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Auction Theory: Applications In Real Estate Auctions

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Abstract:

Auction theory plays a pivotal role in optimizing real estate transactions, addressing challenges such as bidder strategies, market efficiency, and fairness. With the rapid expansion of China's real estate market and the increasing prevalence of auctions across judicial, governmental, and digital platforms, understanding the mechanisms that drive auction outcomes has become both timely and relevant. This study explores the application of auction theory in real estate auctions, comparing mechanisms like English, Dutch, and sealed-bid auctions, and their economic impacts. Through theoretical analysis and a case study of the Wanliu Shuyuan property auction in Beijing, the research highlights how auction design influences outcomes, including bid shading, reserve pricing, and the "winner's curse." The findings underscore the importance of standardized information, anti-collusion measures, and behavioral insights to enhance transparency and efficiency. The study provides actionable recommendations for policymakers, financial institutions, and online platforms, contributing to the evolution of auction theory in a digitalized economy. Limitations and future research directions are also discussed.

Keywords: Auction; Foreclosure; Mathematical induction.

1. Introduction

In market economy, auction has become an efficient way of resource distribution. Real estate in China has experienced a significant growth in scale, which leads to a large increase in auction cases. From government land transfer to dispositions of non-performing loans of banks, judicial sale to online real estate trading platform, different mechanisms can directly affect the efficiency of trading and the mark fairness. Auction theory, as a theoretical base of real estate auctions, can provide a structure.

Knowing that there are four ordinary ways of auctions (English auction, Dutch auction, First-Price Sealed-Bid Auction, Second-Price Sealed-Bid Auction), there exists significant difference in bidders' strategies and the market's equilibrium. For example, in a judicial sale of mortgaged properties by banks, due to the dissymmetry of information and the risk of properties, the bidders take the "conservative quotation" strategy in most cases, causing the assets sold at a discount; and in the land transfer case, property

developers' conspiracy may distort rivalries, lower the earnings of the governments. Therefore, designing a doable mechanism in auction to balance efficiency, earnings and fairness have become critical.

Auction theory's application in real estate has multiple practical significances. Firstly, through perfecting land auction rules(setting cap on land prices, competitive construction of supporting facilities), governments are able to curb the housing price bubble and secure public interest; Secondly, bank and property management enterprises need to rely on the auction theory to optimize pricing and sale strategies of non-performing houses, so as to maximize the debt recovery rate; Also at the same time, the rising of online platform such as Auction.com, sf.taobao.com brings new problems of dynamic bidding, algorithm agent etc.

This study is aimed at summarizing auction theory's application in real estate, through comparing different auction mechanism's effects on economy and analyzing actual cases, then discussing available routes to optimize auction mechanisms. This study not only could help perfect auction theory's actual meaning, but also could provide references for policy makers, financial institutes, and trading platforms, then promote the transparency and the efficiency of real estate market.

This study adopts a combined approach of theoretical derivation and empirical analysis to systematically examine core auction models and their applications in real estate. It begins with a literature review summarizing the evolution of classical and behavioral auction theories and their modeling differences. Subsequently, using mathematical induction, the equilibrium bidding strategy under the first-price sealed-bid auction is derived to reveal bidder behavior under information asymmetry. Finally, a case study of the Wanliu Shuyuan auction in Beijing is incorporated to analyze how mechanism design influences real-world transaction outcomes. This integrated framework—connecting theory, modeling, and empirical evidence—provides a comprehensive basis for the subsequent discussion on optimizing auction mechanisms.

2. Literature Review

Azasu's research was based on the classic auction model system. It mainly adopted Milgrom and Klemperer's structure, which included modeling auctions as dynamic games of incomplete information [1]. Paul Milgrom revolutionized auction theory by formalizing the linkage principle and designing modern auction formats like the simultaneous multiple-round auction [2]. Paul Klemperer's key contributions include pioneering the "wallet game" to illustrate the winner's curse and emphasizing the practical importance of robust auction design over theoretical optimality, famously arguing that attracting sufficient competition often matters more than the auction format itself [3]. This research emphatically analyzed four basic auctions' equilibrium solutions under Independent Personal Value and Affiliated Value, stressing in particular Vickrey's proof of Second-Price Sealed-Bid Auction's equivalency with English auction and Milgrom and Weber's conclusion of the income equivalence theorem's invalidation under associated values.

Gunnelin introduced behavioral auction theory on the basis of classic theories. With questionnaire surveys, the bidders' strategies can be concluded in three dimensions: timing, bid increment and reaction time. These behavioral variables were systematically brought into quantitative model, which broke through the assumption that bidders are completely rational and independent. The research focused on the "auction fever" phenomenon, which formed a theoretical dialogue with Kagel and Levin's winner's curse [4].

Both papers used Hedonic Pricing Model as basic analysis structure, but there existed some differences in specifications of variables and estimations of goals. Azasu's model:

$$lnP_i = \alpha + \beta AuctionType_i + \gamma M_i + \delta X_i + \epsilon_i \quad (1)$$

In the function, Pi is the price of deal, $AuctionType_i$ is the four basic auction types mentioned in introduction, M_i is the market category, X_i is the house property characteristics, and ε_i is random error. So it mainly focused on verification of classical auction theories.

On the other side, Gunnelin constructed a more complex two-stage model system:

$$N_i = \delta_0 + \delta_1 Strategy_i + \delta_2 Underpricing_i + \delta_3 Z_i + v_i \quad (2)$$

In this function, N_i is the number of bidders, Strategyi represents the bidding strategy, Underpricingi denotes the initial underpricing level, Z_i encompasses control variables, and v_i is the error term. This model aims to capture the dynamics of bidder participation and their strategic behavior, providing a nuanced understanding of auction outcomes.

$$= \theta_0 + \theta_1 N_i + \theta_2 Strategy_i + \theta_3 Underpricing_i + \theta_4 X_i + \mu_i \quad (3)$$

In this function, lnP_i is the natural logarithm of the deal price, N_i captures bidder influence, $Strategy_i$ reflects strategic choices, $Underpricing_i$ indicates initial pricing impact, X_i includes additional factors, and μ_i is the error term. This dual-stage approach allows for a comprehensive analysis of how bidder strategies and initial pricing collectively shape final auction prices, enhancing predictive accuracy and strategic insights.

These two models are indeed very innovative but still have limitations. They were all based on Sweden real estate markets' data, which may affect their generalizability to other regions.

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3. Methodology

This work mainly focused on the first-priced auction, which is prevalent in many markets, analyzing its formulas' induction and application can significantly help us have a better understanding of chinese market dynamics. So, in this part, the brief introduction of equilibrium Bidding Strategy in First-Price Sealed-Bid Auctions will be introduced [5].

First, consider a first-price sealed-bid auction with n symmetric bidders, each with a private valuation vi drawn independently from a common distribution F(v) with support [0, $\bar{v}$] and density f(v). A bidder with valuation v_i choosing to bid bi has an expected payoff,

$$\pi(v_i, b_i) = (v_i - b_i) P(Win \mid b_i) \tag{4}$$

where the probability of winning is the probability that all other bidders bid less than b_i:

$$P(Win \mid b_i) = F\left(b^{-1}(b_i)\right)^{n-1} \tag{5}$$

Here, b^{-1} is the inverse bidding function.

Then, to maximize the expected payoff, differentiate $\pi(v_i, -b_i)$ with respect to b_i and set to zero:

$$\frac{d}{db_i}\left[(v_i - b_i) F\left(b^{-1}(b_i)\right)^{n-1}\right] = 0 \tag{6}$$

After a couple of simplification,

$$-\mathrm{F}\left(\mathrm{b}^{-1}(\mathrm{b_i})\right)^{n-1} + \frac{1}{\mathrm{b}'\left(\mathrm{b}^{-1}(\mathrm{b_i})\right)}(\mathrm{v_i} - \mathrm{b_i})(\mathrm{n}-1)$$
$$\mathrm{F}\left(\mathrm{b}^{-1}(\mathrm{b_i})\right)^{n-2} \mathrm{f}\left(\mathrm{b}^{-1}(\mathrm{b_i})\right) = 0 \tag{7}$$

In symmetric equilibrium, $b_i = b^*(v_i)$, implying $b^{-1}(b_i) = v_i$,Substituting:

$$-F(v_i)^{n-1} + \frac{1}{b^*(v_i)'}\left(v_i - b^*(v_i)\right)(n-1) F(v_i)^{n-2} f(v_i) = 0 \tag{8}$$

At last, solve the differential function:

$$\beta(v) = v - \int_0^v F(y)^{n-1} \frac{dy}{F(v)^{n-1}} \tag{9}$$

This function above is the equilibrium strategy of the first-priced auction. In real life, bidders submit bids below their true valuation ($b^*(v) < v$) to maximize expected profit. Using this strategy can help to avoid the "winner's curse", which means that in common-value auctions (e.g., oil leases, corporate takeovers), winning at $b^*(v)$ reduces the risk of overpaying due to incomplete information, and if the bidders win, they will get part of their rest values ($v - b^*(v)$). Also, the equilibrium strategy shows that bid shading decreases as competition (n) increases. Sellers can combat bid shading by setting a reserve price r*[6]:

$$r^* = argmax_r\left[r\left(1 - F(r)\right)\right] \tag{10}$$

This function can be used in foreclosure auctions.

4. Case study

The auction of the prestigious property Wanliu Shuyuan in Beijing had drawn many people's attention. Here is some basic information about this auction (Table 1):

Table 1. The process of the Wanliu Shuyuan auction

Category	Phase 1 (May 2023)	Phase 2 (July 2023)	Post-Auction
Units Listed	42	33 (incl. 4 unsold from P1)	4 remaining units
Starting Price	70% of appraisal (~¥19.6M)	80% of P1 reserve (~¥15.7M)	Negotiated transfer (65%)
Units Sold	38	33	2 sold, 2 retained by Huarong
Average Price	¥23.8M/unit (+21.4%)	¥21.3M/unit (+15.8%)	-
Highest Bid	¥25.6M (298 m²)	-	-
Lowest Bid	-	¥19.2M (penthouse)	-
Bidding Rounds (Max)	89 rounds	47 rounds	-
Key Participants	PE funds (60%), Tycoons (35%)	Similar to P1	Huarong Asset
Unsold Reasons	Title disputes (4 units)	-	Legal complexities

In phase 1, there existed intense competition (89 bidding rounds for one unit), driven by limited supply and perceived undervaluation. In phase 2, there were more cautious bidding („last-minute sniping"), reflecting reduced urgency after initial demand was met. From this case, this study can find out that auction achieved about 20% premiums over reserve prices, confirming strong demand despite economic slowdown, and many units were sold at 30–50% below pre-crisis market values, highlighting liquidity risks in luxury real estate. For investors' strategies, anonymous buyers likely used trust arrangements to circumvent ownership regulations.

Also, some problems remain to be solved, such as the standardization of the markets, the transparency of the in-

formation, the rationality of bidders and so on [7].

5. Conclusion

Auction theory provides a robust framework for understanding and optimizing real estate auctions, as demonstrated through its application in various contexts, including government land transfers, judicial sales, and online platforms. By comparing different auction mechanisms and analyzing real-world cases, this study highlights the critical role of auction design in balancing efficiency, revenue, and fairness. The equilibrium strategy derived for first-price sealed-bid auctions, for instance, offers practical insights into bid shading and reserve price setting, which can mitigate issues like the winner's curse and enhance market outcomes.

However, this study acknowledges certain limitations: while behavioral auction theory introduces realism by accounting for bidder irrationality, quantifying phenomena like „auction fever" remains challenging, and models may not fully capture the complexity of human decision-making. Additionally, the case study of Wanliu Shuyuan, while illustrative, is limited by its focus on a single high-profile property, potentially overlooking broader market trends or smaller-scale auctions. Furthermore, the rise of online platforms introduces new variables (e.g., algorithmic bidding) that traditional auction theory may not fully address, necessitating further research to adapt theoretical frameworks to digital environments.

Governments and platforms should standardize information disclosure (e.g., property conditions, legal status) to reduce information asymmetry and build bidder confidence, while sellers can utilize the derived equilibrium strategy to set reserve prices that balance revenue and liquidity, particularly in foreclosure auctions. Anti-collusion measures, such as anonymous bidding and penalties for bid-rigging, are essential to curb developer conspiracies in land auctions and ensure fair competition. Furthermore, auction platforms should incorporate behavioral insights (e.g., time limits, bid increment rules) to mitigate irrational bidding and „winner's curse" effects, and online platforms ought to leverage AI and real-time data analytics to detect anomalous bidding patterns and dynamically adapt auction rules.

Future research could expand cross-cultural comparisons of auction mechanisms, validate behavioral models in diverse markets, and explore hybrid auction designs tailored to specific real estate segments (e.g., distressed assets, luxury properties). Policymakers, financial institutions, and platforms should collaborate to implement these evidence-based solutions, ultimately promoting a more transparent, efficient, and equitable real estate auction market. By addressing these limitations and implementing targeted reforms, auction theory can continue to evolve as a vital tool for optimizing real estate transactions in an increasingly complex and digitalized economy.

This study has several limitations that should be acknowledged. First, the theoretical models and case analysis are primarily based on data and contexts from the Chinese real estate market, which may restrict the generalizability of the conclusions to other regions with different institutional, legal, or cultural environments. Second, while behavioral elements such as "auction fever" and bidder strategies are discussed, the models do not fully incorporate dynamic psychological factors or real-time decision-making processes under uncertainty. Finally, the impact of rapidly evolving technologies—such as AI-driven bidding algorithms and blockchain-based transaction systems—on auction mechanisms remain underexplored. Future research could address these gaps through cross-market comparative studies, richer behavioral data incorporation, and deeper analysis of technology-mediated auction formats.

References

[1] Azasu, S. Auctions in the Real Estate Market—A Review. Royal Institute of Technology, 2006, Division of Building and Real Estate Economics, Stockholm.

[2] Milgrom, Paul R. Putting Auction Theory to Work. Cambridge University Press, 2004.

[3] Klemperer, Paul. "Auction Theory: A Guide to the Literature." Journal of Economic Surveys, vol. 13, no. 3, 1999, pp. 227–286.

[4] Hungria-Gunnelin, R. Real Estate Auctions—An Empirical Analysis of Auction Strategies. KTH Royal Institute of Technology, 2015.

[5] Krishna, Vijay. Auction Theory. Academic Press, 2009.

[6] Myerson, Roger B. "Perspectives on Mechanism Design in Economic Theory." American Economic Review, vol. 98, no. 3, 2008, pp. 586–603.

[7] "Why Was the Top-End Luxury Residence Wanliu Academy Put Up for Auction?" Chinanewsweek, 12 May 2023, finance.sina.cn/2023-05-12/detail-imytperx0154648.d.html. Accessed 11 Sept. 2025.