Computer Software Applied in Cooperative Game Analysis Using Myerson Value in the Probability Graph

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Abstract. With the development of economy and society, technology trading activities in China are increasingly frequent, science and technology intermediary is an important part of China’s technology trading market system, the cooperation among technology suppliers, technology demanders and technology intermediaries has become a major trend in technology trading market, however, there are many uncertainties in the process of tripartite cooperation. In order to better describe the situation of practical cooperation in technology trading, this paper introduces the Myerson value in the probability graph in cooperative game to analyze the profit distribution problem among technology supplier, technology intermediary and technology demander in technology trading market, and discusses the effect of utility distribution on the interests of all parties by using the relevant model, and makes a comparative analysis with the Myerson value in the general graph, Finally, some suggestions are put forward to promote the stability and sustainable development of the technology trading market.

Keywords: Technology trading market, Probability graph, Myerson value, Cooperative game

1. Introduction
Technology trading is an important means for innovation subject to acquire external knowledge and technology in market economy [1], it is also an important patent operation mode [2]. With the development of economy and society, China's technology trading activities have become more and more frequent, and the promotion of technology trading has become a key point in the relevant policies of the Party and the state. The improvement of technology trading efficiency has an important impact on the construction of the national technology innovation system and the transformation of scientific and technological achievements [3]. However, due to the limited number of trading parties in the technical market and the information asymmetry between trading parties, the probability of opportunism and moral hazard will increase in the process of trading. On the other hand, in the fierce competition environment of commodity economy, enterprises have changed from closed research and development to open innovation, and the technological iteration is "fast but not broken", and the demand and frequency of technology trading have increased significantly. To sum up, it is a relatively compromise choice for technology service intermediaries to participate in technology trading to establish a national unified and open technology trading platform, and at the same time, it will not impede the entry of both supply and demand and indirectly raise the entry threshold due to repeated information collection and...
market supervision. Science and technology service intermediaries are third-party service organizations that connect technology suppliers and demanders and provide technology transfer and knowledge diffusion services [4]. Therefore, the cooperation among the technology supplier, the technology demander and the technology intermediary has become a major trend in the technology trading market. In the process of tripartite cooperation, the technology transaction cost is the key to the operation of the technology market, and the profit distribution among the three parties is a crucial issue. In addition, there are uncertainties in tripartite cooperation, that is, whether the technology supplier and the technology demander choose to trade through the technology service intermediary is uncertain, and the transaction costs and risks generated by the technology supplier and the demander are also different with the degree of the technology intermediary's participation in cooperation. Therefore, it is also an important issue to add uncertainty factors in cooperation to benefit distribution. In this way, we can find the value of market participants according to the uncertainty in bilateral relations, so as to distribute the benefits of the three parties in a more fair and reasonable way.

2. Literature review and research ideas

Literature review

In the existing technology trading market tripartite interest distribution relationship research, Wang Qingjin discussed the game relationship between science and technology intermediaries and innovation subjects, and analyzed the interest relationship between all parties by pair game [5]. Jiang Hao proposed the benefit distribution mechanism of three parties for the first time by using the infinite bargaining game model [6]. Based on the typical Rubinstein three-stage bargaining game model, Chang Yue explored the benefits of technology providers and potential adopters before and after the participation of intermediaries and made comparative analysis respectively, and pointed out the necessity of the existence of intermediaries [7]. Li Bozhou included intermediary organizations as the main body of the original innovation income distribution of the enterprise-university-research cooperative enterprises, and analyzed the income distribution mechanism among all parties by using Shapley value from the perspective of cooperative game [8]. Zhao Weishuang quantified the factors affecting cooperation by AHP analysis method and added them to the modified Shapley value model and compared them with the original benefit distribution mechanism, so as to obtain a more fair and reasonable distribution scheme [9]. According to different psychological pressures of enterprises, Wu Jie first built a bargaining model between enterprises the alliance, then built a game model with intermediary participation, analyzed and discussed the influencing factors and strategy choice of the revenue change of the three parties of cooperation [10]. In addition, Hua Dongfang used the evolutionary game theory and introduced trust and information sharing factor variables to analyze the impact of science and technology intermediary on the dynamic relationship between technology supplier and demander[11].

Research ideas

Through the above analysis, it is found that although the research on the income distribution of the tripartite cooperative alliance in the technology trading market is deepening, there are still some defects and deficiencies, which are specifically manifested in the following aspects: First of all, most of the known researches are based on the non-cooperative game model to explore the interests of all parties, while the non-cooperative game emphasizes that individuals adopt beneficial strategies to maximize their own interests, which often results in low efficiency. Secondly, although some literatures analyzed the income distribution mechanism among three parties from the perspective of Shapley value method of traditional cooperative game, Shapley value method [12] has a good application effect when all subjects can cooperate effectively. In the case of restrictive cooperation, that is, when there is no effective cooperation between participants, The Shapley value in the traditional cooperative game is far less suitable than the Shapley value in the graph game, namely Myerson value. Finally, in the technology trading market, there are uncertainties in the tripartite cooperation between the technology supplier, the technology intermediary and the technology demander. In other words, the degree of the technology
intermediary's participation in the cooperation is different for the transaction costs and risks generated by the technology supplier and the technology buyer. Most existing studies have ignored this uncertainty factor. However, we can better reflect the respective contributions and values of the participants in the technology trading market according to the uncertainty of bilateral cooperation, so as to make the distribution more reasonable. In this case, the Myerson value in the general graph game is less applicable than that in the probability graph game. Myerson value on the probability graph is to assign a certain probability to each pair of edges that can be directly connected to the participants, indicating the degree of cooperation between the participants, which can describe the cooperation between the participants in a more comprehensive and specific way.

Therefore, based on the above analysis, this paper chooses the Myerson value of probability graph in cooperative game to analyze the income distribution among the technology supplier, technology intermediary and technology demander in the technology trading market, and makes a comparative analysis with the Myerson value in the general graph, so as to obtain a more fair and reasonable distribution scheme.

3. Problem description
In the technology trading market, there are mainly three parties: the technology supplier, the technology intermediary and the technology demander. We make the following assumptions:

(1) The technology innovation cost of the technology supplier $S$ is $I$, the cost of searching for the technology demander is $C_s$, the technology demander needs to pay the technology supplier the technology price of $P_s$ for each unit of product sold, and $E_s$ as the supplier's income;

(2) The original cost of a unit product produced by technology demander $U$ is $t$, $P_u$ as the price of unit product sold to customers, and the cost of searching technology supplier is $C_u$. By using new technology, the production cost of unit product produced by demand side can reduce $R_u$, but at this time, the price of unit product sold by technology demand to customers is $P_u' = P_s(1 + e)$, where $e$ is the profit rate, $P_u' > P_s + t - R_u$, assuming that the market structure is a perfectly competitive market, $D$ is the demand in a perfectly competitive market, that is, the maximum production capacity of technology demander $U$. Here, it is assumed that $D$ remains unchanged, and $E_u$ as the income of technology demander;

(3) The search cost of science and technology intermediary $M$ is $y$, and the intermediary fee charged is $P_m, P_m < C_s, P_m < C_u, E_m$ as the income of science and technology intermediary;

4. Theoretical Basis

Cooperative game
The main theoretical basis of this paper---Cooperative game theory, also known as alliance game theory, plays an increasingly important role in economics in recent years because of its unique methods in solving various resource sharing problems and avoiding conflicts in the world. A utility transferable cooperative game, referred to as TU game, denoted as a pair $(N, v)$. $N$ as set of participants, $v$ as the characteristic function that defined on the set of all subsets of $N$, where the benefit of cooperation of all members of the alliance $S$ is called the utility of $S$, denoted as $v(S)$. Cooperative game emphasizes group rationality, and according to binding agreements, some participants form small groups that cooperate with each other to seek greater interests, known as coalitions, and the coalitions formed by all participants are known as grand coalition.

Myerson value
The Myerson value is a classic alliance allocation method in cooperative game theory, which is suitable for the distribution of the total income generated in cooperative games with multiple players. It determines the income of each player according to the marginal contribution to the alliance, which
reflects the principle of fairness and is conducive to further improving the stability of the alliance. This method is often used in cooperative game income distribution cases.

A cooperative game with transferable utility, or TU-game or game simply, is a pair \((N, v)\), where \(N = \{1, 2, \ldots, n\}\) is a set of \(n\) players and \(v: 2^N \rightarrow R\) is a function with \(v(\emptyset) = 0\). A subset \(S \subseteq 2^N\) is called a coalition, and \(v(S)\) displays the worth of the coalition \(S\). The coalition \(N\) is called the grand coalition. Let \(V_N\) be the set of all games \((N, v)\). Denote by \(v_T\) the subgame of \(v\) restricted by \(T\) defined as \(v_T(S) = v(S)\) for \(S \subseteq T\). The cardinality of a set \(S\) is denoted by \(|S|\) or the corresponding letter \(s = |S|\).

A mapping \(f: V_N \rightarrow R^N\) is called an allocation rule or a value, where \(f_i(N, v)\) signifies the payoff for player \(i \in N\). An allocation rule \(f\) is called efficient if \(\sum_{i \in N} f_i(N, v) = v(N)\) for \((N, v) \in V_N\). The Shapley value (1953) \(\text{Sh}(N, v)\) is a well-known efficient value defined by

\[
\text{Sh}_i(N, v) = \sum_{S \subseteq N \setminus \{i\}} \frac{s!(n - 1 - s)!}{n!} [v(S \cup \{i\}) - v(S)], \quad \forall i \in N
\]

A graph on player set \(N\) is a family \(L\) of subsets \(e \subseteq N\) with \(|e| = 2\), in which each \(e = \{i, j\} \in L\) is called a link. A link \([i, j]\) is written as \(i \sim j\) or \(j \sim i\). A graph \(L\) on \(N\) is also denoted by \((N, L)\). For any \(S \subseteq N\), let \(L_S = \{e \in L: e \subseteq S\}\) be the subgraph induced by \(S\). Let \(L_N\) be the set of all graphs \((N, L)\) on player set \(N\), and \(L\) the set of all graphs.

For any \(S \subseteq N\), distinct \(i, j \in S\), we say that \(i\) and \(j\) are connected in \(L_S\) if there is a sequence \(i = u_1, u_2, \ldots, u_k = j\) of distinct players such that \(u_j u_{j+1} \in L_S\) for \(1 \leq j < k\). A set \(S\) is called connected if \(|S| = 1\) or any pair \(i, j\) in \(S\) are connected in \(L_S\). A maximal connected subset of \(S\) is called a component of \(S\) in \(L\). Denote by \(S/L_S\), or \(S/L\) simply, the set of all components in \(L_S\). For \(i \in N\), let \(C_i\) denote the component of \((N, L)\) containing \(i\). So \(C_i = C_j\) if \(ij \in L\).

A communication situation is a triple \((N, v, L)\) that consists of a TU-game \((N, v)\) and a communication graph \((N, L)\). Write \((V, L)_N\) as the set of all graph games \((N, v, L)\) with player set \(N\). For \(T \subseteq N\), \((T, v_T, L_T)\) is the sub-communication situation of \((N, v, L)\) restricted by \(T\).

Myerson (1977) defined the graph-restricted game or graph game simply[13], \((N, v_L)\) for \((N, v, L)\) as \(v^L(S) = \sum_{R \in S/L} v(R)\). The Myerson value (1977) \(\mu\) is a well-known allocation rule on \((V, L)_N\) that is defined as the Shapley value \(\text{Sh}(N, v_L)\), namely

\[
\mu(N, v, L) = \text{Sh}(N, v_L)
\]

Myerson value on the probability graph

Considering the cooperation is not complete between members in real life, Calvo et al. (1999) provided an extension of the Myerson value (Myerson (1977)) based on

Restricting the cooperation in a probabilistic way [14]. They defined a probabilistic graph as a pair \((N, p)\), where: \(\{ij{:}i, j \in N, i \neq j\} \rightarrow [0, 1]\) is a function that assigns a probability to each link \(ij \in L^N\). The probability of each link is assumed to be independent and the Myerson value in probabilistic communication situation \((N, v, p)\) is defined and characterized by component efficiency, fairness and balanced contributions.

Assuming that these probabilities are independent of each other, if the participants \(i\) and \(j\) in the alliance can cooperate with probability \(p_{ij}\), they can get the cooperation income \(v(i, j)\), and at the same time there is a \((1 - p_{ij})\) possibility that they will not cooperate. In this case, they can only get the sum of the benefits obtained by working alone, that is \(v(i) + v(j)\). Therefore, the expected payoff for participants \(i\) and \(j\) is \(v_p(i, j) = p_{ij}v(i, j) + (1 - p_{ij})v(i) + v(j)\);
Then, define \( l \) as the any link in alliance \( S \), and define the link set derived from all points in alliance \( S \) as \( L(S) = \{\{i,j\}|i,j \in S, i \neq j\} \). For any subset of links \( L \subseteq L(S) \), if satisfy \( p^S(L) = \prod_{i \in L} p_{ij} \prod_{(i,j) \not\in L} (1 - p_{ij}) \), then the link subset \( L \) is probabilistically realized based on the alliance \( S \). Assuming the link subset \( L \subseteq L(S) \), The connected branches derived in the alliance \( S \) are denoted as \( S/L \), and \( v_L(S) \) as the Myerson value in the general graph, then the Myerson value of alliance \( S \) in the probability graph is \( v^p(S) = \sum_{L \subseteq L(N)} p^N(L) \mu(N, v, L) \), according to this equation, the Myerson value in the probability graph can be expressed as follows:

\[
\mu(N, v, p) = \sum_{L \subseteq L(N)} p^N(L) \mu(N, v, L)
\]

5. Example analysis

For the convenience of analysis, it is assumed that the technology innovation cost of technology supplier \( I \) is 480, the cost of searching for technology demander \( C_s \) is 370, the original cost of producing a unit of product \( t \) is 24, the price of selling unit of product to customers \( P_u \) is 28, and the cost of searching for technology supplier \( C_u \) is 330, by using new technology, the production cost of unit product of the demander can be reduced by 22.5. The technology demander shall pay the technology price \( P_s \) is 16 to the technology supplier for each unit product sold by the technology demander. At this time, the price of unit product sold by the technology demander to the customer is \( P_u' = P_s (1 + e) \), where \( e = 0.9 \). The maximum production capacity of the technology demander \( D \) is 110, the search cost of the technology intermediary \( y \) is 180.5, and the intermediary cost \( P_m \) is 300;

\textit{Income distribution solution based on Myerson value}

Consider a tripartite cooperative game \((N, v)\), where \( N = \{1,2,3\} \), in which participants 1, 2, and 3 respectively represent the technology supplier, the science and technology intermediary, and the technology demander. The reduction of search cost and increase of profit are set as revenue value \( v \), then the revenue characteristic function \( v \) can be defined as follows:

- \( v(\{1\}) = v(\{2\}) = 0 \), the profit is 0 when the technology supplier and the technology intermediary act alone;
- \( v(\{3\}) = 440 \), the profit of the technology demander before the application of innovative technology is \((28 - 24) \times 110 \);
- \( v(\{2,3\}) = 440 \), the technology demander only cooperates with the intermediary without the participation of the technology supplier, and the profit of cooperation is still 440.
- \( v(\{1,2\}) = 0 \), the profit is 0 when the intermediary cooperates with the technology supplier;
- \( v(\{1,3\}) = 1999 \), the profit of the coalition is when the technology supplier cooperates with the demander;
- \( v(\{1,2,3\}) = 2518.5 \), the tripartite cooperation not only increases the overall income of the three parties to \((30.4 - 24 + 22.5) \times 110 - 480 - 370 - 330 \), but also reduces the search cost by \( 370 + 330 - 180.5 \);

The utility obtained by the three parties from the total income obtained from the transformation of scientific and technological achievements can be allocated in the form of monetary amount as agreed in the agreement, and the specific amount allocated can be calculated by Myerson value:

\[
\mu_1(N, v, L) = 952.7 \\
\mu_2(N, v, L) = 173.2 \\
\mu_3(N, v, L) = 1392.7
\]
To sum up, the Myerson value in this example is: $\mu(N, v, L) = (952.7, 173.2, 1392.7)$

Using Myerson value in the general graph above in the cooperative game, the utility distribution scheme is $(952.7, 173.2, 1392.7)$, that is, the benefits that should be distributed to the technology supplier, the technology intermediary and the technology demander are 952.7, 173.2 and 1392.7 respectively.

**Income distribution solution based on Myerson value on the probability graph**

The income distribution solution of Myerson value is based on the assumption that the cooperative relationship between the participants can be established. In reality, that is not the case. The cooperation between the participants may be incomplete, but only a certain degree of cooperation. It is necessary to assign a probability of "cooperation" to each connected link.

In order to get closer to the reality, that is, the extent to which technology intermediaries participate in the cooperation is also different for the transaction costs and risks incurred by the technology supplier and demander. Taking into account the degree of due diligence of technology intermediaries participating in cooperation, the probability graph game, namely the Myerson value on the probability graph, is introduced to calculate the income distribution solution under different probability settings. Figure 1 is a schematic diagram of the alliance cooperation relationship on the probability graph.

![Diagram of Tripartite Cooperation in Technology Transactions](image)

**Figure 1.** Diagram of Tripartite Cooperation in Technology Transactions

The edge set on the probability graph $\mathcal{L}(N) = \{\{1, 2\}, \{2, 3\}, \{1, 3\}\}$, there are 8 subsets in total, and the Myerson value of each participant on the probability map is as follows:

$$
\mu(N, v, P) = \left( \mu_1(N, v, p), \mu_2(N, v, p), \mu_3(N, v, p) \right) = \sum_{L \subseteq \mathcal{L}(N)} p^N(L) \mu_1(N, v, p) + \sum_{L \subseteq \mathcal{L}(N)} p^N(L) \mu_2(N, v, p) + \sum_{L \subseteq \mathcal{L}(N)} p^N(L) \mu_3(N, v, p)
$$

$$
= (1 - P_{12})(1 - P_{13})(1 - P_{23}) \left[ \begin{array}{c} \mu_1(N, v, L_1) \\ \mu_2(N, v, L_1) \\ \mu_3(N, v, L_1) \end{array} \right] + P_{12}(1 - P_{13})(1 - P_{23}) \left[ \begin{array}{c} \mu_1(N, v, L_2) \\ \mu_2(N, v, L_2) \\ \mu_3(N, v, L_2) \end{array} \right]
$$

$$
+ (1 - P_{12})P_{13}(1 - P_{23}) \left[ \begin{array}{c} \mu_1(N, v, L_3) \\ \mu_2(N, v, L_3) \\ \mu_3(N, v, L_3) \end{array} \right] + (1 - P_{12})(1 - P_{13})P_{23} \left[ \begin{array}{c} \mu_1(N, v, L_4) \\ \mu_2(N, v, L_4) \\ \mu_3(N, v, L_4) \end{array} \right]
$$

$$
+ P_{12}P_{13}(1 - P_{23}) \left[ \begin{array}{c} \mu_1(N, v, L_5) \\ \mu_2(N, v, L_5) \\ \mu_3(N, v, L_5) \end{array} \right] + P_{12}P_{23}(1 - P_{13}) \left[ \begin{array}{c} \mu_1(N, v, L_6) \\ \mu_2(N, v, L_6) \\ \mu_3(N, v, L_6) \end{array} \right]
$$

$$
+ (1 - P_{12})P_{13}P_{23} \left[ \begin{array}{c} \mu_1(N, v, L_7) \\ \mu_2(N, v, L_7) \\ \mu_3(N, v, L_7) \end{array} \right] + P_{12}P_{23}P_{13} \left[ \begin{array}{c} \mu_1(N, v, L_8) \\ \mu_2(N, v, L_8) \\ \mu_3(N, v, L_8) \end{array} \right]
$$
Assume that in this example, we divide the cooperation between technology intermediaries and technology suppliers and demanders into two types: (1) Due diligence cooperation \( p_1 \), that is, the probability of cooperation between the technology intermediary and technology supplier and demander \( P_{12} = P_{23} = 0.9 \); (2) Non-due diligence cooperation \( p_2 \), that is, the probability of cooperation between the technology intermediary and technology supplier and demander \( P_{12} = P_{23} = 0.2 \); Among them, the probability of cooperation between the technology supplier and the technology demander \( P_{13} \) is both 0.6.

Using the Myerson value on the probability graph to calculate the respective benefits of each participant are:

(1) \[ \mu(N, v, p_1) = \begin{bmatrix} \mu_1(N, v, p_1) \\ \mu_2(N, v, p_1) \\ \mu_3(N, v, p_1) \end{bmatrix} = \begin{bmatrix} 795.05 \\ 327.35 \\ 1235 \end{bmatrix} \]

(2) \[ \mu(N, v, p_2) = \begin{bmatrix} \mu_1(N, v, p_2) \\ \mu_2(N, v, p_2) \\ \mu_3(N, v, p_2) \end{bmatrix} = \begin{bmatrix} 510.65 \\ 42.95 \\ 947.13 \end{bmatrix} \]

We can see that when the technology intermediary fails to cooperate diligently, the income distributed by the technology supplier, the technology intermediary and the technology demander is 510.65, 42.95 and 947.13 respectively. The three are distributed to 1500.73, and the remaining 1017.8 is not distributed; and when the technology intermediary due diligently cooperates with the technology supplier and demander, the benefits obtained are 795.05, 327.35 and 1235 respectively. The three are allocated to 2357.4, and only 161.1 is not allocated. This is because the Myerson value on the probability graph only satisfies the branch effectiveness, not the overall effectiveness. However, we can see from the results of whether the technology intermediary is due diligence: when the technology intermediary works diligently with the technology supplier and demander, the benefits of all participants are far greater than the benefits of the participants when they do not cooperate dutifully. Therefore, the technology intermediary should give full play to its role as a bridge, and cooperate with the technology supplier and demander to promote the completion of technology transactions, so as to maximize the interests of all participants;

Since the Myerson value on the probability graph only satisfies the branch effectiveness, not the overall effectiveness, in order to ensure the overall effectiveness of the allocation, it is more intuitive to compare and analyze with the Myerson value in the general graph.

This case introduces the effective solution based on Myerson proposed by Rene van den Brink in 2012 to the unallocated remainder [15]. The specific calculation formula is as follows:

\[ \varphi_i(N, v, p) = \mu_i(N, v, p) + \frac{v(N) - v_p(N)}{n} \]

Among them, \( v_p(N) = \sum_{i \in N} \mu_i(N, v, p) \), which represents the sum of Myerson values of all participants on the probability graph, \( v(N) \) is the income of the coalition, \( n \) is the number of participants. Through calculation, the final income distribution solution is:

\[ \varphi(N, v, p_1) = \begin{bmatrix} \varphi_1(N, v, p_1) \\ \varphi_2(N, v, p_1) \\ \varphi_3(N, v, p_1) \end{bmatrix} = \begin{bmatrix} 848.75 \\ 381.05 \\ 1288.7 \end{bmatrix} \]

The reason for the difference between the income distribution solution in the general graph and the income distribution solution on the probability graph is because the Myerson value in the general graph is calculated when the participants are fully cooperative as long as they are connected \( (p_{ij} = 1) \), so For
it, it only looks at the connected relationship, not the degree of cooperation, in other words, the Myerson value in the general graph is a special case when the edge probability is 1 on the probability graph. However, the Myerson value on the probability graph not only considers whether it is connected or not, but also considers the degree of cooperation (measured by $p_{ij}$), therefore, as long as the degree of cooperation between the two members is not 1, the alliance benefits will decrease. Moreover, Compared with the income distribution solution in the general graph (952.7, 173.2, 1392.7), the income distribution solution on the probability graph when the technology intermediary is due diligence is closer to reality. This is because the addition of probability can more truly describe the degree of cooperation among participants, better highlight the role played by the technology intermediary as a bridge in the technology trading market, and be closer to the actual situation.

6. Conclusions and Suggestions

In the technology market, there are uncertainties in the cooperation among the technology supplier, the technology intermediary and the technology demander. The degree to which the technology intermediary participates in the cooperation is also different for the transaction costs and risks generated by the technology supplier and the technology buyer. In this paper, the Myerson value on in the general graph is used to calculate the income distribution solutions of all parties under different probability Settings. Through comparison, it is found that the benefits of all parties are far greater than when they do not cooperate due diligence. Therefore, technology intermediaries should give full play to their role as a bridge, cooperate with technology suppliers and suppliers due diligence, and promote the completion of technology transactions, so as to maximize the benefits of all parties.

In order to facilitate the stability and sustainable development of the technology trading market and ensure the long-term existence of the cooperation among the three parties, after proposing a reasonable income distribution scheme, we make the following suggestions: First of all, science and technology intermediaries should constantly improve their professional capabilities, and do a good job of technological docking among the main subjects of technological innovation, so as to lay a good foundation for their own survival and development. Secondly, in order to achieve long-term and stable development, science and technology intermediaries should not only play a connecting role between the technology supplier and the demander to provide technology transfer services, but also use their own professional ability to provide technical services, technical consulting services, technical evaluation services and so on, so as to improve their profitability. Finally, science and technology intermediaries should have strong credibility, and give full play to their role to safeguard common interests, so as to establish a good reputation among customers and lay a reputation in the society.

References

[1] Fan Xia, Hua Feng. Technological market size and regional technological progress: An analysis of multiple mediating effects based on innovation input [J]. Macroeconomic Research, 2020(1): 95-111.

[2] Chunjuan Luan, Hefa Song, Caixia Xie. Patent operation model based on technology trading network [J]. Management of science and technology, 2019, 40(9): 3-17.

[3] Haibo Liu, Yongjie Wang, Wei Fa. Optimize the technology trading service system and promote the high-quality development of technology trading [J]. Technology Review, 2020, 38(24): 9-17.

[4] Lei Xiao. Analysis on the Evolutionary Game of Technology Transfer with the Participation of Science and Technology Service Intermediaries [J]. Technology and Market, 2021, 28(01): 47-48.

[5] Qingjin Wang, Xue Zhou, Yang Wang. Research on the Game between Science and Technology Intermediary and Regional Innovation Subject [J]. Science and Technology Management Research, 2011, 31(04): 1-3.

[6] Hao Jiang, Yanguang Ji, Rui Nie. Game analysis of technology intermediary operation and management mechanism [J]. China Management Science, 2006, (14): 182-186.
[7] Yue Chang, Xiaofeng Ju. Game Research among Innovation Providers, Intermediaries and Potential Adopters [J]. China Soft Science, 2013, (3): 152-157.

[8] Bozhou Li, Xiaofang Luo. Research on original innovation income distribution of industry-university-research cooperative enterprises based on Shapley value method [J]. Operations research and management, 2013, 22(04): 220-224.

[9] Weishuang Zhao, Huajin Zhu. Research on Benefit Sharing Mechanism of Technology Innovation Alliance in High-end Equipment Manufacturing Industry -- Taking Shenyang City as an Example [J]. Transactions of Shenyang Ligong University, 2015, 34(05): 71-75.

[10] Jie Wu, Xiaoju Wu, Xiaojing Che, et al. Game Analysis of Tripartite Interest in Knowledge Transfer of Alliance Enterprises with Intermediary Participation [J]. China Management Science, 2018, 26(10): 176-186.

[11] Dongfang Hua, Fuxin Jiang. Research on the dynamic relationship between science and technology intermediary and technology supplier and demander: from the perspective of tripartite evolutionary game [J]. Science and technology for development, 2019, 15(03): 271-280.

[12] Shapley L S. A value for n-person games [J]. Contributions to the Theory of Games, 1953, 2(28): 307-317.

[13] Myerson R B. Graphs and cooperation in games [J]. Mathematics of Operations Research, 1977, 2(3): 225-229.

[14] Calvo E, Lasaga J, Nouweland A. Values of games with probabilistic graphs [J]. Mathematical Social Sciences, 1999, 37(1): 79-95.

[15] Brink R, Khmelnitskaya A, Laan G. An efficient and fair solution for communication graph games [J]. Economics Letters, 2012, 117(3): 786-789.