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RESEARCH ARTICLE

Number of bidders, level of competition, and bid pricing in public procurement

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This article examines the factors that influence competition and how competition affects prices in public contracts in Burkina Faso. It is based on a data set comprising 1,604 contracts awarded by various contracting authorities between 2016 and 2018. Two models are used: a negative binomial model to identify the determinants of competition, and an instrumental variable model based on heteroskedasticity to analyze the impact of competition on the winning bid price. The results show that an optimal number of seven to nine bidders is crucial to maximize competition, whereas the current average is only five. Achieving this range could lead to average savings per contract of between 0.5 percent and 3.15 percent, or approximately 3.7 million CFA francs. These savings highlight the need to reform public procurement policies to promote greater competition and improve efficiency.

Keywords instrumental variables method • imperfect competition • auctions • public procurement

JEL codes C36 • D43 • D44 • H57

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Introduction

Open tendering is regarded as the main principle for awarding public contracts, mainly because it improves efficiency in public procurement, which is vital for effective public policy. This procedure aims to encourage more participation from bidders and promote intense competition, ensuring public procurement is efficient (Tátrai et al, 2024; Iossa et al, 2025). Conversely, when competition is limited or absent, the goal of obtaining the best value for money may be at risk (Lewis-Faupel et al, 2016; Basdevant et al, 2022).

According to auction theory, increased competition among bidders usually lowers their profit margins, resulting in a reduction in award prices and lower procurement costs (Brannman et al, 1987; Branzoli and Decarolis, 2015). As a result, governments and multilateral development organizations promote open tendering in public procurement (Taş, 2019). However, the theoretical connection between the number of competitors and the level of competition, as well as between competition and prices, remains somewhat unclear (Menezes and Quiggin, 2012; Amaral et al, 2013; Vandegrift and Duke, 2015). This relationship depends on such factors as the type of good or service being procured, the quality of the contracting authority, and the estimated contract value. Therefore, open competitive bidding does not automatically guarantee effective competition. While increased competition can lower prices (Bulow and Klemperer, 1996; Onur et al, 2012; Tátrai et al, 2024), it may also lead to higher prices as competition intensifies (Hong and Shum, 2002; Fan and Wolfstetter, 2008).

This article aligns with existing literature on the prerequisites for effective public procurement. Specifically, it examines the factors influencing the number of bidders in public procurement auctions and the effect of competition on prices. The analytical framework introduced in this article represents a significant empirical advancement over previous research. To our knowledge, it is among the first to utilize data from sub-Saharan African countries. In 2019, Onur and Taş (2019) highlighted the lack of analyses on the effectiveness of public procurement in developing economies, mainly due to limited or inaccessible data. This claim, recently reaffirmed by de Oliveira Leite et al (2025), remains true, especially in African nations south of the Sahara, where statistical systems are still developing. Furthermore, existing empirical studies tend to focus on specific countries (for example, Brazil, the Czech Republic, Japan, Spain, and Turkey), making it difficult or even impossible to generalize their findings due to differences in procurement laws, market maturity, and institutional quality. In the absence of a framework that allows for comparison across various institutional contexts, this article broadens the scope of available case studies. To address this, an innovative database was created from daily publications of *La Revue des marchés publics*, the official public procurement journal, covering 1,604 public procurement procedures initiated by contracting authorities in Burkina Faso between 2016 and 2018.

The article also adds to the empirical literature by highlighting the significant role of external financing, a factor often overlooked in empirical studies, with Iimi (2006) and Estache and Iimi (2008) being notable exceptions. Specifically, public procurement plays a key role in implementing official development assistance projects. The disbursement processes used by donors usually differ from those used for domestic funding, despite the commitments to align practices and use national systems and procedures outlined in the Paris Declaration (OECD, 2005). As a result, the operational methods of development aid agencies may impact the efficiency of public procurement, especially in promoting competition and reducing public contract costs.

The following section reviews the literature on factors affecting the number of bidders and their impact on pricing in public procurement. The third section outlines the institutional framework governing public procurement in Burkina Faso. The methodology and data used in the analysis are described in the fourth section. The fifth section presents and discusses the findings, and the sixth section provides the article's conclusions.

Literature review: theoretical foundations and empirical evidence

A notable aspect of the literature is the divergence between theoretical propositions and empirical results, especially regarding the indicators used to measure auction effectiveness and the factors influencing it. The wide variety of efficiency indicators and their measurement methods seems, at first glance, to be the main reason for this divergence. These indicators include, for example, expected revenues (Bulow and Klemperer, 1996; Bergemann et al, 2017), guaranteed gains (Bergemann et al, 2019; Brooks and Du, 2021), participants' surplus (Milgrom and Weber, 1982; Goeree and Offerman, 2003), the ratio of the winning bid to the reserve price, the relative bid (Bajari and Hortaçsu, 2003; Klemperer, 2004; Bhattacharya et al, 2014), the number of participants and level of competition (Levin and Smith, 1994; Cao and Tian, 2010; Gentry and Li, 2014; de Oliveira Leite et al, 2025), bid concentration or dispersion (De Silva et al, 2008; Wallimann et al, 2023), ex post performance (Decarolis, 2014; 2018), and vulnerability to collusion (Basdevant et al, 2022; Kawai and Nakabayashi, 2022; Kawai et al, 2023).

Measuring the effectiveness of public procurement involves different approaches (Patrucco et al, 2016; Cavalieri et al, 2025). Some analyze the attribution and execution phases separately, while others examine the entire cycle. In both cases, the selection and development of relevant indicators depend on the level of detail and availability of information specific to each stage or phase of the process. Therefore, choosing an indicator involves balancing the ideal methodological approach, guided by the research goal, against practical limitations posed by data availability. As a result, among various theoretical options, the criterion of accessibility often takes precedence, even if it sacrifices some conceptual precision. This article, by focusing on price, acknowledges this methodological bias, which is limited by the scope of the available data.

It thus appears that the efficiency of public procurement can be defined by the level and quality of competition generated by a procedure, the cost of awarding the contract, the completion time, the final cost, or the quality delivered compared to what was promised (Flyvbjerg et al, 2003; Ganuza, 2007). A public contract is considered effective if it meets the desired level of the indicator, especially if it is completed on time and there are no cost overruns (Guccio et al, 2014).

While many empirical studies use price or its derivatives as an indicator of efficiency (Coviello and Mariniello, 2014; Coviello and Gagliarducci, 2017; Chiappinelli, 2020; Arachi et al, 2024; Caserta et al, 2025), the literature nonetheless recognizes that cost reduction is not the only key characteristic of an efficient public procurement system (Rizzo, 2013; Arachi et al, 2024). Therefore, many also consider other indicators, such as completion time (Lewis and Bajari, 2011; Coviello et al, 2018; Ravenda et al, 2020), the number and occurrence of renegotiations (Guasch, 2004; Decarolis, 2014; Beuve and Saussier, 2021), and the level of competition (Ravenda et al, 2020; de Oliveira Leite et al, 2025), among others.

The use of price and its derivatives as performance indicators arises from the constitutive nature of price in public procurement. In fact, the core legal definition of public procurement contracts explicitly characterizes them as acts for the consideration of value (Baldi et al, 2016), making price a central part of public procurement. Therefore, price is not only an economic variable but also a legal cornerstone of public procurement.

Theoretically, the absence of convergence between propositions also seems to depend on the assumptions concerning the fundamental features of auction procedures. The assumption regarding entry into the auction influences whether the number of bidders is considered exogenous or endogenous (McAfee and McMillan, 1987; Levin and Smith, 1994; Bajari and Hortaçsu, 2003; Gentry et al, 2017; Grundl and Zhu, 2024), and the assumption about the informational paradigm affects whether an auction is modeled as a common-value or private-value type, which are not necessarily parallel (Goeree and Offerman, 2003; Casari and Cason, 2016; Laohakunakorn et al, 2019). The organizational features of the auction, the expected profit, bidders' characteristics (such as size and risk attitude), the nature and availability of information, the initial market structure, and the characteristics of the auctioned item all influence the assumptions underlying the theoretical models.

Initially considered exogenous (Chakraborty and Kosmopoulou, 2001; Klemperer, 2002; Estache and Iimi, 2011), the literature has been expanded by including the idea that the number of bidders is endogenous (De Silva et al, 2008; Rezende, 2008; Ohashi, 2009; Estache and Iimi, 2011). This means that the number of participants in an auction results from strategic decisions that consider their risk tolerance, their perception of their own importance, the information structure, entry costs, expected competition, and anticipated gains.

Levin and Smith (1994) lay the theoretical groundwork for how participation costs influence the best entry strategies. Their models are crucial for understanding the connection between expected profits and the number of bidders (Levin and Smith, 1994; Moreno and Wooders, 2011). In these models, an increase in the number of bidders affects profits by intensifying competition and diluting the probabilities of winning, suggesting the existence of an optimal level of competition (Li and Zheng, 2009; Onur and Taş, 2019). This supports the idea of a non-monotonic relationship between the number of participants and the price (Rezende, 2008). This idea does not contradict the notion that there may be, if not a significant difference, then at least a nuance between the number of bidders and the level or strength of competition (Garcia and Tor, 2009; Lamothe, 2015; Conley and Decarolis, 2016).

Expected profit and the variables from which it is derived, such as reserve price and entry and bidding costs, form the basis of many theoretical frameworks (McAfee and McMillan, 1987; Cao et al, 2024). These frameworks, therefore, adopt the assumption of endogenous entry and relax the assumption of a fixed number of bidders (Lauermann and Speit, 2023), allowing the number of participants to be an equilibrium outcome rather than an exogenous parameter (Perrigne and Vuong, 1999).

Empirically, the role of entry costs has been studied by Li et al (2025), who showed that high transaction costs limit participation in auctions and decrease cost-effectiveness. Similarly, Estache and Iimi (2009) highlighted the importance of expected net profit by demonstrating that high-quality standards increase entry costs and reduce the number of bidders. Likewise, Azman (2014) found that the likelihood of participating in an auction is related to the expected gains in construction auctions in Malaysia. Drake and Xu (2025) also demonstrated that expected direct profits influence market entry.

Given the entry costs, each participant evaluates whether the potential profits outweigh these costs. For example, Groeger (2014) discovered that when bidders anticipate higher earnings due to lower costs, their likelihood of participating increases.

This finding aligns with Nakanishi (2022), who included transparency in his analysis and demonstrated that greater openness leads to higher entry rates.

In Turkey, Onur et al (2012) observed that as the number of bidders increases, the average contract price tends to decrease, supporting the idea that more bidders generally boost competition and lower procurement costs. This finding, also confirmed by Benamghar and Iimi (2011), further shows that the relationship between competition intensity and price is non-monotonic.

Asymmetry in auction theory underpins the interactions between new entrants and incumbents, shaping the auction's outcome (Estache and Iimi, 2010). In a scenario with asymmetric bidders, the theory predicts two potential results. A passive approach involves abstaining from participation, which decreases the effective number of bidders and weakens competition (Cantillon, 2008; Estache and Iimi, 2011). Conversely, the second outcome involves an increase in the number of bidders, as new entrants may decide to participate and bid more aggressively to secure the contract at any cost, signaling their presence (De Silva et al, 2009; Taş, 2019). This aggressiveness can also stem from excessive optimism, often resulting from a lack of experience and knowledge, leading to a winner's curse (Li and Philips, 2012). Unlike passive behavior, aggressive bidding raises the number of bidders and lowers prices. Meanwhile, incumbents, aware of their advantage, tend to raise their bids, which increases prices compared to more symmetrical competitive situations (Aryal et al, 2023). Models with endogenous entry suggest that participation declines as asymmetry and informational disadvantages or cost handicaps increase (Chakraborty and Kosmopoulou, 2001).

The study of the passenger rail transport market by Carnehl and Weiergraeber (2023) revealed that the presence of information asymmetry systematically reduces the number of bidders. Estache and Iimi (2010) attributed the lack of a significant decline in overall market prices to existing asymmetries. Taş (2019) found a similar result and confirmed that in the presence of asymmetry, competition decreases. Reducing these asymmetries is therefore often suggested as a way to promote stronger competition. This proposition argues that participation is higher when procurement formats and contractual rules minimize differences in strategic information or costs (Carnehl and Weiergraeber, 2023). Tátrai et al (2024) demonstrated that simply increasing the number of bidders in procurement auctions does not always lead to lower prices or greater efficiency when substantial asymmetries remain. They concluded that fostering more meaningful competition requires policy interventions that lower barriers to entry for weaker bidders. Similarly, Athey et al (2011) and Bajari and Hortaçsu (2003) showed that there is no consistent relationship between the number of bidders and bid prices.

Another significant concern in auction theory involves how bidders' risk attitudes influence their decision to participate, their quantity, how competitive the auction becomes, and the prices that result. Traditional auction analysis usually assumes bidders are risk neutral. However, more accurate theoretical models suggest that auctions often better align with risk-averse bidders (Vasserman and Watt, 2021).

In first-price, sealed-bid auctions, such as public procurement, risk-averse bidders tend to bid more aggressively because the utility loss from not winning is greater for them than for less risk-averse bidders (Campo, 2012; Liu et al, 2012). This behavior increases their chances of winning but also exposes them to the winner's curse, which more knowledgeable bidders are better equipped to avoid.

The winner's curse tends to grow as the number of bidders increases, eventually leading to lower competitive pressure (Padhi et al, 2016). At equilibrium, participants expect the winner's curse, causing them to use less aggressive pricing strategies (Milgrom, 1989). Two opposite effects can occur when the number of bidders goes up (Hong and Shum, 2002). The first, called the "competition effect," involves adopting aggressive strategies to boost the chances of winning the contract. This benefits the public buyer, who pays a lower price.

The second effect stems from the anticipation of the winner's curse, causing bidders to increase their bids (Wilson, 2021). The "curse" effect raises the prices paid by the public purchaser. This effect supports the idea of a consistent relationship between the number of competitors and the emergence of the winner's curse. However, Bulow and Klemperer (2002) argue that a reduction in the number of bidders, which lessens the curse problem, may lead competitors to become more aggressive in their pricing. This influence is likely more substantial than the competition effect. Therefore, having fewer competitors could result in lower winning bid prices (Klemperer, 2004).

In an empirical assessment of the impact of the winner's curse on auction outcomes, De Silva and Rosa (2023) demonstrated that the curse, by affecting expected profits, has a significant negative impact on the number of participants. The analysis, based on Oklahoma state bridge work data, showed that the winner's curse leads to a 4.6 percent decrease in the number of participants and a 4.4 percent increase in prices.

Another key theoretical idea links anti-competitive practices, such as corruption and collusion, to the choice of auction format and its parameters. Generally, analyses see competition and the risk of corruption and collusion as inversely related, meaning that higher competition reduces collusion and corruption rents, thus lowering these practices. However, several studies highlighting how common collusion is in auctions (Hendricks and Porter, 1989; Porter and Zona, 1999; Pesendorfer, 2000; Salmon, 2004; Asker, 2010) suggest that intense competition can make bidders collude or engage in corruption to avoid competing (Carbone et al, 2024). Endogenous participation models include the possibility that corruption influences incentives to enter the auction, leading to less efficient or strategically chosen participation (Celentani and Ganuza, 2002; Burguet and Perry, 2007; Huang, 2019; Huang and Xia, 2019).

Since collusion and corruption are offenses punished upon discovery, few reasons would justify a bidder capable of withstanding competitive pressure entering into a collusive agreement or engaging in corruption. The possibility of collusion in auctions introduces a nuance between the number of competitors and the level of competition (Conley and Decarolis, 2016). While this difference seems obvious in theory, difficulties in objective measurement cause empirical analysis, as in this article, to rely on the number of competitors, assuming no collusion (Llorente-Saguer and Zultan, 2017; de Oliveira Leite et al, 2025). In this context, using multi-lot contracts to encourage participation must be questioned, as the number of competitors does not directly reflect the level of competition or the potential collusive effects of competition intensity. Theoretically, dividing into lots can have two opposing effects: it can either promote competition or hinder it (Li et al, 2015; Giosa, 2018; Hoekman and Taş, 2022). The uncertainty associated with obtaining multiple lots to offset fixed costs may discourage large companies from participating and prevent the buyer from benefiting from economies of scale (Burguet and Sákovics, 1999). Furthermore, dividing into lots can be exploited to facilitate collusive agreements through bid rigging (Giosa, 2018). It can also help

maintain cartel discipline (Bhattacharjea and Sinha, 2015; Che et al, 2018; Kawai et al, 2023). Previous research has not sufficiently incorporated this strategy into the understanding of competition dynamics and the efficiency of public procurement (Grimm et al, 2006). Integrating this element into empirical analysis remains a challenge that this article aims to address.

Analyzing the cost effects of bundling on public procurement costs, Ridderstedt and Nilsson (2023) concluded that the economies of scale linked to bundling were significant but tended to decrease because of the costs of bundling. This work emphasizes that the decision between unbundling (division into lots) and bundling should be based on a detailed comparison of the expected costs and benefits of each option.

Nishikawa (2024) compared bid levels and contract price ratios across over 22,000 public procurement contracts and showed that higher risk exposure for bidders significantly influences prices. Benamghar and Iimi (2011) discovered that in environments with limited information or greater payment uncertainty, prices tend to increase. The impact of risk on competition and prices is also examined in Li et al (2008) on highways. Athias and Nunez (2009), along with Eso and White (2004), explored this from the perspective of how risk aversion affects bid prices, while Ohashi (2009) demonstrated that perceived risk raises both the number of bidders and measures of competitive intensity.

It is interesting to note that most of the studies reviewed have barely addressed, if not avoided entirely, the issue of the source of public procurement funding. However, the nature of the funding source can introduce, mitigate, or worsen various risks, which affect bidders' confidence. This article considers this factor essential in analyzing the effectiveness of public procurement.

Institutional background of public procurement in Burkina Faso

Public procurement regulations in Burkina Faso originate from the integration of directives from the West African Economic and Monetary Union into national law. These regulations define four distinct categories of contracting authorities: (1) "Collectivité territoriale," which includes regional and municipal entities; (2) "Etat central," covering ministries and state institutions; (3) "Etablissement public de l'Etat," referring to state entities that have legal personality and operational independence; and (4) "Société d'Etat," composed of state-owned enterprises and companies with a majority public stake, operating with legal and financial independence under commercial law principles. The distinctive aspect of this last category of companies is that they can act under stringent conditions as bidders and compete with purely private companies. Specifically, they meet the dual requirements of legal and financial autonomy and management under commercial law. They face the challenge of balancing their public service obligations with the profitability needed for their survival and sustainability (de Pilla et al, 2025). Although regulations include safeguards to mitigate potential competitive advantages that could distort free competition, this risk still exists.

Various procurement methods are allowed for acquiring goods, services, and works, ranging from open competition to bilateral negotiations. Except for open tendering,

the other methods depend on specific conditions related to the estimated contract value, the unique nature of the purchase, or the presence of a monopoly, which can restrict access for certain economic operators.

All procedures, except for direct negotiation, use a two-envelope system. The first envelope contains the technical bid, which explains how the bidder's proposal meets the contracting authority's technical requirements and specifications outlined in the bidding documents. The second includes the bid price, along with its detailed components. Evaluation begins with the technical bids, using a pass/fail system. Only bids deemed compliant in the technical evaluation move on to the second stage, where the financial bids are assessed. The award is based on the first-price auction principle.

Public procurement is funded primarily from two sources. The first source is domestic funding, which includes allocations from the state budget, local governments' funds, and resources from state-owned enterprises or public institutions. The second source is external funding provided by bilateral and multilateral donors as part of official development assistance.

Methodology and data

This section presents the methodology and data used.

Methodology and empirical specification

To identify the factors influencing competition in public procurement and their effects on costs, we present Equation 1, based on research by Domberger et al (1995) and outlined in the introduction of this article:

$$\gamma = f(Z, X) \tag{1}$$

Equation 1 specifies that γ, which is alternatively a measure of the level of competition (N) and a measure of the cost of public procurement (C), is a function of a variable of interest Z or W and a set of control variables X or V. Consequently, Equation 1 can be rewritten to specify each measure of γ. This gives us two equations representing the competitive determinants equation and the competitive effect of the number of bidders equation, respectively:

$$\begin{aligned} N &= f(X, Z) \\ C &= f(V, W) \end{aligned} \tag{2}$$

Determinants of competition levels

Following the literature review, the degree of competition is estimated based on the number of effective bidders. The formulation derived from Equation 2, utilized for evaluating the competition equation, is expressed as follows:

$$\begin{aligned} BIDDER_i = \beta_0 + \beta_1 ESCOST_i + \beta_2 TIME_i + \beta_3 NLOT_i + \sum \alpha_{1k} PROCEDURE_{ik} + \\ + \sum \alpha_{2k} AUTHORITY_{ik} + \sum \alpha_{3k} TYPROCU_{ik} + \sum \alpha_{4k} BUDGET_{ik} + \varepsilon_i \end{aligned} \tag{3}$$

The dependent variable $BIDDER$ is the number of effective bidders in a procurement procedure i. The independent variables include the following: the estimated contract

cost (*ESCOST*); the lead time (*TIME*); the number of lots comprising the contract (*NLOT*); the award procedure used, which is a three-mode indicator variable (*PROCEDURE*); the contracting authority, which is a four-mode indicator variable (*AUTHORITY*); the contract's nature, which is an indicator variable distinguishing between goods, works, and services (*TYPROCU*); and the source of funding, which is a binary variable differentiating between domestic (*BUDGET* = 1) and external (*BUDGET* = 0) resources. Variable definitions and codes are provided in Table A1 in the Appendix.

Impact of competition on public contract costs

An equation similar to Equation 2 is used to describe the relationship between the competition variable and the public procurement cost variable. Several considerations come into play when deciding on a particular methodology or technique. In particular, the research question, the method of awarding the contract (lowest bid or most economically advantageous bid), the nature of the variables involved, and the nature and quality of the data explain a large part of the choices made. For example, Ravenda et al (2020) used linear regressions to estimate the effect of mafia infiltration on the number of valid bids submitted. Lotti et al (2024) employed the difference-in-differences method to estimate the indirect savings associated with centralizing public procurement. They aimed to assess the impact of a public policy. Decarolis et al (2020) assessed the causal effect of judicial inefficiency on delays in the execution of public contracts using a frontier discontinuity method and quantile regression.

Authors interested in measuring the link between competition and prices in public procurement have hypothesized either a monotonic or a non-monotonic relationship. Authors like Matilla-García and Vega (2025), who assume a monotonic relationship, and de Oliveira Leite et al (2025), who suggest a non-monotonic relationship but do not aim to find an optimal number of bidders, favor a linear model. Others, such as Onur and Taş (2019), who propose a non-monotonic relationship that indicates the existence of an optimal number of bidders, prefer a quadratic functional form. A quadratic model linking the two variables not only aligns with the idea of an optimal level of competition but also makes it possible to identify and determine that level. Therefore, the model used in this article can be expressed as follows:

$$WINBID_i = \beta_0 + \beta_1 ESCOST_i + \beta_2 BIDDER_i + \beta_3 BIDDER_i^2 + \beta_4 TIME_i + \beta_5 THRES_i + \\ + \sum_{k=1}^{3} \alpha_{1k} PROCEDURE_{ik} + \sum_{k=1}^{4} \alpha_{2k} AUTHORITY_{ik} + \sum_{k=1}^{3} \alpha_{3k} TYPAUC_{ik} + \sum_{k=1}^{2} \alpha_{4k} BUDGET_{ik} + \varepsilon_i \quad (4)$$

The dependent variable *WINBID* is the amount awarded, which equals the price of the lowest bid that meets the technical compliance criteria. This is the amount submitted in the first-price auction, meaning the lowest bid among all that pass the technical evaluation. The two variables of interest are the number of bidders (*BIDDER*) and its square ($BIDDER^2$). Additionally, there is an indicator variable (*THRES*) for the threshold for mandatory use of the competitive procedure (open or restricted), alongside the variables controlling the relationship in Equation 3.

Incorporating the square of the "number of bidders" helps verify the nature of the informational environment in public procurement (Velamuri and Onur, 2011). The price offered by bidders can be seen as a "product" of both the common value (v) and

the private value (b_i) components: $c_i = b_i * v$. The term b_i denotes the private cost element for each bidder, covering variations in work efficiency, experience, expertise, and managerial capabilities. This reflects the bidder's inherent ability to complete the contract if selected. Additionally, there is a shared but indeterminate component of the contract performance cost during the bid preparation phase. This common cost, which applies to all bidders, may be affected by the country's fiscal and commercial policies and laws, as well as its labor regulations.

Data

The data were gathered on 1,604 procurement procedures by analyzing the daily issues of *Revue des marchés publics*, the official journal for procurement in Burkina Faso, from 2016 to 2018. The annual procurement plans, along with the associated notices and results, are accessible in PDF format on the website of the Directorate-General for Oversight of Public Procurement and Financial Commitments, which is part of the Ministry of the Economy and Finance (available at: www.dgcmef.gov.bf/).

The publication of results for a specific procedure provides essential details about the contracting authority's identity, the nature and subject matter of the contract, and the award procedure. It includes information on the number of bidders and their identities, the total number of lots, the number of bids submitted and their respective prices, and the completion deadline for the contract or each lot. Additionally, these publications offer insights into the administrative estimate of contract costs, the amount awarded for the contract or each lot in cases of multi-contracts, the successful bidder(s), and the funding source. Funding may come from internal resources, such as the state budget and the funds of various contracting authorities, or from external sources through bilateral or multilateral cooperation.

The data include all public procurement contracts without exception and regardless of threshold. No contract has been excluded based on a threshold criterion. However, these data do not include unsuccessful procedures, meaning those where no contract was awarded. The reasons for an unsuccessful procedure include no bids being submitted, no compliant bids meeting the technical requirements of the bidding document, or financial reasons, such as the bid price exceeding the administrative estimate after the 15 percent reduction. A procedure is canceled when the need expressed by the contracting authority disappears during the process or if the bidding document contains technical deficiencies that undermine the procedure's credibility. Publications on unsuccessful or canceled procedures do not provide sufficient information to evaluate them.

The average number of bidders is 5.238, ranging from one to 45. When classified by procurement type, the typical number of bidders is 5.501 for goods, 5.056 for services, and 4.919 for construction projects. Regarding procurement procedures, the average number of bidders is 6.715 for open competitions, 4.313 for restricted competitions, and 3.594 for simplified competitions.

Dividing contracts into lots is a strategy aimed at increasing small and medium-sized enterprise (SME) participation in public procurement. In the database, the number of lots ranges from one to 16, while the total number of bids received varies from one to 91. The number of bids can exceed the number of bidders when a contract

includes multiple lots and allows bidders to submit offers for different lots. However, regulations permit each contracting authority to limit the number of lots awarded to a single bidder, even if the bid is technically compliant and offers the best price for all lots. Without this restriction, a single bidder could win all the lots in a public contract, undermining the objective of dividing contracts into lots.

The maximum contract value is set at 4 billion CFA francs, while the minimum exceeds 1 million CFA francs. Our analysis includes all procedures leading to an award, specifically those with at least one bidder. We also include procedures for situations where the awarded amount exceeds the administrative estimate. The administrative estimate functions as the reserve price, reflecting budget constraints. Regulations permit adjustments by reducing quantities when the lowest bid exceeds the administrative estimate, as long as it is technically feasible. However, any quantity reduction must not result in a financial decrease greater than 15 percent. Therefore, we examine all procedures where the ratio of the awarded amount to the administrative estimate is less than or equal to 1.5.

The distribution by contracting authority category shows that the territorial authorities account for 33.28 percent, while the central government category makes up 33.29 percent. The categories of public state organization and state-owned company represent 15.65 percent and 12.84 percent, respectively. A simple correlation analysis between the number of bidders and the different categories of contracting authority reveals statistically significant correlations for all categories. Notably, the presence of the public state organization and territorial authority categories is linked to a slight decrease in the number of bidders. In contrast, the state-owned company category is associated with a modest increase in bidder participation.

Goods account for 53 percent, while works and services make up 39.15 percent and 7.79 percent, respectively. The data indicate a strong preference for open tendering, which accounts for 52 percent, alongside simplified tendering at 45 percent. The simplified competitive procedure applies when the administrative estimate of the contract is below the 20 million CFA francs threshold. Therefore, we created a dummy variable called *THRES*, which takes the value of 1 if the administrative estimate is greater than or equal to 20 million CFA francs and 0 otherwise. Descriptive statistics show that 54.61 percent of contracts have estimated amounts exceeding this threshold. The main differences between this procedure and open competition are the absence of a financial capacity requirement and a shorter deadline for submitting bids. Although this option is allowed, its use is at the discretion of the contracting authority. In contrast, restricted competition is a discretionary process that permits only selected candidates by the contracting authority to participate, setting it apart from open competition.

Estimation methods

The dependent variable—the number of bidders in the competition equation—has a distinctive characteristic: it can only take positive integer values greater than zero. This unique property necessitates a specific estimation technique, which, in turn, leads to the use of counting models. Prior studies investigating similar relationships have also used counting models (Bajari and Hortaçsu, 2003; Onur and Taş, 2019). The descriptive statistics show high overdispersion of the dependent variable. In fact, the variance (21.27) is more than four times the

mean (5.24). The negative binomial model is handy for handling overdispersion caused by unobserved heterogeneity.

The data set includes a wide variety of contracts, with differences in procurement type, estimated costs, lead times, number of bidders, and number of lots. To mitigate the effects of size and dispersion arising from the measurement scales of these variables, the equation was estimated using different functional forms.

In public procurement cost analysis, the dependent variable is the awarded amount, which is the price of the winning bid and indicates the contract's value. The contract value might not match the actual payment made by the contracting authority. If there is a renegotiation, the actual payment could differ from the initially awarded amount. Alternatively, the ratio of the winning bid to the administrative estimate of the contract cost ($\frac{WINBID}{ESCOST}$) is used as a dependent variable to measure the cost of the public procurement contracts. The use of the ratio acts as a form of normalization, reducing the impact of price variability by including a range of contracts with widely spread costs in the analysis. It also indirectly considers price trends over time. A ratio greater than 1 indicates that the awarded amount exceeds the administrative estimate, while a ratio below 1 shows cost savings for the contracting authority. This ratio or its inverse are used alongside or instead of other indicators, such as the rebate, the difference between the administrative estimate and the awarded amount, bid dispersion, final payment, actual execution time, quality of execution, and so on, as measures of public procurement effectiveness in the literature (Bajari and Ye, 2003; De Silva et al, 2009; Conley and Decarolis, 2016; Hoekman and Taş, 2024; Matilla-García and Vega, 2025).

Across the entire sample, the ratio ranges from 0.170 to 1.2, with an average of 0.808, indicating that the awarded amount is, on average, less than the administrative estimate. This ratio has been used as a dependent variable in various empirical studies for similar reasons (De Silva et al, 2005; 2009; Ishii, 2009; Onur et al, 2012; Onur and Taş, 2019). Specifically, Ishii (2009) reported a ratio of 0.8 to 0.95, whereas Onur and Taş (2019) reported an average ratio of 0.18.

Including the number of bidders (*BIDDER*) as an explanatory variable may compromise the reliability of the least squares estimate. This concern arises from the strong endogeneity assumption associated with this variable. Research indicates that the decision to participate, which determines the number of bidders, is influenced by unobserved bidder characteristics that may also affect the awarded price. If endogeneity exists, it will bias the results of ordinary least squares (OLS) estimations. The endogeneity of the number of bidders is a key issue often discussed in empirical auction literature (Bajari et al, 2009; Ohashi, 2009; Onur and Taş, 2019).

Two alternative instrumental variable (IV) methods were employed to address the endogeneity of the number of bidders. The first employs the two-stage least squares (2SLS) method in conjunction with the generalized method of moments (GMM), under the assumption of homoskedastic errors. The second addresses heteroskedasticity by applying robust error estimation through the 2SLS method and the heteroskedasticity-based GMM (GMM-HB). The latter approach, introduced by Lewbel (2012), allows for the identification of structural parameters even in the absence of valid instrumental variables, while also accounting for heteroskedasticity.

Public procurement's attributes and award procedures can significantly influence firms' participation, thereby affecting the number of bidders. The open procedure (*OPEN PROCEDURE*) is the standard method used for all public procurement contracts.

Generally, selecting an alternative procedure requires justification and approval, making the process less vulnerable to bidder influence. Additionally, the decision to purchase goods (*GOODS*) relates to the needs expressed by contracting authorities to fulfill their public service missions. Finally, dividing into lots encourages greater participation from companies, especially SMEs, thereby increasing the number of bidders. However, this decision and the number of lots are at the sole discretion of the contracting authority. Contracting authorities are required to divide the contract into lots whenever it is possible to identify and separate its components. For example, in construction procurement, it is mandatory to divide into lots (for example, structural work, plumbing, and electrical work). Overall, there is no indication that these variables are related to unobservable factors that could reduce the number of bidders. Therefore, the variables used as instruments are the number of lots (*NLOT*), the category of goods (*TYPROCU: Goods*), and the category of open competition (*PROCEDURE: Open*).

Results and discussion

This section presents the preliminary results and performs robustness tests to confirm the results before proceeding with the analysis and discussion.

Baseline results

Competition equation

The findings from estimating the competition equation using the negative binomial model are detailed in Table 1. The parameters and goodness-of-fit criteria indicate that the model is well fitted. The coefficients of the variables align with the anticipated signs. Specifically, the administrative estimate of the contract cost has a significant positive effect on the number of bidders, implying that a higher reserve price is likely to increase competition, as more bidders see the contract as profitable.

The significant positive coefficient for the number of lots (*NLOT*) indicates a positive relationship between the number of lots and bidders. Additionally, the coefficient for the lead time (*TIME*) is positive and significant, suggesting that a longer turnaround time encourages more competition. The coefficient of the interaction term between lead time and the administrative estimate, used as a proxy for the complexity of public procurement, is significant and negative, suggesting that complex contracts discourage bidding.

The contracting authority category, contract characteristics, and award procedure all influence the level of competition. Unlike the central government, public contracts awarded by public institutions and municipalities tend to attract fewer bidders, with a statistically significant difference at the 1 percent level. Conversely, while the public enterprise category has a negative coefficient, it does not have a statistically significant relationship with the number of bidders. These results align with our expectations, given that the main buyers, namely the "Etat central" and "Société d'État," which offer the most significant business opportunities, are mainly located in large urban cities.

Compared with goods, the procurement of works is associated with a significant reduction in the number of bidders. Additionally, there is a positive but nonsignificant relationship between service contracts and competition levels. The coefficient of the

Table 1: Determinants of the number of bidders: negative binomial model

Variables	Dependent variable: lnBIDDER								
	1	2	3	4	5	6	7	8	9
ln_ESCOST	0.124*** (0.007)	0.120*** (0.008)	0.278*** (0.036)	0.058*** (0.007)	0.097*** (0.017)	0.083*** (0.008)	0.079*** (0.009)	0.140*** (0.007)	0.121*** (0.007)
ln_TIME		0.023 (0.015)	0.586*** (0.127)						
c.ln_ESCOST#c.ln_TIME			–0.033*** (0.007)						
ln_NLOT				0.335*** (0.019)					
THRES					0.141** (0.062)				
AUTHORITY (Base: Central State)									
AUTHORITY: Establishment						–0.112*** (0.036)			
AUTHORITY: State-owned company						–0.039 (0.037)			
AUTHORITY: Community						–0.398*** (0.034)			
PROCEDURE (Base: Open)									
PROCEDURE: Restrict							–0.208*** (0.041)		
PROCEDURE: Simpli							–0.262*** (0.036)		

(*Continued*)

Table 1: Continued

Variables	Dependent variable: lnBIDDER								
	1	2	3	4	5	6	7	8	9
TYPROCU (Base: Goods)									
TYPROCU: Works								−0.228*** (0.028)	
TYPROCU: Services								0.078* (0.046)	
BUDGET (Internal = 1)									−0.072** (0.034)
Intercept	−1.857*** (0.127)	−1.883*** (0.128)	−4.573*** (0.621)	−0.867*** (0.125)	−1.465*** (0.279)	−0.982*** (0.138)	−0.964*** (0.163)	−2.066*** (0.130)	−1.748*** (0.138)
Observations	1,604	1,604	1,604	1,604	1,604	1,604	1,604	1,604	1,604
Wald Chi2	307.805	312.678	328.887	790.828	104.035	426.287	328.766	387.929	311.048
Prob > Chi2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: The dependent variable is the natural logarithm of the number of bidders. Robust standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

funding variable (*BUDGET*) indicates a negative correlation between the number of bidders and contracts financed by internal resources.

The results demonstrate a negative relationship between the number of bidders and the restricted and simplified procedures when open procedures serve as the reference modality. This highlights the importance of the open procedure as a key factor influencing participation decisions. This finding is related to the significant, positive coefficient on the threshold variable that triggers the reference competitive procedure.

Public procurement cost equation

We initially present the OLS estimate in Table 2 to facilitate comparison and demonstrate the advantages of the IV estimation results.

We account for the endogeneity of the variable *BIDDER* by re-estimating the equation using the IV method. We use the number of lots (*NLOT*), the goods contracts (*TYPROCU: Goods*), and the open procedure (*PROCEDURE: Open*) as instruments for the two endogenous variables. The characteristics of these variables, analyzed earlier, indicate that they meet the conditions for valid instruments and are outside the bidders' influence.

The diagnostic tests confirm the endogeneity of the number of bidders while also establishing the exogeneity of instruments. The underidentification test, which uses the Kleibergen–Paap *rk LM* statistic ($\chi^2(2) = 60.303\, p - value = 0.0000$), demonstrates that the model is adequately identified and that the instruments employed are pertinent. Furthermore, the Stock and Yogo (2005) instrument weakness test, represented by the Kleibergen–Paap *rk* Wald *F* statistic, shows that $F = 19.952$, which exceeds the critical thresholds set by Stock and Yogo for a maximum bias of 10 percent ($F = 13.43$), thereby indicating that the instruments possess sufficient strength to mitigate the weak instrument issue. The overidentification test ($\chi^2(1) = 0.055\, p - value = 0.8148$) further corroborates the validity of the instruments, suggesting an absence of significant correlation between the instruments and the error terms, which confirms their appropriateness. Collectively, the findings from these three tests validate that *NLOT*, *PROCEDURE: Open*, and *TYPROCU: Goods* serve as reliable and robust instruments.

Table 3 shows that the signs and magnitudes of the estimates from the two methods, namely 2SLS and GMM, are similar. As expected, the results from GMM and 2SLS outperform those from OLS. Additionally, both GMM and 2SLS improve the statistical significance of the coefficients and enhance their effect size.

To improve the accuracy of our findings, we incorporate heteroskedasticity by using robust error estimation through the 2SLS approach (robust 2SLS) and apply Lewbel's (2012) methodology to address potential limitations related to instrument selection. As previously noted, this approach utilizes the GMM-HB to evaluate the robustness of our results. The data in Table 4 show that the coefficients of the variables remain statistically significant and in the expected direction. The coefficients for the number of bidders and its square are significant and have the expected signs, consistent with our hypotheses. The observed significance aligns with the framework established by Velamuri and Onur (2011), indicating that the informational context of public procurement resembles a common-value auction. Research in auction theory has shown that such environments are particularly vulnerable to the winner's curse (Paarsch, 1992; Klemperer, 1998), leading bidders to adjust their pricing accordingly.

Table 2: OLS estimation of the relationship between the number of bidders and the cost ratio in public procurement processes

Variables	Dependent variable: lnRATIO = lnWINBID – lnESCOST								
	1	2	3	4	5	6	7	8	9
ln_BIDDER	–0.062*** (0.004)	–0.054*** (0.011)	–0.060*** (0.004)	–0.067*** (0.004)	–0.051*** (0.004)	–0.064*** (0.004)	–0.060*** (0.004)	–0.061*** (0.004)	–0.041*** (0.011)
ln_BIDDERsq		–0.003 (0.005)							–0.005 (0.005)
ln_TIME			–0.008** (0.004)						0.002 (0.004)
THRES				0.024*** (0.007)					0.032*** (0.012)
AUTHORITY (Base: Central State)									
AUTHORITY: Establishment					–0.010 (0.011)				–0.000 (0.012)
AUTHORITY: State-owned company					0.003 (0.013)				–0.009 (0.014)
AUTHORITY: Community					0.046*** (0.008)				0.043*** (0.009)
PROCEDURE (Base: Open)									
PROCEDURE: Restriction						–0.003 (0.015)			0.005 (0.016)
PROCEDURE: Simple						–0.012* (0.007)			0.007 (0.012)
TYPROCU (Base: Goods)									
TYPROCU: Works							0.021*** (0.006)		0.004 (0.007)
TYPROCU: Services							–0.069*** (0.021)		–0.064*** (0.023)

(*Continued*)

Table 2: Continued

Variables	Dependent variable: lnRATIO = lnWINBID – lnESCOST								
	1	2	3	4	5	6	7	8	9
BUDGET (Internal = 1)								0.014 (0.010)	0.012 (0.011)
Intercept	–0.137*** (0.005)	–0.141*** (0.004)	–0.104*** (0.017)	–0.144*** (0.005)	–0.168*** (0.009)	–0.128*** (0.007)	–0.142*** (0.006)	–0.150*** (0.011)	–0.206*** (0.023)
Observations	1,604	1,604	1,604	1,604	1,604	1,604	1,604	1,604	1,604
R-squared	0.114	0.115	0.117	0.121	0.139	0.116	0.141	0.115	0.164
Adj. *R*-squared	0.114	0.114	0.116	0.120	0.137	0.114	0.140	0.114	0.158

Notes: The dependent variable is represented by the natural log of *RATIO*, which is calculated as the natural log of the winning bid subtracted by the natural log of the estimated cost. The variables of interest include the natural log of the number of bidders (*lnBIDDER*), along with its squared term. Robust standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Table 3: Estimation by instrumental variables of the effect of the number of bidders on the public procurement cost ratio

Variables	1		2		3		4	
	2SLS	**GMM**	**2SLS**	**GMM**	**2SLS**	**GMM**	**2SLS**	**GMM**
ln_BIDDER	–0.139*** (0.048)	–0.139** (0.055)	–0.166*** (0.047)	–0.166*** (0.054)	**–0.174***** (0.055)	–0.174*** (0.063)	–0.153*** (0.050)	–0.153*** (0.055)
ln_BIDDERsq	0.033** (0.015)	0.033* (0.017)	0.042*** (0.015)	0.042** (0.017)	**0.039**** (0.016)	0.039** (0.019)	0.036** (0.016)	0.036** (0.018)
ln_TIME			–0.010** (0.004)	–0.010*** (0.004)				
THRES					0.023** (0.010)	0.023** (0.009)		
TYPROCU (Goods)								
TYPROCU: Works							0.019*** (0.007)	0.019** (0.008)
TYPROCU: Services							–0.065*** (0.020)	–0.065*** (0.013)
Intercept	–0.111*** (0.030)	–0.111*** (0.033)	–0.054* (0.029)	–0.054 (0.034)	–0.093*** (0.034)	–0.093** (0.037)	–0.104*** (0.032)	–0.104*** (0.035)
Observation	1,604	1,604	1,604	1,604	1,604	1,604	1,604	1,604
R-squared	0.072	0.072	0.056	0.056	0.068	0.068	0.090	0.090
Adj. *R*-squared	0.071	0.071	0.054	0.054	0.066	0.066	0.088	0.088
*BIDDER**	*8.22*	*8.22*	*7.22*	*7.22*	*9.31*	*9.31*	*8.37*	*8.37*

Notes: The dependent variable is the natural logarithm of *RATIO*, defined as the natural logarithm of the winning bid minus the natural logarithm of the estimated cost. Robust standard errors in parentheses for 2SLS. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Table 4: Effect of competition on the relative cost of public procurement: robust 2SLS and Lewbel (2012)

Variables	1		2		3		4	
	Robust 2SLS	**GMM-HB**	**Robust 2SLS**	**GMM-HB**	**Robust 2SLS**	**GMM-HB**	**Robust 2SLS**	**GMM-HB**
ln_BIDDER	–0.139*** (0.048)	**–0.136*** (0.047)	–0.166*** (0.047)	–0.170*** (0.047)	**–0.174*** (0.055)	–0.171*** (0.055)	–0.153*** (0.050)	–0.147*** (0.050)
ln_BIDDERsq	0.033** (0.015)	**0.032** (0.015)	0.042*** (0.015)	0.043*** (0.015)	**0.039** (0.016)	0.038** (0.016)	0.036** (0.016)	0.035** (0.016)
ln_TIME			–0.010** (0.004)	–0.010** (0.004)				
THRES					0.023** (0.010)	0.025*** (0.010)		
TYPROCU (Base: Goods)								
TYPROC: Works							0.019*** (0.007)	0.018*** (0.007)
TYPROCU: Services							–0.065*** (0.020)	–0.061*** (0.020)
Intercept	–0.111*** (0.030)	–0.114*** (0.029)	–0.054* (0.029)	–0.051* (0.029)	–0.093*** (0.034)	–0.093*** (0.034)	–0.104*** (0.032)	–0.107*** (0.032)
Observation	1,604	1,604	1,604	1,604	1,604	1,604	1,604	1,604
R-squared	0.072	0.073	0.056	0.053	0.068	0.071	0.090	0.094
Adj. *R*-squared	0.071	0.072	0.054	0.052	0.066	0.069	0.088	0.092
BIDDER*[a]	7.85	8.77	**7.22**	7.22	9.31	**9.49**	8.90	7.70

Notes: [a] The optimal number of bidders (*BIDDER**) in each specification is derived by solving the following equation: $\frac{\partial \ln RATIO}{\partial \ln BIDDER} = \beta_1 + 2\beta_2 * \ln BIDDER = 0 \Rightarrow BIDDER^* = \exp\left(\frac{-\beta_1}{2\beta_2}\right)$. The dependent variable is the natural logarithm of *RATIO*, defined as the natural logarithm of the winning bid minus the natural logarithm of the estimated cost. Robust standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

The findings adjusted for endogeneity using Lewbel's (2012) method confirm the earlier results. The number of bidders and its squared term show the expected signs, indicating a nonlinear relationship between competition levels and the awarded bid price. Moreover, the relationship between the control variables and the public procurement cost ratio remains consistent, though there are slight changes in the size of the coefficients.

Robustness checks

Sensitivity analyses are carried out in this subsection to check the robustness of the results.

Sensitivity analysis of results based on financial performance

The relative cost of procurement acts as an indicator of financial performance during the award phase. An award is considered efficient if this ratio is below 1, indicating that the procurement process was effectively managed from the initial identification of needs and cost estimation to selecting the winning bidder.

The estimated model, with results for various specifications shown in Tables 2, 3, and 4, was re-evaluated by capping the dependent variable *RATIO* at 1. This restriction allows us to assess the sensitivity of the results within a subsample where the awarded price is equal to or less than the administrative estimate. The results presented in Table 5 maintain the same significance and sign characteristics as those in the previous tables. These findings are consistent with the hypothesis that a higher number of bidders contributes to lower procurement prices. The analysis of this additional regression reinforces the robustness of the results shown in Table 4. Furthermore, the optimal number of bidders remains unchanged when focusing on procedures classified as financially efficient. This shows a common phenomenon in common-value auctions, where the benefits of competition decrease beyond a certain threshold as competition intensifies.

Sensitivity analysis with various values of the dependent variable

In addition to the conclusions drawn from the subsample established by setting the threshold of the dependent variable at 1, we analyze the entire sample by examining different percentiles of the dependent variable. The variables of interest retain their sign, with a gradual decrease in significance at the upper quartiles. This decline reflects the reversal of signs once the optimal point has been reached. Segmenting the data according to the quartiles of the dependent variable further supports the robustness of the results as summarized in Table 6.

Discussion

Low-value public contracts often lack the profitability needed to attract potential bidders. The fixed costs involved in preparing and submitting bids make these contracts unprofitable. Conversely, the prospect of earning significant profits from high-value public contracts tends to boost competitors' confidence, who are more likely to bid. Our results show that a 1 percent increase in the administrative estimate is linked to a corresponding rise in the number of bidders, ranging from 0.05 percent to 0.28 percent. This finding aligns with the conclusions drawn by Onur et al (2012).

Table 5: Estimating the effect of the number of bidders on the public procurement cost ratio: the Lewbel method

Variables	1		2		3		4	
	2SLS	**GMM-HB**	**2SLS**	**GMM-HB**	**2SLS**	**GMM-HB**	**2SLS**	**GMM-HB**
ln_BIDDER	**–0.155***** (0.047)	**–0.151***** (0.047)	**–0.184***** (0.046)	**–0.191***** (0.046)	**–0.192***** (0.053)	**–0.194***** (0.053)	**–0.164***** (0.049)	**–0.157***** (0.049)
ln_BIDDERsq	0.039*** (0.015)	0.038*** (0.015)	0.048*** (0.015)	0.050*** (0.014)	0.045*** (0.016)	0.045*** (0.016)	0.041*** (0.016)	0.038** (0.015)
ln_TIME			–0.010** (0.004)	–0.010** (0.004)				
THRES					0.024*** (0.009)	0.028*** (0.009)		
TYPROCU (Base: Goods)								
TYPROCU: Works							0.023*** (0.007)	0.022*** (0.007)
TYPROCU: Services							–0.066*** (0.020)	–0.061*** (0.020)
Intercept	–0.109*** (0.029)	–0.111*** (0.029)	–0.051* (0.029)	–0.045 (0.029)	–0.089*** (0.032)	–0.086*** (0.032)	–0.107*** (0.031)	–0.109*** (0.031)
Observation	1,579	1,579	1,579	1,579	1,579	1,579	1,579	1,579
R-squared	0.073	0.075	0.054	0.048	0.069	0.070	0.099	0.104
Adj. *R*-squared	0.072	0.074	0.052	0.046	0.067	0.068	0.096	0.102
BIDDER*	*7.29*	*7.29*	*6.80*	*6.75*	*8.44*	*8.63*	*7.39*	*7.89*

Notes: The dependent variable is the natural logarithm of *RATIO*, which is defined as the natural logarithm of the winning bid minus the natural logarithm of the estimated cost. The estimation concerns a subsample for which the variable $RATIO \leq 1$. $BIDDER^{*}$ is the optimal number of bidders calculated for each specification. Robust standard errors in parentheses.
*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Table 6: Quantile estimate of the effect of the number of bidders on the relative cost

Variables	Percentile			
	25%	50%	75%	100%
ln_BIDDER	–0.279*** (0.039)	–0.124*** (0.038)	–0.046 (0.047)	0.239 (0.250)
ln_BIDDERsq	0.089*** (0.015)	0.045*** (0.012)	0.022* (0.013)	–0.059 (0.070)
Obs	1,604	1,604	1,604	1,604

Notes: The dependent variable is the natural logarithm of *RATIO*, which is defined as the natural logarithm of the winning bid minus the natural logarithm of the estimated cost. The results are obtained via the GMM estimator heteroskedasticity-based IV regression. Only the two variables of interest are presented. The percentiles are defined according to the dependent variable. Standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Dividing contracts into lots significantly increases the attractiveness of public procurement. Increasing the number of lots encourages bids, which corroborates the findings of Tátrai et al (2024). This strategy breaks down complex projects into smaller, more manageable segments, even for SMEs, thereby encouraging greater participation by these companies. However, this approach can also have disadvantages, as large companies may withdraw if they consider the lots too small to achieve economies of scale or cover their fixed costs.

The strong positive relationship between lead time and the number of bidders supports the findings of Jofre-Bonet and Pesendorfer (2003), who show that companies already engaged in projects are less likely to bid on short-term contracts. Participants assess their ability to meet the deadlines specified in the call for tenders before deciding whether to participate. Short deadlines are often seen as added pressure, which can discourage some bidders, especially SMEs, who may lack the resources to complete the contract quickly without sacrificing quality (Lewis and Bajari, 2011). Conversely, a longer lead time allows companies to prepare more thoroughly and fulfill their commitments. In such cases, even less experienced companies may feel motivated to bid. Extended lead times can be viewed as a form of support for learning by doing, thereby improving performance. However, a short lead time imposes constraints that can lead to unpredictable and challenging cost estimates.

The location of the contracting authority, contract characteristics, and award procedures significantly influence competition levels for public contracts. Unlike central government contracts, those by other categories tend to attract fewer bidders. The central administration is the most prominent and best-informed category, mainly through the budgetary processes established by the National Assembly. This supports Hattori (2010) and Onur et al (2012), who show that urban areas with the most contracting authorities typically draw more participants. Companies generally locate near consumers or production factors. The fewer bidders for "Société d'Etat" compared to "Etat central" can be due to the budget process, informational benefits, and the ambiguous role of "state-owned enterprises," which sometimes act as contracting authorities and other times as bidders, creating mistrust among private bidders. For private bidders, this situation incurs specific costs that weaken their competitiveness and may discourage them from participating in tenders issued by these state-owned enterprises. This finding aligns with Leite (2025), who emphasizes the adverse effects of uncertainties tied to public actions in public procurement.

The funding source shows a negative link between the number of bidders and the share of contracts funded internally versus externally. This aligns with Benamghar and Iimi (2011), who found about 4.5 bidders for government-funded projects versus 7.3 for World Bank-funded projects. This difference likely stems from payment terms: externally funded contracts follow donor procedures, reducing intervention by contracting authorities and political powers. This perceived lack of manipulation encourages companies to pursue such contracts. Also, flexible payment terms, especially requiring an advance, help address cashflow issues faced by construction and public works companies, providing a further incentive.

The findings also show that a 1 percent increase in competition levels leads to an approximately 0.14–0.17 percent decrease in the ratio of the assigned price to the estimated cost. This supports the observations of Matilla-García and Vega (2025), who noted an average cost reduction of 2.1 percent in public procurement after a one-unit rise in the number of bidders. However, this relationship is not linear. De Oliveira Leite et al (2025) confirmed this nonlinear pattern. Additionally, Pavel and Slavík (2018) demonstrated that the strong initial competitive effect weakens as price reductions near the fixed costs that bidders cannot modify in the short term. Nakanishi (2022) found a consistent decrease of 14.475 in the ratio for each unit increase in the logarithm of the number of bidders. Meanwhile, Stehlík (2018) reported a price decline of 3.04 percent with each additional bidder.

The results indicate that optimal competition, combined with cost minimization, is observed for a number of bidders between 6.75 and 9.31. This range is consistent with estimates established by Onur and Taş (2019) for the Turkish context and by Nishikawa (2024) for Japan. As a comparison, the current average number of bidders is 5.24. If competition reached its optimal level, the relative cost of public contracts would decrease by 0.5–3.15 percent, with an estimated average reduction of 1.85 percent. In absolute terms, this decrease would translate into additional savings per contract of between 1.2 and 6.3 million CFA francs, with an average saving of approximately 3.7 million CFA francs compared to the situation with 5.24 competitors.

Turnaround times and thresholds influence the escalation of public contract prices. The impact of an extended lead time on pricing seems to contradict earlier empirical studies (Lewis and Bajari, 2011; Li and Shao, 2015). Bidders view a longer lead time as a sign of insufficient time incentives, which may cause them to forgo other potential opportunities. Since time is linked to financial resources, bidders often add a premium to their bids to compensate for these missed opportunities, leading to higher bid prices. Conversely, strict time constraints might force bidders to raise their prices to cover the additional costs of speeding up project completion. This contrasts with previous research that associates shorter lead times with higher costs. Specifically, Chever et al (2017) found a significant correlation at the 10 percent level, indicating that for each extra month added to the contract duration, the relative price decreases by 0.005. This suggests that more extended contracts may encourage bidders to offer lower prices.

The positive and significant effect of the threshold variable on bidder participation is supported by Onur and Taş (2019) and Onur et al (2012). This variable operates similarly to the administrative estimate, with larger public contracts attracting more bidders. Public works contracts positively influence the bidder ratio, while service contracts have an adverse effect. This difference can be explained by the unique characteristics of these contract types, which impose different levels of constraints and responsibilities on bidders.

Conclusion

This article has examined the effectiveness of public procurement by analyzing the factors that influence competition and their effect on public contract costs. It has utilized a data set of procurement procedures initiated by various contracting authorities from 2016 to 2018. The findings support the initial hypothesis of a competitive effect, showing that an increase in the number of bidders tends to lower public procurement prices. The results also indicate that the procurement procedure, the origin of funding, the number of lots, the contracting authority, and the administrative estimate are not neutral regarding the level of competition. Specifically, there is a positive relationship between open procedures, the number of lots, central-level contracting authorities, external funding, and the number of bidders.

Regarding competition, results show that the current number of bidders is low and confirm a nonlinear negative relationship between the number of bidders and the price of public contracts. This competitive effect results in an average decrease of 1.85 percent in the ratio of the winning bid to the reserve price when competition is increased to its optimal level of seven to nine bidders. Contracting authorities can expect to pay roughly 3.7 million CFA francs less per contract. Therefore, supporting policies and strategies that boost competitive effects is important. The positive influence of the number of lots, contrasted with the negative impact of contract complexity, highlights the need for governments to strengthen policies that improve access to public procurement for SMEs, which are a vital part of the economic ecosystem. The positive effect of external funding on participant numbers stems from the transparency promoted by bilateral and multilateral funding agencies, as well as from lower submission costs and easier payment processes for completed contracts. Reforms encouraging strong participation could focus on building bidders' confidence and adopting flexible payment options to address companies' financial challenges. For instance, many donors, including the World Bank, require a start-up deposit for the contract to take effect. However, attracting participants must be managed carefully. This strategy only works when the number of participants is below the optimal level. Once the ideal number is reached, additional efforts may waste public resources meant to promote business engagement and could encourage collusive practices among bidders, thus weakening policy goals.

Our analysis has certain limitations. Our results should be interpreted with the understanding that this is only partial research and cannot be generalized. Many other factors, such as submission costs, influence the effectiveness of public procurement by affecting competition levels and prices, but these were omitted. Moreover, focusing on the awarded price instead of the final price paid after contract completion narrows the scope of conclusions regarding the competitive effect. The decrease in the awarded price could be part of strategic moves to secure the contract, with negotiations during project execution used to recover lost profits and achieve higher gains.

Finally, the possible reasons for the non-linearity between the number of bidders and the relative price of public procurement have not been identified or assessed. Investigating participation strategies, such as consortia or subcontracting, related to collusion or corruption in future research could be a first step toward answering this question.

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Appendix

Table A1: Description of variables

Variable	Definition	Obs	Mean	SD	Min	Max
WINBID	Amount in CFA francs awarded corresponding to the winning bid	1,604	2.00e+08	1.34e+09	824310	3.63e+10
ESCOST	Estimated amount (reserve price) or administrative estimate of the cost of the contract before launching the procedure	1,604	2.49e+08	1.68e+09	1223808	46870
BIDDER	Number of different bidders who submitted at least one bid, a variable used to measure competition	1,604	**5.238155**	**4.612294**	1	45
NBID	Number of bids received, which may be different from the number of bidders if the contract has more than one lot and when bidders are authorized to bid for more than one lot	1,604	7.666459	10.01436	1	91
NLOT	Number of contract lots, a variable that can be a measure of the market's complexity	1,604	1.819202	1.722402	1	16
TIME	Contract performance period in days announced and fixed in the contract award notice by the contracting authority	1,604	111.2781	120.27	7	900
SAVINGS	Measurement of "savings" achieved (difference between allocated amount and estimated amount)	1,604	4.89e+07	3.45e+08	–3.44e+07	1.06e+10
RATIO	Measurement of procedure "performance" (ratio between amount awarded and estimated amount)	1,604	.808823	.0998585	.1704703	1.2
THRES	Binary indicator variable taking the value of 1 if the administrative estimate is greater than or equal to the 20 million CFA francs threshold for the mandatory bidding procedure and 0 otherwise	1,604	.5461347	.4980223	0	1

(*Continued*)

Table A1: Continued

Variable	Definition	Obs	Mean	SD	Min	Max
AUTHORITY	Institutional variable designating a set of four indicator variables referring to the category of contracting authority (Central_State, State-Owned_Establishment, State_Company, Region_Municipality)	1,604	1.55985	1.295237	0	3
PROCEDURE	Set of three indicator variables referring to the procedure used to award the contract (open tender: Open_Auction; restricted tender: Restricted_Auction, Request for Quotation; Simplified_Auction)	1,604	.9301746	.9827519	0	2
TYPROCU	Set of three indicator variables identifying the type of market (goods, works, or services)	1,604	.5473815	.6355054	0	2
BUDGET	Binary indicator variable designating the source of market financing (Internal Resources or External Resources), taking the value of 1 if Internal Resources and 0 otherwise	1,604	.8834165	.3210235	0	1