Based on Negotiation Strategies and Dynamic Learning Model Generation Rights Trade

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Abstract: - The accelerating development of China has meanwhile induced some negative issues, such as energy and environmental problems. This paper has brought Generation rights trade into the current electricity market environment, which not only effectively alleviate the contradictions arising from rapid development, but also enable the generation right buyers and sellers to achieve their mutual profit maximization. According to the general trading psychology, both sides expect the price close to their expected price in order to maximize their profits.Thus by establishing the electricity market transaction negotiation model, buyers and sellers estimate rival's price bottom line via past experience, and also implement the dynamic learning of random disturbance term with the help of symmetry information during transaction process, and then reacquaint the rival's bottom line. After that both sides make decision optimization by using Zeuthen decision to test the wind resistance of buyers and sellers, and each makes its most beneficial offer decisions. Finally, both sides reach to the final offer through repeated negotiation. The simulation results show that the transaction price is comparatively consistent with the ideal price, and also the transaction price is close to the optimal solution of Nash plot.

Keywords: - power trading; decision optimization; dynamic learning; transaction risk

1. Introduction

The demand of Chinese energy consumption continues to grow, and it is difficult to guarantee the continuity of energy supply only depending on domestic production. According to the Statistics[1]of British Petroleum (BP), in 2011, Chinese oil, gas, coal reserve/production ratio were respectively 9.9,29.8 and 33 years, which were far behind the world average.While faced with the pressure of energy supply,the emissions of China's greenhouse gas and polluting gases is worrying. In 2011,CO_2 emmisions caused by fossil fuel combustion and cement production reached 9.70 Gt, 4.28 Gt more than the United States[2]. Though SO_2 emissions achieved consecutively four-year decline,still it was at a high level of pollution[3].China's energy supply and environmental pollution urgently needs improvement through the collaboration of all sectors of society.

Based on the above background, electricity production must gradually transit to efficient, clean, sustainable operating style to ease the pressure of energy and environmental. As a coordination mechanism, Generation rights trade will transfer power generation of inefficient set to efficient set. In terms of the social environment, it can reduce consumption of coal and fuel for power generation,and then reduce emissions level of greenhouse gas and polluting gases, which creates the extra economic benefits[4-5] for both sides.In 2008, after Electricity Regulatory Commission issued 《Interim Measures generation rights trade regulation》,generation rights trade turned into the promotion stage from the pilot phase; by the end of the first half of 2012, 18 provinces had carried out generation rights trade, and had accomplished the trade of 357 million kW • h, equivalent to the consumption savings of 2.63 million ton of standard coal, and CO_2

and SO_2 emissions were reduced by 684 ton, 68 000 ton.The benefit of energy savings and emissions reduction were remarkable.

Research on generation rights trade mainly includes three aspects: firstly, generation rights trade optimization. Literature [6] constructed generation rights trade optimization model according to different objectives. Literature [7-8] involves congestion management on the electricity trading optimizing, and literature [9] will bring the net loss in optimization model; Secondly, generation rights trading patterns. The match making trading[6], the bilateral trade[10], agency transactions[11], options trading[12], mixed transactions[6,13-14] and other transaction mode should be optimized. Lastly, profit distribution of bidding strategy of generation companies. Literature [15-17], from the perspective of power generation companies, studied trading price to optimize their trading bidding strategy. Literature [18] have proposed Shapley profit distribution model for the generation companies participating in the generation rights trade.

The study is essentially concerned with the transaction results, with little attention to the process of trade negotiations. Bilateral deals with generation rights as a platform, jointing Zeuthen strategic theory and dynamic learning mechanism of stochastic disturbance term to construct decision models of negotiation process between buyers and sellers and study how to make an offer without knowing the trading bottom line of the other party. And in the end, validating the negotiation efficiency of the model through Nash product.

2. Zeuthen Policy Model

As a bargaining tool for buyers and sellers,Zeuthen strategy[19] puts forward compromise offer through estimating the mutual maximum risk accpetability. And after repeatedly negotiation, the offer gradually constrains to agreement, as shown in figure 1. If the offer can not reach to agreement,and both sides believe they are in high risk,then the negotiation breaks down.

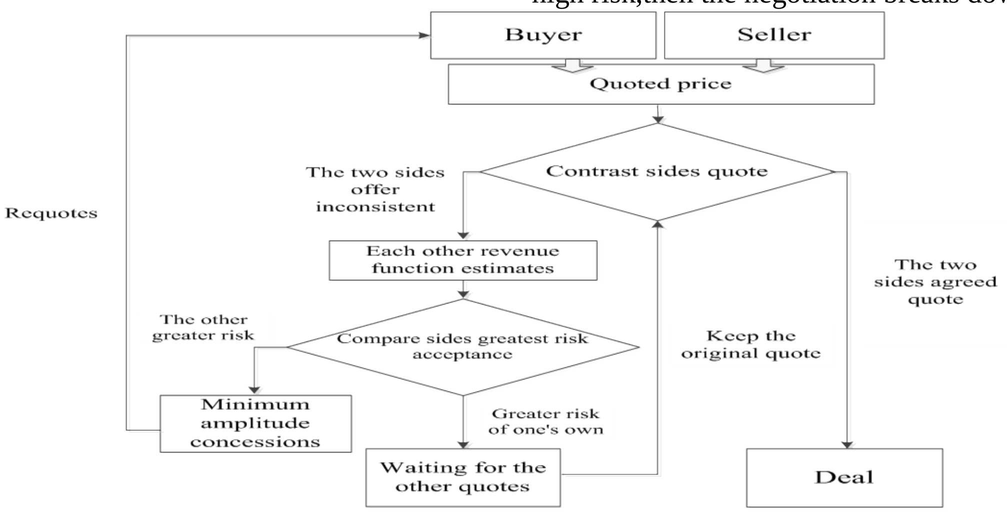

Fig.1 Negotiation process with Zeuthen strategy

During the process of negotiation transaction, Zeuthen strategy mainly helps carry forward the trade in two aspects below.

1)Estimate the maximum risk acceptability

Considering the opposite side's offer, one side will estimatethe both side's risk.If this side is in low risk, then it will make concessions to let the offer astringe graually; and if this side is in higher risk, then it will maintain the original offer.During the negotiations, the maximum risk acceptability of both sides are:

$$r_t^b = \frac{V^b(\pi_t^b) - V^b(\pi_t^s)}{V^b(\pi_t^b) - V_0^b} \quad (1)$$

$$r_t^s = \frac{V^s(\pi_t^s) - V^s(\pi_t^b)}{V^s(\pi_t^s) - V_0^s} \quad (2)$$

In the formula: r_t^b and r_t^s are respectively thebuyer's andthe seller's maximum risk acceptablity during the negotiatio of round t; V^b and V^s are respectively the buyer's and the seller's economic benefit function on offer (for the buyer, V^b is a self-knowing function ,V^s is an estimated function; while forthe seller,V^s is a self-knowing function, V^b is an estimated function); π_t^b and π_t^s are respectively the offer of the buyer and the seller during the negotiation of round t; V_0^b and V_0^s are respectively the economic benefits of the buyer and the seller when negotiation breaks down. And once negotiation breaks down, both sides will fail to obtain profit through the generation rights trade, which can be regarded as 0.

The buyer of generation rights should firstly estimate the benefit function of the seller; Then, based on the level of the both sides' offer,the buyer caculates its own maximum risk degree and estimates the seller's maximum risk degree; Finally, whether making concessions or maintaining the original offer is determined by both side's maximum risk degree.If the buyer's maximum risk degree is high, then the buyer maintains the original offer, otherwise the buyer makes concessions.So is to the seller of generation rights.

2) The minimum concession range

If one side's risk is lower the other side's, then this side may make minimum concessions to change the risk acceptability of both sides, and induces the other side to make concessions in the next stage. Assuming the buyer's maximum risk degree is lower than the seller's($r_t^b < r_t^s$), to enable transactions to sustain, the buyer will make concessions so that both sides are confronted with the unanimous risk:

$$\frac{V^s(\pi_t^s) - V^s(\pi_{t+1}^b)}{V^s(\pi_t^s) - V_0^s} = r_t^b \qquad (3)$$

So, the buyer's minimum concessions range in the new round is:

$$\Delta\pi_t^b = \pi_{t+1}^b - \pi_t^b \qquad (4)$$

3. Random disturbance term dynamic learning

During the negotiation ,both sides' offer is based on each other'sincome level. On the one hand,this will avoid the offer's deviation from the other side's acceptability to cause the termination of negotiation, and on the other hand this will guarantee each other's income level. Therefore,during the negotiation,both sides have to implement thedynamic learning on the opposite's income level.The so-called dynamic learning is that based on the opposite's offer sequence and through random disturbance term learning formulas,both sides constantly amend priori knowledge in order to master each other's bottom line price more accurately[20-21].

In an establishing model, assuming thatthe two existing sides quote dependently and continuously,and meanwhile both sides are influenced by the quoting behaviour and outcome of both the opposite side and itself. The function $\omega_j(t) \in [c,d]$ will explain the enterprise's quoting behaviour, where t represents quoting time, and j quoting enterprises.Because of the random disturbance, the quoting behavior of enterprises can be represented in the form of probability distributions.Suppose $G_j(\omega,t)$ is the probability distribution function of enterprises's quoting behaviour, the the density function is $g_t(\omega,t) = G_t(\omega,t)$.

Let $m-1$-dimensional vector $\omega_{m-1}(t)$ is the quoting behavior j corresponding to other $m-1$ enterprises's behaviour. $G_{m-1}(\omega_{m-1},t)$ is correspondingly the quoting action probability distribution of $m-1$ enterprises. We use $L(s)$ represents the offer at time t, then:

$$L\left[\left(s_j\left(\omega_j(t)\right),t\right)\right] = \int\left(sj\left(\omega_j(t)\right)\right),\omega_{m-1}(t)dF_{m-1}\left(a_{m-1},t\right), j = 1,2,\cdots m.$$

(5)

While quoting, both sides will constantly adjust their behavior to bring themselves higher income. At the same time, enterprises will be influenced by various noise disturbance and make faults during the whole process,which can be represented by the random disturbance term. The above process can be expressed by the following equation:

$$d\omega_j(t) = L\left[\left(s\left(\omega_j(t)\right),t\right)\right]dt + \xi_j d\omega_j(t),\ j = 1,2,\cdots,m.$$

(6)

The first term of the right of the equation is the adjustment amount that the latest quoted price subtracts the old quoted price. The second term is the noise disturbance that is likely to lead to mistakes in the quoting behavior, and the probability is $\xi_j . \omega_j(t)$ is the standard Wiener process, and is submitted to normal distribution with the mean value 0 and the variance dt .Combined with the above formula, the estimated value of the bottom line expectations of both sides will update, thus for any bidder:

$$\frac{\partial G_j(\omega_j,t)}{\partial t} = -L\left[\left(s_j(\omega_j),t\right)\right]' g_j(\omega_j,t) + \frac{\xi_j^2}{2} g_i'(\omega_j,t) \quad j=1,2\cdots m. \tag{7}$$

Above equation describes the systematic evolution process of constant quoting behaviour of enterprises who are qualified for dynamic learing, and it can be used as the basis to re-esimate the seller's benefit function. During the process of seller's constant quoting, the buyer continuously update the estimation of the seller's bottom line, and the buyer will collect information as much as possible to guarantee its benefit.

4. Model generation rights trade negotiations

4.1 Consumption Characteristics generating unit

The relationship between generation cost C and generation capacity Q of coal-fired units in unit time can make up of a quadratic function [22] as showing in the following:

$$C=aQ^2+bQ+c \quad (8)$$

In the formula: a, b, c are relevant cost function parameters for the coal-fired generating unit.

According to the consumption characteristics of unit, formula (8) is a monotonically increasing function, as shown in Figure 2. Under different power states, Units increase or decrease the same amount of electricity generation rights which will casue different generation costs. Therefore, during the generation rights trading process, both parties need to learn and simulate the unit consumption curve of the other party through negotiation, and on this basis, making offers in order to make sure common interest of both parties. Assuming the initial generation rights of buyers and sellers is Q_0 , for the buyer, the increased cost of power generation for purchaseing ΔQ is $C(Q_0+\Delta Q) - C(Q_0)$, and the buyer, on that account, wants to enter into contracts; while for the seller, the decreased cost of power generation for selling ΔQ is $C(Q_0) - C(Q_0 - \Delta Q)$, and the seller wants to conclude transactions on the basis of reduced generation cost. If both parties adhere to their own quoted price, the two sides could not reach a consensus resulting in transactions failure.

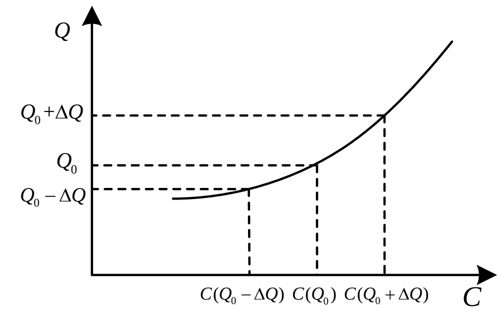

Fig.2 Relationship between output and cost of thermal unit

4.2 Benefit Analysis parties to the transaction

Revenue of both parties will be changed throug the generation rights trading. And the buyer profit can be calculated according to the following formula:

$$\begin{aligned} P^b &= \psi^b \cdot \Delta Q - (C^b(Q_0^b + \Delta Q) - C^b(Q_0^b)) \\ &\quad -\pi \cdot \Delta Q - F^b \cdot \Delta Q \\ &= \Delta Q(\psi^b - 2a^b Q_0^b - a^b \Delta Q - b^b - \pi - F^b) \end{aligned} \tag{9}$$

Seller profit:

$$\begin{aligned} P^s &= \pi \cdot \Delta Q - F^s \cdot \Delta Q \\ &\quad -(\psi^s \cdot \Delta Q - C^s(Q_0^s) + C^s(Q_0^s - \Delta Q)) \\ &= \Delta Q(\pi - \psi^s + 2a^s Q_0^s - a^s \Delta Q + b^s - F^s) \end{aligned} \tag{10}$$

In the formula: P^b and P^s are trading income respectively for buyers and sellers; ψ^b and ψ^s are on-grid price of the units; ΔQ refers to electric quantity per unit time; C^b and C^s stand for electricity generation cost function respectively for buyers and sellers; Q_0^b and Q_0^s are initial electricity generating capacity before the generation rights trade; π is the quoted price for buyers and sellers; F^b and F^s, respectively, are negotiation cost for the generation rights trade. Thus, the trading income of electric quantity V^b and V^s for buyers and sellers are as following:

$$V^b = P^b/\Delta Q = \psi^b - 2a^b \cdot Q_0^b - a^b \cdot \Delta Q - b^b - F^b - \pi \quad (11)$$

$$V^s = P^s/\Delta Q = \pi - \psi^s + 2a^s \cdot Q_0^s - a^s \cdot \Delta Q + b^s - F^s \quad (12)$$

Generation rights in a given electric energy production, the formula (11) and (12) are fixed parameters in addition to the transaction prices, so the electric profits of the buyers and sellers trading can be considered as a linear function relating to generation rights trading, assuming :

$$A = \psi^b - 2a^b \cdot Q_0^b - a^b \cdot \Delta Q - b^b - F^b \quad (13)$$

$$B = \psi^s - 2a^s \cdot Q_0^s + a^s \cdot \Delta Q - b^s + F^s \quad (14)$$

Puting formula (13) and (14) respectively into (11) and the formula (12) we have:

$$V^b = A - \pi \quad (15)$$

$$V^s = \pi - B \quad (16)$$

When $\pi > A$, the Buyer will be loss in the power generation rights trading, and the buyer will interrupt the negotiations; And when $\pi < B$, the Seller will be loss and the negotiations will be interrupted by him. A and B can be regarded as the bottom line of the negotiations of the parties, in order to ensure the smooth implementation of the transaction, quoted price π of buyers and sellers must satisfy the following condition:

$$B \le \pi \le A \quad (17)$$

Therefore, the generation right buyers want the transaction price as closer as possible to B, and power generation right seller will want the transaction price closer to A ,hence, achieving the maximum transaction price $A - B$. However, because the two sides do not know the characteristics of the power consumption of the oposite sides' unit condition, both parties need to keep learning through negotiations, and gradually understand each other's expectations for the transaction price and then make a favorable quoted price.

4.3. Zeuthen strategy based learning model

By analyzing economic benefits of the buyers and sellers during the trading process, it can be concluded that the buyer wants to grasp the value of B, and the seller wants to grasp the value of A, in order to take the initiative in the negotiations position. Therefore, before the negotiations both sides begin to estimate the bottom line of the other side, that is, getting prior knowledge of the bottom line probability distribution. Moreover, there is a subjective estimation of the price bottom probability distribution for each type of transaction. Combining prior knowledge with its own transaction bottom line, buyers and sellers can make decisions. During the offer-making process, the parties can make dynamic learning according to the other side's offer, and update the transcendental knowledge to learn more about each other's trading bottom line. On account of the offer of the other side and the estimated transaction bottom line, buyers and sellers can take advantage of the Zeuthen strategy to estimate the biggest risks acceptanbility of both sides. If the second party has a higher risk, the original offer will be kept, otherwise propose a new quoted price at the least expense, thereby making the negotiation proceeded. In the negotiation process, the quoted price will gradually converge. When both quoted price comes to an agreement, the transaction negotiation model will output the optimal solution. Generation rights trade flow shown in Figure 3.

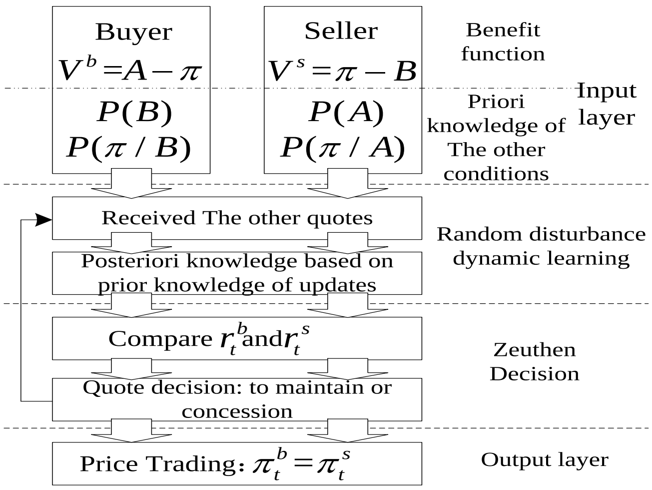

Fig.3 Process of generation rights trade

5. Case Simulation

Generation right of buyers and sellers' tariff were 370 yuan / (MW • h) and 380 yuan / (MW • h) respectively, and the two sides agreed transaction amount per unit time of 100 MW • h. Based on the considerations of the original level of revenue and the revenue generation rights trade, the seller offered 75 yuan / (MW • h) initially. While the purchaser bidden 55 yuan/(MW • h) originally since increasing generating capacity would enhance the marginal cost. The unit parameters of round turn can be seen in Table 1.

Table 1 Unit coefficients of buyer and seller

The counterparty	Q_0 /（MW·h）	F /（yuan·（MW·h）-1）	a /（yuan·（MW·h）-2）	b /（yuan·（MW·h）-1）	c /yuan
Buyer	400	0.5	1.36E-02	278	11160
seller	300	0.5	2.20E-02	317	7200

5.1. The buyer decision process

1) Seller bottom line estimation

Estimating the probability distribution of the seller's base price and bidding strategy in terms of the seller's condition and the experience of cooperation, the estimation results of interval probability distribution of the seller's base price are shown in Table 2.

Table 2 Interval probability distribution of seller's base price

Scenarios	1	2	3	4	5	6
The bottom line (yuan)	[40,45)	[45,50)	[50,55)	[55,60)	[60,65)	[65,70)
Probability	0.10	0.15	0.25	0.25	0.15	0.10

Seller's bidding strategy is influnced by its level of trading bottom line. It means the lower trading bottom line, the lower bidding level, and vice versa. Under the different trading bottom lines, the estimation of conditional distribution of seller's price range is seen in Table 3. If the seller's trading bottom line falls in the range of [40,45), the probability of bidding price locating in [40,50) will be 0.01. In table: B_i represents the i th interval in both transaction negotiations bottom line.

Table 3 Interval conditional probability distribution of seller's offer

The bottom line Bi/yuan	Pricing / yuan					
	(40,50]	(50,60]	(60,70]	(70,80]	(80,90]	(90,100]
(40,45]	0.10	0.15	0.20	0.25	0.20	0.10
(45,50]	0.05	0.10	0.20	0.30	0.20	0.15
(50,55]	0	0.10	0.20	0.35	0.20	0.15
(55,60]	0	0.05	0.15	0.30	0.30	0.20
(60,65]	0	0	0.15	0.30	0.35	0.20
(65,70]	0	0	0.10	0.25	0.40	0.25

Before negotiation, according to priori knowledge of Table 2 the buyer can estimate the expectations of seller's transaction bottom line as:

$$E(B)=\sum B_i \times P(B_i)=55$$

After the seller's offer of 80 yuan / (MW • h) , the buyer can be dynamically learning according to Table 3, the update-seller baseline estimates (Table 4), dynamic learning after that transaction underscores Seller expectations of 54.9 Yuan / (MW • h).

Table 4 Updated interval probability distribution of seller's base price

Scenarios	1	2	3	4	5	6
The bottom line Bi/yuan	[40,45)	[45,50)	[50,55)	[55,60)	[60,65)	[65,70)
Probability	0.083	0.149	0.289	0.248	0.149	0.083

2) The buyer decision Zeuthen

① One's own payoff function. Purchaser according to equation (13) calculated the value of one's own bottom line transactions, resulting in the unit's own electricity trading revenue function:

$$V^b=79.26-\pi$$

② Other revenue function. The seller estimated revenue for the electricity trading of units:

$$V^s=\pi-54.9$$

③ Contrast sides risk. Calculate the maximum risk mutual acceptance:

$$r_1^b=[V^b(55)-V^b(75)]/V^b(55)=0.824$$

$$r_1^s=[V^s(75)-V^s(55)]/V^s(75)=0.995$$

The greatest risk acceptance of the two contrast sides is : $r_1^b<r_1^s$, and buyers have less risk. In order to allow negotiations to be ongoing, the buyer should make concessions to improve power generation right of purchase price.

④ Smallest concession amplitude. Buyers based on the minimum margin to raise its quoted price concessions, making the seller's own risk and consistent. So:

$$[V^s(75)-V^s(\pi_2^b)]/V^s(75)=r_1^b=0.824$$

Solving equations obtained:

$$\pi_2^b=58.4$$

Therefore, the buyer can in the second round quote from the original 55 yuan /(MW • h) increased to 59 yuan / (MW • h), by reducing the risk of inducing each other's price negotiations in the next decision to make price cuts gurantee smoothly. While reducing the seller quotes level, the buyer will repeat the dynamic learning and Zeuthen decision-making process until the negotiations come to satisfactory solution.

5.2. Seller decision-making process

1) Purchaser bottom line estimate

The bottom line interval buyer transaction probability distribution is shown in Table 5.

Table 5 Interval probability distribution of buyer's base price

Scenarios	1	2	3	4	5	6
The bottom line Bi/yuan	(65,70]	(70,75]	(75,80]	(80,85]	(85,90]	(90,95]
Probability	0.10	0.15	0.25	0.25	0.15	0.10

According to prior knowledge (Table 5), the bottom line of Seller to Buyer transaction price was estimated to be 80 yuan / (MW • h), and the buyer offer 55 yuan / (MW • h), the combination of Table 6 and dynamic learnig, the bottom line of the buyer updated to 78.23 yuan / (MW • h).

Table 6 Interval conditional probability distribution of buyer's offer

The bottom line Bi/yuan	Pricing / yuan					
	(40,50]	(50,60]	(60,70]	(70,80]	(80,90]	(90,100]
(65,70]	0.25	0.45	0.25	0.05	0	0
(70,75]	0.20	0.40	0.30	0.10	0	0
(75,80]	0.20	0.30	0.30	0.15	0.05	0
(80,85]	0.15	0.30	0.30	0.15	0.10	0
(85,90]	0.10	0.25	0.30	0.20	0.10	0.05
(90,95]	0.10	0.15	0.25	0.25	0.15	0.10

2) The first one negotiation process

Seller According to equation (14) calculated the value of one's own transaction under scores B, resulting in the unit's own electricity trading revenue:

$$V^s = \pi - 52.5$$

The estimated buyer unit electricity trading revenue function is:

$$V^b = 78.23 - \pi$$

Contrast the two sides risk, in the first one after the Seller offer greater risk, so seller maintains the original offer.

3) The second negotiation process

The Purchaser will offer up to 59 yuan / (MW • h), the seller will through a dynamic learning re-estimate the baseline of buyer is 76.68 yuan / (MW • h). At this point Seller lower risk than the buyer, so the Seller concessions by the smallest margin will be reduced to 71 yuan quote / (MW • h).

4) Several rounds of negotiation process

The seller's offer will be reduced to 71 yuan / (MW • h) after the end of the first two quotes. And the buyer next offer, the purchaser will repeat the dynamic learning and decision-making processes Zeuthen negotiation until satisfactory.

5.3. Trading results of the negotiations

Through negotiations between buyers and sellers offer progressively converge, in the 7th round of negotiations between buyers and sellers generation right transaction agreement finally reached, the transaction price is 66 yuan / (MW • h) (Figure 4). Transaction price π satisfies $B \le \pi \le A$, buyers and sellers are able to get through generating additional profits trading.

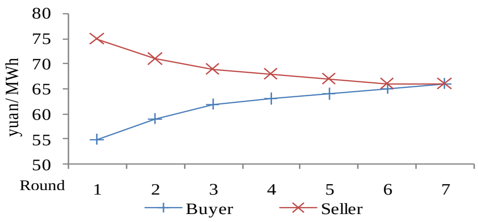

Fig.4 Offer series of buyer and seller

Nash product describes the alliance's overall level of efficiency, Nash product maximization of the general form:

$$Max\ \ f(U^b, U^s) = (U^b)^{\lambda^b} \times (U^s)^{\lambda^s} \quad (18)$$

$$s.t. \quad \lambda^b + \lambda^s = 1 \quad (19)$$

In the formula: $f(U^b, U^s)$ is the league overall utility function; U^b and U^s are transactions between buyers and sellers benefit; λ^b and λ^s are both buyers and sellers trading position.

Nash Product is one of indicators determining ofbargaining power trading efficiency. In order to maximize the benefits of the two parties, the transaction price A satisfies:

$$\max\{V^b(\pi)^{\lambda_b} \cdot V^s(\pi)^{\lambda_s}\} \quad (20)$$

Assuming the status of the negotiations on the other ($\lambda_b = \lambda_s = 0.5$), then the formula (20) is equivalent to:

$$\max\{(A - \pi)(\pi - B)\} \quad (21)$$

In Formula (21), if and only if $\pi = (A + B)/2$ Nash becomes maximum. Generation rights cases were parties to the transaction underscores 79.26,52.5 yuan / (MW • h), when the offer for 65.88 yuan / (MW • h) when the product reaches the maximum Nash 179.024; The parties to the transaction generation rights at 66 yuan / (MW • h) the price of transaction, Nash is 179.01, very close to the optimal solution. Contrasting Nash product shows that Zeuthen decision based dynamic learning model can help generate electricity trading parties grasp each other in the case of incomplete information,make reasonable offer decisions and realize maximizing the benefits of both sides .

6. Conclusion

The price of generation rights trade determines the level of income level of buyers and sellers.If one side fails to grasp the information of the other side or correctly apply the negotiating strategies during the negotiation, then on the one hand, it may undertake the unfair outcome during the trade, and on the other hand the negotiation may break down, therefore both sides will miss the opportunity.

The article has built the negotiation model based on Zeuthen decision and the dynamic learning model. The result of case simulation shows that:①Through the dynamic learning, both sides can update the probability distribution condition of the opposite's bottom line during the transaction. After repeatedly rounds of negotiations, both sides gradually realize each other's transction line, which is the foundation for both sides to estimate each other's income condition.②Underthe principle of maximum risk acceptability,comparing both sides'risk will help both sides to decide whether to keep the original price or to make concessions in the next stage. However, according to the principle of minimum concession range, one side induces the other side to make concessions in the next quoting round while avoiding the excessive concessions to be caught in a passive state; ③ through repeatedly dynamic learning and Zeuthen decision, the offer of both sides will gradually astringe to a final transaction price.And compared with the optimal solution of Nash plot, the negotiation model mentioned in this article is highly efficient, close to the optimal value.

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