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Rationality in bidding theory: a construction industry perspective

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Abstract:
Since the publication of Friedman’s paper in 1956, bidding theory has gained popularity in academic research. However, despite the many publications and a long history, bidding theory is still to gain general acceptance and is largely lacking in implementation – particularly in the construction industry. The major problem seems to be the rather unrealistic assumptions involved. Of these, the assumption of rationality is the most critical as it is well accepted outside economic circles that people’s thoughts and behaviours are not strictly rational in the economic sense.

This paper investigates rationality in economic theories to help understand the rational assumptions implicit in bidding theory; the ramifications of departures from these assumptions and possible adjustments needed to existing theory to align it more closely with practice. The discussion begins with an exploration of rationality and its importance in economic study, followed by a review of the rational assumptions underlying bidding theory. Finally, research gaps are identified and suggestions for improvement are provided.

Keywords:
Bidding theory, rationality, rational assumption, bounded rationality

Introduction

The importance of bidding in the construction industry

Construction bidding is the procedure of submitting a proposal by contractors to carry out a described construction project for an agreed price with the client/owner. A successful bid could not only save investment cost, but also bring substantial profit to the contractor to maintain and develop its construction business (Park & Chapin, 1992).

The applicability of bidding theory

Competitive bidding, as the predominant procurement form in the building industry (Grinyer & Whittaker, 1973), has been studied for more than 50 years (Egemen & Mohamed, 2007). An early notable paper is Friedman’s (1956) ‘A competitive-bidding strategy’, which used Operations Research to solve problems in competitive bidding and led to a flood of literature on the topic. Gates (1967) used a similar method to reinterpret Friedman’s strategy for a single bid into a general, profit maximising pricing model (Gates, 1967; Runeson & Skitmore, 1999). At the same time, Vickrey (1961) considered a second-price alternative bidding procedure in which the lowest bidder is awarded the contract but to the value of the second lowest bid.
There are also a number of empirical and theoretical tests of the appropriateness of the proposed methods (e.g., Rothkopf & Harstad, 1994; Seydel, 2003). However, Runeson and Skitmore’s (1999) paper ‘Tendering theory revisited’ claimed that bidding theory was unsound in its basic assumptions. Similarly, the predictions implied by bidding theory are not always correct. The most obvious example is the ‘winner’s curse’, which appears to occur in laboratory auction markets but seldom in the real business world (Dyer & Kagel, 1996). The Vickrey auction is rarely used (Rothkopf, Teisberg, & Kahn, 1990) and real construction bidding practitioners show little interest in bidding theory (Egemen & Mohamed, 2007), possibly due to the models used being unrealistic.

**Failure factors of bidding theory**

What cause the failure of bidding theory? One of the major reasons may be that bidding theory’s assumption of rationality is far from what happens in reality. Rothkopf et al (1990), for example, point out five reasons for the rarity of the Vickrey auction: 1. multiple objects for sale; 2. bidder risk aversion; 3. bidder asymmetry; 4 nonindependent values; and 5. inertia - all of which are contrary to the rational assumptions of Vickrey’s theory. In a study by Dyer and Kagel (1996), one of the essential differences between the laboratory study of bidding theory and the natural habitat of bidding practice was that neither the bidding environment created in the laboratory nor the theory are fully representative of the field environment. For example, a considerable amount of private sector work is awarded through negotiated contracts and not one-shot auctions as the assumed in the theory. Runeson and Skitmore (1999) also point out that changes in demand results in changes in price not predicted by bidding theory. They also pointed out that bidding might not be such a random process as assumed and profit/utility maximisation is unlikely to always be the goal of construction firms.

**Improvement of bidding theory**

A crucial issue of bidding theory is how to improve it. This paper examines bidding theory from a novel insight into the study of rational assumptions. First, a framework for representing the relationship between bidding theory and other analysing tools of economic theories is identified. Bidding theory is not an independent theory as such and receives the help of other powerful decision-making tools, such as Operations Research and Game Theory (Park & Chapin, 1992). Next, both the development of rationality in economic theory and bidding theory are explored. Based on Runeson & Skitmore’s (1999) previous study, this paper focuses mainly on academic research over the last decade. Finally, after some theoretical comparisons, the research gap is identified and suggestions of improvement are provided.
A relevant framework for bidding theory

Definitions

Economics
The word ‘economy’ comes from the Greek word for ‘one who manages a household’ (Mankiw, 2006). A definition that captures much of modern economics is that of Lionel Robbins in a 1932 essay ‘The science which studies human behaviour as a relationship between ends and scarce means which have alternative uses’ (Robbins, 1945).

Decision Theory
Decision Theory (DT) is defined by Park and Chapin (1992) as ‘encompass[ing] a wide variety of analytical techniques for handling management problems’. The purpose of decision theory is to solve management problems of the type that traditionally could be attacked only through intuitive judgment.’ In this case, bidding theory could be treated as a specific area of DT.

Operations Research
Operations Research or Operational Research (OR) is an interdisciplinary branch of mathematics using mathematical modelling, statistics, and algorithms to arrive at optimal or good decisions in complex problems which are concerned with optimizing the maxima (such as profit) of some objective function. OR also closely relates to Industrial Engineering, where it is considered to be a major part of the toolset. Some of the primary tools used by operations researchers are statistics, optimisation, queueing theory, game theory, graph theory, decision analysis, and simulation (Churchman, Ackoff, & Arnoff, 1957; Hillier & Lieberman, 1995).

Game Theory
Game Theory (GT) is a branch of applied mathematics that is often used in the context of economics. It studies strategic interactions between agents. In strategic games, agents choose strategies that will maximize their return given the strategies the other agents choose. The essential feature is that it provides a formal modelling approach to social situations in which decision makers interact with other agents (Hillier & Lieberman, 1995).

Auction Theory
Auction Theory (AT) is an applied branch of GT which deals with how people act in auction markets and researches the game-theoretic properties of auction markets. There are many possible designs (or sets of rules) for an auction and typical issues studied by auction theorists include the efficiency of a given auction design, optimal and equilibrium bidding strategies, and revenue comparison. AT is also used as a tool to inform the design of real-world auctions; most notably auctions for the privatisation of public-sector companies or the sale of licenses for use of the electromagnetic spectrum.

Framework of theories

From the above definitions, bidding theory could be treated as a branch of Decision Theory, while Operations Research, Game Theory and Auction Theory could be treated as analysing tools to Decision Theory or bidding theory. Specific relationships are shown in Fig 1.
Rationality in economics

In order to better understand the study of rationality in economic theory, a seemingly useful structure of the advanced rationality of economic theory would be of great value. For this purpose, the author first developed a framework of the main part needed. This framework is approximate, which means that the introductions and relationships presented may be not exactly correct.

Introductions

Behavioural economics

This applies scientific research to human and social cognitive and emotional biases to better understand economic decisions. The fields are primarily concerned with the rationality of economic agents, the models of which typically integrate insights from psychology with neoclassical economic theory.

Three main themes in behavioural economics (Shefrin, 2002; Earl, 2005) are: 1. **Heuristics**: People often make decisions based on approximate rules of thumb, not strictly rational analyses. 2. **Framing**: The way a problem or decision is presented to the decision maker will affect his action. 3. **Market inefficiencies**: There are explanations for observed market outcomes that are contrary to rational expectations and market efficiency.

Cognitive biases

These are instances of evolved mental behaviour. Some are presumably adaptive, for example, because they lead to more effective actions or enable faster decisions, which have been verified empirically in the field of psychology. Others presumably result from a lack of appropriate mental mechanisms, or from the misapplication of a mechanism that is adaptive under different circumstances.

Bounded rationality
This studies the fact that perfectly rational decisions are often not feasible in practice due to the finite computational resources available for making them.

**Framework for rationality in economic theory**

Fig 2 illustrates the relationship between the various aspects of rationality in economic theory. This shows that research work on rationality in bidding theory could be carried out from three different aspects: Framing, Heuristics and Market inefficiencies. Since ‘bounded rationality’ and ‘Cognitive biases’ are specific branches of Heuristics, study on Heuristics would be carried out on the basis of these two points.

![Fig. 2. Advanced rationality in economic theory](image)

**Two remarkable researchers and their work**

The two most remarkable people involved in the study of advanced rationality are Vernon L. Smith and Daniel Kahneman, who together won the Nobel Prize in Economics for 2002 for their contributions to the rationality study in economics. Smith was awarded by the press release of the Bank of Sweden in 2002 for laying the foundation for experimental economics and establishing experiments as an essential tool in empirical economic analysis. He distinguishing two types of rationality: constructivist, by which he means the sort of rationality built into the standard social science model of ‘economic man’; and ecological, which refers to the effectiveness of an institution or behavioural rule within its ecological contest (Eckel, 2004). Daniel Kahneman, also an experimentalist, on the other hand mainly explored the psychology of intuitive beliefs and choices and examined their bounded rationality. Three major topics of his work are heuristics of judgment, risky choice, and framing effects. He valued his work humbly, as in his own words that the contribution was primarily to psychology with a possible contribution to economics as a secondary benefit (Kahneman, 2003).
Rationality development in bidding theory

Importance of rationality study

Why is the study of rationality so important to bidding theory? That is because the rationality assumption is central to bidding theory and yet no one in the world could live and act totally rationally, no matter who they are and no matter where they are. Experiments on class student showed that they do not learn to optimise (Page, 2003). Even economists are found to be affected by cognitive illusions which lead them to wrong answers when their rationality is tested by solving economic opportunity cost problems (Margolis, 2007). Also, an experimental test of rational decision theory was conducted using the laboratory offered by the television game show The Price Is Right, and in which the contestants’ strategies were found to be transparently suboptimal. As a result, it was possible to develop simple rules of thumb to explain observed bidding patterns better than rational decision theory. The frequency of strategic errors by contestants was then reduced by their learning – an outcome which was strongly interpreted as evidence of bounded rationality (Berk, Hughson, & Vandezande, 1996).

Theoretical consciousness

Recently, researchers have become increasingly interested in rationality studies in the bidding field. The book ‘Behavioral Game Theory: Experiments in Strategic Interaction’ by Colin F. Camerer was published in 2003. This is concerns with a new branch of economics termed behavioural economics. Unlike game theory which is often highly mathematical and usually based on introspection and guesses, this book examines the imbalance of theory and facts by describing hundreds of experiments to observe how people actually play games. However, as the author concludes, more experiments are still needed to enhance generalisability further. One useful idea from this book, also pointed out by Eric van Damme (1999, P. 204), is that the extant game theory is inadequate due to the lack of empirical data involved (Camerer, 2003). Eric van Damme also emphasises that, though the current theory does provide insight into actual auction behaviour, our understanding is still far from perfect.

Empirical development

The sole objective of utility or profit maximising strategy in bidding theory is often criticised as being unrealistic.

One main factor affecting the prospects of a firm winning a bid or not is the potential level of competition (Chua & Li, 2000). In a recent study on competitiveness in construction (Flanagan, Weisheng, Liyin, & Jewell, 2007), competitiveness is classified into four different levels: national level, industry level, firm level and project level, and measurements of competitiveness are identified for each level. Differences between competitiveness at the firm level and project level are addressed in some detail, as these two levels are the ones most debated by researchers.

At the firm level, the main bidding procedure for a construction company can be separated into two stages: (1) the bid/no bid decision and (2) the mark-up decision. In the real business world, these involve complex reasoning processes due to the decision makers’ bounded rationality and limited capacity for information processing. Based on many previous empirical studies, Egeman and Mohamed (2007) provide a comprehensive model of these
processes that sheds some light on the nature of bounded rationality in bidding theory. As a result of their survey of 80 contracting organisations in Northern Cyprus and Turkish Key, they were able to determine the factors characterising the two stages and their importance weights. These factors were found to differ in the two stages and the importance scores and ranks vary significantly between the large and small sized contractors involved in the study.

At the project level, on the other hand, Skitmore and Smyth have looked at construction pricing from a marketing viewpoint. They tested the practical applicability of two prevalent marketing paradigms to three kinds of construction procurement systems. Both the good points and limitations of the two approaches are expatiated according in the context of the real environment of the construction industry (Skitmore, Runeson, & Chang, 2006; Skitmore & Smyth, 2007). A recent laboratory study has also examined the learning affected behaviour of bidders (Fu, Drew, & Lo, 2004). In this research, the effect of bidders’ learning was divided into two phases: the start-up phase and the steady-state phase. New bidders became increasingly competitive as they gained more bidding experience, while experienced bidders had a higher and relatively stable bidding behaviour. However, the exact behaviours involved were not identified in their paper.

Conclusions

This paper developed two frameworks for investigating rational assumptions in bidding theory and a clear relationship between bidding theory and other decision analysing tools was presented. A way of studying rationality in economic theory was also shown, based on these two frameworks, and the rational assumptions underlying bidding theory were reviewed.

Although researchers in construction contract bidding have started to shift their attention to more realistic models, development towards practical implementation is still very slow. A deeper understanding and handling of bounded rationality is still needed for the models to be realistic enough for implementation and behaviour economics seems to offer some potential to do this. This is likely to involve more experimental and empirical data on real world bidding behaviour for the development of the new and more realistic models needed.

References:


