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Risk Assessment of Financial Market under the Restriction of Market Incentive Mechanism

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Abstract

In order to solve the problems of fuzzy expression and invalid inter-agent trust during the process of adopting traditional negotiation mode to describe the enterprise and the enterprise supply chain, a global negotiation model based on Norm and trust evaluation is proposed in this paper. Specifically, Norm semantic tool is adopted to describe enterprise information, and such parameters as fitness and trust degree of the negotiation model are evaluated through the "commitment" based trust evaluation method. Meanwhile, the improved genetic algorithm is adopted for the task solution of the negotiation issues involving in enterprise environment, and the improved contract net protocol is adopted for the task solution of the negotiation issues involving in enterprise business. Finally, the example for a certain production enterprise supply chain is adopted for the detailed design of the negotiation model. The experiment proves that the model can realize the global task solution of the negotiation issues involving in both enterprise environment and business, and the solution efficiency thereof is improved more or less.

Keywords*: Trust evaluation; Commitment; Negotiation; Game; Risk*

1. Introduction

At present, the research on the negotiation theory is mainly focused on negotiation strategy, negotiation protocol and negotiation model. Specifically, Randall Devis and Reid G. Smith have proposed a typical negotiation algorithm regarding task and resource allocation ---- Contract Net Protocol [1], and this protocol aims at solving the task distribution among multiple problem solvers in a biding form and is suitable for the distributed problem solution in network environment. Faratin (2000) has proposed the time-dependent strategy, the resource-dependent strategy and the behavior-dependent strategy respectively based on the three protocol convergence influencing factors ---- time, resource and behavior. Zhang Haijun, Shi Zhongzhi [2] (2004), et al. have proposed a dynamic contract net protocol adaptive to the dynamic change of the environment and the agent capability according to the swarm intelligence and on the basis of the threshold value model of the swarm intelligence, and this algorithm presents obvious advantages when the contractor agent number, the task number or the task repetition rate is increased. Zhang Hong (2006) has divided the negotiation strategy into three types in relevant literature, namely choleric type, frugal type and eclectic type. Peng Zhiping (2007) has adopted vectors to represent the negotiation issues, and applied Bayes learning mechanism to the agent learning and finally proposed a bilateral multi-issue negotiation model. In order to obtain good enterprise negotiation environment, a global negotiation model based on Norm and trust evaluation is proposed in this paper. Rich and accurate semantic information of Norm is referenced for enterprise description in order to adopt the standard and global guiding thought to solve the tasks for the enterprise negotiation issues from a local view to a global view according to the "commitment" based trust evaluation mechanism.

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2. "Commitment" based Trust Evaluation Mechanism

Trust is fully defined in standard X.509 in IT—UT[7]: if agent B operates completely according to the expectation of agent A, then agent A is deemed to trust agent B, wherein A is the truster and B is the trustee. Trust degree, as the agentive expectation of one agent upon another agent, is an evaluation method of the trust level.

2.1. Beth Model

In general condition, inter-agent trust includes direct trust and indirect trust, wherein the direct trust is obtained through the experience of the agent and reflects the subjective recognition and feeling of an agent upon another agent; the indirect trust is sourced from the evaluation of this agent upon another multiple agents.

If agents A and B have n negotiations (n>1) including a (a>1) successful negotiations, then the posterior probability for the successful negotiation between the two agents at the n+1th time follows Beta distribution:

$$P_{a+1} = E(\text{Beta}(P|a+1, n-a+1)) = \frac{a+1}{n+2} \quad (1)$$

The weighting function is assumed as U ($\sum u = 1$). If the relative trust degrees obtained by agent A in a successful negotiations are respectively assumed as c1, c2, …,ca, then the direct trust degree of agent A upon agent B is as follows:

$$DC = \frac{s+1}{n+2} * u * \sum_{i=1}^{a} c \quad (2)$$

According to Beth [8] model, the calculation formula for the indirect trust degree is as follows:

$$UC = \frac{1}{n} \sum_{i=1}^{n} UC_i \quad (3)$$

If α and β are respectively assumed as the weight factors of the direct trust degree and the indirect trust degree, wherein $\alpha \in [0,1]$, $\beta \in [0,1]$, and $\alpha + \beta = 1$, then the comprehensive trust degree is as follows:

$$C = \alpha * DC + \beta * UC \quad (4)$$

2.2. Global Trust Evaluation Model Based on Commitment Mechanism

The direct trust degree calculation method of Beth model is applicable to the enterprise supply chain. The indirect trust is the reputation based recommendable trust under the absence of relevant experience of the agent, namely: the indirect trust is adopted for the trust evaluation under the absence of the direct trust. Therefore, for the agent in a competitive environment, the indirect trust can easily cause cheating and defaming behaviors. The indirect trust calculation method of Beth algorithm is inapplicable to enterprise supply chain.

In the trust model based on commitment mechanism, if agent A does not negotiate with agent B, then agent A is required to request agent B to make corresponding commitment and provide a certain quantity of benefit guarantee before negotiation in order to obtain trust from agent A. If the probability for agent A to negotiate with agent B is assumed as Pi, under the cooperation condition without any cheating or defaming behavior, agent B can obtain normal revenue Rd; or else, agent B can obtain additional revenue S; under noncooperation condition, the revenue is 0. If there is any cheating or defaming behavior

and the probability for agent A to detect the above behavior of agent B is assumed as P2, then agent B is required to provide the compensation valued at Cd.

If there is no cheating or defaming behavior, the average revenue of agent B is as follows:

$$c_d >= \frac{P1}{P2} S \tag{5}$$

Under another condition, the average revenue of agent B is as follows:

$$E_f = P_1((R_d + S) - \mathrm{P}_2(\mathrm{C}_\mathrm{d})) + (1 - \mathrm{P}_1)(-\mathrm{P}_2\mathrm{C}_\mathrm{d}) \tag{6}$$

Therefore, under the condition of ensuring Et>=Ef, agent A can guarantee that agent B cannot obtain the maximum revenue. Then, agent B would make real commitment to obtain high indirect trust degree. According to Et>=Ef, Cd value can be determined as follows:

$$c_d >= \frac{P1}{P2} S \tag{7}$$

According to the above formula, larger Cd value indicates higher commitment and higher indirect trust degree obtained by agent B.

As a universal trust degree evaluation mechanism, this evaluation mechanism is applicable to multi-agent negotiation conditions. Due to the “commitment”, the behaviors of the negotiation agents become more rational and the negotiation environment becomes more harmonious.

3. Model Design

In order to better represent the features of the enterprise and enterprise supply chain, a global negotiation model based on Norm and trust evaluation is proposed in this paper on the basis of the global integration and standardization of the corresponding information and the rule restriction of the global enterprise information. n agents are assumed for negotiation in the enterprise supply chain.

3.1. Norm based Environment Negotiation Model

In general condition, such enterprise features as rule system, employee benefit, production mode and product type are relatively stable in the enterprise supply chain, and the influence of the external environment on the enterprise supply chain is also relatively stable in a certain period. Genetic algorithm (GA) [9] is applicable to the task solution in a specific known environment. Since such algorithm can be easily caught in the local optimal solution, the trust degree calculation method of the trust evaluation mechanism based on “commitment” is adopted to adjust the fitness of the model as the weighted sum of the direct fitness and the indirect fitness. The model is adopted to adjust the standards of the enterprise supply chain and the enterprise and noumenon Norm.

According to Norm classification in this paper, agent 1 is assumed as the core agent of the model. Enterprise Norm learning and inner-enterprise negotiation should be implemented according to the model shown in Figure 1:

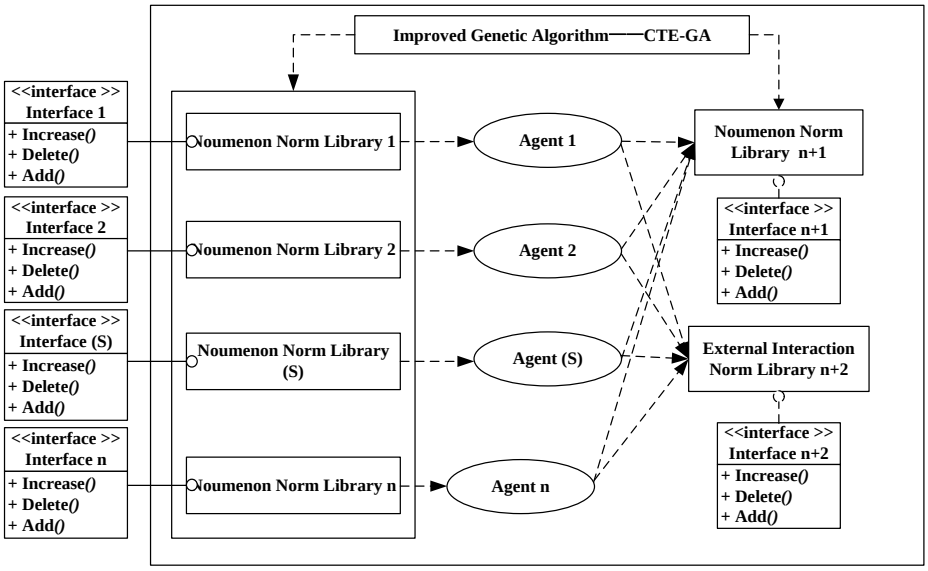

Figure 1. Environment Negotiation Model

In this negotiation model, agent behaviors are restricted, guided and described through Norm in order to learn, supervise, select and decide the standards in Norm library through CTE-GA mechanism. After learning, agent behaviors and enterprise Norm can better guide the inner-agent interaction and the inter-agent interaction, thus to better correspond to various conflicts.

3.2. Business Negotiation Model based on Norm and Trust Evaluation

In the enterprise business environment, the distributors, customers and suppliers of the supply chain have different interactions with the core enterprise, namely: the enterprise selects the partners who are most suitable for the enterprise development and can optimize the whole supply chain among multiple suppliers or distributors. The enterprise may have business contact with another agent, and the interaction between the enterprise and other agents is a dynamic change process. Therefore, the external environment of the enterprise is an unknown mode. The contract net protocol ---- CNP [10] is applicable to the task solution in an unknown mode. Under the condition of meeting the internal Norm mechanism, the improved method is adopted for the negotiation and the task solution in the enterprise business environment according to the features of the enterprise business environment.

In this enterprise supply chain, an agent is assumed to play the role of a manager, and other agents are assumed as the contractor agents with certain priority and trust level which is obtained through the above “commitment” based trust evaluation model and is represented through interactive Norm. The external negotiation model thereof is as shown in Figure 2.

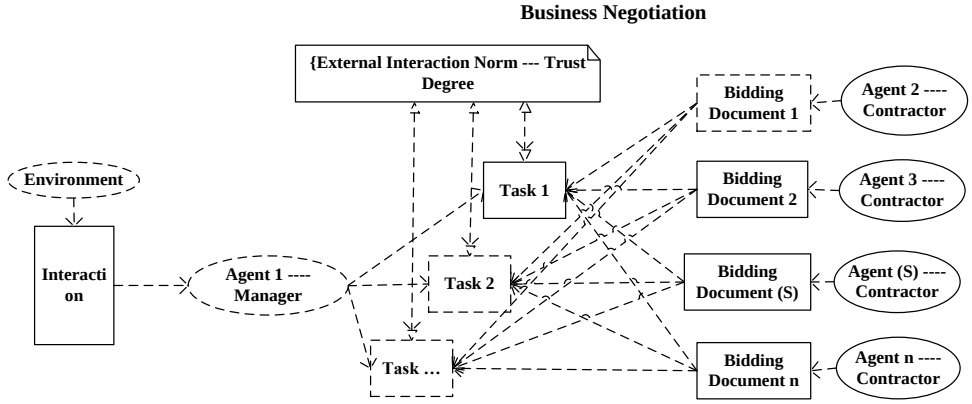

Figure 2. Business Negotiation Model

After interacting with the external environment, a certain agent as the manager will announce a certain task and the contractor agents will evaluate the task according to the capability thereof ---- the trustee degree and send the bidding to the manger. Subsequently, the manager will select the suitable contractor according to relevant trust degree of the contractors. Therein, the trust degree calculation method of the "commitment" based trust evaluation mechanism is adopted to calculate the priority and the trust degree, and the manager would sign a contract with the suitable contractor agent, wait for the task execution result, return the execution result and update the trust degree of the contractor concerned.

4. Model Example

A coal production enterprise is taken as an example for explaining the model. In order to obtain the universality, the universal features of the enterprise supply chain are extracted to design the concept model. The enterprise supply chain includes equipment supplier, core enterprise, distributor, logistics supplier, customer and other agents. Therefore, the concept model established thereby for the enterprise supply chain is as shown in Figure 3:

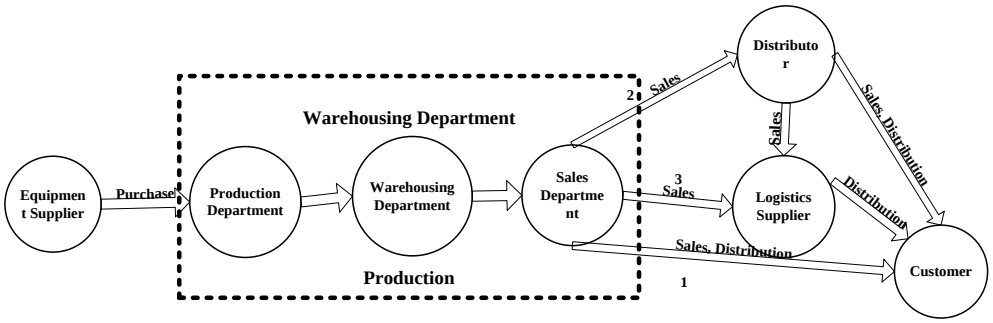

Figure 3. Concept Model of A Production Enterprise Supply Chain

4.1. Environment Negotiation Model of Enterprise Supply Chain

In allusion to the enterprise supply chain structure and the specific requirements (purchase, production, sales, distribution) of the businesses in different stages, Norm and an improved genetic algorithm CTE-GA are adopted to design and implement the internal negotiation model as shown in Figure 4:

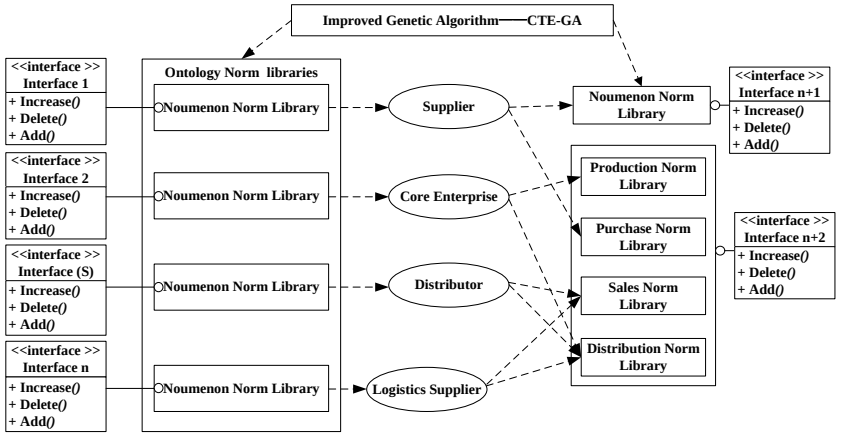

Figure 4. Environment Negotiation Model of Enterprise Supply Chain

In this model, certain interaction exists inside or among the departments during the execution of the production task of the core enterprise, and noumenon Norm is adopted for the description and the rule restriction of such production task. For example, Norm ---- "***whenever*** enterprise production ***if*** the production technology cannot meet the production requirements ***then*** the production technology department ***is oblige to*** submit the production technology report ***else*** the production technology department ***is oblige to*** produce according to the original production technology".

Additionally, the agents have some features and external environment restrictions according to the business requirements thereof, and noumenon Norm is also adopted for the rule restriction thereof. For example, noumenon Norm of the financial department ---- "***whenever*** salary and performance system ***if*** the salary and performance is unreasonable ***then*** the financial department ***is oblige to*** report a new salary evaluation form ***else*** the financial department ***is oblige to*** execute the financial budget according to the original salary and performance system"; Norm ---- "***whenever*** strategic planning ***if*** the enterprise production is influenced by the external environment ***then*** the planning development department ***is oblige to*** collect the data regarding the enterprise business environment". Such Norm can be also described by noumenon Norm.

According to the above examples, the following conditions may be included: the production technology cannot meet the production requirements during the enterprise production activity due to the external environment influence, the new production technology report should be submitted, and the new performance evaluation form should be also reported due to the unreasonable enterprise salary and performance system in order to meet the production and finance requirements. Finally, the local optimal solution is obtained through the task solution of the improved genetic algorithm ---- CTE-GA; in other words, the production technology and the salary and performance system can finally meet the production and finance requirements of the enterprise, thus promoting the formation of the optimal inner-enterprise interaction mode.

Additionally, independent interaction Norm is adopted for the interaction between the core enterprise and other enterprise agents for the rule restriction thereof. Such interaction, under an uncertain mode, involves in the influence of multiple enterprises or environments, so the contract net protocol of the improved "commitment" based trust evaluation mechanism is adopted for the task solution.

4.2. Business Negotiation Model of Enterprise Supply Chain

In allusion to the enterprise requirements (purchase, production, sales, distribution) in different stages and possible business conditions, the contract net protocol of the improved "commitment" based trust evaluation mechanism is adopted to design and

implement the external negotiation model thereof as shown in Figure 5:

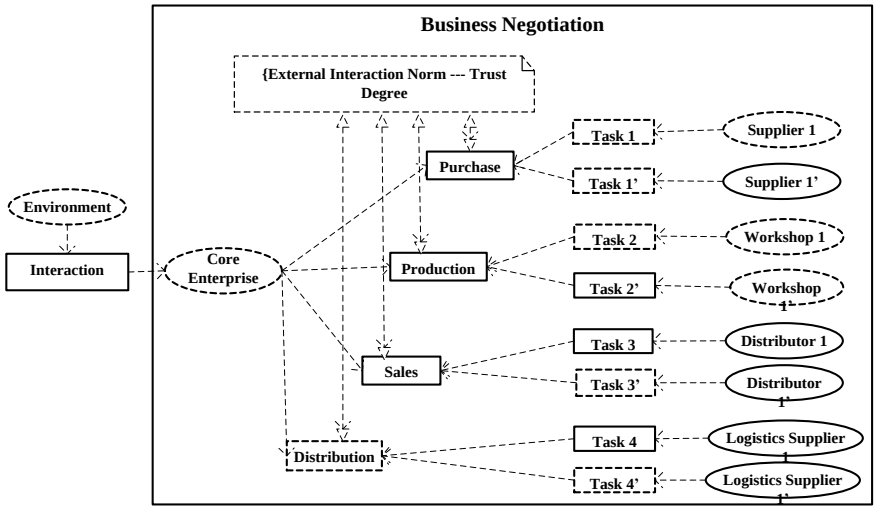

Figure 5. Business Negotiation Model of Enterprise Supply Chain

In this model, the core enterprise, as the manager, needs to interact with other enterprises for completing the production task thereof. A certain quantity of equipment and materials should be purchased in order to complete the production task.

Firstly, each supplier would prepare the bidding document thereof. Note: the trust degree thereof, indicated in the bidding document, is obtained through the trust degree calculation method of the "commitment" based trust evaluation mechanism and is described in the external interaction Norm of the agent. The core enterprise would evaluate the suppliers according to the bidding documents, select the most suitable supplier agent and sign a contract therewith, and wait for the execution of the purchase business. Similarly, the optimal distributor and logistics supplier are selected to complete the sales and distribution tasks so as to finally deliver the products to the customers. Finally, the core enterprise would reevaluate the suppliers, distributors and logistics suppliers according to the execution of all tasks and wait for the execution of the next task.

5. Experiment Result and Analysis

5.1. Test and Simulation Environment

According to the analysis, after the coal production enterprise receives the customer order, various enterprise agents will synergistically play their roles according to the roles and positions thereof in the enterprise and serve for the production and business objective of the enterprise.

Experiment environment: Myeclipse 8.0 experiment platform, java platform development language and swarm program package.

Simulation environment: the coal production enterprise has 14 pairs of mines, two suppliers, two distributors and two logistics suppliers; the bidding weight factors include time, quality and cost.

5.2. Simulation Result Analysis

The multi-agent negotiation frequency of the enterprise supply chain under three negotiation modes is simulated in this experiment, and the three modes are as follows:

Supply chain negotiation mode based on dynamic contract net protocol (DCNP);

Supply chain internal negotiation model based on improved genetic algorithm (CTE-

GA);

Supply chain global negotiation model based on Norm and trust evaluation.

Therein, the multi-agent negotiation frequency is calculated according to Formula 8:

Multi-agent Negotiation Frequency = Successful Multi-agent Negotiation Times/Multi-agent Negotiation Time (8)

Under the above three negotiation modes, when the simulation program is operated for about 600 periods, the corresponding multi-agent negotiation frequency is as shown in Figures 6~8:

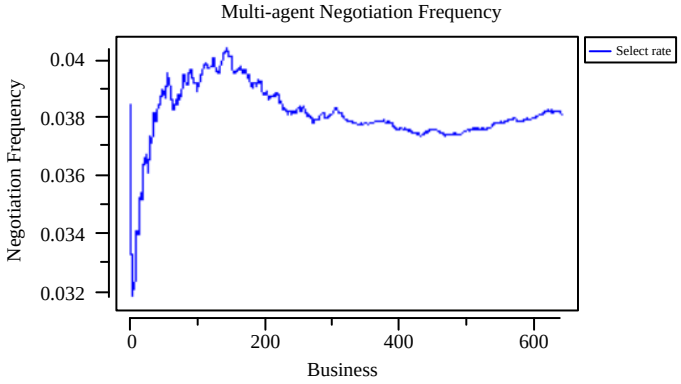

Figure 6. DCNP Mode

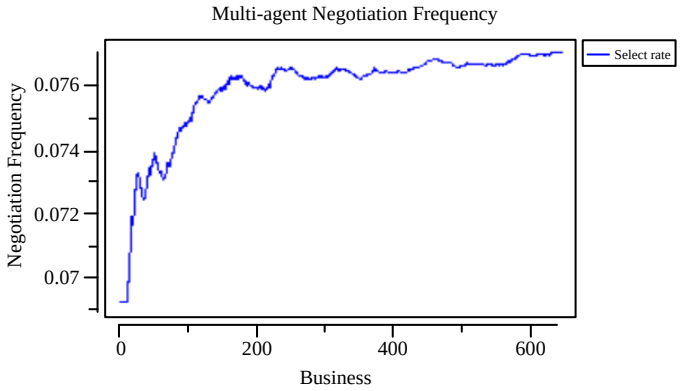

Figure 7. Supply Chain Environment Negotiation Mode based on Improved Genetic Algorithm

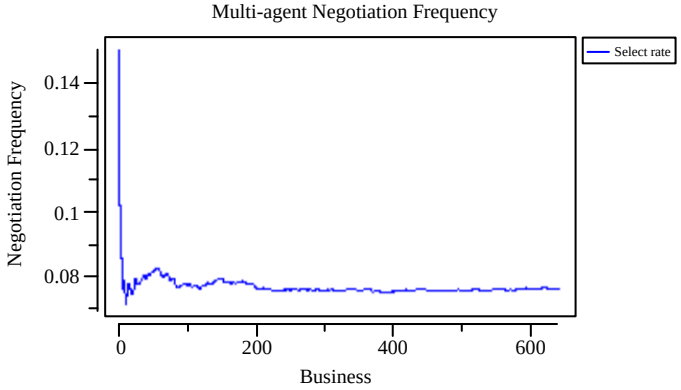

Figure 8. Supply Chain Global Negotiation Mode based on Norm and Trust Evaluation

According to the result analysis of the above simulation figure, under the negotiation mode based on dynamic contract net and improved genetic algorithm, negotiation exists among and inside the agents of the enterprise supply chain, but the inter-enterprise coordination is not guided by the specific restriction rules, so there are many internal conflicts and negotiation cannot be well implemented. After the global negotiation model based on Norm and trust evaluation, the corresponding Norm restriction is added to standardize the negotiation inside and among the enterprise agents to become better, thus to well solve various enterprise conflicts and realize task solution.

The simulation experiment indicates that the global negotiation mode based on Norm and trust evaluation can realize the standard competition and cooperation inside and among the enterprises, thus to realize the win-win benefit among the agents of the enterprise supply chain.

6. Conclusion

A global negotiation model based on Norm and trust evaluation is proposed in this paper, and according to enterprise Norm classification, noumenon Norm is adopted for the rule restriction of the features and the external environment needed by the enterprises for completing the business tasks thereof, and interaction Norm is adopted to describe the business interaction rules of the core enterprise. Meanwhile, the "commitment" based trust evaluation method is combined to calculate the fitness and the trust degree in this model. According to relevant analysis, in the cooperation and competition among the enterprises in the supply chain, the model can obtain good negotiation effect for the enterprise negotiation issues in a complex environment. In future, the research will be focused on the combination of Norm intention & faith features and the intelligence of the agents in order to gradually realize the intelligent characteristic of the negotiation model.

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