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A Study on the Mutual Rental Model of Container Shipping Alliance Cabins based on Blockchain

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ABSTRACT

As one of the main modes of capacity sharing in the shipping alliance, the essence of which is the space mutual rent transaction among members. However, under the current trading system, the sharing of capacity between shipping enterprises requires a lot of transaction costs and communication costs, cooperation efficiency is not high, and there is a certain competitive relationship between enterprises, they work for their own interests, resulting in more difficult cooperation, and blockchain consensus mechanism, intelligent contracts, distributed bookkeeping and other characteristics can solve these problems of alliance cooperation. Therefore, based on the idea of blockchain, this paper designs a model of mutual lease cooperation in shipping union cabins, gives the model and process of mutual lease transactions based on blockchain, realizes mutual trust and win-win situation among members, simulates through the combination of Hyperledger Fabric and Matlab, and verifies the applicability of blockchain to shipping alliance capacity sharing cooperation.

1. Introduction

Today, container transportation is the preferred mode of maritime import and export trade transportation. With the development of large-scale ships, the use of super-large container ships can reduce the cost of single-box transportation and achieve economies of scale, but the uncertainty of shipping market demand and excess container capacity still exist. In addition, the outbreak of neo-crown pneumonia has affected the shipping industry as a whole, with entry or transit restrictions in ports in various countries leading to a continued decline in shipping demand and additional costs from the suspension of large numbers of

container captains. And the shipping alliance can be in the field of transport services routes and ports to complement each other, ship time coordination, capacity sharing, as well as in the field of transport ancillary services information exchange, the construction of common terminals and dumps, the sharing of inland logistics system, so that on the one hand can achieve economies of scale, better control costs, on the other hand, can also make full use of resources, so that alliance members in the market downturn to resist the risk of excess capacity, to achieve win-win cooperation.

In terms of capacity sharing, the forms of cooperation of the Container Shipping Alliance include class

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inter-lease, class exchange and co-shipment, and cabin mutual-lease is the most commonly used form. However, in the mode of space mutual rent cooperation, the capacity cooperation between alliance members involves the communication of multiple data, which requires a high degree of information sharing among members, however, the cooperation data between members is still stored on their own servers, when the data saved by the partners is consistent, the cooperation can proceed smoothly, but in fact, due to the different servers, software, staff and data recording methods, it is difficult to achieve complete data, so enterprises often check transaction data through the form of accounting, Inefficient and wasted a lot of manpower and material resources. It is difficult to establish trust relationships between enterprises, resulting in limited capacity-sharing cooperation, and the need to pay intermediary fees for managing cooperative transactions within the Alliance through intermediaries, resulting in increased costs. In addition, for the mode of mutual lease cooperation in class, the alliance formed by the strategic alliance is a relatively loose organization formed by the members through the conclusion of the space mutual lease agreement, although the shipping alliance has some provisions and restrictions on the distribution of routes, capacity-sharing cabin arrangements, freight rates, etc., but is not protected by law, and the authenticity of the data generated in the course of the transaction is difficult to guarantee, the trust between members needs to be strengthened. In addition, the settlement of funds after the transaction also needs to be carried out with the participation of banks and other financial institutions, banks charge a certain amount of interest, resulting in increased transaction costs. For member's cabin mutual lease transaction, how to price the class in order to maximize the benefits of the alliance is an important part to consider.

In short, the alliance of shipping enterprises is an effective way to solve the current downturn in the shipping market. However, there are obstacles to data sharing, trust building and maximizing alliance benefits when working together on capacity among members of shipping alliances. As a secure and reliable distributed database, blockchain has the advantages of de-centralization, high trust and data non-tampering, can achieve secure and trustworthy data sharing, members of the joint accounting to ensure the authenticity of each transaction and difficult to tamper with, intelligent contracts can realize the automatic execution of transactions and rapid transfer of benefits, can effectively avoid malicious arrears. Therefore, blockchain technology can be used as the underlying technology of cooperation among the members of the shipping alliance to achieve the benign development of the alliance.

2. Review of the Relevant Literature

At present, the shipping alliance is the focus of the current development of the shipping industry. Shih-Liang Chao ^[1] studies have found that in the case of a serious imbalance between supply and demand, the alliance between shipping companies can achieve flexible adjustment of the remaining capacity. As one of the main modes of capacity cooperation of the shipping alliance, the space inter-lease is the mode of capacity cooperation, most scholars have studied the construction of the mode of space allocation, Xuan Qiu and so on ^[2], think that in the context of "Belt and Road", container liner alliance ship sharing is very important to establish an effective maritime transport network, and for the situation of ships, design two kinds of container space allocation model. Chen Jihong and others ^[3] set up a model for the rental and configuration of container liner positions based on the shipping alliance based on the method of ship distribution on liner routes.

Scholars consider that it is an important breakthrough in the development of shipping industry to promote the transformation of shipping industry through paperless, intelligent and other digital means, thereby reducing the human dependence of the industry. Xu Kai ^[4] believes that the use of electronic bill of lading in China's container shipping business is a very good opportunity. Blockchain technology is at the peak of the expected maturity curve of Hong Kong's information technology, and the combination of shipping industry and blockchain technology has broad application potential. Li ^[5] believes that blockchain distributed databases and decentralization features can simplify the transaction of funds and reduce the flow of shipping documents, to achieve process monitoring. Ashraf Shirani ^[6] studied the feasibility of using blockchain technology in container shipping logistics, designed and developed web-based concept validation prototype applications, and simulated the potential capabilities of blockchain.

Blockchain-based inter-lease transactions between members of the shipping alliance have great independence and are typical P2P transactions. Blockchain P2P trading is the most researched area is the retail power trading market, Wenxuan Zhao ^[7], etc. through the introduction of transaction matching center and the use of blockchain intelligent contracts, the construction of blockchain-based power trading model. Matteo Troncia ^[8] proposes a new fully automated P2P local power market platform that enables decentralized operation of the energy and ancillary services market in distribution networks. Blockchain technology can provide a good system solution for the development of shipping alliances, put cooperative

transactions between alliance members on the chain, can guarantee the authenticity of transaction data, enhance the trust of members. However, in the specific class mutual lease transaction, how to use blockchain technology to develop a reasonable class mutual lease pricing strategy to protect the interests of the alliance as a whole and individual members, is very worthy of study. Richa Agarwal^[9] and others, based on the concepts of mathematical planning and game theory, have designed a side payment mechanism to guide carriers in shipping alliances to pursue the best overall interests of the alliance. In the study of blockchain P2P power trading, Wang Dewen^[10] and others designed a two-way auction pricing mechanism to obtain clearing prices, and gave a regional energy trading process based on smart contracts. However, the shipping alliance class mutual lease transaction and the power P2P transaction is somewhat different, the class mutual lease is carried out under the premise of limited space resources, and does not have the auxiliary service market as the power market as a supplement. In addition, the indivisible nature of the demand for space is also one of the characteristics of the space mutual rental transaction different from the power and energy transaction. Therefore, how to design the space mutual rent pricing strategy on the basis of blockchain is also the focus of this paper.

3. Blockchain-based Shipping Alliance Class Inter-lease Transaction Framework

Blockchain-based shipping alliance class mutual rental model is the blockchain system as the underlying technology system of cooperation among alliance members, the data information generated in the process of space mutual lease transactions are stored on the blockchain, and through the blockchain to achieve transfer settlement. Unlike traditional trading methods, both parties no longer rely on intermediaries for mutual trust and cooperation, as shown in Figure 2. The main body of the shipping alliance class inter-lease transaction is the class supplier and demander, during the trading cycle, the space supply direction blockchain trading system submits the availability information of the class (including route, number of classes, class of travel and class unit quotation, etc.) and the class mutual-lease transaction request, which is submitted to the system by the charter authority of the class demand, and then the system sends the request to the certification authority of the blockchain trading system (Certificate Authority, CA) to determine whether the class mutual lease transaction request meets the requirements, if it meets the requirements, the transaction request will be sent to the mutual lease transaction matching center.

The Transaction Matching Center (TMC) will automatically perform matching according to the preset pricing strategy. In the matching process, the quotations reported by the members of the alliance are encrypted by digital encryption technology, and the other party's quotations cannot be seen among the members, that is, the system connects the member's quotes with a string of random strings and uses Hash encryption as a sealed quote, which not only makes the sealed quote un tamperable, but also ensures that the quote is not disclosed to other members prematurely^[14]. After the mutual lease cooperation match is successful, the system sends the transaction information to both parties to the transaction, waits for confirmation by both parties, formulates the contract for the transaction and uses the private key to sign. Fabric's multi-channel mechanism creates a channel for each transaction, each of which contains only the two parties to the class-of-travel mutual lease, thus isolating the data within and outside the channel. Finally, the digital proof that the class supply side transfers control of the cabin through the blockchain to the demand side with which it trades. After that, the transaction is broadcast to the entire network, the node is confirmed by consensus mechanism and recorded in the blockchain, and the trading system receives the confirmation information and sends it to the dispatch center. At the end of a trading cycle, the system uses smart contracts to transfer and settle data recorded on the blockchain.

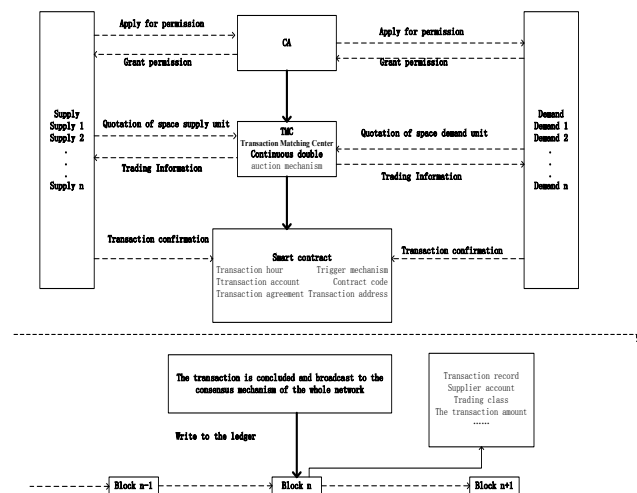


Figure 2. Overall architecture of based on the blockchain shipping alliance of shipping space mutual lease

4. Shipping Alliance Class inter-lease trading Method based on Smart Contracts

4.1 Class Inter-lease Transaction Process based on Smart Contracts

In a blockchain environment, participants can perform

trusted operations without the involvement of a third party through smart contracts. According to the characteristics of the class mutual lease transaction, it can be divided into five stages: transaction authentication, information release, transaction matching, transaction confirmation and fund settlement, the specific process is shown in Figure 3.

4.1.1 Transaction Certification phase

At this stage, members of the shipping union with avialage and demand for space apply to CA for access to the relevant set of attributes in the trading network (including identification, wallet address, member type and permissions, etc.), while CA uses the primary private key MPK to issue public and private keys and digital certificates to each member unit.

4.1.2 Information Release Phase

During the n-1 cycle prior to the start of the transaction, shipping alliance members report supply and demand information to the blockchain system based on their own supply and demand conditions and publish it through TMC. Among them, the information release function of the class supply side and the demand side are shown in the formula (1) and (2).

$$Int_a (ID_a, Addr_a, L_a, S_a, ASK_a, Sig_a) \rightarrow Supply \quad (1)$$

$$Int_b (ID_b, Addr_b, L_b, S_b, ASK_b, Sig_b) \rightarrow Demand \quad (2)$$

Among them, ID_a and ID_b are the identity of the class supplier and the demand side respectively, $Addr$ is the wallet address, R_a and R_b represent the supply side and demand side route, ASK_a and ASK_b are an array containing quotations and the number of seat supply and demand, and Sig generates signatures for the information.

4.1.3 Trade Matching Phase

Class mutual lease traders through TMC transaction matching, TMC executes a continuous two-way auction mechanism to determine the transaction price (see section 3.2), the transaction match is successful and then added timestamp T_{ab} , generating the transaction match result Result.

$$Match(Demand, Supply, T_{ab}) \rightarrow Result \quad (3)$$

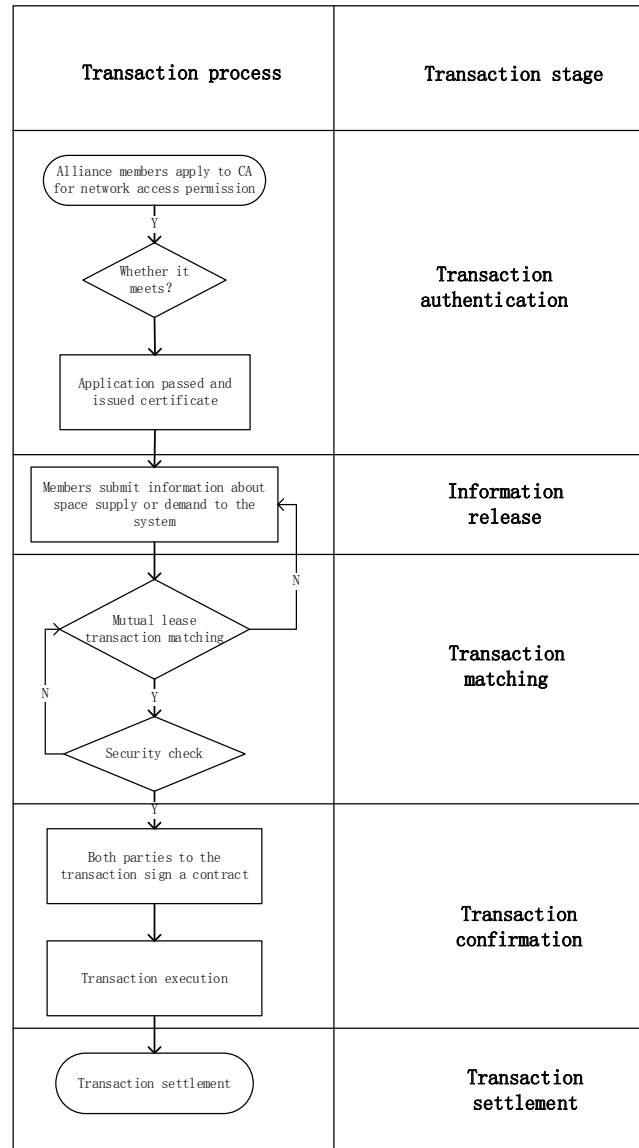


Figure 3. Mutual leasing trade process based on intelligent contract

4.1.4 Trade Confirmation Phase

Transaction matching results will be broadcast to the entire network for transaction verification, and the content of the order will be distributed through consensus mechanism calculation and authentication, and then the P2P webcast certification results will be used. Once the authentication is successful, the parties to the transaction select a suitable TMC node to form a shift path for control of the cabin, while the TMC generates a random number, as shown in the formula (4).

$$Hash(SU_{id}, DU_{id}, TMC_{id}) \rightarrow Rand \quad (4)$$

Among them, SU_{id} , DU_{id} represents the identity in-

formation of the class supply side and the demand side, TMC_{id} is the matching information of the class inter-lease transaction, and $Rand$ is the generated random number.

4.1.5 Trade Settlement Phase

When the transaction is completed, it is submitted to the sorting service for sorting, and the random number $Rand$ formed by hash encryption is combined with the transaction match result $Result$ into a transaction that is included in the blockchain ledger, as shown in the formula (5).

$$Int_r = (Result, Rand) \rightarrow Record \quad (5)$$

Due to market uncertainty, there is strong uncertainty between the two parties to the class inter-lease transaction, there may be no contract to rent and lease the cabin, so in the transaction settlement phase designed a trust-based penalty mechanism to adjust the distribution of the interests of the last member, thereby avoiding the risk of trust in the transaction (see section 3.3).

4.2 Based on the Improved Two-way Auction Mechanism, the Class Rent Pricing Strategy

Traditional shipping alliances often apply for classes including rental prices through leasing members, asking the class of travel available for rent by the class supplier, and when the number of classes and the rental of the cabins replied by the supplier meet their intended objectives, the two sides sign a mutual lease agreement and enter into cooperation. This is not only inefficient, but also reduces the range of choices between the two sides, which is not conducive to maximizing their interests. Therefore, this paper adopts a continuous two-way auction mechanism based on blockchain to develop the pricing strategy of mutual rental of space among members. The two-way auction mechanism is in the case that the trading participant is many-to-many, the buyer and seller can submit the expected quotation at any time during a certain trading cycle, through the “price first, time first” principle, once the match is successful can be completed [15].

However, in the shipping alliance space mutual lease model, not only the matching of prices, but also the matching of supply and demand, it is necessary to consider the matching of supply and demand. Assuming that the demand is indivisible, the transaction will only be carried out when the demand is fully satisfied. Therefore, based on the Gjerstad-Dickhaut (GD) strategy [16], this paper proposes an improved double auction mechanism that considers the supply and demand of space in the blockchain environment, and uses the historical transac-

tion information recorded by the blockchain technology to establish trust Function to adjust the quote. Realize peer-to-peer transactions in a decentralized environment. In this peer-to-peer transaction model, participants make independent decisions, and use “benefit first, time first” as the auction principle, that is, the system first considers the auction portfolio that maximizes the total profit. When the supplier receives the same benefit, then The demand side is selected according to the order of registration time. In this mechanism, the mutual lease transactions between shipping alliance members are divided into n cycles. During the cycle, the blockchain system will collect the supply and demand of the space submitted by the supplier and demander of the space, including the initial quotation. Information, the system matches with the goal of maximizing overall benefits, and returns the matching results to the supplier and the demander. Both parties agree to complete the auction, and the two parties reach cooperation. It should be noted that due to different routes, alliance members may be either the suppliers or the demanders of space. Let the set of space suppliers in the system be $I = \{1, 2, \dots, n\}$, the fixed shipping cost of the supplier $i \in I$ is f_i , the cost of unleased unit space is c_i , the maximum supply is D_i . So that the collection of the demand side of the cabin is , the demand of the demand side $j \in J$ is q_j , and is willing to rent space at a higher reserve price bh_j . After the transaction is matched, the lowest quotation of the unsuccessful supplier is set to Q_{ask} , if all the seats of the supplier can be rented, then $Q_{ask} = \max$, \max means the highest quotation of the supplier allowed by the market; In the same way, the highest quotation of the demander who has not successfully traded is set to Q_{bid} . If the demand can be fully satisfied, then $Q_{bid} = 0$. The supply and demand members of the class that have not been successfully matched need to modify the quotation to participate in the matching again, in the newly submitted quotation information, the supplier’s quotation should not be greater than Q_{ask} , and the demander’s quotation should not be less than Q_{bid} , otherwise, the system will invalidate its quotation and cannot continue to participate in matching, before the start of the trading cycle, $Q_{ask} = \max$, $Q_{bid} = 0$ [17].

Before the start of the trading cycle, each space provider predicts the expected transaction volume , and calculates the lowest price it is willing to accept as , as shown in formula (6).

$$al_i = \frac{f_i + ex_i \cdot c_i}{ex_i} \quad (6)$$

The specific strategy of double auction of a certain

route is as follows:

(1) After the beginning of the transaction cycle, the space supplier and the demander respectively continuously submit quotation information to the blockchain system. The quotation information submitted by the space supplier is $ask(q_i, p_i, i)$, which means that the supplier i hopes to rent q_i spaces at the unit price of p_i ; the demand information of p_i the demand side is $bid(q_j, p_j, j)$, which means that the demand side j wants to rent q_j units at the unit price of q_j . The system arranges the supplier's quotations in ascending order, the demander's quotations in descending order, and the same quotations are arranged in the order of quotation time.

(2) During the transaction, suppose the supplier's historical quotation set is $A = \{a_1, a_2, \dots, a_n\}$, The demand-side historical quotation set is $B = \{b_1, b_2, \dots, b_m\}$, Introduce the trust function [18], expressed as follows:

Supplier-side trust function:

$$\left\{ \begin{aligned} p^*(a_i) &= \frac{\sum_{a_j \geq a_i} TA(a_j) + \sum_{b_j \geq a_i} TB(b_j)}{\sum_{a_j \geq a_i} TA(a_j) + \sum_{b_j \geq a_i} TB(b_j) + \sum_{a_j \leq a_i} RA(a_j)} \\ p^*(0) &= 1, p^*(M_a) = 0 \end{aligned} \right. \quad (8)$$

Among them, $a_i \in A (i = 1, 2, \dots, n)$, TA and TB are the set of successful transactions in the historical quotations of the supplier and the demander, respectively, RA is the set of unsuccessful transactions, that is, $A = TA + RA$, it is assumed here that the supplier's offer is 0 and is always acceptable, that is, $p^*(0) = 1$, and there is a very high offer that is always rejected, that is, $p^*(M_a) = 0$,

Demand-side trust function:

$$\left\{ \begin{aligned} q^*(b_i) &= \frac{\sum_{b_j \leq b_i} TB(b_j) + \sum_{a_j \leq b_i} TA(a_j)}{\sum_{b_j \leq b_i} TB(b_j) + \sum_{a_j \leq b_i} TA(a_j) + \sum_{b_j \geq b_i} RB(b_j)} \\ q^*(0) &= 0, q^*(M_b) = 1 \end{aligned} \right. \quad (9)$$

Among them, $b_j \in B (j = 1, 2, \dots, m)$, RB is the set of unsuccessful quotations in the historical quotations of the demand side, namely $B = TB + RB$. Assuming that the demand side's quotation is always rejected by the market when it is 0, that is, $q^*(0) = 0$, there is a very high quotation that can always be accepted by the market, that is, $q^*(M_b) = 1$.

Discrete function continuity: Since the quotation is a discrete data set, the trust function is also a discrete function. Therefore, the cubic spline interpolation method is used here to make the trust function continuous. Methods

as below:

For the supplier, arrange its historical quotations in the order from low to high, and the two-dimensional coordinates of any two adjacent quotations a_i, a_{i+1} are $(a_i, p^*(a_i)), (a_{i+1}, p^*(a_{i+1}))$, using cubic spline interpolation to solve the continuous function $p(a)$, as shown in equation (10)(11). And solve the equation coefficients c_1, c_2, c_3, c_4 through the formula.

$$p(a) = c_1 a^3 + c_2 a^2 + c_3 a + c_4 \quad (10)$$

$$s.t. \begin{cases} p(a_i) = p^*(a_i) \\ p(a_{i+1}) = p^*(a_{i+1}) \\ p'(a_i) = 0 \\ p'(a_{i+1}) = 0 \end{cases} \quad (11)$$

$$\begin{bmatrix} a_i^3 & a_i^2 & a_i & 1 \\ a_{i+1}^3 & a_{i+1}^2 & a_{i+1} & 1 \\ 3a_i^2 & 2a_i & 1 & 0 \\ 3a_{i+1}^2 & 2a_{i+1} & 1 & 0 \end{bmatrix} \begin{bmatrix} c_1 \\ c_2 \\ c_3 \\ c_4 \end{bmatrix} = \begin{bmatrix} p^*(a_i) \\ p^*(a_{i+1}) \\ 0 \\ 0 \end{bmatrix} \quad (12)$$

The historical quotations of the demand side are arranged in order from high to low, and the discrete trust function is expanded into a continuous function in the same way as above.

(3) Calculate and adjust the maximum expected profit quotation of the supplier and the demander through the trust function, as shown in equations (13) and (14).

$$\hat{a} = \arg \max_{al \leq a \leq Q_{ask}} p(a) \cdot (a - al) \quad (13)$$

$$\hat{b} = \arg \max_{Q_{bid} \leq b \leq bh} q(b) \cdot (bh - b) \quad (14)$$

Among them, \hat{a} and \hat{b} represent the maximum expected profit quotation of the supplier and the demander, al and bh are the lowest price that the supplier is willing to accept and the highest price that the demander is willing to pay. If $Q_{ask} < al$, the supplier's quotation information will not be submitted by the system; similarly, if $Q_{bid} > bh$, the demander's quotation information will not be submitted. That is to say, the supplier's quotation is not lower than the lowest price it is willing to accept, and the demander's quotation is not higher than the highest price it is willing to pay.

The overall profit of the alliance is calculated as follows:

$$P_{total} = P_s + P_v \tag{15}$$

$$s.t. \begin{cases} P_s = \sum_{i \in I_s} \left[\left(\sum_j d_{ij} \cdot bp_{ij} \right) - \left(f_i + \sum_j d_{ij} u_i \right) \right] \\ P_v = \sum_{j \in I_v} q_j (bh_j - sp_j) \\ \sum_k d_{ik} \leq D_i \end{cases} \tag{16}$$

Among them, P_{total} represents the overall profit of the alliance, P_s and P_v respectively represent the total profit of the supplier and the demander of all spaces, I_s is the set of suppliers of all successful transactions, d_{ij} and bp_{ij} represent the quantity and rental price of different demand-side transaction slots of supplier i respectively, and the sum of the slots of all demand-side j that successfully transacted with i is not greater than i The maximum space capacity D_i , sp_i represents the transaction price of the demander, and I_v is the set of demanders of all successful transactions (all the demands of the demander are met before the transaction).

4.3 Punishment Mechanism for Breach of Contract based on Trust

When the number of seats actually supplied by the supplier member is less than the amount agreed in the smart contract, it will cause a default. In order to avoid the risk of default, a penalty mechanism needs to be designed to punish members who do not perform operations in accordance with the contract. The transaction after the penalty of member i The electricity price is shown in equations (17) and (18).

$$G_{i,t} = \left(\frac{H_{i,t}}{100} - 1 \right) bp_{i,t} \tag{17}$$

$$H_{i,t} = \begin{cases} 100, \frac{O_{i,t}}{E_{i,t}} \leq \mu \\ 100[1 - (1 - \alpha) \frac{O_{i,t}}{E_{i,t}}], \frac{O_{i,t}}{E_{i,t}} > \mu \end{cases} \tag{18}$$

Among them, $H_{i,t}$ represents the supplier's reputation value in the t -th trading cycle; $O_{i,t}$ represents the actual number of leased spaces and the number of spaces transacted in the contract of the i -th supplier in the t -th period, $E_{i,t}$ represents the number of trading slots of member i in the t -th cycle, α represents the degree of trust (derived from the previous section), and μ represents the difference

between the number of slots actually provided by member i and the number of slots transacted The deviation, when μ is set to 0.2, the trading reputation curve of members whose trust degree α is 0.3, 0.5, and 0.8 is shown in Figure 4.

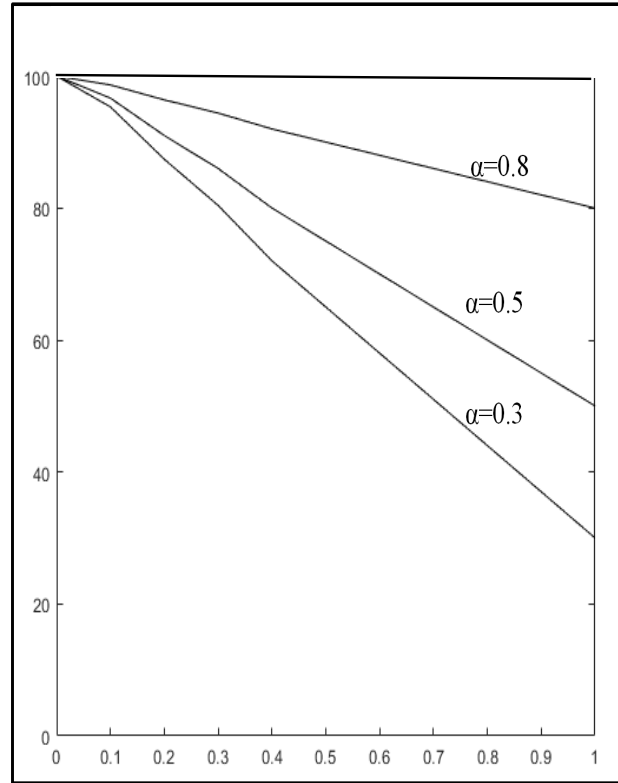


Figure 4. Credit curve

5. Case Simulation

In order to verify the feasibility of the blockchain shipping alliance space mutual lease transaction, on the basis of the Fabric network, a local client is created through the Java SDK to serve as the space mutual lease transaction platform. Under the Ubuntu 18.04 system, install the Docker container to configure the relevant Participants can call smart contracts (chain codes) through the application terminal to initiate a mutual lease transaction. And use Matlab to simulate the transaction matching center for testing. Because the continuous double auction market is automatically quoted by the agent, the quotation time is extremely short. The quotation period of the participants in the mutual lease transaction of space is set to 1s, and the alliance members automatically quote within the 1s range. The initial quotation information of members participating in the mutual lease of shipping alliance space is shown in Table 1.

Table 1. Shipping alliance shipping space mutual rental transaction information

The member type	ex_i/TEU	f_i/CNY	$c_i/CNY \cdot TEU^{-1}$	$p_i/CNY \cdot TEU^{-1}$
Supply 1	500	135700	6600	16600
Supply 2	500	125800	4500	14100
Supply 3	500	106200	4200	16200
Supply 4	700	153800	5500	13700
Supply 5	400	123500	6500	18600
Supply 6	500	141200	8500	14800
The member type	q_j/TEU	$p_j/CNY \cdot TEU^{-1}$	$bh_j/CNY \cdot TEU^{-1}$	
Demand 1	400	15800	18700	
Demand 2	200	14800	19200	
Demand 3	300	13800	17500	
Demand 4	500	13800	15600	
Demand 5	300	18000	16100	
Demand 6	300	15800	16600	
Demand 7	600	14800	15000	
Demand 8	200	14800	16500	

The simulation results are shown in Figure 5, where the bracket labels indicate the serial numbers of the supplier and the demander respectively. There are five rounds of quotation in the transaction. In the second round, 6, 7, and 8 belong to the third, fourth and fifth trading rounds respectively.

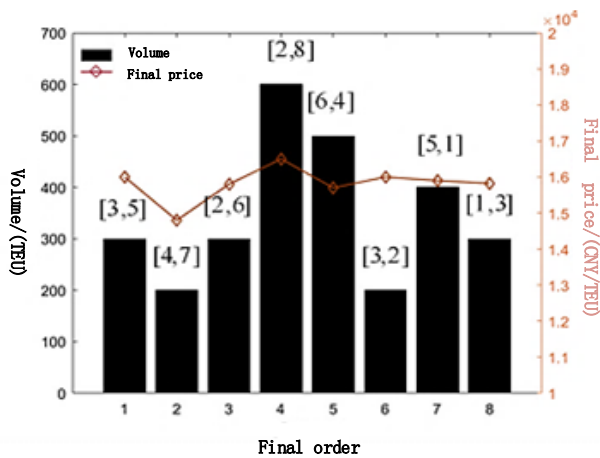


Figure 5. Result of Members' shipping space mutual rental transaction

Finally, the blockchain system settles the transaction. Transaction payment settlement refers to the payment operation through the payment institution after the mutual lease cooperation of space is completed. The alliance chain is responsible for the accounting processing of the transaction results. The system executes the benefit distribution result as shown in Figure 6 below. Through the consensus mechanism, each node guarantees that the ledger

records are consistent, each transaction is transparent and open and cannot be tampered with, and members can view the transaction records through the blockchain query function.

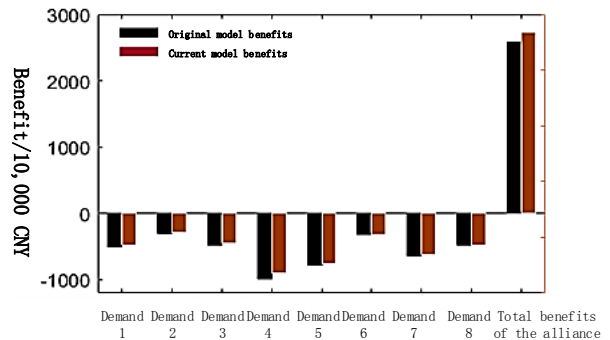


Figure 6. Result of benefit distribution

6. Conclusion

This paper studies on the basis of blockchain, shipping alliance members to carry out mutual lease cooperation between shipping alliances, through the construction of the mutual lease model, the combination of blockchain technology and alliance internal cooperation, and the use of blockchain consensus mechanism, To realize the trust collaboration between members. In terms of cooperative rental pricing for space mutual leases, this paper establishes a dual auction model for space mutual leases, which not only protects the interests of members, but also realizes the increase in the overall interests of the alliance. The blockchain smart contract replaces the paper contract, which is automatically executed and cannot be tampered with at will, effectively improving the efficiency of member cooperation. In addition, the blockchain uses the historical quotation information of the alliance members to calculate the trust and reputation value of the members, and obtains the penalty transaction cost in the case of a member's default, thereby restricting the behavior of the members and reducing the risk of default.

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