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Study on the Evolution of International Investment Dispute Settlement Mechanisms and China's Countermeasures

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ABSTRACT
The effectiveness of international investment dispute settlement mechanisms directly affects the stability and legal security of transnational investment. The current investment dispute arbitration system still has many challenges in terms of fairness, cost-effectiveness and enforcement. This paper constructs a dispute resolution model based on game theory, proposes a quantitative assessment method, combines data-driven analysis to optimize the arbitration mechanism, and explores China's investment dispute resolution path. Through the design of intelligent technology path, system optimization strategy and the construction of risk prevention and control framework, it can improve the winning rate and execution power of Chinese investors in international dispute resolution, reduce legal risks and enhance the security of cross-border investment.

KEYWORDS
International investment disputes; Arbitration mechanism; Game model; Quantitative assessment

1 Introduction

In the context of economic globalization, transnational investment has become increasingly active, with a consequent increase in investment disputes, and the legal conflicts between investors and host countries over issues such as policy changes, expropriation and compensation, and contract performance have become increasingly complex. Although the existing International Settlement of Investment Disputes (ISDS) mechanism provides a legal remedy channel to a certain extent, there are problems such as long arbitration period, high cost and disputes over impartiality. In particular, Chinese enterprises face greater legal risks in the process of "going out" due to institutional constraints and the uncertainty of the legal environment. Exploring a more scientific, efficient and fair dispute resolution mechanism has become an important issue.

2 Mathematical modeling of investment dispute settlement mechanisms

2.1 Dispute resolution game model

The settlement of investment disputes involves multiple parties such as states and investors, host governments and international organizations, and has complex game characteristics. In order to characterize the game behavior, a dynamic game model based on asymmetric information can be constructed to describe the strategy choices of investors and host countries in the dispute settlement process. Let the investor (I) and the host country (H) be the two parties of the game, and the strategy sets are , $S_I=\{proceedings,conciliation,abort\}S_H=\{take\ up,rejection,defer\}$ The return function of the investor depends on the investment return (R), litigation cost (C_I), arbitration time discount (δ) and probability of winning the case (p). The host country's return, on the other hand, is affected by the investment attractiveness (V), settlement payment (C_H), and the country's credit loss (L). The investor return function can be expressed as:

$$U_I=p\left(R-C_I\right)+\left(1-p\right)\left(-C_I\right)-\delta T$$

The host country gain function is then:

$$U_H=V-pC_H-\left(1-p\right)L$$

In equilibrium, investors tend to litigate if they expect a high probability p of winning and low litigation costs; conversely, they favor settlement or exit. The host country then influences investors' decisions by adjusting $\boldsymbol{C_H}$ and L to form a dynamic equilibrium. Further combining the signal game with **evolutionary stabilization strategy (ESS) analysis, China's investment dispute resolution strategy can be optimized.

2.2 Risk assessment measurement methodology

In the process of investment dispute settlement, risk assessment is the core link, which directly affects investors' decision-making and dispute handling efficiency. In order to realize scientific and quantitative assessment, an investment dispute risk assessment model can be constructed, taking into account key factors such as political risk (R_p), legal risk (R_l),

economic loss risk (R_e) and arbitration uncertainty (R_a). Let the comprehensive risk scoring function be:

$$R = w_p R_p + w_l R_l + w_e R_e + w_a R_a$$

Where, , , w_p w_l w_e w_a ,are the weights of each risk factor to satisfy$\sum w_i = 1$. The weights can be determined by hierarchical analysis method (AHP) or entropy weight method to ensure scientific rationality. For the political risk R_p , it can be measured by using Event Study Model (Event Study Model), setting the impact of political conflict at time t asΔP_t , the cumulative impact is expressed as:

$$R_p = \sum_{t=1}^{T} \beta_t \Delta P_t$$

Legal RiskR_l The Legal Uncertainty Index (LUI) can be used to calculate the ambiguity of the law and the consistency of the precedents of international arbitration cases. Economic Loss RiskR_e Depends on the investment size I and expected loss ratio λ with the following expression:

$$R_e = \lambda I$$

Arbitration UncertaintyR_a is then satisfied as measured by the award bias of historical casesσ_a :

$$R_a = f(\sigma_a)$$

Based on the above quantitative model, the dispute resolution solution can be optimized to provide our investors with scientific risk prevention and control strategy support.

2.3 Analysis of data-driven arbitration mechanisms

In the process of international investment dispute resolution, the operational efficiency of the arbitration mechanism, the fairness of the award and cost control directly affect the rights and interests of investors and the outcome of dispute resolution. With the application of big data technology, data-driven arbitration analysis can reveal key variables such as historical award trends, average hearing cycle and investor win rate of arbitration institutions, providing quantitative support for investor decision-making. Based on historical arbitration case data, an arbitration efficiency-win rate assessment model can be constructed. Let the average adjudication time of an arbitration institution i beT_i and the investor win rate beS_i , then the overall arbitration efficiency indexE_i can be expressed as:

$$E_i = \frac{S_i}{T_i}$$

The higher theE_i , the better the investor-friendliness and efficiency of the institution's arbitration. From the historical data, there is a significant difference between ICSID, UNCITRAL, ICC and other institutions in terms of hearing time and win rate (see figure). Among them, SIAC has the shortest arbitration time (18 months) and the highest win rate (65%), indicating that it possesses higher dispute resolution efficiency. Combined with the machine learning prediction model, the impact of case characteristics on arbitration results can be further explored to provide Chinese enterprises with more accurate investment dispute prediction strategies and improve international investment legal risk management capabilities.

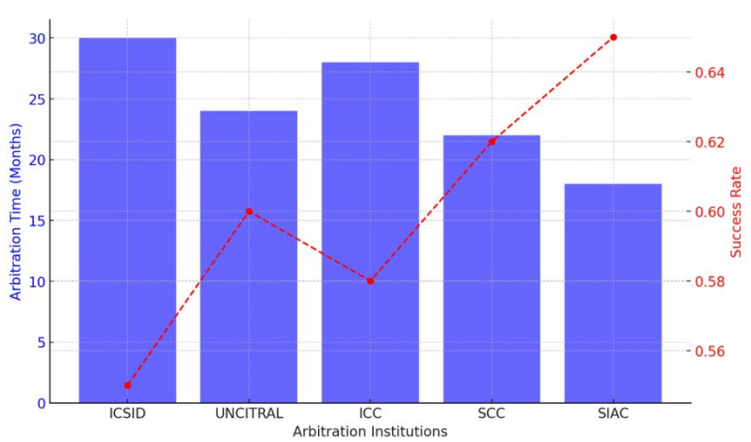

Figure 1 Analytical diagram of data-driven arbitration mechanism

3 Quantitative assessment of investment dispute settlement mechanisms

3.1 Indicators for evaluating technical efficiency

The evaluation of the technical efficiency of the investment dispute settlement mechanism involves multiple

dimensions, including the arbitration cycle, the win rate, the cost-effectiveness, the appeal rate and the enforcement of the award. A scientific evaluation index system can help identify the efficiency differences between different arbitration institutions and provide a decision-making basis for optimizing China's investment dispute settlement path.

(1) Arbitration Duration (T): reflecting the time required from the acceptance of the case to the final award, the shorter the period, the higher the efficiency of arbitration. Data show that the average length of SIAC arbitration is 18 months, which is more efficient than the 30 months of ICSID.(2) Success Rate (S): Measures the probability of an investor winning a case; the higher the success rate, the stronger the investor's confidence in the arbitration institution. The data show that SIAC's success rate of 65% and SCC's 62% are better than ICSID's (55%).(3) Cost Efficiency (C): the cost of arbitration per unit of case. The lower the cost, the lower the burden on the investor; SIAC has the lowest cost ($400,000) and ICSID the highest ($500,000).(4) Appeal Rate (A): a measure of the stability of the decision, the lower the appeal rate, the greater the credibility of the decision; SIAC has the lowest appeal rate (10%) and ICSID the highest (20%).(5) Enforcement Compliance (E): Indicates how well an arbitral award has been enforced; SIAC has the highest enforcement compliance (90%) and ICSID the lowest (75%).

Table 1 Indicators for evaluating the technical efficiency of investment dispute settlement mechanisms

Evaluation indicators	ICSID	UNCITRAL	ICC	SCC	SIAC
Arbitration Duration (months)	30	24	28	22	18
Success Rate (%)	55	60	58	62	65
Cost Efficiency (USD/Case)	500,000	450,000	470,000	430,000	400,000
Appeal Rate (%)	20	18	15	12	10
Enforcement Compliance (%)	75	80	85	88	90

3.2 Cost-benefit model of arbitration

There is a complex trade-off between the cost of arbitrating investment disputes and the expected return; excessive arbitration costs may undermine the investor's return, while reasonable arbitration inputs can increase the win rate and safeguard the return on investment. In order to quantify this relationship, an arbitration cost-benefit model can be constructed, where the investor's arbitration return R is jointly determined by the probability of winning the case p, the amount of investment I, and the cost of arbitration C, and the return function is expressed as follows:

$$R = pI - C$$

where p is influenced by the arbitration institution, the type of case and the international law environment, I is the size of the investment and C is the cost of arbitration. Data analysis shows that institutions with lower arbitration costs (e.g., SIAC) correspond to higher expected returns, while high-cost institutions (e.g., ICSID) may reduce the final returns to investors (see Figure 2). The cost-benefit ratio (CBR) is further introduced, defined as:

$$CBR = \frac{R}{C} = \frac{pI - C}{C}$$

This indicator is used to measure the economic rationality of arbitration, and a higher CBR indicates that the arbitration program is more attractive to investors. Arbitration institutions with moderate costs (e.g., SCC and UNCITRAL) perform best in CBR, indicating that they combine both economy and guarantee of success, which provides a reference for Chinese investors to optimize their dispute resolution strategies.

Figure 2 Cost-benefit model of arbitration

3.3 Quantification of multidimensional performance

In the evaluation of investment dispute settlement mechanisms, it is difficult for a single indicator to fully reflect the strengths and weaknesses of arbitration mechanisms. Therefore, a multi-dimensional performance quantification method

should be adopted to comprehensively examine key factors such as arbitration efficiency, economy, fairness and enforceability, in order to provide a comprehensive basis for decision-making.

(1) Arbitration efficiency (Efficiency): It mainly measures the degree of optimization of the hearing time and process of the case, the shorter the hearing time, the higher the efficiency.

(2) Cost-Effectiveness: including arbitration costs, attorney's fees and other related expenses, the lower the cost, the better the economy.

(3) Fairness: The fairness of arbitration is guaranteed by evaluating the success rate, transparency of cases and legal consistency.

(4) Enforceability: Measures the strength of enforcement and international recognition of arbitral awards; the higher the enforcement, the greater the benefit to investors.

Table 2 Table of quantitative analysis of multidimensional performance

Performance dimensions	ICSID	UNCITRAL	ICC	SCC	SIAC
Arbitration efficiency (hearing time in months)	30	24	28	22	18
Economy (average cost, US$ million)	50	45	47	43	40
Fairness (success rate, %)	55	60	58	62	65
Enforceability (implementation rate, %)	75	80	85	88	90

SIAC has the best performance in all indicators, with the shortest hearing time, the lowest cost, and the highest win rate and enforceability, indicating that it has a high overall performance in dispute settlement. This analysis can provide a quantitative basis for China to optimize its investment dispute settlement strategy.

4 Optimizing china's investment dispute settlement path

4.1 Technology pathway design

Against the backdrop of an increasingly complex global investment environment, China needs to build an efficient, fair and enforceable investment dispute settlement system to enhance the level of international investment protection. The optimization of the technical path should be carried out at three levels: institutional innovation, intelligent application and international cooperation, so as to form a systematic and sustainable dispute settlement system. In terms of institutional innovation, the localized development of international investment dispute settlement mechanism should be promoted, an investment dispute arbitration institution with Chinese characteristics should be established, the dispute settlement clauses of the Arbitration Law and the Foreign Investment Law should be improved, and the reform of the multilateral investment dispute settlement mechanism should be promoted. At the same time, the interface between arbitration and conciliation should be strengthened, and an integrated "conciliation-arbitration-enforcement" mechanism should be constructed to enhance the flexibility and effectiveness of dispute settlement.

In terms of intelligent applications, the dispute resolution process should be optimized with the help of big data and artificial intelligence. Machine learning technology should be used to analyze historical investment dispute cases and establish an investment dispute prediction system to improve the accuracy of case assessment. Further, blockchain technology can be used to build an arbitration credit assessment system to improve the credibility and enforceability of awards. In terms of international cooperation, China should actively participate in the revision of the International Convention on the Settlement of Investment Disputes, promote the construction of regional investment dispute resolution mechanisms (such as the Belt and Road International Commercial Arbitration Center), and strengthen cooperation with international arbitration institutions (such as the ICSID, SIAC, etc.), so as to enhance the right of Chinese investors to have a say in international investment disputes. The Chinese government should strengthen cooperation with international arbitration organizations (e.g. ICSID, SIAC, etc.), and enhance Chinese investors' voice in international investment disputes.

4.2 System Intelligent Optimization Strategy

Under the development trend of international investment dispute settlement mechanism, the in-depth application of intelligent technology has become a key direction to optimize the dispute settlement system. China should build a dispute resolution system based on artificial intelligence, big data analysis, blockchain and smart contracts to enhance arbitration efficiency, reduce dispute costs and improve the enforceability of awards. The establishment of an Intelligent Arbitration Assistance System (IAAS) can significantly optimize the arbitration process. Based on natural language processing (NLP), the system parses the terms of investment contracts and intelligently matches them with a historical case database to quickly identify potential legal risks and provide an optimal dispute resolution path. Deep learning algorithms can be utilized to predict the success rate of cases and assist investors and governments in making optimal

decisions.

Big data-driven risk assessment models can enhance the foresight of investment dispute resolution. Through data mining of global investment arbitration cases and analyzing the trend of awards, fee structure and enforcement of different arbitration institutions, a real-time dynamic investment risk index is constructed to provide investors with precise dispute prevention strategies. The combination of blockchain and smart contracts can enhance the credibility and enforcement of arbitration awards. Smart contracts can be used to automatically execute dispute resolution agreements to ensure the transparency and compliance rate of investment contracts, while utilizing the non-tamperability of the blockchain to enhance the credibility of evidence management, thereby reducing enforcement resistance and increasing the international recognition of awards.

4.3 Technical framework for risk prevention and control

In the face of the uncertainty of the global investment environment, China needs to build a multi-level, data-driven, intelligent technical framework for the prevention and control of investment dispute risks, in order to improve the security of international investment, reduce the incidence of disputes and enhance the initiative of Chinese enterprises in international arbitration. An investment risk early warning system should be established to analyze changes in the global investment environment based on big data and artificial intelligence, monitor the political, legal and economic risks of host countries in real time, and form a dynamic risk index to provide enterprises with pre-investment decision-making support.

Constructing an intelligent compliance review mechanism, utilizing natural language processing (NLP) and machine learning technologies to automate the review of investment contracts, identify potential legal loopholes and dispute risks, ensure that investment terms comply with international legal norms, and reduce the possibility of disputes. The evidence deposit system of blockchain technology should be promoted to ensure the transparency and non-tamperability of investment contracts, transaction records, and the dispute resolution process, so as to improve the credibility and enforcement of arbitration and reduce the risk of damage to investors' rights and interests.

5 Conclusion

The evolution of the international investment dispute settlement mechanism reflects the continuous optimization of the global governance system for fair and efficient dispute handling. Based on the game model, quantitative assessment and data-driven analysis, this paper discusses the optimization path of the ICSID mechanism and proposes technical solutions to meet the needs of Chinese investors. By building an intelligent arbitration system, optimizing the technical path of dispute resolution, and strengthening the risk prevention and control framework, China's investment dispute resolution capability can be effectively enhanced and its international competitiveness strengthened. In the future, China should further strengthen multilateral cooperation, promote the internationalization of the investment dispute arbitration mechanism with Chinese characteristics, and ensure the protection of the rights and interests of Chinese enterprises in the global investment system.

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