same level indicators. Let s_j be the importance comparison coefficient of the j th index relative to the previous index, k_j be the correction coefficient, q_j be the recurrence value, and w_j be the swara weight; Further combine the swara weight and DEMATEL significance share to obtain the comprehensive weight ω_j used in this section, as shown in equation (5):

$$k_j = s_j + 1 \quad (5a)$$

$$q_j = \frac{q_{j-1}}{k_j} \quad (5b)$$

$$w_j = \frac{q_j}{\sum_{j=1}^n q_j} \quad (5c)$$

$$\omega_j = \frac{w_j \cdot \frac{P_j}{\sum_{j=1}^n P_j}}{\sum_{j=1}^n \left(w_j \cdot \frac{P_j}{\sum_{j=1}^n P_j} \right)} \quad (5d)$$

where s_j is the importance comparison coefficient of the j th index relative to the previous index; k_j is the correction factor; q_j is a recursive value; WJ is the normalized weight of swara; ω_j is the comprehensive weight combined with DEMATEL significance share. Here, w_j mainly reflects the business judgment of the management side of the power plant on the priority of indicators at the same level, and ω_j further incorporates the participation of indicators in the overall action network into the weight formation process. The final ω_j retains the order preference and structure information at the same time, and is used as the weight input of subsequent trader comprehensive evaluation and risk correction.

The reason for this treatment is clear. DEMATEL gives the position of the index in the action network; Swara reserves the business judgment of the management side of the power plant on the priority of indicators. The former solves "which indicators are more likely to affect other indicators", and the latter solves "how to sort the indicators at the same level in procurement practice". When the two parts of information are put together, the weight result will not be completely dominated by the degree of discreteness, nor will it only stay in the empirical judgment. Research on power system has shown that when DEMATEL is combined with subsequent priority identification methods, the identification of key factors will be clearer, and the results will be more suitable for the actual management scenarios [22].

After the above processing, what we get in 2.2 is not a simple list of indicators, nor is it an abstract weight separated from the scene, but a set of computable evaluation structure for power plant coal traders. At this stage, the evaluation system has answered three questions: what indicators the power plant looks at, how they affect each other, and to what extent should these indicators be valued. The next section will continue to deal with risk correction and comprehensive ranking on this basis.

2.3 RPN-based risk correction, comprehensive ranking procedure, and validation protocol

In the audience impact modeling stage, this paper divides the response variables into two groups: shallow participation and deep participation. The former corresponds to clicking, browsing and likes or reactions, which mainly reflects attention arrival and light touch. The latter corresponds to comment, sharing, comment chain depth and cross platform re dissemination, which is closer to the extension of discussion expansion and public communication. Such hierarchical processing is consistent with the expectation of digital news interaction, social media editing practice and mobile terminal contact logic, and is more suitable for explaining the difference between news being "seen" and "discussed" on different platforms. At the same time, testimonial narration, platform packaging and story expression often have additional impact on comments and diffusion, so deep participation cannot be replaced by shallow indicators [23].

Accordingly, this paper deals with the potential vulnerability separately from the comprehensive score. The specific method is as follows: first, according to the comprehensive weight obtained in 2.2, the standardized values of each trader on 15 secondary indicators are aggregated to obtain the basic performance score; Combined with the risk consequences, occurrence frequency and identification difficulty in the coal supply business, the risk priority at the trader level is formed. Here, severity corresponds to the impact of risk events on the

continuity of arrival, inventory safety line and unit operation arrangement once they occur; Occurrence corresponds to the frequency of problems such as delayed arrival, quality mismatch, supply failure, document error and path interruption during the study period; Detection corresponds to the degree of difficulty that related problems are found and intercepted in time before shipment, on the way and at the initial stage of arrival. The higher the RPN value obtained after the summary of the three scores, the more the trader's nominal performance needs to be reduced. After this processing, the sorting result will not keep the objects with "higher usual score but more fragile under disturbance" in the front row.

Risk reduction does not change the index system itself, but the comprehensive performance of trader. After completing the RPN normalization, this paper corrects the basic performance score according to the trader level to form the final ranking after risk correction. In addition to the final ranking, the result output also retains three levels of information: one is the basic performance score, which reflects the trader's comprehensive service capability during the normal procurement period; The second is the risk exposure level, which is used to identify objects with high score but high risk, low cost but low flexibility, etc; The third is the first level dimension score and key short board indicators, which are used to determine whether the problem mainly lies in cost control, supply assurance capacity or implementation collaboration. The research on coal risk assessment and mixed multi criteria modeling has pointed out that if only one total score is retained, it is difficult for the decision-making end to see whether the main weakness of the object comes from fluctuation control, performance continuity or execution instability [24]. In order to avoid the comprehensive evaluation results staying at the single ranking level, this paper further sets up scenario comparison, weight disturbance and ranking consistency test, as shown in Figure 3.

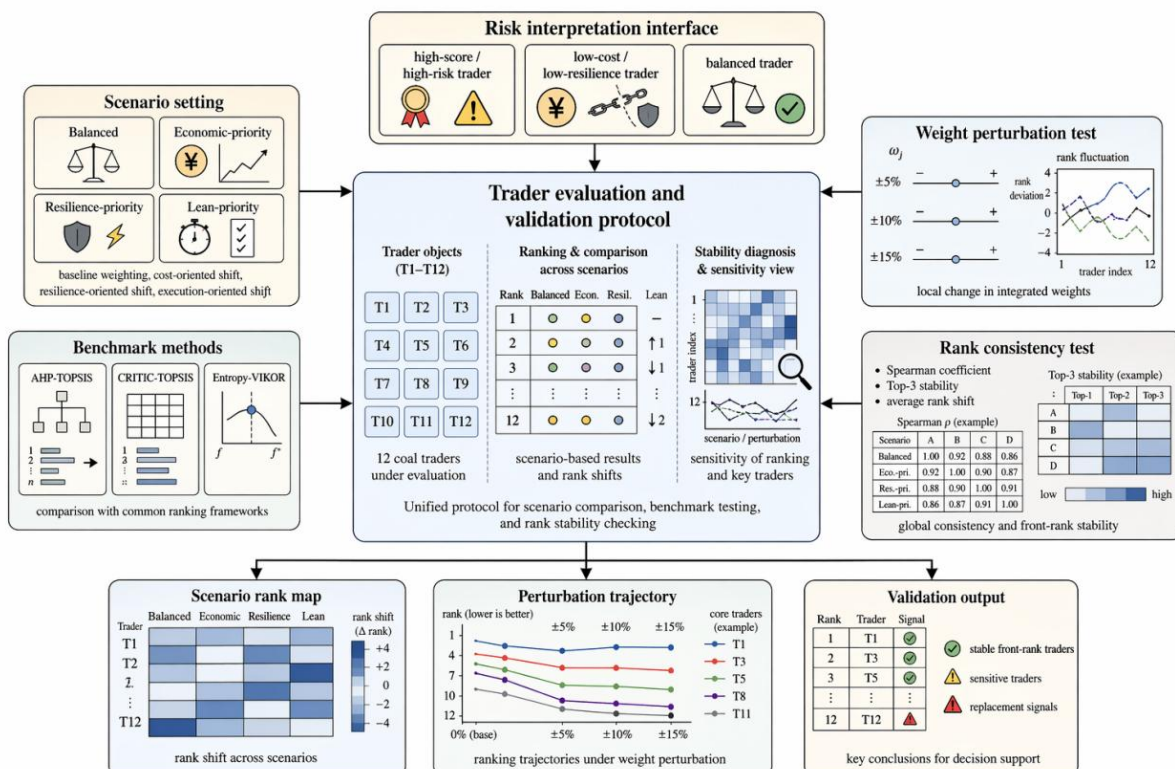


Figure 3: Experimental protocol, comparison strategy, and validation design

In the verification design, this paper sets up four scenarios. The balanced scenario maintains the benchmark weights of the three first-class dimensions; The relative impact of improving cost related indicators in the economic priority scenario; In the resilience priority scenario, indicators such as replenishment speed, path redundancy and continuous performance are strengthened; Lean priority scenario improves the relative weight of arrival on time, quality consistency and collaborative execution indicators. Through these four scenarios, we can observe whether the ranking of the same trader depends on a single management preference. If an object only remains in the forefront under the condition of economic priority, but significantly declines under the condition of elastic priority, its advantage is more from the normal cost performance; If an object fluctuates less in a multi scenario, it means that its ability structure is more balanced and more suitable for long-term cooperation.

In order to further check whether the ranking is still stable under the alternative method and the weight disturbance, ahp-topsis, critical-topsis and entropy VIKOR are introduced as the comparison methods, and the comprehensive weights are disturbed by $\pm 5\%$, $\pm 10\%$ and $\pm 15\%$. The Spearman rank correlation coefficient, top-3 stability and average rank shift are read synchronously during verification. Spearman coefficient is used to judge the overall ranking consistency under different methods or scenarios; Top-3 stability is used to identify whether the core trader is significantly replaced; The average rank shift is used to measure the sensitivity of each object under disturbance. If a trader always keeps the front position under different methods and different disturbance conditions, it can be considered that its ranking has strong stability; If the ranking of a trader fluctuates significantly with a slight change in weight, it means that its comprehensive performance depends on local indicators, and the cooperation boundary should be set more carefully. Relevant studies have noted that if the mixed performance measurement model lacks scenario comparison and ranking consistency test, the final result is closer to the one-time score, and it is difficult to directly enter the continuous procurement management [25].

After the above processing, what 2.3 gets is not a single ranking table, but a group of result outputs that can directly enter the purchase decision. According to this, the power plant can distinguish three types of objects: the first type remains at the forefront after normal performance and risk correction, and is suitable for inclusion in the core cooperation list; The basic score of the first class is high, but the risk is significantly moved back after reduction, which is suitable for retaining but not suitable for assuming too high guarantee weight; There is also a category whose total score is not necessarily the highest, but it fluctuates less in the amorous scene, which is more suitable for entering a stable combination. The results obtained can be used to support traders' reservation, replacement and combination configurations.

3 Results and Discussion

3.1 Causal structure and key weights of the economic-resilience-lean evaluation indicators

This section first answers two questions: which indicators are in a more critical position in the overall network, and which indicators have a greater impact on the trader evaluation results after the weight is formed. DEMATEL results show that the 15 indicators are not evenly distributed at the same level, and the significance and causality have been clearly stratified. The indicators in the high significance range mainly focus on continuous performance stability, emergency supply response time, path and port redundancy capacity, quality consistency and arrival on time rate; In the low significance range, it is mainly the economy of transportation organization and the response efficiency of claim and price difference adjustment. This result

shows that when power plants judge coal traders, it is not the transaction terms themselves that really open the gap, but the continuity of supply, substitution capacity and the stability of the execution end. The spatial distribution of indicators in significance, causality and comprehensive weight has been clearly stratified, as shown in Figure 4.

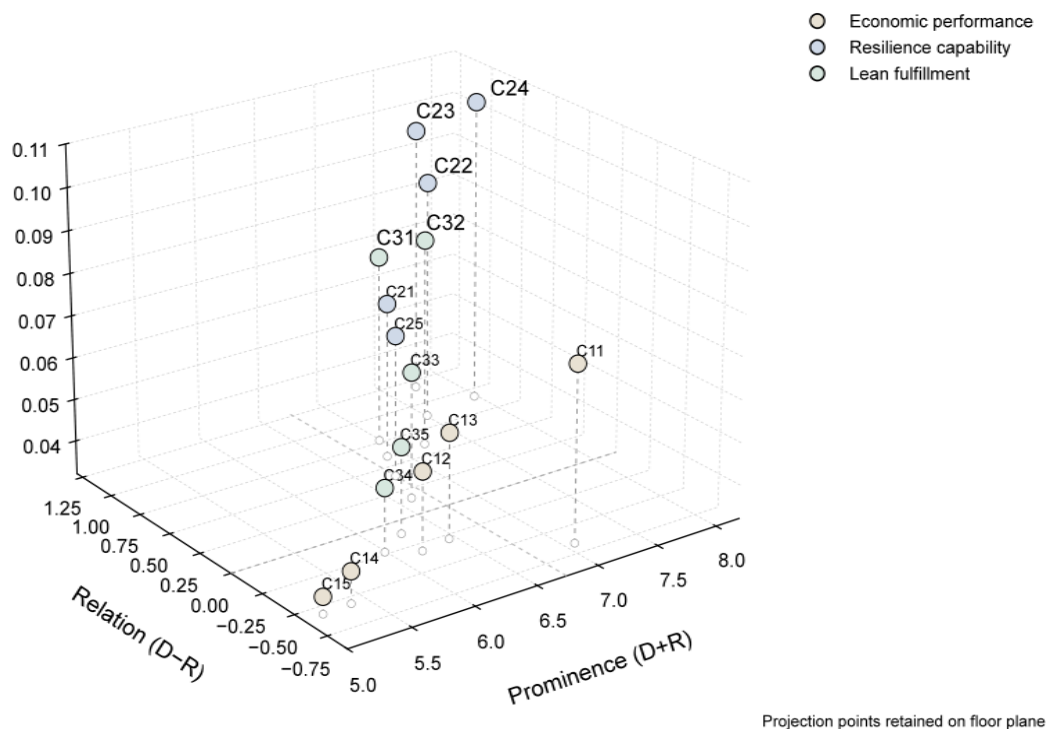


Figure 4: Three-dimensional prominence - relation - weight landscape of evaluation criteria

As can be seen from Figure 4, C24 continuous fulfillment stability, C23 emergency response time and C22 route and port redundancy are both in the high significance and positive causality range, which are the core drivers in this study. The significance of the three indicators were 7.98, 7.74 and 7.51, and the causality were 0.92, 1.18 and 0.87, respectively, indicating that these indicators not only have a high degree of participation, but also will continue to affect the change direction of other indicators. C32 quality consistency and C31 on time delivery rate are also located in the positive causal zone, with the significance of 7.21 and 6.99 respectively, indicating that the stability of the execution end is not a consequential subsidiary performance, but will in turn affect cost control, synergy efficiency and subsequent risk exposure. In contrast, although the significance of C11 delivered calorific cost reached 7.08, the causality was -0.66, which was closer to the result end, indicating that the calorific value cost to the plant was more a comprehensive reflection of the combined action of the preceding conditions than the source of the change of the driving system alone.

This distribution has direct implications for power plant procurement judgment. The reason why continuous performance, replenishment speed and channel redundancy are concentrated on the affected end is that they determine whether the trader can maintain supply continuity under disturbance conditions. Once these indicators are weak, the punctuality rate will drop, the quality control will become passive, and the purchasing elasticity of the inventory warning period will shrink. If the quality consistency and on-time arrival rate enter the high significance range, it indicates that the stability of the execution end is not a simple "back-end performance", but will continue to affect coal unloading coordination, coal blending control and document

processing. In other words, the focus of power plants' evaluation of trader is not a single point cost, but whether it can stabilize the supply process and suppress the implementation fluctuation. DEMATEL results and causal attributes of each indicator are shown in Table 3.

Table 3: DEMATEL results of the evaluation criteria

Code	Indicator	D	R	D+R	D-R	Causal attribute
C24	Continuous fulfillment stability	4.45	3.53	7.98	0.92	Cause
C23	Emergency resupply response time	4.46	3.28	7.74	1.18	Cause
C22	Route and port redundancy	4.19	3.32	7.51	0.87	Cause
C32	Quality consistency	3.91	3.30	7.21	0.61	Cause
C11	Delivered calorific cost	3.21	3.87	7.08	-0.66	Effect
C31	On-time delivery rate	3.88	3.11	6.99	0.77	Cause
C21	Source diversification	3.74	3.14	6.88	0.60	Cause
C25	Shock tolerance to policy and market change	3.57	3.17	6.74	0.40	Cause
C33	Unloading and handover coordination efficiency	3.39	3.23	6.62	0.16	Cause
C13	Settlement flexibility	3.08	3.37	6.45	-0.29	Effect
C35	Loss and coal blending control	3.06	3.18	6.24	-0.12	Effect
C12	Price fluctuation controllability	2.94	3.26	6.20	-0.32	Effect
C34	Document and settlement accuracy	2.88	3.11	5.99	-0.23	Effect
C14	Transport organization economy	2.41	2.97	5.38	-0.56	Effect
C15	Claim and price adjustment response efficiency	2.29	2.86	5.15	-0.57	Effect

Table 3 further shows that 8 of the 15 indicators fall in the positive causal zone and 7 in the negative causal zone. The positive causality zone is mainly composed of resilience capability and partial lean fulfillment indicators, while the negative causality zone is more concentrated on economic performance and implementation results indicators. This structure shows that elasticity and process stability are closer to the driving source of the system, while price, settlement and transportation economy are more passive. The causality of C13 settlement flexibility is -0.29, the causality of C12 price mobility controllability is -0.32, the causality of C14 transport organization economy is -0.56, and the causality of C15 claim and price adjustment response efficiency is -0.57, indicating that the improvement of transaction terms is usually based on the stability of the pre order supply organization and execution. If the channel redundancy is insufficient, the replenishment speed is slow or the continuity of performance is weak, the advantages at the price and settlement levels are difficult to be realized stably.

After the action structure is identified, the weight results further give the actual weight order of these indicators from the management side of the power plant. The results of index ranking, recursive weight and comprehensive weight are shown in Table 4.

Table 4: SWARA and integrated weights of the evaluation criteria

Rank	Code	Indicator	s _j	k _j	q _j	SWARA weight	Integrated weight
1	C24	Continuous fulfillment stability	—	—	1.0000	0.0891	0.1043
2	C23	Emergency resupply response time	0.06	1.06	0.9434	0.0840	0.0954
3	C22	Route and port redundancy	0.04	1.04	0.9071	0.0808	0.0890
4	C32	Quality consistency	0.05	1.05	0.8639	0.0769	0.0814
5	C31	On-time delivery rate	0.03	1.03	0.8388	0.0747	0.0766
6	C11	Delivered calorific cost	0.05	1.05	0.7988	0.0711	0.0739
7	C21	Source diversification	0.04	1.04	0.7681	0.0684	0.0690
8	C25	Shock tolerance to policy and market change	0.03	1.03	0.7457	0.0664	0.0657
9	C33	Unloading and handover coordination efficiency	0.04	1.04	0.7170	0.0639	0.0620
10	C13	Settlement flexibility	0.06	1.06	0.6764	0.0602	0.0570
11	C35	Loss and coal blending control	0.05	1.05	0.6442	0.0574	0.0525
12	C12	Price fluctuation controllability	0.03	1.03	0.6255	0.0557	0.0507
13	C34	Document and settlement accuracy	0.04	1.04	0.6014	0.0536	0.0471
14	C14	Transport organization economy	0.07	1.07	0.5621	0.0501	0.0395
15	C15	Claim and price adjustment response efficiency	0.05	1.05	0.5353	0.0477	0.0360

Table 4 shows that the top five indicators with comprehensive weights are C24 continuous fulfillment stability, C23 emergency resupply response time, C22 route and port redundancy, C32 quality consistency and C31 on time delivery rate, and their comprehensive weights were 0.1043, 0.0954, 0.0890, 0.0814 and 0.0766, respectively. The total weight of the first five items reached 0.4467, nearly half of the total weight, indicating that trader's evaluation results were mainly driven by the core competencies of "continuous performance - rapid replenishment - channel redundancy - stable quality - on-time delivery". The comprehensive weight of heat value cost C11 to the plant is 0.0739, ranking sixth, indicating that cost is still important, but its priority is lower than supply continuity and execution stability. The indicators at the bottom of the list are C34 document and settlement accuracy, C14 transport organization economy and C15 claim and price adjustment response efficiency, The comprehensive weights are 0.0471, 0.0395 and 0.0360 respectively, indicating that these indicators can affect the cooperation experience, but are not enough to determine the comprehensive position of trader alone.

This weight distribution is basically consistent with the previous causal structure. Most of the indicators falling at the impact end have entered the higher weight range at the same time; The weight of indicators that fall on the receiving end with low significance is also relatively low. This result shows that power plants pay more attention to the stability of the supply chain in the trader evaluation, rather than regarding the price and settlement conditions as the only priority. If a trader is superior in price, but continues to be weak in supply speed, path redundancy and continuous performance, its comprehensive position is difficult to enter the

forefront; If the cost of a trader is not the lowest, but the supply process is stable and the implementation fluctuation is small, it is easier to maintain an advantage in the subsequent sequencing. As far as 3.1 is concerned, the results here have given a clear judgment line: the core that really determines the difference between traders is not the static trading conditions themselves, but whether the continuity of supply and execution stability can form a sustainable support. On this basis, the next section will further compare the comprehensive position, risk correction results and ranking performance of different traders under different scenarios.

3.2 Comprehensive ranking, scenario comparison, and robustness of coal trader evaluation results

After the key indicators and their weights have been determined in 3.1, the comprehensive position of each trader begins to differentiate clearly. After putting the basic performance, risk exposure and ability balance into the same space, the difference between the front-line objects and the middle and rear objects is no longer only reflected in the total score, but also reflected in the rank change after risk reduction. The spatial distribution of each trader in terms of basic performance, risk exposure and balance has formed a hierarchy, as shown in Figure 5.

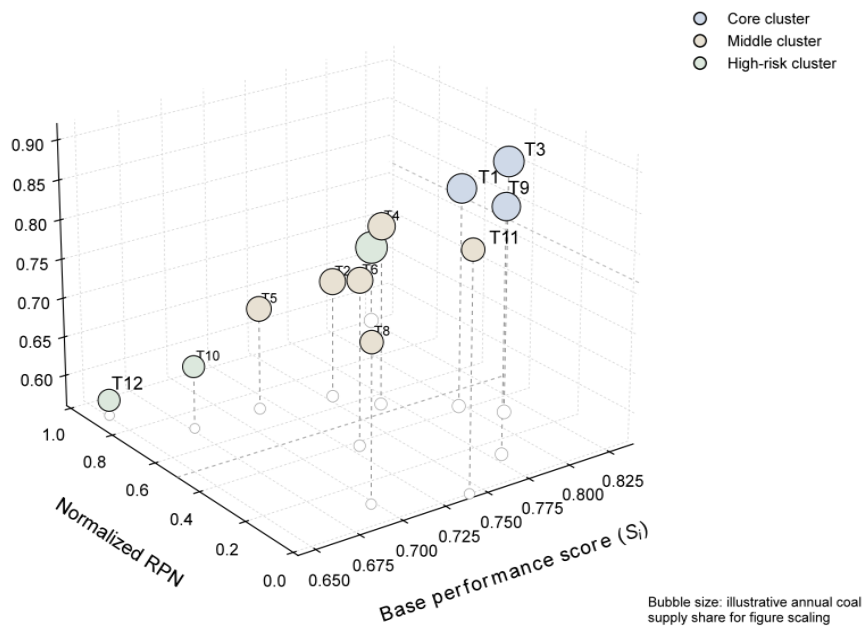


Figure 5: Three-dimensional performance - risk - balance map of coal traders

From the perspective of basic performance score, T7, T3, T1 and T9 are in the forefront, with scores of 0.826, 0.812, 0.798 and 0.781 respectively. After the risk reduction is connected, the front-line order is adjusted. T7 had the highest basic score, but the RPN was 252. After correction, the score fell to 0.718, and the ranking moved from the first place to the fourth place; The basic score of T3 was 0.812, the RPN was 168, and the corrected score was 0.741, rising to the first place; The basic score of T1 and T9 was slightly lower than that of T7, but the RPN was 180 and 144, respectively. After correction, the score reached 0.724 and 0.723, ranking second and third respectively. The ranking adjustment mainly comes from the difference of risk exposure, not from the absolute level of basic score.

Traders in Figure 5 can be divided into three categories. T3, T1 and T9 are in the regions with high score, low risk and high equilibrium index at the same time, which are more suitable

for entering the core cooperation list. T7 is located in the high zone, but the risk exposure is high and the equilibrium index is low, indicating that its leading position is more based on local dimensional advantages. The basic score of T11 is 0.742, which does not rank high, but the RPN is only 128, and the equilibrium index reaches 0.86. After risk correction, it rises to the fifth place, indicating that its advantage comes from the small overall fluctuation. T10 and T12 at the end fall into the low score and high-risk range at the same time, indicating that their weakness is not concentrated in a single indicator, but multiple key indicators are weak together.

It is not enough just to see the final ranking, but also to see whether the score structure of the front-line objects comes from the same type of ability. This difference has been further expanded by the standardized portraits and first-class dimension contours of each trader, as shown in Figure 6.

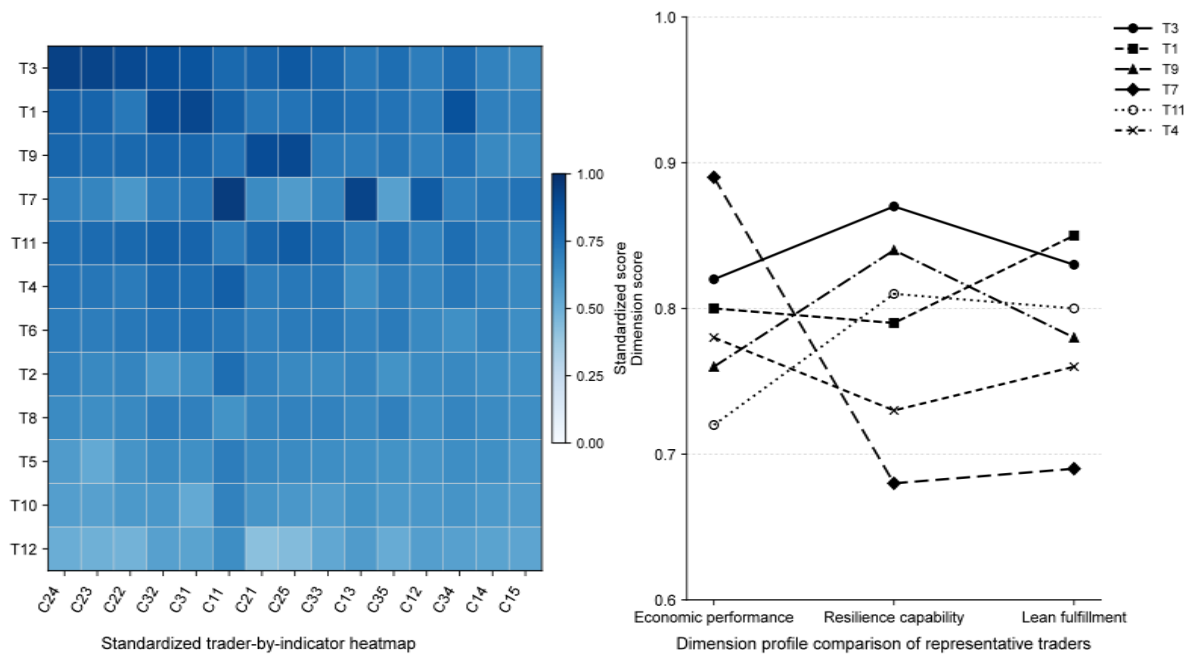


Figure 6: Standardized trader-by-indicator heatmap and multi-curve profile comparison

The heat map results show that the distribution of the top six traders in the high weight index is not consistent. T3 maintains high values in the three driving indicators of continuous performance stability, emergency supplementary supply response time and path redundancy; T1 is more prominent in the punctuality rate of arrival, quality consistency and document accuracy; T9's advantages lie more in the diversification of supply and impact tolerance; T7 has a strong performance in the cost of calorific value and settlement flexibility, but it continues to be weak in path redundancy, impact tolerance and loss control. The contour map further compacts this difference. T3 scored 0.82, 0.87 and 0.83 in the three first level dimensions of economic performance, resilience capability and lean fulfillment, respectively, with the most balanced three-dimensional distribution; The scores of T1 were 0.80, 0.79 and 0.85, respectively, and the advantage was more concentrated in the executive end; The scores of T9 were 0.76, 0.84 and 0.78, respectively, and the support point was mainly from the supply guarantee ability; T7's economic score reached 0.89, but its elasticity and lean scores were only 0.68 and 0.69, which is also the direct reason for its backward position after risk reduction.

The basic scores, RPN results, risk adjusted scores and main weaknesses of each trader are shown in Table 5.

Table 5: Comprehensive scores, RPN correction, and final ranking of coal traders

Trader	Base score (S _i)	Severity	Occurrence	Detection	RPN	Balance index (B _i)	Adjusted score (F _i)	Final rank	Main weakness
T1	0.798	6	5	6	180	0.84	0.724	2	Route and port redundancy
T2	0.754	7	6	5	210	0.71	0.669	8	Quality consistency
T3	0.812	6	4	7	168	0.88	0.741	1	Claim and price adjustment response efficiency
T4	0.768	7	4	7	196	0.79	0.689	6	Settlement flexibility
T5	0.716	6	6	6	216	0.69	0.643	10	Emergency resupply response time
T6	0.731	5	5	7	175	0.77	0.674	7	Document and settlement accuracy
T7	0.826	7	6	6	252	0.66	0.718	4	Shock tolerance, route redundancy
T8	0.698	7	4	5	140	0.76	0.662	9	Delivered calorific cost
T9	0.781	6	4	6	144	0.87	0.723	3	Unloading and handover coordination efficiency
T10	0.677	6	6	6	216	0.64	0.612	11	On-time delivery rate
T11	0.742	4	4	8	128	0.86	0.701	5	Transport organization economy
T12	0.651	8	5	6	240	0.58	0.571	12	Source diversification

Table 5 shows that the position change of the first six traders is mainly triggered by two situations. The first is that the basic score is high, but the risk exposure is also high. T7 and T4 fall into this category. The basic score of T4 was 0.768, the RPN was 196, and the final ranking fell to the sixth place. The second is that the basic score is not the highest, but the risk is low and the structure is flat. T11 belongs to this category. Its basic score only ranks 7th, but it rises to 5th after risk reduction. There are also obvious differences in the problems of the middle and rear segment of the trader. The short board of T5 focuses on the response time of emergency supplementary supply. The score loss of T10 is mainly from the on-time arrival and continuous performance, while T12 is weak in the diversification of supply and impact tolerance. From this point of view, the gap between traders is not directly opened by a single low price advantage, but determined by whether the high weight indicators can stand at the same time, and then superimposed on the results of risk exposure.

After sorting into different management scenarios, the front structure is not completely fixed. The ranking change under different management preferences and weight disturbances has given a clear stability boundary, as shown in Figure 7.

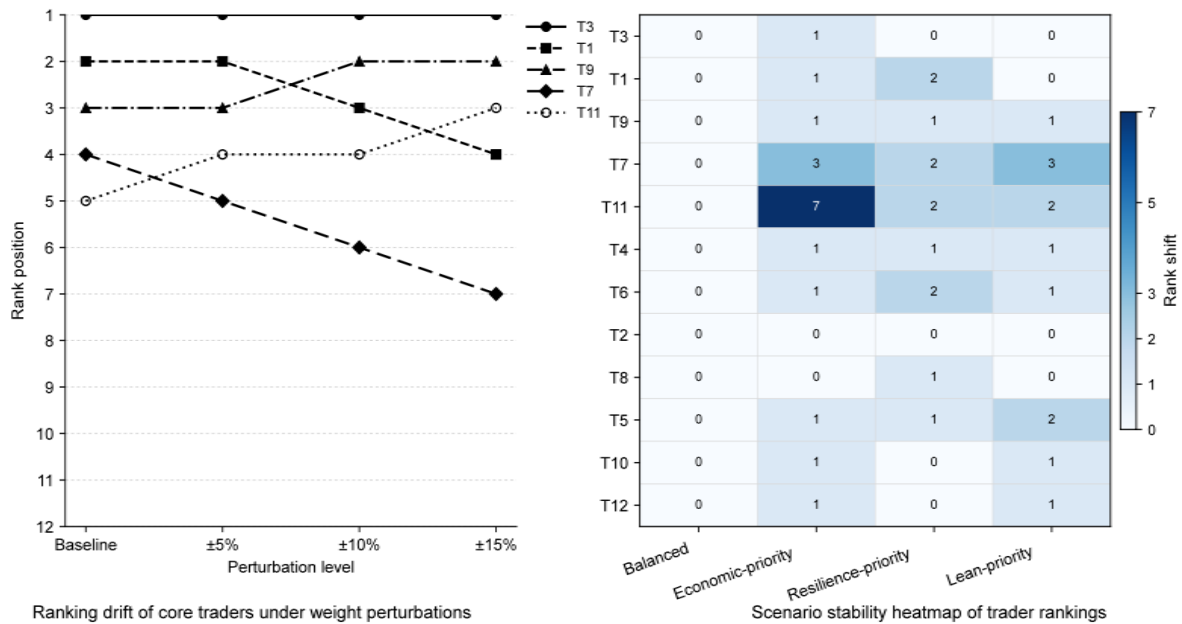


Figure 7: Ranking sensitivity and scenario stability under weight perturbations

In the balanced scenario, T3, T1 and T9 rank in the top three; In the economic priority scenario, T7 rose to the first place, T3 and T1 ranked second and third respectively; In the resilience priority scenario, T3, T9 and T11 enter the top three; In the lean priority scenario, T3, T1 and T11 rank at the top. T3 is the only object that remains in the top two under the three core scenarios. T1 remains the top two in the balanced and lean priority scenarios, but moves back to the fourth place in the resilience priority scenario. T9 rose to the second place in the resilience priority scenario, indicating that its ranking support mainly comes from the elasticity dimension. The fluctuation of T7 is the most obvious, ranking first in the economic priority scenario, and falling to No. 6 in the resilience priority scenario, indicating that its ranking is more dependent on cost orientation.

The results of scenario comparison, ranking consistency index and disturbance test are shown in Table 6.

Table 6: Scenario comparison and ranking consistency test results

Setting	Top-3 traders	Spearman coefficient	Average rank shift	Top-3 stability	Most sensitive trader
Balanced	T3, T1, T9	1.000	0.00	100.0%	—
Economic-priority	T7, T3, T1	0.912	1.42	66.7%	T11
Resilience-priority	T3, T9, T11	0.941	1.08	66.7%	T7
Lean-priority	T3, T1, T11	0.926	1.17	66.7%	T5
± 5% weight perturbation	T3, T1, T9	0.981	0.42	100.0%	T7
± 10% weight perturbation	T3, T9, T1	0.956	0.83	100.0%	T7
± 15% weight perturbation	T3, T9, T11	0.927	1.33	66.7%	T7

From the Spearman rank correlation coefficient, the correlation coefficients of economic priority, resilience priority and lean priority relative to balanced scenarios are 0.912, 0.941 and 0.926, respectively. The overall ranking remains the same, but the front row objects have been replaced. The results of weight perturbation further showed that the average ranking deviation under the conditions of ± 5%, ± 10% and ± 15% were 0.42, 0.83 and 1.33, respectively;

The stability of top-3 remained 100.0% at $\pm 5\%$ and $\pm 10\%$ disturbances, and decreased to 66.7% at $\pm 15\%$ disturbances. This result shows that a small weight adjustment will not rewrite the front structure, but when the offset continues to expand, there will be a ranking replacement between T1, T9 and T11. According to Trader individuals, T7 is the most sensitive object in the sample with an average ranking shift of 2.25; The average ranking shift of T3 is only 0.25, indicating that its advantages come from the joint support of multiple key indicators.

Based on the results of this section, T3, T1 and T9 are more suitable to be included in the core cooperation list; T7 and T4 can be retained for use in supplementary procurement or price game scenarios, but should not assume too high supply guarantee weight; T11 is more suitable for stable combination. At this stage, the comprehensive ranking has pulled apart the normal performance difference, risk exposure difference and scenario stability difference between traders at the same time.

3.3 Cross-Outlet Heterogeneity and Theoretical Implications

The risks in the sample are mainly concentrated in three categories. The first category falls on the continuity of supply, which is characterized by slow response to emergency supplementary supply, insufficient stability of continuous performance and weak path redundancy. Once this kind of short board enters the inventory warning period, it will quickly push up the risk exposure of trader and change its final position. The second category falls on the fluctuation of the execution end, which is mainly reflected in the punctuality rate of arrival, quality consistency, coal unloading coordination and loss control. Such problems may not immediately push the basic score to the end, but will continue to raise the occurrence and detection, thus pushing up the RPN. The third category falls on the structural imbalance, that is, individual traders perform strongly in terms of costs or transaction terms, but the high weighted indicators do not stop at the same time, and finally move backward after risk reduction. For power plants, what really needs to be suppressed first is the continuity and fluctuation at the execution end that will continue to conduct along the supply chain. The difference between different traders is not only reflected in the final ranking, but its heterogeneity is more clearly reflected in the distribution of elastic execution collaborative portfolio and risk exposure sources, as shown in Figure 8.

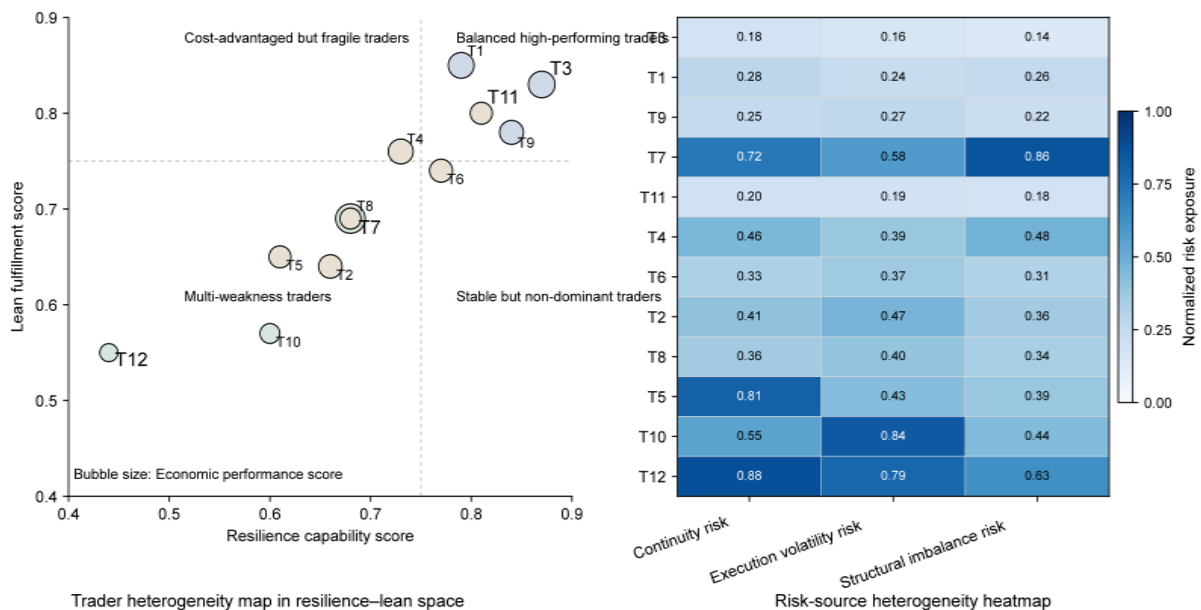


Figure 8: Heterogeneity structure of coal trader types and risk-source composition

The difference of representative traders can be applied to four types of objects. The first type is a high score and stable balanced trader, represented by T3. This object maintains an excellent position in the three dimensions of basic performance, risk exposure and equilibrium index. Continuous performance, replenishment speed, path redundancy and quality consistency stand at the same time, so the ranking fluctuation is the smallest in different scenarios. Such traders are suitable for entering the core cooperation list and bearing a high proportion of annual long-term cooperation or guaranteed supply weight. The second type is the high score but high-risk skewed trader, represented by T7. This object is outstanding in the cost of calorific value to the plant and settlement flexibility, so it can rise to the first place under the economic priority scenario, but its path redundancy, impact tolerance and loss control are weak, with an RPN of 252, and the ranking moves to the fourth place after the risk reduction. Such traders can be retained, but they are more suitable for undertaking price game, periodic replenishment or partial substitution tasks, and should not be placed in the position of high guarantee and supply weight. The third type is the robust trader with non extreme scores but small fluctuations, represented by T11. This object does not rely on a single high score to enter the forefront, but it has low risk, less short board and stable position in multiple scenarios. Such traders are more suitable to be put into a stable portfolio to hedge the uncertainty brought by high-yield but high volatility objects. The fourth type is the fragile trader with low score and multiple weak items, represented by T12. The object is weak in terms of diversified supply, impact tolerance and comprehensive performance at the execution end. Even if local terms are negotiable, its overall position is difficult to improve. Such traders should not be maintained in the main cooperation sequence.

The difference of representative traders can be applied to four types of objects. The first type is a high score and stable balanced trader, represented by T3. This object is superior in three dimensions: basic performance, risk exposure and equilibrium index when using the ranking results, power plants need to see the source of ranking formation synchronously. If a trader is in the forefront by its cost advantage, but its supply speed and redundancy ability are weak, its cooperation boundary should be tightened; If the total score of a trader is not the highest, but the high weight index is balanced and the risk exposure is low, its allocation proportion in the portfolio should be increased. The sorting table shows the position. The short board field in Table 5 corresponds to the source of loss of points. Figure 7 and table 6 reflect whether this position can stand under different conditions. After the three are combined, the purchaser can complete the executable trade-offs.

The results falling to the power plant side mainly correspond to three types of actions. The first type of action is to determine the core supply assurance layer, which is composed of objects such as T3, T1 and T9 that are still in the forefront after risk reduction and have small fluctuations in multiple scenarios. It is suitable for undertaking the main tasks of long-term cooperation, winter and summer peak supply assurance and inventory warning period. The second type of action is to set the strategy adjustment layer, which is composed of objects with higher basic scores but stronger potential vulnerability such as T7 and T4. It is suitable for use in the price window period, replenishment purchase or local market substitution, but the allocation proportion should not be too high. The third type of action is to establish the observation and replacement layer, which is composed of T10, T12 and other objects. The short board of such traders has been concentrated on the high weight indicators, and should be managed as the replacement priority list. Instead of passively handling the contract at the later stage, it is better to reduce its cooperation share in advance in the quarterly review.

Adjusting the configuration ratio and cooperation level of the trader cannot just stay at the result end. For trader with weak continuous performance and replenishment speed, the power plant should focus on alternative channels, emergency coal blending and replenishment time

limit; For traders with large fluctuations in quality consistency and punctuality rate, batch inspection, pre shipment sampling inspection and factory arrival rhythm control should be moved forward; For traders with high scores but high risks, local advantages should be restrained from being over amplified through hierarchical contracts, quantity caps and dynamic assessment. After this round of processing, the ranking results can continue to be transformed into the basis of contract weight, inventory strategy and cooperation structure adjustment.

The short board on the high weight index will first push up the RPN, then move the ranking backward, and finally compress the cooperation boundary of the trader. After the implementation of this result, traders' reservation, replacement and combination configuration have a clearer landing point, and the core guaranteed supply list is easier to maintain stability under disturbance conditions.

4 Conclusion

Focusing on the specific object of coal traders' evaluation of China's power plants, this paper constructs a dematel-swara-rpn model for procurement practice, and completes the index identification, weight formation, risk reduction, comprehensive ranking and scenario comparison. The research results incorporate the normal performance, potential vulnerability and ranking stability of trader into the same evaluation framework at the same time, so that the judgment of the power plant on the partner will no longer stay on the single price or one-time performance record, but can fall into the executable reservation, replacement and combination configuration.

(1) At the level of data and object organization, this paper combines transaction, quality inspection, logistics, settlement and expert judgment into the same trader unit, and combines the original business fields into three first-class dimensions of economic performance, resilience capability and lean fulfillment and 15 second-class indicators. The evaluation structure formed in this way puts the judgment basis originally scattered in the purchase, fuel, transportation and financial links under a unified caliber, so that different traders can be directly compared at the same decision level, and also provides a unified input for subsequent relationship identification, weighting and risk correction.

(2) At the method and result level, this paper first uses DEMATEL to identify the role of indicators in the overall network, and then uses swara to form the order weight, and finally uses RPN to deal with the potential vulnerability separately. The results show that the stability of continuous performance, the response time of emergency supplementary supply, the redundancy ability of route and port, the consistency of quality and the punctuality rate of arrival are at a more critical position, and jointly determine the main differences between traders. After the access of risk reduction, some objects with higher basic scores but stronger vulnerability moved back, while objects with more balanced ability structure and lower risk exposure maintained or improved their positions. According to the final results, the top traders with small fluctuations are suitable for entering the list of core guaranteed suppliers, the objects with high scores but high risks are more suitable for undertaking the tasks of replenishment procurement or price game, and the objects with multiple high weight indicators that are continuously weak should enter the observation and replacement sequence.

(3) There is still room for further expansion of this article. First, the fine-grained samples at the trader level are mainly from the business organizations at the power plant side, and the public bank level data is still limited; Second, the RPN score retains some elements of expert judgment; Third, the sample object and application boundary mainly correspond to the coal and electricity procurement environment, and the extrapolation to other energy varieties still needs to be recalibrated. The follow-up study can continue to expand the sample range, introduce a

longer time window, cross regional power plant data and rolling update mechanism, and further modify the risk score and dynamic sequencing process.

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About the Author

Liu Huiqiao was born in Ningxia Province, China, in 1989. In 2012, she obtained a Bachelor's degree in Management from Northwest A&F University in China. In 2016, she obtained a Master's degree in Regional Economics from Northwest A&F University. From 2016 to 2019, she served as an assistant professor at the Business School of Yinchuan Energy College in Ningxia, China. Since 2020, she has been a lecturer at the same institution. She has presided over two provincial-level teaching projects in Ningxia and published more than three articles. Her research interests include energy economics, regional economics and industrial development, as well as micro- and macroeconomics.

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