

Retraction

Retracted: Design of PPP Project under Computer Network and Different Capital Structures

Mobile Information Systems

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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- [1] S. Chen, "Design of PPP Project under Computer Network and Different Capital Structures," *Mobile Information Systems*, vol. 2022, Article ID 7585176, 7 pages, 2022.

Research Article

Design of PPP Project under Computer Network and Different Capital Structures

Shuting Chen 

School of Business, Central South University, Changsha, Hunan 410083, China

Correspondence should be addressed to Shuting Chen; hainanchengzi@163.com

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In order to address the applicability of the PPP project auction system in the current market, this paper studies the mechanism and related models of PPP projects under different capital structures and improved approach of selecting items only by price, using computer network systems and heuristic algorithms. The electronic reverse auction (ERA) of PPP projects under different capital structures under the diversified environment is established. This paper selects the traditional government procurement model as the reference group. The ERA of PPP projects under the computer network background and different capital structures was selected as the observation group, through the comparative analysis of the procurement cost, the negotiation time cost, the supplier selection range, the project construction efficiency, the project cost, and other aspects. The correlation and feasibility were also tested by a bivariate t test. The results suggest that the system automates PPP project selection, it can realize the optimization of each comprehensive level of the survey project, meet the procurement needs of different funds, improve the procurement efficiency, and reduce procurement costs; in the context of computer networks, the ERA of PPP projects under different capital structures can effectively save the cost of buyers and bidders and improve cost-saving efficiency. Different from the traditional auction mechanism, it is no longer an auction. Even shopping around can make the auctioneer or bidder get best interests. The ERA mechanism developed under the background of this new computer network provides new possibilities and impetus for the further development of the auction mechanism.

1. Introduction

With the rapid development of computer networks, the emerging business model based on computer networks is becoming more and more powerful, improving market flexibility, breaking traditional business model space and region limitations, and providing a steady stream of power for future economic growth. However, Wang Zijian (2015) had said that as the network environment has become increasingly complicated [1], the old model of e-commerce has become increasingly unable to meet people's evolving new wants, and a reverse auction system with initiative and intelligent adaptability of an intelligent service system has developed. The reverse auction system has gotten a lot of attention from business and scientific research circles as a new trading mechanism.

In essence, an ERA is a type of Internet-based purchasing process in which bidders and suppliers work together to accomplish a transaction. Li Boyu et al. (2018) think that this type of purchasing strategy, in a certain circle, can greatly increase supplier competition enthusiasm [2], activate supplier group price reduction behavior, and enable the purchaser to acquire the lowest feasible purchase cost while ensuring quality and delivery time. According to Wuxing (2021)'s statistics, it can save the buyer 10 to 20% of the buying price [3]. Aside from cost savings, other advantages of external procurement include a quicker price negotiation period, a larger variety of suppliers, access to providers' technical evaluations, more transparent negotiations, and other advantages. According to the survey, ERA procurement software is used by 70% of Fortune 500 organizations. The US employs RAT for worldwide procurement, with \$3

billion in purchases made in India alone in 2003. Large Chinese companies such as Huawei and Lenovo made agreements with Free Market, a worldwide supply management, as early as 2003 to use its e-procurement platform to purchase connected goods and services needed by group operations. Expanding into the Chinese market is also a strategic emphasis of Free Market's company development.

Many management scientists, economists, and computer application technology researchers are interested in the theory and practice of ERA mechanism design, which has become the fastest-growing field in e-commerce. An ERA is quickly developing in China, and society is very interested in learning more about the mechanism. This study report is set against such a backdrop.

Different from the traditional auction in which the seller announces the goods to be sold and the potential buyer bids, in the reverse auction, the buyer first lists the goods they want to buy, and the seller bids according to the purchase price given by the buyer. ERA as a new procurement tool, breaks the traditional inventory management and product pricing modes, allowing for the determination of product price and resource allocation through a competition mechanism. Divik and Tarun (2021) think it is a cost-effective way to tighten cost management and increase operational efficiency in conventional industries while also avoiding resource waste [4]. It gives international corporations a fresh lease on life in terms of strategic procurement, and it also offers a viable option for adjusting China's industrial structure. It removes regional restrictions on procurement and allows businesses to discover competitive suppliers throughout the globe, allowing them to keep competitive advantages and continuously enhance procurement efficiency.

Electronic government procurement is being more commonly employed, and the reverse auction is gradually being used in government procurement, thanks to advancements in computer technology and ERA. The purchaser sets the counter-auction items and rules, and the suppliers who pass the qualification exams engage in the quotation, which ultimately determines the concluding suppliers in government procurement. Traditional government procurement (GP) and Public Private Partnership (PPP) are the two most common methods for obtaining infrastructure (PPP). The former separates infrastructure supply and construction, with the government signing a long-term contract with one or more businesses to build and operate infrastructure under government control. In the latter, Wang L J (2021) thinks that the government ties infrastructure building and operation together by entering into a contractual contract with a company that is in charge of both construction and operation [5]. Public bidding, invitation bidding, competitive negotiation, and single-source procurement are all options for the Chinese government to purchase PPP projects. Yuan Xiaolin (2021) had said that in the PPP bidding procedure, however, the lowest price winning mode without a pretender basis is typically used, which is the inverse of the sealed first-level price auction theory [6]. Zhang Yuxin (2021) had said that the PPP mode, as opposed to traditional government

procurement, can improve project efficiency, reduce project cost, avoid project capital risk, reduce financial burden, and achieve mutual benefit and win-win advantages for the government and social capital, so it has become a constant pursuit in recent years [7].

This paper studies the mechanisms and related models of PPP projects under different capital structures and improved an approach of selecting items only by price, using computer network systems and heuristic algorithms. The reverse auction system of PPP projects under different capital structures under the diversified environment is established. It is compared with the traditional government procurement from the procurement cost, price negotiation time, supplier selection scope, project construction efficiency, project cost, and other aspects. Finally, a feasible reverse auction process for PPP projects is proposed.

2. Fusion Conditions of Electronic Reverse Auction and PPP Project

From the standpoint of bidders, ERA is distinct from the traditional auction; the key advantages are as follows: (1) save time, increase efficiency, and shorten the procurement cycle; (2) optimize procurement channels, minimize inventory, and integrate supply chain; and (3) lower unit pricing. The following are the primary benefits for bidders: (1) access to new supply markets and customers; (2) reduce sales costs; (3) make the market more transparent that ERA can also assist businesses boost their annual residual value by reducing negotiation time and speeding up the flow of revenue.

However, there are some restrictions on the use of ERA; first, bidders must have a certain purchasing power; second, it must meet the conditions of no less than two bidders; third, suppliers can keep costs low; fourth, the purchase price is negotiable and opaque; fifth, the buyer lacks a thorough understanding of the market; sixth, the acquired projects or services are essentially standardized; seventh, suppliers must have the ability to accurately identify the nonprice nature so as to improve the efficiency of bidding competition.

In a broad sense, a reverse auction is a type of auction that is the inverse of a regular forward auction. The bidder in a reverse auction is both the buyer and the seller. Through reverse auction, the bidder obtains the right to supply products, while the auctioneer acquires some commodities through reverse auction. A market procurement technique is referred to as an "auction." The buyer's strategy will have a direct impact on the auction's eventual outcome. Reverse auction is currently recognized as a successful approach for improving large corporate procurement processes since it allows procurement employees to search for supplies from around the world rapidly, effectively, and cost effectively. The reverse auction mode e-procurement process consists of three steps: (1) the bidding party publishes the definition of the standard bidding item, which includes the product name, brand, specification model, quantity, delivery date, maximum price, and other information; (2) the bidding party publishes the bidding rules, which include the product

name, brand, specification model, quantity, delivery date, maximum price, and other information; (3) the bidding party publishes the bidding to conduct a supplier qualification examination, and only those suppliers who pass the qualification examination are eligible to participate in the auction; (3) after the auction officially begins, suppliers who passed the qualification examination can reduce the price according to their own price reduction rules. Of course, the purchaser will choose the winner based on its own selection allocation technique; (4) once the bidding is completed, the final winner is announced, and the contract is signed.

Some scholars argue that customers generally believe that reverse auctions that require cost reduction are wrong and damage the connection between suppliers and accepting purchases; they, therefore, provided four recommendations to help improve the existing situation: (1) Assess several aspects, such as quality, reliability, value-added services, and using a multiattribute auction method besides the price. (2) Nonstrategic products are used by reverse auction. (3) The hidden cost of the auction is confirmed, such as potential cost transfers, increased future costs due to errors or negligence, and structural distortion costs. (4) the Golden rule is followed, which is to produce a “win-win” outcome for both sides rather than putting excessive pressure on suppliers in price. The integration of ERA and PPP projects performs well in many aspects. Therefore, this paper designs a PPP project. According to the description of the above article, Figure 1 shows the basic steps of reverse auction.

In Figure 1, Auctioneers: buyer; the bidder: the seller; release bidding items: define bidding rules include the product name, brand, specification, quantity, delivery date, and maximum price, and other information; view bidding items: view the bidding rules include the product name, brand, specification, quantity, delivery date, and maximum price, and other information; application for participation: the bidder applies to participate in the bidding project issued by the auctioneer; prequalification: qualification review of suppliers, the suppliers who can finally pass the qualification review can participate in the auction; bidding: suppliers who have passed the qualification examination can reduce the price according to their own set price reduction rules; the winner shall determine: the auctioneer shall select the most qualified bidder in the auction process; contract signing: the auctioneer and the bidder reach an agreement, signing a contract.

3. Construction of Electronic Reverse Auction Model for PPP Project

3.1. Bidder Model Selection. According to the principle that the supplier is bound to make profits, when a supplier is selected by the customer, the supplier will get a profit value of β times above the cost price. The total bidding cost is minimized including transaction cost and bidding cost formula, as shown in the following equation:

$$\min \sum_{i=1}^n \{(1 + \beta)C_i(q_i)q_i + x_i k_i\}. \quad (1)$$

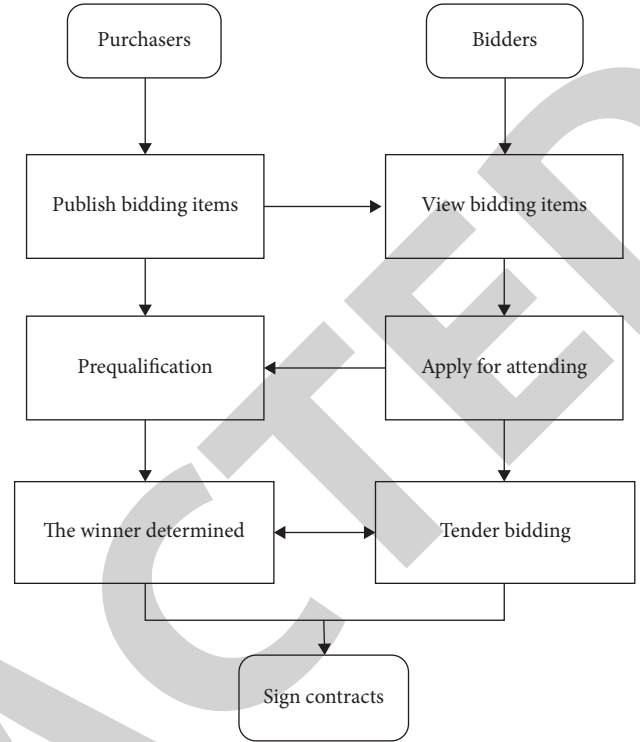


FIGURE 1: Basic step diagram of reverse auction.

Among them, x_i denotes the binary decision variable; $x_i = 1$ if the vendor i is selected, and 0 vice versa; q_i denotes the integer decision variable, representing the number of items the bidder auctioned from the i th vendor; k_i denotes the transaction costs incurred when the bidder deals with the supplier i ; $C_i(q_i)$ denotes the cost matrix of supplier i is the purchase price of a single item when the bidder takes the q_i item from the i th supplier; β denotes the minimum percentage of suppliers; n : number of suppliers.

Formula (2) is a constraint on the total quantity of supply; that is, the number of auction items must be equal to the quantity of the scheduled bid:

$$\sum_{i=1}^n q_i = M. \quad (2)$$

Among them, q_i denotes the integer decision variable, representing the number of items auctioned by bidders from the i th supplier; M is a constant; n is the number of suppliers; formula (3) is the supplier's supply capacity limit; that is, the maximum supply of the supplier does not exceed the supply capacity of the supplier for this series of projects:

$$q_i \leq x_i Q_i^{\max}, \quad i = 1, 2, 3, \dots, n. \quad (3)$$

Among them, Q_i^{\max} denotes the maximum project supply available by the i th supplier; x_i denotes the binary decision variable; $x_i = 1$ if the supplier i is selected, otherwise, 0; q_i denotes the integer decision variable, indicating the number of items auctioned by the bidder from the i th supplier; n is the number of suppliers.

The type of decision variables is shown in the equation as follows:

$$x_i \in \{0, 1\}. \quad (4)$$

Among them, x_i denotes the binary decision variable; $x_i = 1$ if vendor i is selected, and 0 vice versa; this is a linear planning problem with single objectives, but since all variables are integer variables, it cannot be solved by the ordinary simplex method. When the number of suppliers n is large enough, the problem is similar to the combinatorial explosion class, so heuristic algorithm is considered here.

3.2. Heuristic Algorithm Design. Unit price matrix (\bar{P}) refers to the equivalent unit of product price matrix of all suppliers. The value is related to the production cost and transaction cost of each supplier, and the specific calculation formula is such as shown in the formula as follows:

$$\bar{P}_i(q_i) = (1 + \beta)C_i(q_i) + \frac{k_i}{q_i}. \quad (5)$$

Among them, \bar{P} denotes that each row represents the unit product price of a supplier when the acquisition quantity changes from 1 to Q_i^{\max} ; Q_i^{\max} denotes the maximum project supply from the i th supplier; x_i denotes the binary decision variable; $x_i = 1$ if vendor i is selected, and 0 vice versa; q_i denotes the integer decision variable, representing the number of items auctioned by bidders from the i th supplier; $C_i(q_i)$ denotes the cost matrix of the supplier i , which is the purchase price of a single item when the bidder takes the q_i item from the i th supplier; k_i denotes the transaction costs incurred when the bidder deals with the supplier i .

Each column represents the respective unit product price of all suppliers at the same amount of q . Since the cost per supplier varies with the supply, we can consider converting the supplier's cost structure matrix into the average unit price matrix of the corresponding quantity and then allocating the heuristic at the lowest price.

Step 1. Read the supplier's cost structure matrix $C_i(q_i)$

Step 2. In each supplier, when the supply is changed from 1 to Q_i^{\max} , the unit price matrix of the supplier in different quantities is calculated to form a new matrix \bar{P}

Step 3. For the unit price matrix \bar{P} , search by line, search by column, find out the lowest value, and find out the corresponding supplier and quantity, then this quantity is the value assigned to the merchant, stored, and all the rows in the \bar{P} matrix are set to infinity

Step 4. Each value is found, and the sum of the previous values is calculated S_t (the first t times identified is worth adding), if $S_t < M$, skip on to the Step 3; if $S_t > M$, jump to Step 5; if $S_t = M$ termination

Step 5. Calculate the value of $M - S_{t-1}$, find out the minimum value from the line $M - S_{t-1}$ of the P matrix, corresponding to the merchant that we want to give the quantity of $M - S_{t-1}$, and terminate

The program flow block diagram for this heuristic algorithm is shown in Figure 2.

In Figure 2, the program is started to proceed; C and K are extracted from the data file; the unit price matrix P is calculated in the order that the quantity changes from 1 to Q_i^{\max} ; the matrix transformation is conducted; Data are preprocessed; the unit price matrix P is searched, row by row and column by column, for the minimum value, and this corresponding supplier and supply are read; all locations of that merchant are set to infinity; By calculation and assignment, the sum of all the things found is taken, and let us say that it is the TTH calculation.

4. Analysis of Reverse Auction Mechanism of PPP Projects under Computer Network Background and Different Capital Structures

In order to analyze the reverse auction mechanism of PPP projects under different capital structures, first, the reference group and observation group are set up, and then the reference group and observation group are analyzed from the aspects of procurement cost, cost negotiation time, supplier selection scope, project construction efficiency, and project cost.

To verify the role of the reverse auction mechanism for PPP projects in the computer network context and under different capital structures, R^2 values were obtained using the linear regression method under SPSS, and t values and P values were obtained using bivariate t -calibration.

The R^2 values were counted as the ratio of the regression residue to the mean residue, as shown in the following formula:

$$R^2 = \frac{\sum_i (x_i - \bar{x})}{\sum_i (x_i - \bar{x}_i)}, \quad (6)$$

$$\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i.$$

Among them, \bar{x} denotes the investigation of the average value of the sample sequence calculation; \bar{x}_i denotes the i th regression value in the sequence; x_i denotes the i th input value in the sequence; n is the number of samples examined.

The t value and bivariate t value come from the bivariate t -check process, where the t value is the value of the output result, when $t > 10.000$, and the greater the t value, the greater the statistical difference; the P value is the Log value of the output result, when $P < 0.05$; when $P < 0.01$, the lower the P value, the higher the confidence degree. Subject to length, only t values are explained here, as shown in the following formula:

$$t_{\text{value}} = \frac{\bar{x} - \mu}{\sigma_x / \sqrt{n - 1}},$$

$$\bar{x}, \mu = \frac{1}{n, m} \sum_{i=1}^{n, m} x_i, \sigma_x = \frac{1}{n - 1} \sqrt{\sum_{i=1}^n (x_i - \bar{x})^2}. \quad (7)$$

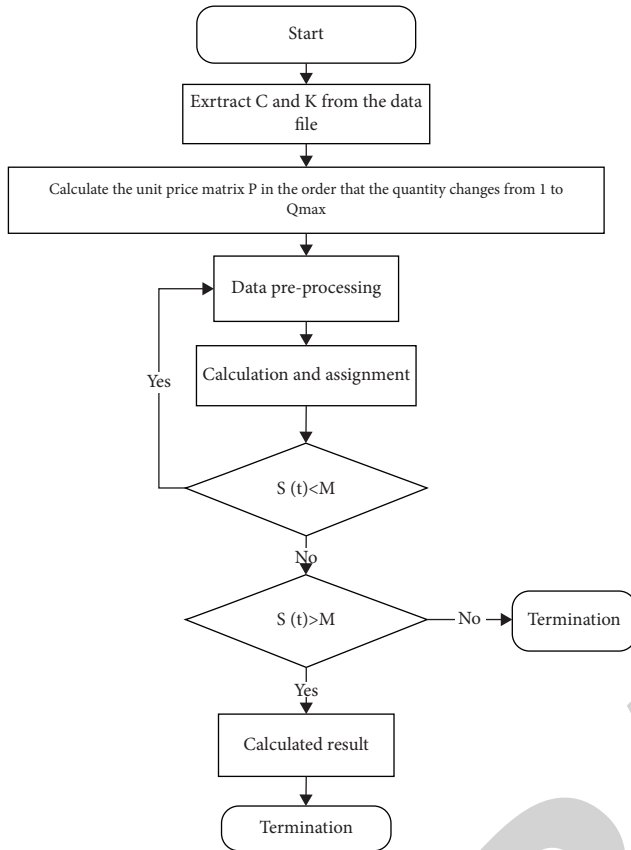


FIGURE 2: Flowchart of reverse auction of PPP algorithm PPP project.

Among them, \bar{x} denotes the investigation of the average value of the sample sequence calculation; μ denotes the mean value of the reference sample sequence; n is the number of nodes examining the sample sequence; m is the number of nodes of the reference sample sequence; σ_x denotes the standard deviation rates of the sample sequences were examined.

4.1. Design of Efficiency Verification Experiment

4.1.1. Selection of Observation Groups and reference Groups.

This paper selects a traditional government procurement model as a reference group and selects the reverse auction mechanism of the PPP project under a computer network background and different capital structures as an observation group. The data of traditional government procurement model and the background of computing machine networks and different capital structures are based on the comprehensive system of an extensive spatial convolutional neural network and a fuzzy convolutional neural network. According to the research focus on reverse auction, this study only discusses the specific algorithm of the observation group in detail and not the specific algorithm of the reference group. However, in the past 8 years, the reverse auction mechanism of PPP projects under the computer network background and different capital structures belongs to the more advanced business procurement mode.

4.1.2. *Analysis and Alignment Analysis.* Through the comparative analysis of procurement cost, cost negotiation time, supplier selection range, project construction efficiency, project cost, and other aspects, the comparative analysis data of procurement cost, price negotiation time, and supplier selection range can show that the reverse auction can save the buyer's cost; the comparative analysis data of project construction efficiency and project cost can be obtained, which can effectively reduce the cost saving degree and efficiency of the bidder.

4.2. Summary and Discussion of the Simulation Experiment Results

4.2.1. *Results of the Purchaser.* For the comparative analysis between the reference group and the observation group in the procurement cost, the price negotiation time, and the supplier selection range, the detailed analysis of the data is shown in Table 1.

In Table 1, reference group refers to the traditional government procurement mode; observation group refers to the PPP project reverse auction mechanism under different capital structures; procurement cost refers to the average cost spent by the buyer; price negotiation time refers to the average time spent by the buyer and the bidder to negotiate the price; supplier selection range refers to the extent to which the purchaser can choose the supplier.

In Figure 3, reference group refers to the traditional government procurement mode; observation group refers to the PPP project reverse auction mechanism under different capital structure; procurement cost refers to the average cost spent by the buyer; price negotiation time refers to the average time spent by the buyer and the bidder to negotiate the price; supplier selection range refers to the extent to which the purchaser can choose the supplier. From Table 1, the observation group has a lower procurement cost and price negotiation time and a wider range of supplier selection compared with the reference group. In the comparative evaluation results of procurement cost, price negotiation time, and supplier selection range, $t < 10.000$, $P < 0.05$; it shows that the reverse auction mechanism of PPP projects under different capital structures has the above three aspects compared with the traditional government procurement mode, indicating that the reverse auction mechanism of PPP projects under different capital structures can effectively reduce the cost of purchasers and strengthen the benefit efficiency of the purchaser.

4.2.2. *Results of Cost-Saving and Efficiency Evaluation of the Bidder.* For comparative analysis between the reference group and the observation group and the construction efficiency and project cost, detailed data are summarized in Table 2.

In Table 2, reference group refers to the traditional government procurement mode; observation group refers to the reverse auction mechanism of PPP projects under computer network background and different capital structures; project construction efficiency refers to the bidder's

TABLE 1: Cost-saving efficiency table of the purchaser.

Groups	Procurement cost/ R^2	Price negotiation time/ R^2	Scope of supplier selection/ R^2
Reference group	0.993	0.989	0.905
Observation group	0.812	0.762	0.995
T	6.503	6.290	8.544
P	0.006	0.006	0.008

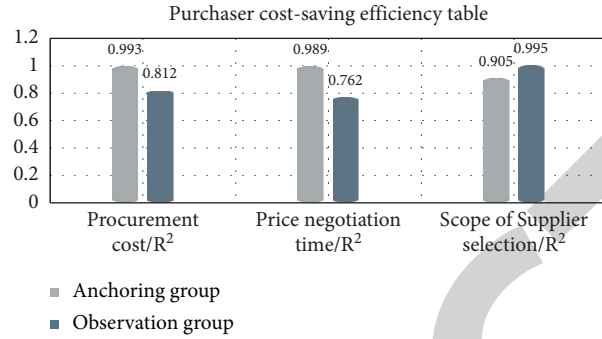


FIGURE 3: Cost-saving efficiency table of the purchaser.

TABLE 2: Cost-saving efficiency table of the bidder.

Groups	Engineering construction efficiency/ R^2	Engineering cost/ R^2
Reference group	0.761	0.911
Observation group	0.993	0.821
T	4.362	5.933
P	0.003	0.006

construction efficiency; project cost refers to the average cost of the bidder to fake the project.

In Figure 4, reference group refers to the traditional government procurement mode; observation group refers to the reverse auction mechanism of PPP projects under computer network background and different capital structures; project construction efficiency refers to the construction efficiency of the bidder; project cost refers to the average cost of the forged project by the bidder. As can be seen from Table 2, the observation group was more efficient and had a lower engineering cost than the reference group. While the results of the correlation and feasibility tested by bivariate t tests showed that the two differ significantly, it shows that the reverse auction mechanism of PPP projects under different capital structures can effectively reduce the cost and improve the construction efficiency so as to improve the income and efficiency of the bidder.

5. Summary

According to the auction process of selecting PPP projects in this paper, the reverse auction model is formulated in the background of computer network, which can achieve the optimum of various comprehensive levels of the investigation project, meet the needs of procurement in different capital, improve the procurement efficiency, and reduce the procurement cost. The reverse auction mechanism of PPP projects under different capital structures and the traditional government procurement mode in procurement cost, price

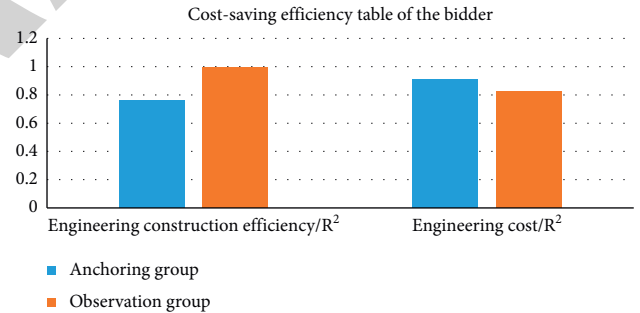


FIGURE 4: Cost-saving efficiency table of the bidder.

negotiation time, supplier selection scope, construction cost, engineering cost is compared. The results show that the reverse auction mechanism of PPP projects under different capital structures can effectively save the cost of the buyer, and the bidder and increase the cost-saving efficiency. Different from the traditional auction mechanism, no longer an auction, shopping around can make both auctioneer or bidders can get their best interests; the ERA mechanism developed in the background of this new computer network gives a new possibility and promotes the further development of the auction mechanism.

Data Availability

The data underlying the results presented in the study are available within the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

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