

A FUZZY LOGIC ENHANCED BARGAINING MODEL FOR BUSINESS PRICING DECISION SUPPORT IN JOINT VENTURE PROJECTS

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Abstract. Project businesses are increasingly emerging and many companies cooperatively participate in various projects by the manner of joint venture (JV) for creating synergistic competitiveness. In a project-based short-term JV, the project tasks of JV parties can be properly allocated based on complementary specialties but the rewards sharing is always a challenge in the bargaining process. For improving the manager's reasoning process of pricing decisions, this paper incorporates game theory and fuzzy set theory for the development of a bargaining model, which can be used to estimate acceptable prices for JV parties in accordance with each party's costs and each party's need for the project's revenue. The proposed decision support model can assist JV companies to understand their bargaining positions and select a bargaining strategy in a systematic and rational manner. Irrational offers and alternatives can also be detected and eliminated during the dynamic bargaining process, so as to maintain right businesses.

Keywords: negotiation, bargaining, pricing, decision- making, joint venture, strategic alliance, game theory, fuzzy logic.

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1. Introduction

As a response to the changing business environment and diverse market demands, strategic alliances have been considered as effective business models for creating competitive advantages. In recent decades, project businesses are increasingly emerging and many companies cooperatively participate in various projects by the manner of joint venture (JV). The project-based short-term alliances are especially popular in the construction industry (Norwood and Mansfield 1999). Since construction projects have become larger and more complex, a growing number of projects have exceeded the scope

that can be handled by a single company. The desire for and search for collaborators to achieve synergistic competitiveness is the prime motive for companies to collaborate (Xu *et al.* 2005). Through the manipulation of the appropriate resources, a JV may bring about different kinds of benefits to participating companies, such as risk sharing, resource complementarities, reduced cost, knowledge sharing, and technology transfer (Tam 1999; Munns *et al.* 2000; Nicolini *et al.* 2001; Proverbs and Holt 2000; Simchi-Levi *et al.* 2001). JV has become an important strategy for construction companies in response to the increasing demands in the construction industry. The JV teams can also be significantly competitive for the projects delivered by the qualification-based selection system (Lo and Yan 2009).

To form a JV team, companies have to select partner(s), assign each party's work scope, and especially, negotiate the sharing of rewards, which is usually done by arranging separate amounts of the expected total rewards or by sharing proportionally, depending on the collaborating relationships among the JV teams. However, in a negotiation, two parties may have different objectives and conflicts (Saeed 2008). Since each JV party is pursuing its maximum reward, the conflicts of interest make the sharing of rewards always a challenging task. Lai (1989) pointed out that bargaining is needed when a conflict lies between participating parties, and communications and compromises are required to reach an agreement. Raiffa (1982) proposed the concept of "zone of agreement", which can be figured out by deducting the lowest, acceptable price for each party from the total amount. As each party strives for its maximum price, which is also acceptable to the other party, in the "zone", bargaining usually is carried out through numerous repetitions of offer-and-counteroffer until an agreement is reached, or the bargaining is given up.

Bargaining in the construction industry is quite different from other industries. The collaborations between JV parties are usually on a short-term, project-to-project basis and the time allowed for bargaining is strictly limited. Since time factor is crucial in this type of negotiation, the JV parties may be forced to make a concession because of the need to submit a bid on time. Thus, how to evaluate a bargaining situation and offer a price acceptable to both parties in a timely manner is critical for the success of a JV project. However, current practices still lack a systematic tool or model for supporting a company's pricing decisions. The research aim is to fill the gap.

There are many factors that could affect a company's pricing on a specific project. However, previous research has pointed the outcome of bargaining is highly influenced by the stakes of the bargainers, the bargainer's level of dependence on the outcome of bargaining (Bacharach and Edward 1981). Accordingly, this research focused on the variable, need for the revenue from the project, which is used to represent company's level of dependence on the profit from a JV project. A sequential bargaining model is developed, based upon game theory, which is used to estimate acceptable prices in accordance with each party's costs and needs. The game theory perspective helps decision makers to take into account not only the current strategy of the competitor, but his forthcoming responsive actions as well (Ginevičius and Krivka 2008). Furthermore, fuzzy logic is used to quantify a company's need for the revenue from the project, which always features a certain degree of uncertainty. The applications of fuzzy logic enhance the bargaining model to support quantitative analysis and operational research of bargaining strategies.

2. The sequential bargaining model

Game theory has been defined as “the study of mathematical models of conflict and cooperation between intelligent rational decision-makers” and successfully applied to many important issues, such as negotiations, finance, and imperfect markets. It allows researchers to find mathematical solutions of conflict situations (Peldschus 2008). Based on the concept of dynamic games, the bargaining between two parties of a JV team is modeled as a sequential bargaining process. In this model, the JV parties are termed as “players”.

2.1. Basic symbols and definitions

In the game theoretical analysis, the rationale of players’ behavior is to maximize their payoffs calculated based on quantified considerations and both players are assumed risk neutral, while the utility function can be used to modify this model in cases where the players have other risk attitudes. Definitions of each basic symbol and assumption in the model are as follows:

- k represents players in the bargaining, while a refers to player A and b refers to player B.
- n represents round of bargaining. Each player’s offer accounts for a round.
- E represents total contract amount estimated based on announced budget information and market price. The total contract amount is assumed the award price. As agreement is reached, the total contract amount is the sum of the payment obtained by player A (a^*) and the payment obtained by player B (b^*).
- a_n represents player A’s quotation for its work scope in the n^{th} round. In this model, player A makes the first offer, a_1 , in the 1st round for its work scope. Further, since both parties take turns to offer a price, only when the number of round is odd ($n = 1, 3, 5, \dots$) player A can offer its price.
- b_n represents player B’s quotation for its work scope in the n^{th} round. As assumed above, first player A offers a_1 in the 1st round for its work scope, and then player B may make a counteroffer, b_2 , for its work scope. Since both parties take turns to offer, only when the number of round is even ($n = 2, 4, 6, \dots$) player B can offer its price.
- C_k represents cost estimated by the player k according to individual work scopes. C_a indicates player A’s cost; C_b indicates player B’s cost. Since information associated with market prices of materials and labor is quite open, it is assumed in this research that both parties in the bargaining can obtain clear awareness of each other’s cost.
- F represents total profit of the project (total profit plus total cost of the project equals the total contract amount).
- P represents probability of failure in the bargaining.
- $L_{k(n)}$ represents the loss of potential profits when agreement is not settled.

2.2. Sequential bargaining process

In this model, it is assumed that bargaining begins with the offer proposed by player A in round 1 ($n = 1$), and there are three possible responses from player B: (a) accepts the offer, (b) rejects the offer and closes the bargaining, and (c) makes a counteroffer. If player B makes a counteroffer, then similarly, player A may accept, reject, or make a counteroffer to player B. Usually the bargaining is an offer-counteroffer process till the n^{th} round, when an agreement is reached, or the bargaining is given up. Accordingly, different rewards or losses in each round are expected (as shown in Fig. 1). At the n^{th} round, it could be player A's or player B's turn to make the offer. Nevertheless, in the bargaining model shown in Fig. 1, it is assumed that it is player A's turn to propose the offer.

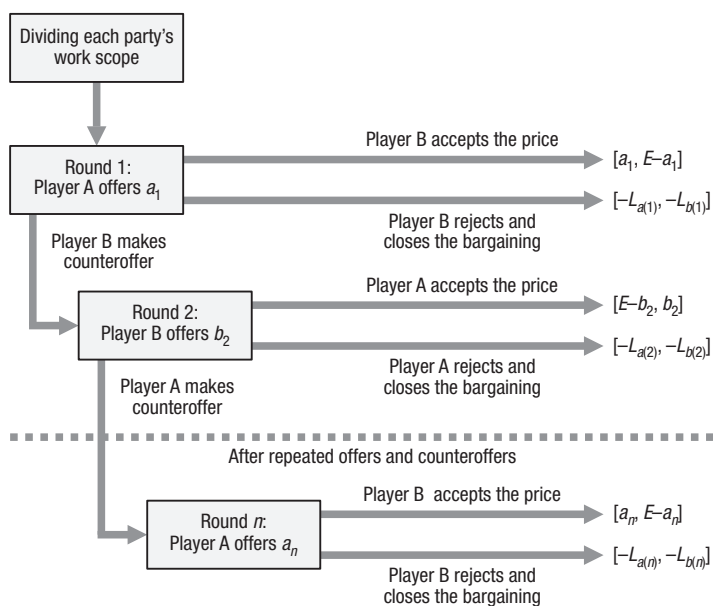


Fig. 1. The sequential bargaining process

2.3. Equilibrium of sequential bargaining

In order to understand how players behave in the sequential bargaining process, this research introduced the concept of “Nash equilibrium”, one of the most important concepts in game theory. Nash equilibrium refers to a situation in which individuals participating in a game pursue the best possible strategy while possessing the knowledge of the strategies of other players. In Nash equilibrium, each player's strategy should respond to the other player's strategy, and no player wants to deviate from the equilibrium solution (Myerson 1991). Thus, the equilibrium price of sequential bargaining process is a best price for both parties under the sets of information and bargaining situation.

The equilibrium of sequential bargaining can be solved through “backward induction” (Gibsons 1992). According to the method, whether a player accepts the counterpart’s offer depends on his expectation of rewards in the next round. Only when the reward offered by the counterpart exceeds or equals what is expected would a player accept the offer and settle the agreement. So, if player A offers the highest price of a_n at the n^{th} round ($n \geq 3$), a potential loss, $PL_{a(n)}$, may be incurred, thus the expected payoff of player A in the n^{th} round is as Eqn. (1):

$$a_n - PL_{a(n)}. \tag{1}$$

Furthermore, since player B knows that, in the $(n-1)^{\text{th}}$ round, any price higher than Eqn. (1) would be accepted by player A, player B’s best offer in the $(n-1)^{\text{th}}$ round is as Eqn. (2):

$$E - a_n + PL_{a(n)}. \tag{2}$$

Similarly, for player B, in the $(n-1)^{\text{th}}$ round, the expected payoff in the $(n-1)^{\text{th}}$ round is as Eqn. (3):

$$E - a_n + PL_{a(n)} - PL_{b(n-1)}. \tag{3}$$

In addition, since player A understands that, in the $(n-2)^{\text{th}}$ round, any price higher than Eqn. (3) would be accepted by player B, and player A’s offer in the $(n-2)^{\text{th}}$ round is as Eqn. (4):

$$a_n - PL_{a(n)} + PL_{b(n-1)}. \tag{4}$$

As a summary of the aforementioned description, Table 1 shows the prices acceptable to player A and player B in the last three rounds as induced by backward induction.

Table 1. The acceptable prices in the last three rounds

Round	Acceptable price for player A	Acceptable price for player B
$n-2$	$a_n - PL_{a(n)} + PL_{b(n-1)}$	$E - a_n + PL_{a(n)} - PL_{b(n-1)}$
$n-1$	$a_n - PL_{a(n)}$	$E - a_n + PL_{a(n)}$
n	a_n	

Based on the concept of equilibrium, the player cannot produce a price better than a_n . Therefore, the equilibrium price can only be solved when player A’s offer in the n^{th} and $(n-2)^{\text{th}}$ round is the same as Eqn. (5):

$$a_n = a_n - PL_{a(n)} + PL_{b(n-1)}. \tag{5}$$

Since bargaining between players is a repetitive process of offer-counteroffer, when the round of bargaining $n \rightarrow \infty$, the P in each round will be very close. Thus, in this model, the probabilities of failure in any bargaining round are assumed the same and Eqn. (5) can be simplified as Eqn. (6):

$$L_{a(n)} = L_{b(n-1)}. \tag{6}$$

2.4. Equilibrium price function

In this research, $L_{k(n)}$ is the loss of potential profits in the JV project. However, bargaining theory (Bacharach and Edward 1981) suggests that potential profits considered by a player in the bargaining should be additional profit which can not be gained from other projects. If a player has other opportunities that may earn the same amount of profit, there is no potential profit for this project. Therefore, this research developed a variable, need for the project (S_k), to encompass the above concept. Losses expected by player A and player B are as Eqn. (7) and Eqn. (8) respectively.

$$L_{a(n)} = \left(\frac{E - b_{n-1} - C_a}{C_a} \right) S_a, \tag{7}$$

$$L_{b(n)} = \left(\frac{E - a_{n-1} - C_b}{C_b} \right) S_b. \tag{8}$$

It is common that player A and player B of the JV team may invest on different scales. Thus, the $L_{k(n)}$ is evaluated on the unit basis for the sake of fairness. Value of S_k is assumed to fall between 0 and 1; the higher the value, the higher the need for the project, and vice versa. The value 1 indicates that the player has no other opportunities, which can earn the same amount of profit as this project. 0 indicates that the player can earn the same profit from other opportunities and does not need the profit at all.

Since bargaining between players is a process of offer-counteroffer, both players tend to gradually lower their offers to reach an agreement. When the bargaining reaches $n \rightarrow \infty$, it can be inferred that the players' offers will converge and players' offers in the last three rounds tend to be the same. Thus, a_{n-2} , a_n , and a^* can be considered equal and the same principle applies to b_{n-3} , b_{n-1} , and b^* . Eqn. (9) can be derived by substituting Eqn. (7) and (8) given for $L_{a(n)}$ and $L_{b(n)}$ in Eqn. (6):

$$a_n = E - C_b - \frac{(E - b_{n-1} - C_a)C_b S_a}{C_a S_b}. \tag{9}$$

Based on the definitions of this research, the total contract amount, E , is the sum of a^* and b^* , while total profit plus total cost of the project equals the total contract amount. Thus, an equilibrium price function can be derived from Eqn. (9) as Eqn. (10):

$$a^* = C_a + C_b + F - C_b - \frac{(a^* - C_a)C_b S_a}{C_a S_b} = C_a + \frac{F S_b}{\frac{C_b}{C_a} S_a + S_b} = C_a + \frac{C_a F S_b}{C_b S_a + C_a S_b}. \tag{10}$$

Eqn. (10) can be promptly used to suggest player A's offer as an acceptable price for both parties. In most cases, the required parameters of the equation, C_a , C_b , and F are already established before bargaining, while S_a and S_b are not. Thus, S_a and S_b are two key variables for determining the price. Through Eqn. (10), the impacts of S_k on company's offers can be analyzed by using a fixed S_b with different values of S_a . It is found that player A's suggested offer decreases as the S_a increases (see Fig. 2).

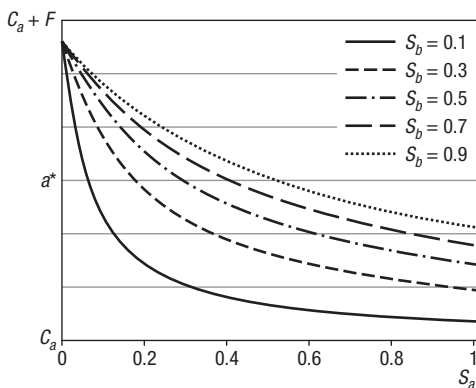


Fig. 2. The impacts of S_a on a^*

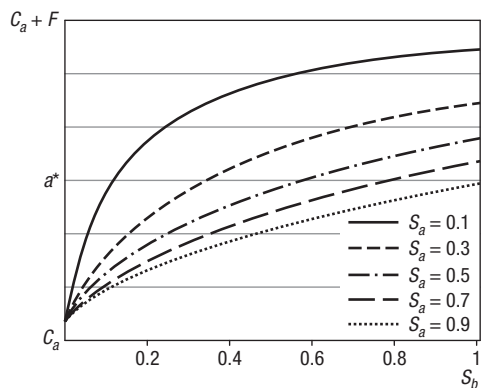


Fig. 3. The impacts of S_b on a^*

This scenario is more significant as the S_b decreases. Similarly, this research tests the suggested offers based on a fixed S_a with different values of S_b , and finds that the suggested offer increases as the S_b increases (see Fig. 3). This scenario is more significant as the S_a decreases. To summarize these results, a company with relatively high need for the project is likely to lose more of the profit of the JV project.

3. Fuzzy rule-based estimation of company's demand for the project

Based on the aforementioned equilibrium price function, individual company's demand for the project would have an impact on the equilibrium price. Thus, quantitative analysis of the need for the project is essential and it can be enabled by using fuzzy logic. In a JV team, each party can obtain business information and speculate on its partner's "need for the project" (S) through public or private information channels. For example, the awareness that the counterpart has not taken any construction project in the past six months and opportunities for construction projects will be rare in the following six months suggests that the counterpart's "S" must be high. However, it is difficult to transform the above information and linguistic variables into a specific value to facilitate the decision-making. To the imprecise data or linguistic variables, fuzzy logic is a widely used approach in helping decision making (Arslan and Aydin 2009). Therefore, this research incorporates fuzzy logic to quantify the "S" of each party and enable further quantitative analysis.

3.1. Measure of need for the project

Carr (1987) proposed that a company's pricing should be consistent with its status of business operation. If a company's returns gained from business operations cannot cover its general and administrative expenditures, this company will suffer loss. Thus, if a company's total revenue is expected to fall behind its scheduled revenue target, the company is in an urgent "S" and thus forced to lower its offer for better opportunities. On the contrary, if its scheduled revenue target has been reached, this company's "S" is relatively low. In this research, the degree of "S" is regarded in terms of the company's fulfillment of scheduled revenue target. The lower the degree of scheduled revenue target attainment, the higher the company's "S." The degree of fulfillment of scheduled

revenue target is closely related to received revenues and potential business prospects in the future. Moreover, future revenue is associated with future business opportunities and the level of competition. Thus, this research assumes that a company’s “S” is influenced by three factors, “received revenues”(R), “future business opportunities”(O), and “level of competition”(L).

3.2. Fuzzy sets and membership functions

Both “R” and “O” are evaluated against the company’s degree of attainment of its scheduled revenue target. For example, if “R”/scheduled revenue target yields a value of 0.95 (covering 95% of its scheduled revenue target), it is suggested that this company’s “R” is rather high. Both “R” and “O” may exceed scheduled revenue target, so values of these two items range between 0~2 and are further divided into three degrees of “High”, “Moderate”, and “Low”. As for the variable of “L”, the value is represented by “number of competitors”, which has been the most frequently used criterion for measurement of competition level in previous research. Note that the number of competitors is an adaptive parameter, which is adjustable for specific cases in different industries. Lo *et al.* (2007) have conducted a nation-wide study on the traffic construction projects in Taiwan and proposes an estimation of the number of competitors ranging from 3 to 13. In this research, we took the estimation for the demonstration of the fuzzy membership function. Therefore, this research ranges the value of “L” from 3 to 15 so as to include some extremely competitive cases (3 competitors is the minimum requirement for open bids); higher values indicate higher level of competition, which is also divided into three levels of “High”, “Moderate”, and “Low”. “S” is defined in the range between 0 and 1, and further divided into three levels of “High”, “Moderate”, and “Low”.

Membership functions commonly used include triangular functions and bell-shaped functions (Yu and Skibniewski 1999). To demonstrate the concept more efficiently, triangular functions are used in this research (see Fig. 4). In a triangular membership

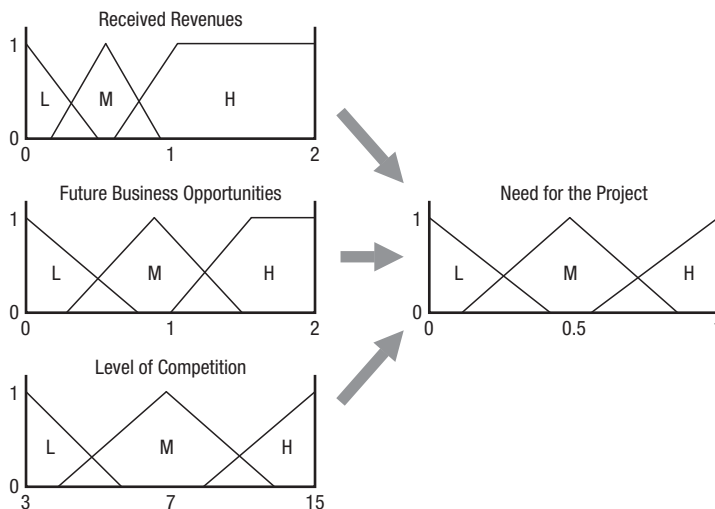


Fig. 4. Membership functions of each criterion and output

function, each triangular fuzzy number has linear representations on its left and right side such that its membership function can be defined as Eqn. (11):

$$\mu(x/M) = \begin{cases} 0, & \text{if } x < s \text{ or } x > l, \\ (x - s)/(m - s), & \text{if } s \leq x \leq m, \\ (l - x)/(l - m), & \text{if } m \leq x \leq l, \end{cases} \quad (11)$$

where s and l represent the smallest and the largest possible values and m represents the most promising value that describes a fuzzy event.

3.3. Fuzzy if-then rules

To effectuate the composition of the variables considered for estimating a company’s demand for the project, fuzzy inference rules can be developed (Costantino and Gravio 2009). The company’s perceptions about the counterpart’s need for the project can be grouped into three rule categories as follows:

- If a company’s “R” is high, and: (a) “O” is high, then expected “S” will be low; (b) in other cases, the expected “S” will be moderate.
- If a company’s “R” is moderate, and : (a) “O” is high while “L” is low, then the “S” will be low; (b) “O” is not high, then a high “S” is expected; (c) in other cases, the expected “S” will be moderate.
- If a company’s “R” is low, and : (a) “O” is high while “L” is low, then the “S” will be moderate; (b) in other cases, the expected “S” will be high.
- Twenty-seven If-Then rules are developed based on the combinations of the aforementioned three rule categories (see Table 2).

Table 2. The fuzzy if-then rules

Rule code	“R” is	“O” is	“L” is	“S” is
1	IF High	and High	and High	THEN Low
2	IF High	and High	and Moderate	THEN Low
3	IF High	and High	and Low	THEN Low
4	IF High	and Moderate	and High	THEN Moderate
5	IF High	and Moderate	and Moderate	THEN Moderate
6	IF High	and Moderate	and Low	THEN Moderate
7	IF High	and Low	and High	THEN Moderate
8	IF High	and Low	and Moderate	THEN Moderate
9	IF High	and Low	and Low	THEN Moderate
10	IF Moderate	and High	and High	THEN Moderate
11	IF Moderate	and High	and Moderate	THEN Moderate
12	IF Moderate	and High	and Low	THEN Low
13	IF Moderate	and Moderate	and High	THEN High

End of Table 2

Rule code	“R” is	“O” is	“L” is	“S” is
14	IF Moderate and Moderate and Moderate THEN High			
15	IF Moderate and Moderate and Low THEN High			
16	IF Moderate and Low and High THEN High			
17	IF Moderate and Low and Moderate THEN High			
18	IF Moderate and Low and Low THEN High			
19	IF Low and High and High THEN High			
20	IF Low and High and Moderate THEN High			
21	IF Low and High and Low THEN Moderate			
22	IF Low and Moderate and High THEN High			
23	IF Low and Moderate and Moderate THEN High			
24	IF Low and Moderate and Low THEN High			
25	IF Low and Low and High THEN High			
26	IF Low and Low and Moderate THEN High			
27	IF Low and Low and Low THEN High			

4. Illustrative case study

Two companies intend to form a JV, so as to bid for a project which consists of 5.5 km of tunneling work and a substation. The assumed amount of the winning bid is 3,229 million dollars. It is agreed that company A handles the station portion and company B handles the tunnel portion. Information for the JV project is summarized in Table 3.

Table 3. Information of the JV project

Information	Company A	Company B
Estimated total amount of the project (E)	3,229 million dollars	
Work scope	Station portion	Tunnel portion
Estimated cost (C_a and C_b)	1,180 million dollars	1,770 million dollars
Estimated total profit of the project (F)	279 million dollars	

For the company A, the highest price is cost (C_a) + estimated total profit (F) = 1,180 million dollars + 279 million dollars = 1,459 million dollars. On the other hand, the highest price of company B is $C_b + F$ = 1,770 million dollars + 279 million dollars = 2,049 million dollars. Since the total budget is limited, these prices are hardly acceptable to both parties. Therefore, to expedite the bargaining and make a rational bargaining strategy, both parties need to collect information about each party’s need for the project and estimate the values of S_a and S_b . Based on the information implied in each party’s

“received revenues”, “future business opportunities”, and “level of competition”, S_a and S_b estimated by company A are 0.72 and 0.41, respectively. Then the company A that used the equilibrium price function may infer that it may earn 1, 256.77 million dollars while the company B may receive 1, 972.23 million dollars.

If company B’s recognition of each party’s demand for the project is similar to that of company A, the agreement can be reached immediately. If both party’s perceptions about their own and the other part’s need for the project differ, conflicts in the bargaining may be incurred. In this situation, the accuracy of the information received should be confirmed by both parties and as more information is exchanged between both parties, the equilibrium price function can be very helpful for both parties to adjust their pricing policy in a timely and rational manner.

Considering a case that the company A can make sure that S_a is 0.72, while S_b is not definite. By implementing a scenario analysis, the acceptable rewards in different bargaining positions can be estimated by the proposed model. Note that the estimation of high S_b represents that company A takes an optimistic bargaining position and low S_b for pessimistic bargaining positions. As shown in Fig. 5, the suggested offer based on different sets of S_b can be easily obtained. Similarly, company B can lock S_b (suppose it is 0.41) and infer the company A’s possible offers based on different sets of S_a (the rewards willing to share by company B in Fig. 5). In this case, once the reward willing to share by company B is more than the acceptable reward for company A, the agreement can be made.

In addition to figure out the possible individual rewards in various bargaining positions, the scenario analysis can turn to project level by evaluating the total rewards needed with different bargaining positions. As shown in Fig. 6, since the contract amount is fixed, the possibility of agreement can be evaluated by comparing the contract amount and the acceptable total reward. If both parties take too optimistic bargaining positions, then the acceptable total reward might over the contract amount to lower the possibility of agreement. Thus, these objective evaluations give each company a clear guideline for pricing. Irrational alternatives can be detected and eliminated with the support of the proposed model and the functions can help making rational decisions (Šarka *et al.* 2008).

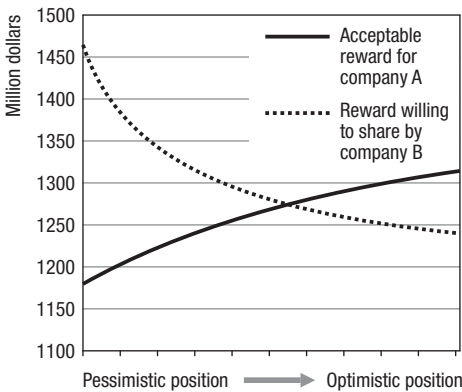


Fig. 5. Estimated individual bargaining positions and rewards

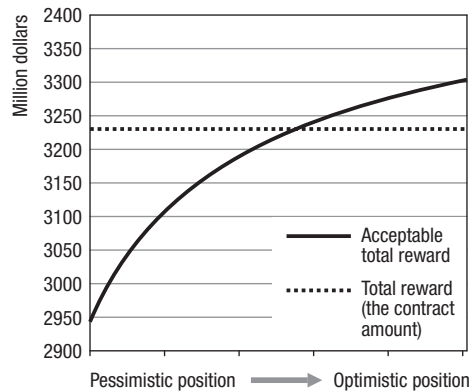


Fig. 6. Estimated acceptable total rewards in different bargaining positions

5. Conclusions

During a business bargaining process, many interaction effects might occur due to different levels of presentational and negotiation skills or social psychological phenomena. A proper pricing strategy in the dynamic bargaining process is important for an enterprise because it can ensure right businesses when cooperating with other partners. However, due to the lack of decision support models, business managers tend to adopt a more intuitive and subjective approach to the bargaining problem. Thus, a quantitative decision support model would help decision makers to maintain their bargaining positions and contract price lines. Irrational offers and alternatives can thus be detected and eliminated during the bargaining process.

To solve bargaining problems, many researchers have theoretically focused on the unique equilibrium price by assuming the information for pricing is perfect. However, perfect information situation is not common in real bargaining cases and companies inevitably continuously collect information, evaluate bargaining situations, and repetitively make pricing decisions in the bargaining process. Instead of finding a unique equilibrium price, the approach of this paper is to propose a bargaining decision support model, which can be used to assess the bargaining situation and select a pricing strategy in a scientific and rational manner. With the complementary use of game theory and fuzzy logic, the research results are useful for JV parties to determine the best price based on each party's cost and the estimated degree of need for the JV project, thus can improve the possibility to reach an agreement. In addition, this research provides a quantitative analytic framework for objective business pricing and the framework enables further developments of rational and quantitative bargaining models. With this pilot study, the modeling assumptions can be improved for solving specific bargaining problems and broader applications.

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FUZZY LOGINIO PASIKEITIMŲ VERTINIMO METODO TAIKYMAS JUNGTINĖS VEIKLOS PROJEKTŲ VERTEI NUSTATYTI

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Santrauka

Verslo projektai savo dydžiu, tematika, pobūdžiu ir kitais aspektais nuolat kinta, todėl dauguma kompanijų, siekdamos išlaikyti konkurencinį pranašumą bei rengdamos įvairius projektus, jungiasi į tam tikras jungtines įmones, kurios vykdo jungtines veiklas, skirtas tik tam projektui įgyvendinti. Tokios įmonės, kurios apribotos projekto trukmės, įgauna tam tikrų savybių, kai tikėtina nauda iš šio susijungimo yra neapibrėžta ir nuolat kinta. Šio straipsnio autoriai, siekdami pagerinti motyvacinę vadovų sistemą, priimdami sprendimus dalyvauti jungtinėje veikloje ir įvertindami priimtina santykį tarp investuojamos sumos dydžio ir tikėtinos naudos, taiko žaidimų teoriją bei Fuzzy metodą.

Reikšminiai žodžiai: derybos, vertinimas, sprendimų priėmimas, jungtinės veiklos įmonė, strateginis susivienijimas, žaidimų teorija, Fuzzy metodas.

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