BIDDING STRATEGIES IN THE MOROCCAN PUBLIC PROCUREMENT MARKET

STRATEGIES D’ENCHERES SUR LE MARCHE MAROCAIN DE LA COMMANDE PUBLIQUE

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Submission date: September 2, 2022
Acceptance date: January 15, 2023
Revision date: February 23, 2023
Publication date: March 22, 2023
DOI: https://doi.org/10.48376/IMIST.PRSM/remarem-v15i1.42455
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ABSTRACT

Public procurement market accounts for an average of 13% to 20% of GDP worldwide (THE WORLD BANK, 2020) and 17% of the GDP in Morocco. As such, it constitutes a significant source of business opportunities for businesses, especially small and medium enterprises (THE WORLD BANK, 2014). While most research in the field addressed efficiency issues of this important market (KAKWEZI & NYEKO, 2019), the present paper addressed the issue of how companies could efficiently design bidding strategies in the public procurement environment of Morocco to get the best share of this market? To answer this question, the main goal of the present paper was to provide a well-grounded model indicating how to design bidding strategies accurately and efficiently for the Moroccan public procurement market. Through a mix of hybrid exploration and deductive methods, quantitative and qualitative primary data was collected and analyzed to test the working hypotheses of this research paper. This research found that the open tender procedure, as the most used mechanism to award procurement contracts in Morocco, exhibits the patterns of a game auction model that express an equilibrium bidding strategy around which bidding strategies could be rationally and efficiently designed. Moreover, based on an empirical research, this work found that the Moroccan public procurement market is mainly a low competition environment wherein bidding strategies are mostly designed as rather payoff directed strategies than winning procurement contracts directed ones. Finally, while the present work could be considered as a contribution apprehending the field of public procurement from a new market perspective, it doesn’t, however, claim to fully cover all aspects of that same market perspective as many of non-open procedures of public procurement in Morocco remain outside the scope of this research.

KEYWORDS: AUCTION, GAME, BIDDING STRATEGY, PROCUREMENT, BAYESIAN NASH EQUILIBRIUM, MECHANISM DESIGN, COMPETITION, MARKET

RESUME
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Le marché de la commande publique représente en moyenne de 13% à 20% du PIB mondial (LA BANQUE MONDIALE, 2020) et 17% du PIB au Maroc. En tant que tel, il constitue une source importante d'opportunités pour les entreprises, en particulier les petites et moyennes entreprises (LA BANQUE MONDIALE, 2014). Alors que la plupart des recherches ont abordé la problématique de l'efficience de ce marché important (KAKWEZI & NYEKO, 2019), le présent article aborde, quant à lui, la question de savoir comment les entreprises pourraient concevoir efficacement des stratégies d'enchères dans l'environnement de la commande publique au Maroc dans l'objectif d’obtenir la meilleure part de ce marché ? Pour répondre à cette question, l'objectif principal de cet article était de fournir un modèle bien-fondé indiquant comment concevoir des stratégies d'enchères de manière précise et efficace pour le marché de la commande publique au Maroc. À travers un mix de méthodes d'exploration hybride et déductives, des données primaires quantitatives et qualitatives ont été collectées et analysées pour tester les hypothèses de travail de cette recherche. Cette recherche a conclu que la procédure d'appel d'offres ouvert, en tant que mécanisme le plus utilisé pour l'attribution de contrats de marchés publics au Maroc, présente les propriétés d'un modèle de jeu d'enchères qui exprime une stratégie d'enchères d'équilibre autour de laquelle des stratégies d'enchères pourraient être conçues de manière rationnelle et efficace. De plus, sur la base d'une recherche empirique, le présent travail a conclu que le marché de la commande publique marocain est principalement un environnement de faible concurrence où les stratégies d'enchères sont principalement conçues comme des stratégies dirigées plutôt vers le profit que vers l'obtention de contrats de marchés publics. Enfin, bien que le présent travail puisse être considéré comme une contribution abordant la commande publique à partir d'une nouvelle perspective de marché, il ne prétend cependant pas couvrir tous les aspects de ce même marché car de nombreuses procédures de passation de marchés publics restent en dehors du champ d’étude de cette recherche.

MOTS CLÉS : ENCHÈRE, JEU, STRATÉGIE D’ENCHERES, PASSATION DE MARCHÉS, ÉQUILIBRE BAYÉSIEN DE NASH, CONCURRENCE, MARCHÉ.
INTRODUCTION

Public procurement, as the process of procuring goods, services or works by the public sector from the private sector, accounts for an average of 13% to 20% of GDP worldwide and represents a global expenditure of nearly 9.5 trillion US dollars (THE WORLD BANK, 2020). For that reason, the efficiency of public procurement, had been for a long period of time and still until now, the major question discussed among practitioners and academics in the field, regarding its strategic, economic, and managerial challenges especially in developing countries (KAKWEZI & NYEKO, 2019). Nevertheless, less interest had been bestowed on the market dimension of public procurement which constitutes a significant source of business opportunities for private companies especially small and medium enterprises. The present research draws more attention to the public procurement market, especially the question around how local companies could design more accurate and efficient strategies to earn the best shares on local public procurement markets. In a quest to provide the best answers to this question, specifically for the Moroccan public procurement market which accounts for 17% of the GDP (THE WORLD BANK, 2014), the present paper assumed that the open tender procedure, as the major mechanism to award procurement contracts in Morocco, is a game auction environment providing an equilibrium bidding strategy around which accurate bidding strategies could be designed by local companies for the sake of improving their shares on this market. The working hypotheses of this research were evaluated through a hybrid exploration of both the game auction model and the open tender environment, but also using deduction and an empirical investigation. In this regard, quantitative and qualitative primary data of the entire studied population was collected and analyzed. The present research is structured as follows: section 1 emphasizes the theoretical foundations of public procurement, section 2 exposes the research methodology, and section 3 presents the results of the research along with the discussions and implications that emerge from them.

1. THEORETICAL FOUNDATIONS OF PUBLIC PROCUREMENT

Research in public procurement had faced for a long period of time and still facing until now, the challenge of building a dedicated theoretical framework that would help better
understand and solve the practical and theoretical issues raised in the field, especially those dealing with public procurement efficiency which remain the most recurrent and the most discussed regarding their strategic, economic, and managerial importance (KAKWEZI & NYEKO, 2019). These research efforts yielded a large spectrum of theoretical backgrounds referring to many disciplines as diverse as economics, mathematics, management, information technology, psychology and many other fields (FLYNN & DAVIS, 2014). Within the limits of the present article, we will only survey three major components of the theoretical backgrounds mentioned above which seem to be crucial to our current research topic namely: auction theory, game theory and mechanism design theory.

1.1. THE MAIN THEORIES

1.1.1. AUCTION THEORY

Auction theory refers to the environment in which one seller sells an object or many objects to many buyers who have values for that object or objects. Auctions are utilized for various reasons, including price definition, revenue maximization, and government contracts (KLEMPERER, 1999). Auction formats are divided into four categories (MILGROM & WEBER, 1982):

a. First price sealed-bid auctions involve bidders placing their bids in closed envelopes and presenting them simultaneously to the auctioneer. The bidder with the highest bid wins the auction and pays the amount of his bid (AVINASH & BARRY, 2008). In government procurement auctions, this same auction format is used but with one public buyer facing many sellers, and the bidder with the lowest bid winning the auction (KLEMPERER, 1999).

b. Second price sealed-bid auctions (or Vickery auctions) operate similarly, but the winner of the auction does not pay a price equal to his own bid. Instead, he pays the second highest bid, and the dominant strategy for all bidders in this auction is to bid their true valuation of the object auctioned.
In open ascending-bid auctions (English auctions), participants make increasingly higher bids until no one is willing to make a higher bid. The bidder with the highest bid wins the auction and pays his own bid.

d. Lastly, in open descending-bid auctions (Dutch auctions), the price is set high by the auctioneer to dissuade all bidders. Then, the price is gradually lowered until the first bidder who agrees to pay the current price wins the auction (MENEZES & MONTEIRO, 2005).

1.1.2. GAME THEORY

Game theory is a branch of mathematics that studies competitive activities between players who follow a certain set of rules. It has various applications, such as firms competing for business, and bidders competing in an auction (OSBORNE, 2000). One of the most important concepts in game theory is the Nash Equilibrium, which was developed by John NASH in the 1950s. This criterion considers the mutual consistency of players' strategies and is applicable to a wider variety of games than the criterion proposed by Von NEUMANN and MORGENSTERN in the 1920s. Game theory has been widely used in many fields, including economics, social and behavioral sciences (OSBORNE & RUBINSTEIN, 1994). The auction model is one of the most successful applications of game theory. It is a mathematical representation involving a set of players, such as buyers and sellers, who have a set of actions or strategies available to them, with payoffs corresponding to each combination of these actions. In auctions, each player has a set of bid functions or reservation prices, and the payoff of each player under a combination of strategies is the expected utility or expected profit of that player. Game theory models for auctions and strategic bidding generally fall into one of the following categories. In a private values model, each bidder assumes that each of the other competing bidders has a private value for the object being auctioned which is unknown to him and which is randomly obtained from a uniform probability distribution. The private values model usually assumes that the values are independent across bidders. A common value model in game theory assumes that all participants have equal valuations of the item being auctioned, but they lack perfect information about these valuations. The affiliated values model is a more general strategic bidding model, in which the bidder's total utility depends on
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both their individual private signal and an unknown common value. Essentially, both the private value and common value models can be seen as variations or extensions of the general affiliated values model (WATSON, 2013). Most of the published research in game theory applications to auctions assumes symmetric bidders which suggests that the probability distribution from which each bidder in an auction draws his value (or signal) is identical across bidders (TONG ISABELLE & QUANG, 2002). The first formal analysis of auctions as games was done by William VICKREY. VICKREY considered that, in some auctions’ environments, bids can be expressed in terms of functions of bidders’ values: \( b(\nu) = b \). In auctions where each buyer’s value \( \nu \) is an independent draw from a uniform distribution with support \([0, 1]\), VICKREY showed that there is a unique Nash Equilibrium bidding strategy for each bidder to determine his bid according to the following relation: \( b^*(\nu) = \frac{1}{n-1} \cdot \nu \). In this symmetric Nash equilibrium bidding strategy, \( n \) is the number of bidders in the auction, and \( \nu \) is the private value each bidder has for the object being auctioned (VICKERY, 1961). One of the derivations of the basic concept of Nash Equilibrium is the Bayesian Nash Equilibrium which is a method of defining the best response strategy for a player giving the strategy adopted by the adverse player in an environment characterized by incomplete information about the players (MENEZES & MONTEIR, 2005).

1.1.3. MECHANISM DESIGN THEORY

Mechanism design theory is a branch of economics and game theory that focuses on designing economic mechanisms or incentives to achieve desired objectives in strategic settings, where players act rationally. Unlike traditional economic theory, which analyzes the performance of given mechanisms, mechanism design theory takes an objectives-first approach to solve a design problem. In a design problem, the objective function is the focus, while the mechanism itself is unknown. Therefore, the design problem involves a reverse process of traditional economic theory, where the main goal is to create a mechanism that achieves a desired outcome (HURWICZ & REITER, 2006). Mechanism design theory is also called reverse game theory as it starts at the end of the game, then goes backwards. One of its most successful applications has been to the theory of auctions (KRISHNA & PERRY, 1998).
2. RESEARCH METHODOLOGY

Given the importance of public procurement market in the Moroccan economy, especially as a source of business opportunities for local companies, the present research addresses the following issue: how companies could efficiently design bidding strategies in the public procurement environment of Morocco?

As the Moroccan open tender procedure may embody patterns like a game auction model, the present research starts from the following working hypotheses:

- Moroccan public procurement open tender procedure embodies the same core patterns as the game auction model for first price sealed bid auction.
- The game auction model associated with the Moroccan open tender procedure has a Nash equilibrium bidding strategy.
- The Nash equilibrium bidding strategy is a crucial point around which companies can efficiently design bidding strategies in the Moroccan public procurement environment.

The assumptions outlined above are debated and tested through the following methodological points.

2.1. QUALITATIVE RESEARCH METHODOLOGY

Hybrid exploration method (THIETAT ET AL, 2001) of both the theoretical game auction model for first price sealed bid auction (GIBBONS, 1992), and the empirical environment of the open tender procedure as specified in the Moroccan public procurement regulation, had been used to test our first working hypothesis. Indeed, relying on a qualitative approach, the key patterns mapping the theoretical game auction model had been empirically identified in the documents regulating the open tender procedure environment. Our second hypothesis was tested, using a deductive approach, through processing the same reasoning steps for the first price sealed bid auction model corresponding to the Moroccan open tender procedure. The outcome was then compared to the equilibrium expression expected by the theoretical game auction model for first price sealed bid auction.
2.2. QUANTITATIVE RESEARCH METHODOLOGY

To test our third hypothesis, empirical research was conducted to collect and analyze quantitative and qualitative data, respectively on the scale of using the open tender procedure as an awarding mechanism of public contracts in Morocco, as well as on the awarding rules applied throughout this process. Since the Moroccan procurement portal (available at the website address: www.marchespublics.gov.ma) is an online database providing an advanced multicriteria search engine, the entire population of publicly available information on procurement contracts was considered, and related primary data was collected and analyzed. Building on both the results of the empirical investigation and the outcome of testing our second hypothesis, different ways to efficiently design new bidding strategies by local companies had been explored and traced around the Nash Equilibrium bidding strategy.

2.3. IMPORTANCE OF PUBLIC PROCUREMENT FUNCTION

Public procurement accounts for an average of 13% to 20% of GDP worldwide and represents a global expenditure of nearly 9.5 trillion US dollars (THE WORLD BANK, 2020). The development of government procurement markets worldwide is driven by the continuous growing economic importance of this function in developed economies. In the EU alone, government procurement of goods, services and works reached nearly EUR 2 trillion or 13.4% of EU GDP in 2016 (DIMITROVA, 2018). On a country level, public procurement expenditure accounts for 10 to 30% of the European Union member’s GDP (LEMBER, KATTEL & KALVET, 2014). In Morocco, a major reforming decree, on public procurement, became effective starting January 1st, 2014. This unified regulation framework, defines the main principles and rules underpinning the procurement preparation and tender processes, which are conducted by all public buyers namely: central and decentralized government bodies, administrative state-owned enterprises, and all levels of local governments bodies. Moreover, the e-procurement platform offers many online services for bidders and public buyers covering the entire public procurement bidding process in the country (LIPSON ET AL, 2014). According to a study published by the World Bank in 2014, public procurement in Morocco represents 17% of GDP with a total annual value of nearly 187 billion dirhams (WORLD BANK, 2014).
This important market is open to a wide number of businesses, especially small and medium enterprises (SME’s), including those operating in buildings and public works as well as in engineering services. These businesses rely on this market to achieve more than 75% of their annual turnover according to a report published in 2012 by the Moroccan Economic, Social and Environmental Council (ESEC, 2012). This situation is further crucial for the Moroccan economy knowing that SMEs ‘share of the entire business tissue represents nearly 95%, contributing therefore by 40% to the GDP and 46% to the total employment in the country (AUGIER, CASTEL & EL MALKI, 2019). In Morocco, contracts of works, goods and services are awarded using many procedures according to the public procurement regulation in force (decree on public procurement issued March 20th, 2013), wherein the open tender procedure remains by so far, the most used among them as shown in the graph below.

**Graph 1: Share of open tender procedure in the total number of public procurement contracts awarded in Morocco between October 2016 and April 2022**

![Pie chart showing 87% for Open tender Procedure and 13% for Other Procedures]

Source: Moroccan procurement portal database

### 3. RESULTS ANALYSIS AND IMPLICATIONS

The game auction model referred to in this research is the model applied to the first price sealed bid auction format. Nevertheless, this model needs to be adjusted to fit some particularities of the Moroccan public procurement environment (see appendix 1 for details). Indeed, in all the procedures specified in the Moroccan procurement regulatory system as mentioned in point 2 above, bidders are sellers while the unique buyer is the public entity. Moreover, in this system, the object auctioned is not a single item but a contract that may include many items. However, since the procurement contract is concluded to procure a
sufficiently homogenous group of items (goods, services or works), then this contract could be considered as a simplified representation of the item or items procured through it. Finally, except for the procurement of studies, the public procurement regulatory system of Morocco provides that, in the open tender procedure, the contract should be awarded to the bidder with the lowest bid. These are the three major patterns indicating the key adjustments to be introduced in the game auction model used in this research.

3.1. ANALYSIS OF QUALITATIVE AND QUANTITATIVE RESULTS

The Moroccan procurement regulation (Decree on public procurement of March 20th, 2013, chapter 4) provides that, in the open tender procedure, bidders are allowed to submit bids in sealed envelopes to public buyers and only qualified bids in a first admission period, are allowed to enter a final stage wherein prices offered by bidders are simultaneously revealed and evaluated. Additionally, in this same procedure, when the object of the contract is procuring goods, executing works, or realizing services other than studies, the qualified bidder with the lowest bid wins the contract at the final stage. If we consider only this final bidding stage among qualified bidders, we can clearly notice that there is a competing (non-cooperative) game between bidders depending on values these bidders privately have for the contract being auctioned. From this perspective, the open tender procedure seems to display the same core patterns as the game auction model for first price sealed bid auction referred to in this research, and as it should be adjusted for this purpose. Indeed, in the open tender procedure as in the game auction model for first price sealed bid auction, there are sealed bids, a non-cooperative competition game between players, rules of the game and payoffs for bidders. Therefore, the first hypothesis asserting that the Moroccan public procurement open tender procedure embodies the same core patterns as the game auction model for first price sealed bid auction is accepted.

Since the open tender procedure in the Moroccan public procurement system is a game auction wherein bidders (players) engage in competition to win the contract, then it is a non-cooperative game environment. In this game, players have private values (types) for the object auctioned (the contract), actions (strategies), beliefs about other players' actions and
expected payoffs. In this environment of incomplete information, as players have types and engage in a simultaneous game (simultaneously submit sealed envelopes), then the open tender procedure also has a unique Bayesian Nash equilibrium bidding strategy as expected by the game auction model (see details in appendix1). Nevertheless, the process of defining this Symmetric Bayesian Nash equilibrium bidding strategy in the environment of the open tender procedure as specified by the Moroccan public procurement system needs to account for the flowing adjustments:

- Each player’s value $v$ is obtained from a uniform probability distribution defined on the interval $[0,1]$. In the environment of the open tender procedure, $v$ corresponds to the inverse of the bidder’s expected total cost of fulfilling the terms of the procurement contract: $v = c^{-1}$. Players have higher values for the contracts they expect to fulfill with lower costs (high payoffs) and vice versa.

- The bidding strategy of a bidder $i$, $b(v_i) = b$ is a strictly decreasing function: bidder $i$ will always submit lower bids if his value for the contract is higher (his estimated total cost to fulfill the contract is lower).

- Finally, since the bidder with the lowest bid wins the contract, then his probability to win is defined as follows if this bidder is bidder $i$:

$$Pr(w|i) = Pr(b(v_1) > b) \ast \ldots \ast Pr(b(v_{i-1}) > b) \ast Pr(b(v_{i+1}) > b) \ast \ldots \ast Pr(b(v_n) > b)$$

The analyze of the adjusted game auction model for the Moroccan procurement open tender procedure, as detailed in the appendix 1 below, produces the following outcome as the Symmetric Bayesian Nash equilibrium bidding strategy: $b^*(c) = \frac{n}{(n-1)}c$, with $n \in \mathbb{N}$ and $n \geq 2$, $c \in \mathbb{R}^+$. $b^*$ is the equilibrium bidding function (strategy) (with $b^*(c) > c$), $c$ the expected bidding cost of fulfilling the procurement contract estimated by each bidder in the auction, which must be superior or equal to a certain minimum cost. $n$ is a natural positive integer representing the number of bidders bidding in the auction (competition) which must be 2 or more for the game to be possible. Therefore, the second hypothesis asserting that a Symmetric Bayesian Nash equilibrium bidding strategy exists
for the game auction associated with the Moroccan public procurement open tender procedure is accepted. The expression of the equilibrium bidding strategy as specified above suggests that the Moroccan public procurement open tender procedure is an efficient game auction mechanism, since it allows the allocation of the procurement contract to the bidder with the highest value for it: the lowest expected cost to fulfill its terms. Moreover, this same expression offers the strategy terms that no rational bidder would have the incentive to change whatever other bidders’ strategies could be. In the equilibrium expression mentioned above, \( \left(\frac{n}{n-1}\right) \) tends to be closer to 1 as \( n \) increases, and its 2 when \( n = 2 \). indeed, when competition is expected to be extremely low \( (n = 2) \), the equilibrium bidding strategy would be to submit bids twice the expected cost for fulfilling the procurement contract \( b^*(c) = \frac{2}{(2-1)} \cdot c = 2c \). Reversely, when competition is expected to get extremely high \( (n \rightarrow N, with N \in \mathbb{N}, and N \gg n) \), the equilibrium bidding strategy suggests submitting bids closer to the expected cost for fulfilling the procurement contract since the payoff tends to be zero \( \lim_{n \rightarrow N} \frac{1}{(n-1)} * c = 0 \), and \( b^*(c) = c \).

Nevertheless, for bidders, competition is not the only variable to consider in defining bidding strategies. The probability of winning the auction is the other key element that any rational bidder should consider in this regard. Therefore, in such an environment of extreme competition thresholds, bidders must manage the tradeoff between winning the contract and getting the best payoff possible from it. Indeed, a rational bidder acting in an environment of extreme low competition would never submit a bid twice his cost because his probability of winning the contract will drastically fall. Reversely, in the opposite extreme limit when competition is too high, a rational bidder would submit no bid since his payoff is almost null. This suggests that a rational bidder would only submit bids when the expected competition environment is not extreme on both sides.\( J, 2, N \). In this regard, defining efficient bidding strategies would be an exercise combining at least three key elements: the terms of the equilibrium bidding strategy, the estimated cost to fulfill the procurement contract and the expected competition condition on the public procurement market. In the context of the Moroccan public procurement market, data collected form
the Moroccan public procurement portal indicates that, the open tender procedure with the lowest bid rule dominates the shares of contracts awarded as it is the only rule used whenever contracts concern works, goods or services other than studies and architectural services as it is shown in the graph below. Combined with the consecration of the open tender procedure as the most used mechanism to award procurement contracts in Morocco as illustrated in graph 1 above, the analyze of the data collected demonstrates that the open tender procedure is an appropriate environment for bidders to design accurate and efficient bidding strategies for the Moroccan procurement market.

Graph 2: Lowest bid rule in open tender procedure and in other open procedures shares between October 2016 and April 2022.

Source: Moroccan procurement portal database

Therefore, our third hypothesis stating that bidders can design efficient bidding strategies around a Nash equilibrium bidding strategy for the Moroccan public procurement market is accepted.

3.2. RESULTS DISCUSSION

As defining bidding strategies depends on three key elements namely: the terms of the equilibrium bidding strategy, the estimated cost to fulfill the procurement contract and the expected competition condition on the public procurement market, the interaction of these elements could be outlined as shown in the following figure.
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Let $b_1, b_2, b_3$ and $b_4$ be the possible bidding strategies.

a. When the public procurement market fails to draw strong competition for an open tender procedure (in the top row), two strategies are possible depending on the choice of bidders. When bidders choose to submit bids in the high probability to win direction, then their bidding strategy would be $b_2 > c$: by choosing to focus on winning the contract, bidders choose indirectly to minimize their payoff, but the weak competition on the procurement market prevents them from bidding closer to their own expected costs to fulfill the contract. Conversely, if bidders choose to go along the high payoff direction, then their bidding strategy would be $b_1 = 2C$: by focusing on maximizing their payoff, as the weak competition on the procurement market may compensate for the decreasing probability to win, bidders are rather encouraged to bid closer to twice their expected costs to fulfill the contract. In both these cases, bidders are taking advantage from low competition compensation effect on the procurement market to go either one direction or the opposite direction. A weak competitive procurement market is advantaging the side of bidders on the expense of the side of public buyers.

b. When the public procurement market succeeds in drawing strong competition (at the bottom row), there are also two strategic options offered to bidders. Indeed, if bidders choose to go in the high probability to win direction, then their bidding strategy would be $b_4 = c$: by selecting to win the contract and not to maximize their payoff, bidders, under the strong pressure of competition, would bid closer to their expected cost of fulfilling the contract. Reversely, if bidders choose to go in the high payoff direction, then their bidding strategy would be $b_3 < 2c$: by deciding to maximize their payoff and not to maximize their probability to win the contract, bidders would not be able to bid twice their expected costs to fulfill the
contract since the strong pressure of competition would prevent them to do so. In both cases, bidders are enduring the pressure effect generated by the strong competition on the procurement market to go either one direction or the other direction. A strong competitive procurement market is advantaging the side of public buyers on the expense of the side of the bidders. In summary, given the tradeoff that any rational bidder must perform between winning the contract and getting the best payoff from it, we can conclude that the best bidding strategies are those located along the open interval between $c$ and $2C$: $c < b < 2C$ which are $b_2$ and $b_3$ in our case. The data collected from the procurement database of Morocco provides a good insight about the overall shape of bidding strategies in the Moroccan public procurement market as shown in the graph below. Indeed, nearly 52% of contracts awarded through the open tender procedure with the lowest bid rule had a competition scale between 3 and 11 competitors, while only 8% of the contracts awarded had a competition scale between 12 and 33. Contracts awarded with an extreme competition scale of either 2 or 37 competitors reached nearly 19%. Consequently, bidding strategies on the Moroccan public procurement market are mostly designed with a low to moderated competition expectations and are rather payoff directed strategies than winning probability directed ones. Businesses participating in public procurement tenders are taking advantage of the low competition on the public procurement market of Morocco.

**Graph 3: Contracts awarded using the open tender procedure by level of competition.**

**Source:** Moroccan procurement portal database
3.3. MANAGERIAL IMPLICATIONS

From the analysis above, it seems that, despite the efficiency of the open tender procedure as a game auction mechanism, the public procurement market of Morocco remains less competitive than expected and is advantaging the side of businesses. This suggests that prices of procurement contracts may be much more expensive for public buyers than they should be if competition were sufficiently high, let alone the negative impact on the successful contract awarding process. If the open tender mechanism is not effective in drawing higher competition in the procurement process, then public buyers should not rely on that mechanism alone but also take some other strategic measures to make this happen. In this regard, simplifying and dropping the cost of the tender process, and lowering access barriers to public procurement contracts remain the most important.
CONCLUSION

The public procurement market in Morocco is undoubtedly an important source of business opportunities for local companies. This same market is dominated by an efficient game auction mechanism driven by the open tender procedure. This situation provides a suitable environment for Moroccan companies to design a range of accurate and efficient bidding strategies, around a Bayesian Nash equilibrium bidding strategy for the sake of getting the best shares on the local procurement market. These bidding strategies could be designed through the complex play of many factors: the terms of the equilibrium bidding strategy, the state of the competition on the procurement market, the cost policy of the bidders, and the tradeoff between winning the procurement contract and get the best payoff from it. In Morocco, as the public procurement market fails to draw higher competition in the procurement process, bidding strategies are mostly designed as payoff directed strategies rather than winning contract directed ones. While this situation suggests higher costs, and a less effective awarding process for public buyers, it requires some measures like simplifying procurement procedures and lowering access barriers and costs of tender to stimulate competition. Despite the availability and the diversity of the data provided by the search utility offered on the electronic Moroccan procurement database, the main constraints encountered by the present paper were essentially data fragmentation, which required additional time and efforts to collect and process and time shortage to proceed all the empirical investigation needed to back up the findings of this research. While the present work could be considered as a contribution to enrich the literature in the field of public procurement as it provides a new perspective of apprehending issues related to that topic, it doesn’t however, deliver a comprehensive view on all the aspects related to that same market perspective since many non-open procedures of public procurement in Morocco, which may cover an important market share, remain outside the scope of this research. Regardless of its constraints and limits, the present paper could be viewed as a milestone in the way to investigate new perspectives in approaching the classic efficiency issues related to the field of public procurement.
APPENDIX 1

Adjusted Game Auction model for the public procurement open tender procedure.

Assumptions:

- Procurement contract is homogeneous and is the object being auctioned,
- Each bidder has a private value for the contract being auctioned which is the inverse of his estimated total cost of fulfilling the contract: \( v = c^{-1} \) with \( c \in \mathbb{R}^+ \) and \( c \geq \min c \);
- These values \( v_i \) are independent and uniformly distributed over \([0, 1]\).

Rules of the game in the auction:

- There are many sellers (bidders) and one buyer (auctioneer) in the auction.
- Bidders simultaneously submit sealed bids \( b_1, \ldots, b_n \).
- The lowest bid is the first price in this auction,
- The bidder with the lowest bid wins the auction (the contract) and gets paid his the amount of his bid after fluffing the contract.

Remarks:

- This game is a Bayesian game auction of incomplete information because bids are simultaneously submitted, and bidders have private values that they don’t share.
- There is a bidding function of this game: \( b(c) = b \). But, for simplicity and convenience of this model, we will consider \( v = c^{-1} \).
- The payoff of any bidder (player) can be defined as \( \pi(b|v) = Pr(win)(v - b) \)

Problem set:

- What is the Bayesian Nash equilibrium strategy \( b^*(v) = b \) of this game auction?
Solution:

- If bidder \( b \) with a value \( v \) believes all other bidders use \( b^* \), then this bidder must also use this same function \( b^*(v) \) because it is this function that will maximize his expected payoff \( \pi \).

- So, we are looking for a symmetric Bayesian Nash equilibrium bidding strategy.

- \( b^* \) is a strictly decreasing function: bidder \( i \) will always bid less if his value for the contract is high (his estimated total cost for fulfilling the contract is low).

- \( b^*(0) = 0 \) if the bidder’s estimated cost of fulfilling the contract is too high \( v = \frac{1}{c} \), then his value will be 0, so he will not submit a bid.

- \( b^* \) is a strictly decreasing function, so \( b^* \) has a well-defined inverse strictly decreasing function: \( \varphi = b^{*-1} \) for all \( b, v : \varphi(b) = v \leftrightarrow b^*(v) = b \).

- What is the probability of bidder 1 to win the auction?

- Recall that the bidder 1 wins the auction if he submits the lowest bid.

\[
Pr_1(\text{win}) = \rho(b) = Pr(b^*(v_2) > b) \times \ldots \times Pr(b^*(v_n) > b).
\]

\[
Pr_1(\text{win}) = \rho(b) = Pr(v_2 < \varphi(b)) \times \ldots \times Pr(v_n < \varphi(b))
\]

- As \( v \) is uniformly distributed on \([0,1]\), then:

\[
\rho(b) = [\varphi(b)]^{n-1}
\]

So \( \pi(b|v) = [\varphi(b)]^{n-1} (v - b) \).

- Looking for the Symmetric Bayesian Nash equilibrium strategy of this game auction requires that the expression \( \pi(b|v) \) should be maximized. It is maximized when \( b^*(v) = b \): when \( b \) equals what the Symmetric Bayesian Nash equilibrium will prescribe as the equilibrium symmetric bidding strategy.

\( \rho(b)(v - b) \) is maximized when the first order condition is satisfied: derivative must be zero.

\[
\frac{\delta \pi}{\delta b}(b|v) = (n - 1)[\varphi(b)]^{n-2} \frac{\delta \varphi}{\delta b}(v - b) - [\varphi(b)]^{n-1} = 0, \text{ when } v = \varphi(b)
\]
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\[
\frac{\delta \pi}{\delta b} (b|v) = (n-1) [\varphi(b)]^{n-2} \frac{\delta \varphi}{\delta b} (\varphi(b) - b) - [\varphi(b)]^{n-1} = 0
\]

\[
\frac{\delta \pi}{\delta b} (b|v) = (n-1) \frac{\delta \varphi}{\delta b} (\varphi(b) - b) - \varphi(b) = 0 \quad \text{is a differential equation (*)}.
\]

Check if \( \varphi \) is linear \( \rightarrow \varphi(b) = \alpha b + \beta \) with \( \alpha > 0 \) and \( \beta \) could be any number.

Recall that \( b^*(0) = 0 \leftrightarrow \varphi(0) = 0 \rightarrow \beta = 0 \) which implies that \( \varphi(b) = \alpha b \).

\[
(n-1) \frac{\delta \varphi}{\delta b} (\varphi(b) - b) - \varphi(b) = 0 \rightarrow (n-1) \alpha (\alpha b - b) - \alpha b = 0.
\]

So \( \alpha = \frac{n}{n-1} \) solves the differential equation (*)

\[
\varphi(b) = \frac{n}{n-1} \cdot b \rightarrow b^*(v) = \frac{(n-1)}{n} \cdot v
\]

Since \( v = c^{-1} \), then \( b^*(c) = \frac{n}{(n-1)} \cdot c \)

And \( \pi'(b^*|c) = Pr(\text{win})(b^* - c) = \frac{1}{(n-1)} \cdot c \)
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BIBLIOGRAPHY


