

A Review of Research on Interest Distribution of Supply Chain Based on Game Theory

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Abstract—Supply chain management theory is the focus of attention in today's management circles, the application of game theory of the benefits distribution in the supply chain has become an important development direction.

On the basis of carefully combing the relevant research literature at home and abroad, this paper reviews the related research on the benefits distribution in supply chain from three aspects: qualitative analysis, quantitative analysis and case study: qualitative research mainly includes the principle, factors and distribution patterns of benefits distribution in the supply chain; quantitative research is to establish a mathematical model for analyzing analyze the problem of benefits distribution between enterprises; case study is to explore the specific application of benefits distribution of the supply chain' members in various industries.

Finally, this paper summarizes the shortcomings of research, the existing problems and the future direction of further research.

Index Terms—Review, Supply chain, Benefit distribution, Game

I. INTRODUCTION

The distribution of benefits of supply chain has always been one of the topics of concern in supply chain management research, this is because a reasonable supply chain benefit distribution mechanism is the foundation, which can make relevant enterprises in the supply chain and the supply chain system itself stable. Supply chain nodes between the two companies have mutual cooperation and their respective interests, the interests are mainly reflected in the proportion of the distribution of income, the application of the game model to study the distribution of income among the enterprises in the supply chain has achieved good results. Many scholars, at home and abroad, have extended related research in this field. With the emerging of relevant literature at home and abroad, more and more scholars have begun to study the distribution of benefits from different perspectives and related issues under the distribution of benefits. These studies have extremely high theoretical and practical value, and they have some inspiration and guidance for the study of the distribution of benefits of supply chain enterprises.

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II. LITERATURE REVIEW

There are a wide range of research on the distribution of income between different economic entities at home and abroad, such as cooperative research and development, virtual enterprise, dynamic alliance, supply chain, which are related to the rational allocation problem of cooperation income between the different members of the enterprise, the research results have certain guiding significance to the distribution of cooperative income of supply chain. By summarizing the domestic and foreign literature on the use of game theory to study the distribution of supply chain interests, and summed up the existing research, they can be divided into three areas: qualitative analysis, quantitative analysis, and case studies. Among them, qualitative research mainly includes the principle, strategy and coordination mechanism of benefit distribution in the supply chain; Quantitative research is to establish a mathematical model, and introduce the factors affecting the distribution of benefits to analyze the cooperative game between enterprises.

A. Qualitative Analysis

Qualitative analysis mainly discusses the principles, influencing factors and distribution patterns of income distribution. Such as Lye and Bergen (1997) [1] described the issue of the distribution of benefits among partners, and pointed out that the result of rapid response between the manufacturer and the retailer was usually that retailer got benefit, and the manufacturer did not have any benefit that makes it lost the enthusiasm of cooperation. Gavirneni (1999)[2] mainly studied its production and profit distribution problem of a one-to-many secondary supply chain (consisting of one producer and multiple distributors), and discussed the factors that affect the overall interest growth of the supply chain. BABICH (2010)[3] introduced the principle of benefit distribution of the supply chain alliance, focused on demonstrating the impact of risk on the distribution of benefits, and proposed a two-step distribution method of risk-based supply chain alliance, according to their actual situation in the face of specific risks, the member companies got the corresponding benefits of compensation. Domestic scholars such as Chen JuHong[4](2002) put forward three main modes of profit distribution: fixed payment model, output sharing model and mixed mode. Zhang Qiao et al. (2004) [5] argued that the distribution of interests between supply and demand in the supply chain shall take the basic principle of revenue sharing and risk sharing as the starting point and need to

include incentive mechanism to promote cooperation and trust between partners. Ye HuaiZhen(2004) [6]pointed out that, in the establishment of income distribution mechanism, cost factors and risk factors shall be taken into account. Zuan FangZhong(2006)[7] analyzed factors related to benefits distribution in the supply chain, which was summarized as four aspects: fixed investment in the supply chain, the level of their own efforts, the degree of taking risk and the additional contribution to the supply chain. Jiang NengTao(2010)[8]explored the factors influencing the distribution of surplus profit in the cooperative supply chain from the external and internal aspects, and analyzed the factors through the analytic hierarchy process, and finally got the two key factors of the cooperation' satisfaction and the taking risk.

B. Quantitative Analysis

Quantitative analysis is to reflect the size of the profits of member companies through a specific expression or value. At present, the research on this aspect is more extensive, they could be sorted out the following aspects.

Related research based on Shapley method: M.A Ball (2001)[9] applied the combination evaluation to the Shapley method to avoid the irrationality of the single evaluation method, analyzed the cooperative game of portfolio evaluation, and evaluated the weight of the cooperative game combination of variable weight Shapley value, thus ensured the rationality of the weight of various evaluation methods. Huang et al. [10]gave a brief introduction to Shapley's method and made appropriate improvements to apply it to the four-level supply chain profit distribution, and further verified rationality of this method with examples to arrive at the conclusion. Judith Timmer (2004) et al. [11]studied the problem of cooperative game solution by combining the probabilistic theory with the study of three Shapley samples randomly paid solutions. Almeida (2014)[12] argued that the enterprise's earnings are not a fixed value, but there is a certain degree of volatility, so this paper introduced the method of interval value fuzzy pay Shapley value to allocate strategic network benefits. Domestic scholars such as Liu ChunCheng (2003)[13] used the Shapley value method to analyze the income distribution of the logistics enterprise alliance. The results showed that the Shapley value could be used as the distribution value of the income distribution when the game was super-additive and strictly satisfied the completeness of the feature function, and the distribution value was an unbalanced expectation, with the characteristics reflecting the importance of the enterprise in the league. Ma ShiHua (2006)[14], WeiHua Liu (2007)[15], etc., analyzed the distribution of revenue in the supply chain alliance based on the Shapley value .Zhang YaWen et al.[16](2009)took into account the shortcomings of the Shapley value method for the distribution of the benefits of the supply chain alliance, from the point of view of the relationship between the supply chain alliance, a new correction algorithm was proposed based on the theory of link dependency proposed by the coordination theory, which could guarantee the stability of the alliance and its

overall benefit optimization. Duan Mei(2010)[17]took the stakeholder theory as the starting point, analyzed the correspondence relationship between the supply chain relationship type and the income distribution pattern, and focused on discussing the distribution of benefits among the nodes of the supply chain, finally the income distribution model of supply chain organization based on Shapley value method was constructed. Zhang ChenTang(2011),etc.[18],regarded the three-level supply chain (composed of manufacturers, distributors and retailers) as the object of study, and discussed the price-sensitive needs of the alliance game and its income distribution problem. Xu YaNan(2011)[19] considered the influence of technological innovation, cooperation degree and risk factors on the distribution of supply chain benefits, and revised the supply chain benefit distribution model based on Shapley value method.

Related research based on the Nash negotiation model: Cachon and Zipkin (1997)[20] designed the cooperative-incentive mechanism about revenue distribution, based on the linear contract, under the condition of manufacturing-selling enterprise alliance by referring to the game theory, and the competitive equilibrium of the member firms coincided with the optimal Nash equilibrium solution. Gjerdrum and Shah (2001)[21] and others used the Nash game model to study the influence of the cooperation of nodes in the supply chain on the whole supply chain, and concluded that the game model could provide the optimal solution for the overall benefit of supply chain coordination. Mahesh (2008)[22]summarized the application of cooperative game theory in the supply chain, emphasized the issue of profit distribution and cooperation stability, and determined the distribution of the overall profit of the supply chain through the bargaining between enterprises. Karray(2015)[23]proposed three models, namely, the satisfaction distribution model based on satisfaction degree, the weighted center of gravity model and the asymmetric Nash negotiation model, and further gave the profit distribution method of these models, and then carried out the solution analysis combined with the example. Lin ChunYan(2005)[24] took the strategic alliance of aviation as the object of study, and the final income distribution result of the two parties participating in the negotiated negotiation based on the Nash negotiation model would be a stable state. Li XiaoMing(2009)[25] and others used the Nash negotiation game model to discuss the benefits distribution of the goods transferring between the retailers, based on the newsboy model, and finally got the transfer price of the goods when the interests were reasonably distributed. Chen YangYang(2011) et al.[26] constructed the Stackelberg master-slave game model and the Nash cooperative game model under the complete information respectively, and further discussed the problem of the distribution of income between the manufacturer and the valet service provider in B2B and B2C environment. By analyzing and comparing, the optimal income distribution mechanism is obtained.

Relevant research based on revenue sharing contract: Wang Y [27]regarded a supplier and two retailers as the

research object, studied the supply chain's revenue sharing contract problem and discussed the specific demand function of the supply chain's coordination problem. Jochen[28] analyzed the Stackelberg model of a supplier and a buyer, which he extended the results of the game to a number of suppliers and multiple buyers, and demonstrated the value of the parties in the game of different supply chain's revenue sharing contract is also different. Giannocaro (2004) [29] constructed a supply chain's revenue sharing contract model, and tried to change the contract parameters to achieve the rational interests distribution among the members enterprises, and thus promoted the implementation of the synchronize cooperation among member companies. Satyaveer (2005)[30] studied the overall optimal yield of the one-to-one supply chain under the premise of no income sharing contract, and discussed the distribution of the income with full consideration of the risk factors. Lv YongWei et al.[31] took the secondary supply chain formed by suppliers and retailers as the research object, using their respective income distribution ratios as the coordination factor, and analyzed the supply chain's coordination contract under asymmetric information based on revenue sharing. Guo FuLi(2010) and others[32] also regarded this as the research object, under the assumption of the supplier risk is neutral and the retailer risk avoidance, constructed the supply chain's revenue sharing contract model, and the result showed that the range of contract parameters(revenue distribution coefficient) will increase with the increase of retailer risk aversion. Feng Shuang(2012) and others[33] took the two-level supply chain formed by two manufacturers and a retailer as the study object, constructed the game model of revenue sharing contract dominated by the retailer under complete information, and finally obtained the Nash equilibrium solution of the game. Pang QingHua(2012) and others[34] analyzed the secondary supply chain formed by the suppliers and single retailer, and built a supply chain's revenue sharing contract model under different decision preferences.

Related research based on other quantitative methods: Foreign scholar George (1989)[35] explored the relationship between risk took by member companies and benefit distribution in the supply chain, from the point of view of "commission - agent", and pointed out that risk sharing and benefit distribution need to take into account the cooperation expectations of both parties. Karl Morasch[36] adopted the appropriate delegation mechanism, that was, how to distribute price and benefit sharing in a production cooperative enterprise, and determined the benefit distribution structure of the alliance members under different alliance structures, and then analyzes the formation process of the alliance. S.P. Nachiappan (2006) and others[37] analyzed the VMI operation index decision based on VMI in the one-to-one supply chain, based on the genetic algorithm, the results showed that different income distributions proportion among member enterprises would influence the decision index. Z. Yao (2008)[38] studied the revenue sharing contract in the secondary supply chain composed of one

producer and two retailers, based on the newsboy model and numerical analysis method. The conclusion was as follows: compared with the price contract, revenue sharing contract could make the supply chain performance to be more improved; and there were differences in the benefits of different member firms, which depended largely on price sensitivity factors and the variability of demand. Lerner (2010) and others [39] further enhanced the client's rights to terminate the theoretical height, and explored the issue of revenue sharing from the point of view of "commission - agent", with full consideration of moral hazard problem, and demonstrated the feasibility of this kind of governance mechanism in solving the moral hazard problem such as cross - financing of the project. Liu PingFeng(2005)[40] studied the production and profit distribution of the one-to-one supply chain composed of a producer and a seller. Sun HongJie(2006)[41] regarded the supply chain as an ecosystem, based on the theory of symbiosis and marginal analysis, and discussed the benefit distribution mechanism among the members in the supply chain. Sun Rui(2010) and others[42] applied the game theory to the problem of revenue distribution in the collaborative business chain. A two-stage dynamic game model was established for the secondary supply chain formed by the supplier A and the vendor B. Lin Qiang(2010) and others [43] constructed a dynamic game model of income distribution, with full consideration of the risk, contribution and time utility factors in the mixed allocation model, to solve the problem of the distribution of benefits of logistics alliance. On the basis of the traditional income distribution method based on game theory, Zhang WenFang(2011) et al.[44] analyzed the relative weight of each method by introducing Euclidean distance and TOPSIS's thought, and then put forward a more equitable and fair synthesis income distribution method. Wu MingFeng(2012)[45] took the supply chain formed by m producers and n retailers as the research object, and gave the calculation method of supply chain income based on the solution of "kernel" solution in cooperative game. In view of its distribution of benefits, Zhang ZhiYong et al. [46] took the knowledge chain as the research object, it was the organization and cooperation form which was connected by alliance relation. Through the cross-influence analysis method and correlation knowledge of triangular fuzzy number, the proportion of benefit distribution of each member enterprise was obtained. Jiang ShiYing[47] regarded the one-to-one secondary supply chain formed by a manufacturer and a retailer as the research object, constructed a Stackelberg game model of profit distribution, which was dominated by the supplier and the manufacturer under the complete information, and finally obtained the equilibrium solution of profit distribution in the supply chain.

C. Case Study

In the case study of supply chain's revenue distribution, the profit distribution is mainly carried out in a specific industry supply chain to carry out research. Talluri [48] has established a game model related to the mobile device class, involved in the purchase of buyers and suppliers, buyers

first set an ideal goal, then selective bids were carried on based on this goal, and further used this model to evaluate. Zhu(2004)[49] analyzed the game relationship and the benefits distribution model of the supply chain in the automobile industry, and demonstrated that the relationship between the members in the automobile supply chain was the repeated game relationship of the long-term cooperation. Finally, based on the cooperative game, the Shapley value method was used to establish the profit distribution model of the members in the automobile supply chain. On this basis, the Shapley value distribution model with risk factors was put forward, which was beneficial to decisions-making related to the benefits distribution of the members in the automobile supply chain. In view of how to maintain the stability of the low-carbon technology innovation alliance, Guardiola(2007)[50] considered four factors, namely, capital investment, commitment to risk, commitment to cost and innovation contribution, used the AHP method to quantify the indicators, and obtained the benefit allocation method which integrated these strategies. Kaufmann et al.(2015)[51] used the cooperative game model to study the profit distribution of home appliance manufacturers and retailers. The results showed that the profit in the case of cooperation was better than the profit obtained from the independent decision-making, so the supply chain members were more willing to maintain the cooperative state. Xu Ping(2006)[52] took the vegetable supply chain in Xinghua City of Jiangsu Province as an example, this paper used the multiple logit model to analyze the influencing factors of farmers' choice to join the new vegetable supply chain, and the cost and benefit of the peasant households in the upstream node of the vegetable supply chain were compared by using the statistical test method. According to the principle of "risk sharing and benefit sharing", Liu XiaoJun and others(2006)[53] obtained the calculation method of "income-risk" distribution of cooperative construction enterprises in dynamic alliance. Mou MeiYu(2007)[54] explored the coordination of interest-based coordination mechanism based on Shapley's value method to the interests of the member enterprises in the construction supply chain, and combined with the engineering examples, the interest coordination mechanism was described in detail. According to the characteristics of risk sharing and benefit sharing among supply chain nodes, Ma HongYan and others[55] discussed the cooperative-income distribution mechanism in shipbuilding supply chain, analyzed the principle of profit distribution, and designed the negotiation mechanism of cooperative supply distribution of shipbuilding supply chain based on asymmetric Nash negotiation model. Zhao XiaoLi(2007)[56] introduced the cooperation model of coal and electricity enterprises, put forward the Shapley value model based on the profit factor. At the same time, the factors of cooperation contribution and risk were also taken into account, and the distribution methods of these cooperative modes are studied. Ding Shang(2008)[57] applied the basic theory and method of cooperative game, combined with examples, so as to design the income distribution method of automobile supply chain. Lin JiaBao

and others(2009)[58] took the secondary supply chain formed by the mobile operators and service providers as the study object, and constructed the optimization model which could realize the coordination of interests of each member enterprise. Liu XiHua[59] extended the model established by Suijs and Borm, analyzed the risks in the insurance transaction process, gave the insurance' risk distribution, and then illustrated its rationality with examples.

III. CONCLUSION AND OUTLOOK

Through the existing research at home and abroad, based on game theory, the research on the distribution of income in the supply chain has been paid more and more attention by the academic circles. The related research involves a wide range of field to be divided into the following three aspects, including qualitative analysis, quantitative analysis or case study. However, there are still several main problems in the existing literature: the first problem is the lack of practicality, the model is too harsh to limit the conditions, it is not very good application to the complex real situation; The second problem is the lack of comprehensiveness, the models are often constructed from a certain point of view of the distribution of income issues, such as the degree of effort, the size of the risk and so on, and the actual factors affecting the distribution of income is multifaceted, one of the few studies on the influencing factors of income distribution is also a qualitative analysis; the third problem is that the income distribution model usually regarded the secondary supply chain as the research object, and there are a few three-level supply chain as the research object, but the complexity of the member enterprise in the supply chain is much higher than that in the model' assumptions. In general, there is a lack of systematic discussion on the distribution of income in the supply chain enterprise. From the development trend of the supply chain and the market competition environment, this situation obviously can not meet the needs.

Therefore, based on the previous research results at home and abroad, this paper provides a certain direction for further in-depth research. For example, you can try to think of game theory as a basic research tool, learn from the idea of cooperative game, regard cooperative game "solution" as the basis for the distribution of income; and comprehensively consider the main influencing factors of income distribution, introduce the comprehensive influence factor, construct the income distribution model which is applicable to the cooperative supply chain composed of any limited number of member enterprises; and quantitatively analyze the influencing factors in the model, give the solution method, and provide the research ideas and theoretical methods for the reasonable distribution of supply chain coordination income.

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