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Research on Bidding Methods of National Grid Construction Projects Based on Friedman Model

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Abstract

The most competitive tender offer is the key to seeking survival and development in the furious market competition for the bidders in the process of bidding. How to make a appropriate quotation decision-making is the key to tender offer for the bidders. The paper starts from theoretical research and empirical analysis, after studying the existing domestic and international tender offer decision-making model, considering current market conditions, the tender offer decision-making model, Friedman model were proposed which is suitable for the tender offer of the State Grid Corporation Power Transmission Project. An engineering case was applied to prove the validity and practicality of this model.

Key words: Friedman model; State grid tender; Tender offer decision-making; The probability of winning bid

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INTRODUCTION

Tender offer decision-making is an activity that the bidders do a series of calculations, assessment and analysis to bid project, then determine the compliance costs, formulate suitable bidding strategy for projects according to the evaluation principles of tender documents, to ensure profit maximization protection under the premise of winning bid (Manns & Haimus, 2000). Right bid strategies and techniques is critical to project quotation, directly influence the success of a project, the existing bid decision-making model includes: bid decision-making model based on game theory (PEI & JIAN, 2011), bid decision-making model based on probability theory (Friedman, 1956), bid decision-making model based on Analytic Hierarchy Process and utility theory (YONG, ZHI, MI, & SU, 2006), bid decision-making model based on fuzzy mathematics research (GUO, WEI, & JIN, 2012), bid decision-making model based on artificial intelligence (HONG & YI, 2010).

This paper does a lot of research on the existing tender offer model at home and abroad, proposes a new tender offer model called Friedman model combined with the tender offer market environment of State Grid Corporation Power Transmission Project. Then studies the feasibility in bidding offer of State Grid Corporation Power Transmission Project, and demonstrates the guiding role of this bid model to tender offer through a case, which has a certain reference value.

1. BIDDING FEATURES OF STATE GRID PROJECT

State Grid Corporation of a large central enterprise in China, bear the power transmission and distribution business of 26 provinces. Municipalities directly under the Central Government. In January 2005, the headquarters of State Grid Corporation implemented centralized scale bidding to 330kV and above equipment and materials of power transmission project. In 2006, the master equipment and materials of 220kV power transmission project were also included in the scope of the tender, and established corporate headquarters and provincial levels tender system. In 2011, E-commerce Platform (ECP) successfully put into operation in centralized scale bidding.

Overall, the centralized scale bidding of State Grid Corporation has the characteristics of sound management system, professional tendering agency; unified tender document templates, rigorous supplier qualification audit, modern institutionalized bidding means, and highlight the advantages of modern supply chain management system. It is under such circumstances that this paper proposes Friedman tender offer model to adapt to the tender offer decision-making mode under the new system.

2. FRIEDMAN MODEL

In 1956, Friedman proposed project tender offer decision-making model called Friedman model (Friedman, 1956). The model can calculate the winning bid probability of a project by every single competitor's winning rate. The model assumes that the bidders' winning rate was independent with each other, and it's used to calculate the winning rate for all competitors. Friedman aims to draw the maximum expected profit value of bidders by studying specific winning bid probability of Optimum Solution, and quotes as the optimal tender offer.

2.1 Basic Assumptions

Formulating the basic ideas of Friedman model correctly needs to establish the following key assumptions:

(1) Know the number of project participants.

(2) The cost budget of the tender offer can be known according to the tender documents and enterprise overview.

(3) The past quoted price of each competitor can be composed of a random sample of the distribution.

(4) Competitors' offer procedures and principles are relatively stable.

(5) Competitors' former biding information of projects has statistics.

(6) The goal of bidders is the maximum profit in the premise of winning bid.

(7) Independent statistics of all competitors' contract quotation.

2.2 Decision-Making Step

The budget cost of project quotation can be calculated based on the amount of design engineering, technical requirements and management status of contractor and it is usually determined. While the pre-tender has variability and subjectivity because of the different strategies and methods. Pre-tender is inversely proportional to winning bid rate, and directly proportional to profit margin. The higher the pre-tender, the smaller the winning bid possibility, and profit is high after winning bid, and vice versa. The tender offer of the maximum expected profit can be calculated by the ratio of pre-tender to budget cost. Specific decision-making steps are as follows (Friedman, 1956):

(1) Collect and analyze the tender offer in the past distribution of competitors often encountered.

(2) Calculate different competitors and the contractor to the project budget cost ratio for the same project.

(3) The ratio times of different competitors are displayed by histogram, and empirical probability beating competitors is obtained by distribution graph.

(4) This step is divided into two cases.

A. The past competitors better understood

In view of this situation, directly draw histogram and frequency distribution curve formula of various competitors through Friedman model. The formula draws the probability of the contractor beating the known competitors by calculating the tender offer probability of the known competitors in the past.

$$P(f) = P_1(f) \times P_2(f) \times P_3(f) \ldots\ldots P_n(f)$$

$$= \prod_{i=1}^{n} P_i(f) \qquad \text{Formula 2-1}$$

B. The past competitors known a little

If n + m competitors (of which n is the number of known competitors, m is the number of unknown competitors) participate in the tender, but do not fully grasp the tender data of all opponents. In this case, we can take advantage of "the typical bidder" concept. collect and aggregate the tender data of a competitor over a period of time as much as possible to the distribution map in accordance with the above method. The distribution map represents the simulation market behavior of a typical bidder, rather than the bidding behavior of a specific bidder. The contractor can obtain the probability of defeating typical bidder with different pre-tender based on the typical curve. Then, the winning bid probability is as follows when competing with m known competitors and n unknown competitor:

$$P(f) = P_1^{\,m}(f) \prod_{i=1}^{n} P_i(f) \qquad \text{Formula 2-2}$$

Wherein, $P_1(f)$ is the probability defeating a single typical bidder.

(5) Calculate winning bid probability selecting in step (4) according to the situation, use equation 2-3 to obtain the best pre-tender M of maximizing expected profit R(f), and the corresponding best return rate f.

$$R(f) = M \times P(f) \qquad \text{Formula 2-3}$$

Wherein, R (f) is the expected profit of the bidders; M is the pre-tender; P (f) is the winning bid probability.

(6) The contracting company's final quotation B is calculated as:

$$B = C \times (1 + f) \qquad \text{Formula 2-4}$$

Wherein, is the final quotation, C is budget cost, f is the best return rate.

3. CASE STUDY ON TENDER OFFER OF GRID CONSTRUCTION PROJECT

Currently, State Grid's centralized scale bidding has become robust bidding market in power transmission industry. This section uses Friedman model for analysis

and decision-making of the tender offer through the case of State Grid Corporation Power Transmission Project.

3.1 Project Case Profile

Southwest State Grid's 110KV substation need to purchase electrical equipment for a new construction project, so State Grid Corporation establishes supplier management system with company headquarters and provincial levels, regularly organizes research and evaluation work, establish the supplier information database. Company A and B, C, D passed supplier qualification auditing of the power station's scaled project, and they can encounter in the annual bid State Grid Corporation organizes.

3.2 Standard Price of Bid Evaluation Calculation and Criteria for Bid Evaluation

Standard price of bid evaluation calculation and criteria for bid evaluation adopt limited interval floating downward average a time. The calculation process of this method is as follows:

(1) Calculation tender price's arithmetic mean A1 of M detailed assessment bidders; (M is the number of bidders entering the detailed assessment).

(2) If the deviation between tender price and the arithmetic mean A1 is over interval [b, c], the quoted price of the bidder scores zero. By calculating tender price's arithmetic mean A1's floating downward proportion derives A2 as the standard price.

(3) Price score = 100-100 × n × | total bid evaluation price of the bidders - Standard price | / Standard price.

Wherein, when the total bid evaluation price of the bidders >=Standard price, n = n1; when the total bid evaluation price of the bidders <Standard price, n = n2; When the score of calculated price <zero, score zero. If the float downward proportion is marked "extraction", the renderer selects randomly and announces in the opening scene. The range of a extracted is 2% -5%.

Table 1
The Boundary Value of Bid Evaluation Interval

Types of goods	Interval boundary value				
	a	b	c	n	
				n1	n2
**	4%	-25%	20%	2	1

3.3 The Calculation Based on the Friedman Model

There are four finalists of this tender, they are all qualified supplier of State Grid Corporation. All previous quotations for all companies participating in the tender can be found through centralized bidding and bid opening record. According to State Grid evaluation methods, calculate the lowest or second lowest quotation in all bidders' offer probability theory and statistics, commercial quotation points may be higher. According with the quotation decision-making process of Friedman model, company A is familiar with the previous tender offer of its competitors, company B, C, D.

First, calculate the ratio of the three known competitors' tender offer and company A to the same project budget costs based on the sample values of the past bidding statistics.

Table 2
The Ratio of the Three Known Competitors' Tender Offer and Company A to the Same Project Budget Costs

Competitor / Sample No.	B	C	D
1	1.3371	1.6855	1.4818
2	1.3205	1.2840	1.2385
3	1.2917	1.4325	1.4244
4	1.2645	1.3287	1.2718
5	1.6800	1.7479	1.8248
6	1.9848	2.0089	2.1696
7	1.2704	1.2541	1.1243
8	1.3101	1.3542	1.4289
9	1.4111	1.4096	1.3824
10	1.4315	1.4307	1.4157
11	1.4755	0.9312	1.0025
12	1.3277	1.5149	1.1961
13	1.7463	0.9567	0.9970
14	1.3438	1.5519	1.5099
15	1.3523	1.3858	1.3464
16	1.6819	1.1518	1.1875
17	1.9467	2.3277	2.2706
18	1.7727	1.7828	1.6596
19	1.3317	1.4040	1.3749
20	1.4056	1.5052	1.5062

Divide the quotation ratio of company B in table 3-2 into several groups by 0.1 differentials; calculate occurrence number of quotation ratio in different groups, and the corresponding frequency. Draw the relationship between the probabilities defeated by company A with return ratio, which is shown as Table 3.

Table 3
Company B's Quotation Ratio Frequency Number, Frequency and the Relationship Between the Probability Defeated by Company A with Return Ratio In Every Interval

Group No.	Quotation Ratio	Frequency number	Frequency	The probability of defeating competitors%	Company A pre-tender/budget cost%
1	0.8,0.9	0	0	100	-20
2	0.9,1.0	0	0	100	-10
3	1.0,1.1	0	0	100	0
4	1.1,1.2	0	0	100	10
5	1.2,1.3	3	0.15	85	20
6	1.3,1.4	7	0.35	50	30
7	1.4,1.5	4	0.2	20	40
8	1.5,1.6	0	0	20	50
9	1.6,1.7	2	0.1	20	60
10	1.7,1.8	2	0.1	10	70
11	1.8,1.9	0	0	10	80
12	1.9,2.0	2	0.1	0	90
13	2.0,2.1	0	0	0	100
14	2.1,2.2	0	0	0	110
15	2.2,2.3	0	0	0	120
16	2.3,2.4	0	0	0	130

Frequency distribution histogram for the ratio of previous project quotation of company B and company A to the same project's budget cost through the data in Table 3, which is shown as Table 1.

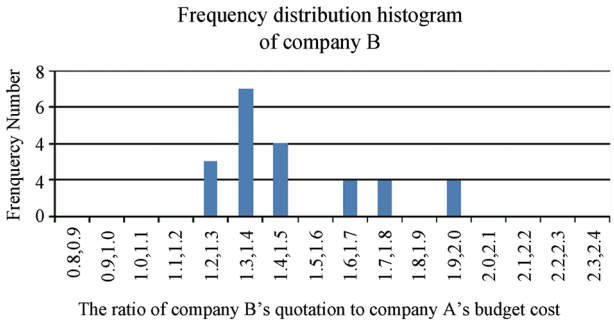

Figure 1
Frequency Distribution Histogram of Company B's Quotation

According to the distribution histogram, we can obtain cumulative number distribution curve as shown in Figure 2, the curve represents the relationship between winning bid probability and gross margin when there are a single competitor.

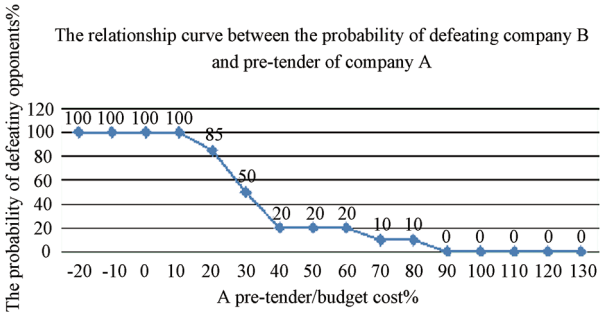

Figure 2
The Relationship Curve Between the Probability of Defeating Company B and Pre-Tender of Company A

And so on, we can get quotation ratio's frequency number and frequency of Company C, D, the relationship between the probability defeated by company A and return rate (Table 4 and Table 5) the frequency distribution histograms of quotation ratio (Figure 3, Figure 5) and the cumulative frequency distribution curves (Figure 4, Figure 6).

Table 4
Company C's Quotation Ratio Frequency Number, Frequency and the Relationship Between the Probability Defeated by Company A with Return Ratio in Every Interval

Group No.	Quotation Ratio	Frequency number	Frequency	The probability of defeating competitors%	Company A pre-tender/budget cost%
1	0.8,0.9	0	0	100	-20
2	0.9,1.0	2	0.1	90	-10
3	1.0,1.1	0	0	90	0
4	1.1,1.2	1	0.05	85	10
5	1.2,1.3	2	0.1	75	20
6	1.3,1.4	3	0.15	60	30
7	1.4,1.5	4	0.2	40	40
8	1.5,1.6	3	0.15	25	50
9	1.6,1.7	1	0.05	20	60
10	1.7,1.8	2	0.1	10	70
11	1.8,1.9	0	0	10	80
12	1.9,2.0	0	0	10	90
13	2.0,2.1	1	0.05	5	100
14	2.1,2.2	0	0	5	110
15	2.2,2.3	0	0	5	120
16	2.3,2.4	1	0.05	0	130

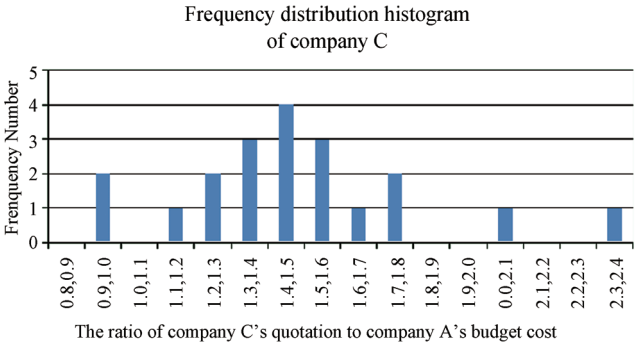

Figure 3
Frequency Distribution Histogram of Company C's Quotation

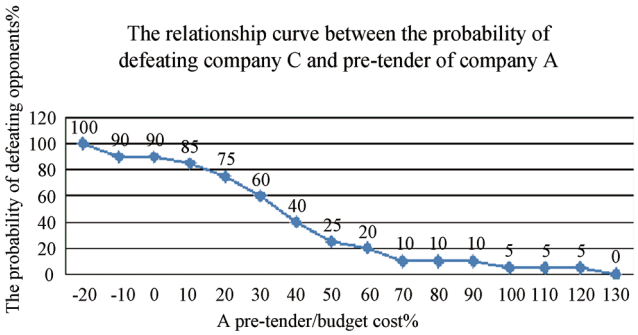

Figure 4
The Relationship Curve Between the Probability of Defeating Company C and Return Rate of Company A

Table 5
Company D's Quotation Ratio Frequency Number, Frequency and the Relationship Between the Probability Defeated by Company A with Return Ratio in Every Interval

Group No.	Quotation Ratio	Frequency number	Frequency	The probability of defeating competitors%	Company A pre-tender/budget cost%
1	0.8,0.9	0	0	100	-20
2	0.9,1.0	1	0.05	95	-10
3	1.0,1.1	1	0.05	90	0
4	1.1,1.2	3	0.15	75	10
5	1.2,1.3	2	0.1	65	20
6	1.3,1.4	3	0.15	50	30
7	1.4,1.5	4	0.2	30	40

To be continued

Continued

Group No.	Quotation Ratio	Frequency number	Frequency	The probability of defeating competitors%	Company A pre-tender/budget cost%
8	1.5,1.6	2	0.1	20	50
9	1.6,1.7	1	0.05	15	60
10	1.7,1.8	0	0	15	70
11	1.8,1.9	1	0.05	10	80
12	1.9,2.0	0	0	10	90
13	2.0,2.1	0	0	10	100
14	2.1,2.2	1	0.05	5	110
15	2.2,2.3	1	0.05	0	120
16	2.3,2.4	0	0	0	130

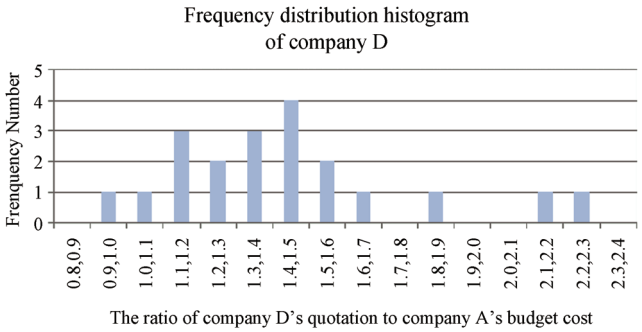

Figure 5
Frequency Distribution Histogram of Company D's Quotation

Figure 3-6 the relationship curve between the probability of defeating company D and return rate of company A.

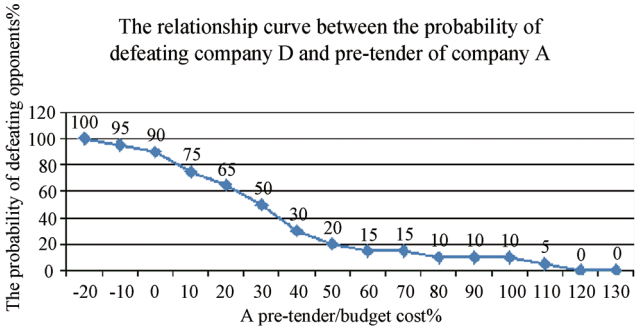

Figure 6
The Relationship Curve Between the Probability of Defeating Company D and Return Rate of Company A

PA (f) is the probability of Company A beating all three competitors with different return rate, it can be calculated by Equation 3-1:

$$P_A(f) = P_B(f) \cdot P_C(f) \cdot P_D(f) \quad (3\text{-}1)$$

The company's expected profit is calculated by formula 3-2:

$$E_A(P) = C \cdot F \cdot P_A(f) \quad (3\text{-}2)$$

Wherein, C is Company A's corresponding estimated project budget cost. Calculate the best return rate f of the maximizing expected profit.

Maximum expected profit can be obtained through formula 3-3:

$$\max E_A(P) = \max C \cdot F \cdot P_A(f) \quad (3\text{-}3)$$

In this example, Company A estimates the project cost is 2.452 million Yuan, the project winning bid probability and expected profit results are shown in Table 6.

Table 6
Calculation Table of Friedman Quotation Model

Return Rate f	Quotation (ten thousand)	Probability of beating a single component			Winning bid probability of Company A	Expected profit(ten thousand)
		B	C	D		
0	245.20	1.000	0.900	0.900	0.810	0.000
5	257.46	1.000	0.875	0.825	0.722	3.609
10	269.72	1.000	0.850	0.750	0.638	6.375
15	281.98	0.925	0.800	0.700	0.518	7.770
20	294.24	0.850	0.750	0.650	0.414	8.288
25	306.50	0.675	0.675	0.575	0.262	6.550
30	318.76	0.500	0.600	0.500	0.150	4.500
35	331.02	0.350	0.500	0.400	0.070	2.450
40	343.28	0.200	0.400	0.300	0.024	0.960
45	355.54	0.200	0.325	0.250	0.016	0.731
50	367.80	0.200	0.250	0.200	0.010	0.500
55	380.06	0.200	0.225	0.175	0.008	0.433
60	392.32	0.200	0.200	0.150	0.006	0.360
65	404.58	0.150	0.150	0.150	0.003	0.219
70	416.84	0.100	0.100	0.150	0.002	0.105
75	429.10	0.100	0.100	0.125	0.001	0.094
80	441.36	0.100	0.100	0.100	0.001	0.080
85	453.620	0.050	0.100	0.100	0.001	0.043
90	465.880	0.000	0.100	0.100	0.000	0.000

It can be drawn according to Table 3-6 that, When the return rate f = 20%, profits of 490,400 Yuan is the maximum expected profit. Therefore, according to Friedman model, we suggest company A adopt the tender offer for 20% return rate. The final quotation of Company A is:

B = 245.2 (l + f) = 245.2 (l +20%) = 294.24 million Yuan

The final result of the bidding for the project is as shown in Table 7.

Table 7
The Tender and Bid Opening Record of State Grid 110KV Station's Equipment

State Grid Corporation Power Transmission Project** batch of substation equipment (including cable) Bidding in 2012

		Bid Opening Schedule	
Bidding No:	**	Time of bid opening	**
Divided Bidding No:	***	Place of bid opening:	State Grid Equipment and Materials Co.,Ltd
Currency:	Million Yuan RMB	Bale No:	**
Project Unit:	****	Name:	**
Project Name :		***	
No.	Bidder Name	Tender Price	Quotation Score
1	B	297.063	88.6
2	C	295.76079	89.5
3	A	293.8104	90.9
4	D	310.37001	79.1
Mean		299	
Standard Price		299*(1-4%)=281	

The result of bid opening shows that the tender offer of company A scores the highest, but together the quotation is more conservative, price has room to rise. If it adopts the quotation for 2942400 Yuan Friedman model analyzing, it will reflect profit maximization in the premise of the highest score. Friedman quotation model plays a role of practical guidance to centralized bidding projects like National Grid, and is worth adopting in the offer decision-making analysis.

CONCLUSION

Qualified suppliers of State Grid are increasing year by year, grid equipment suppliers has been quite intense competition. In the context of the increasingly bid manufacturers, the profit margin decreased year by year, as electrical companies, only full sales can guarantee profits. And then can survive and develop in a competitive market environment.

Friedman model is a tender offer model that adapt to the modern supply chain management system. It has important guiding significance to use skillfully for quantitative analysis of bidding strategy. This paper researches and analyzes Friedman model combining with tender offer of State Grid Corporation Power Transmission Project. This paper verifies the model's objectivity and accuracy to the tender offer strategies through an engineering example, and achieves satisfactory results.

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