Can Lotteries Improve Procurement Outcomes?*

Antonio Estache[†]

Université libre de Bruxelles, ECARES and I3h

Renaud Foucart[‡]

Lancaster University Management School

Tomas Serebrisky[§]

Inter-American Development Bank

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Abstract

This paper makes the case for the inclusion of lotteries in public procurement toolkits when governance and institutional weaknesses lead to recurring undesirable contract award outcomes. For contracts awarded through auctions, a lottery component can increase quality and reduce risks related to limited liability, renegotiations, and bid-rigging. For negotiated contracts, a lottery component can reduce corruption risks related to the selection processes of bidders, decision committee members, or auditors. The summary of the still modest empirical evidence shows promising prospects but also some limitations. The paper argues that more experiments would help to refine the opportunities identified by the theoretical literature.

Keywords: rules, discretion, procurement, lotteries, corruption, auctions
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[†]Antonio.Estache@ulb.be
[‡]r.foucart@lancaster.ac.uk
[§]tserebrisky@iadb.org

1 Introduction

Public procurement represents about 12% of global GDP (Bosio *et al.*, 2022), reaching up to 20% in many of the poorest countries (Adam *et al.*, 2021). For Procurement Agencies (PAs), whether in developed or developing economies, identifying and selecting the right contractor to deliver goods and services is more challenging in practice than procurement theory and operational guidelines suggest. This challenge is particularly constraining when governance and institutional capacity are weak. Limited competence, accountability, budgets, or corruption influence procurement outcomes. This holds true for both basic needs (e.g., office equipment, surgical masks, water pumps, solar panels) and sophisticated needs (e.g., medication, nuclear plants, airplanes, high-speed trains).

The failure to meet procurement challenges is costly. In infrastructure, the IMF staff recently estimated it added up to about 15% to costs in advanced economies, 35% in emerging economies, and 53% in low-income developing countries (Schwartz *et al.*, 2020). In the health sector, during the 2020-2021 Covid crisis, mismanagement of emergency procurement processes for protective masks led to inflated prices or equipment that did not meet quality or safety requirements, leading to public suspicion of corruption and incompetence (Estache and Foucart, 2021).

Quality issues from procurement mismanagement are not only a concern for emerging and low-income countries but can also impact developed economies. In the UK, for instance, some equipment acquired during the Covid crisis had to be disposed of, and 75% of the £12 billion spent by the government on personal protective equipment during the first year of the pandemic was essentially lost (UK Department of Health and Social Care, 2022). The British health sector, like many others, lacked the institutional capacity to handle the crisis demands and failed to anticipate issues raised by standard procurement rules.

The diverse sources of failures explaining high excess costs across sectors and countries have been well documented by academics and international organizations (Baltrunaite *et al.*, 2021; Bandiera *et al.*, 2009; Beuve *et al.*, 2018; Coviello *et al.*, 2018; Decarolis, 2018; Estache and Iimi, 2011; Fazekas *et al.*, 2021; Flyvbjerg *et al.*, 2018; Guasch, 2004; Guasch *et al.*, 2016; OECD, 2016; Persson *et al.*, 2024; Spagnolo, 2012; Szucs, 2024). These authors highlight problems in project design, specification, and implementation stages. Their research emphasizes difficulties in selecting and evaluating bidders as a key driver of failures. Many of these difficulties align with governance and institutional weaknesses, indicating that one size does not fit all contexts. The recurring nature of contract award failures argues for new tools to complement or replace current mainstream choices in bidder selection and assessment. This is where the analysis of lotteries for

awarding government contracts fits.

To show how lotteries could improve procurement outcomes, the paper provides: (i) a stylized framework synthesizing established and new suggestions from the literature to demonstrate when and how adding a lottery component to standard procurement contracts may improve outcomes under governance and institutional limitations, (ii) a discussion of the limitations of this addition to procurement toolkits, and (iii) suggestions for follow-up research and field experiments to test guidance from the literature on social choice, public, and experimental economics.

The main message from synthesizing and reconciling the multiple partial results offered by the literature is that lotteries can address recurring failures in standard procurement processes across various governance, institutional, and sectoral contexts. This applies whether lotteries are discretionary or rule-based. The effectiveness of adding a random component to procurement procedures depends on matching lottery design with failure drivers and choosing appropriate award criteria. Lotteries are not foolproof, and much is still to be learned about improving their implementation in weak governance settings. So far, the main insights are as follows.

When the award is rule-based, as in auctions, lotteries can reduce adverse selection risks, the main problem. Standard procedures often lead to lower-quality projects or increased defaults and renegotiations. Partial lotteries can improve auction quality outcomes or reduce default risks. However, their effectiveness depends on the PA's willingness to prioritize producer surplus over consumer surplus, as lotteries offer higher rents to contractors. Rent levels and distribution are crucial to the viability of lotteries, despite associated political risks.

When the contract award process is discretionary, as in bilateral negotiations, lotteries can mitigate moral hazard risks by decreasing bribery incentives. This is particularly attractive in contexts with weak institutions and proven corruption concerns. Although lotteries are not foolproof and may not always select the most cost-efficient bidder, this cost can be reduced by broadening the pool of potential bidders, including at the preselection stage.

The discussion of these contributions is organized into four parts. The first focuses on the use of lotteries in rule-based procedures (auctions). The second addresses discretionary procedures (direct negotiations). The third identifies issues of practical feasibility and social acceptability. It concludes with a discussion of additional analysis needed to implement lotteries in practice.

2 How Lotteries Can Improve Procurement Auctions

Auctions are widely recognized as an effective method for allowing potential suppliers to compete for government contracts, often relying on the lowest price as the winning criterion. This approach is popular due to its simplicity and promise of cost-efficiency, with over 80% of European contracts awarded using some form of competitive bidding in 2021 (European Court of Auditors, 2023). However, this criterion is increasingly questioned, particularly in developing economies, where complementary criteria are being considered. The same ECA report estimates that 42% of contracts were awarded based based on more dimensions than the lowest price.

2.1 Lotteries can help overcome adverse selection problems

Adverse selection (AS) is a primary concern in price-based auctions due to limited information about bidders, such as their true cost, the quality of their product, or their solvency. Institutional weaknesses can exacerbate this issue, leading to undesirable outcomes such as low-quality projects or defaults.

For instance, Thames Water, the largest privatized water company in the UK, admitted to not complying with contractual obligations to invest in sewage treatment facilities because it had to use the revenue to service its debt and pay dividends, resulting in deteriorated water quality and public safety risks. The case of Thames Water illustrates the well-established result that, even if the PA can define a minimum quality standard for a project, actual quality continues to be a potential strategic cost adjustment variable across sectors and countries.

An added difficulty is that firms bidding more aggressively are more likely to default or renegotiate. This may be either because they are weaker from a financial viewpoint or because they have stronger leverage in their interactions with the authorities.[1] This possible risk has proven to be quite concrete in practice as it explains many of the defaults and renegotiations observed in multiple case studies (Guasch *et al.*, 2016). For Latin America, for instance, Bonifaz and Saavedra (2023) argue that 68% of public-private partnership contracts undergo renegotiations. If lotteries are to be useful, they also need to be able to help minimize this second type of recurring problem with price-based auctions.

To mitigate AS risks, lotteries can be integrated into the auction process. By randomizing the contract award among qualified bidders, lotteries can reduce the likelihood

[1] Here, we consider renegotiation as a situation in which a contractor holds up the PA by asking for more money after the project has started, a negative view that has been challenged, for instance, by Beuve and Saussier (2021) in their study of the French parking sector.

of selecting firms that cut costs by lowering quality or by taking excessive risk of default. This approach is particularly beneficial in sectors where quality issues may not be immediately apparent, such as new utilities or infrastructure projects.

A simple lottery component can be added to auctions by setting a maximum acceptable price and randomizing the contract award among bidders at or below this price. This allows PAs to focus on surplus rather than just cost, potentially increasing consumer surplus.

More complex lottery designs, such as the Lowball Lottery Auction (LoLA), combine lotteries with second-price auctions. LoLA sets a maximum and minimum price, paying the winning firm the second-lowest bid. This design limits the rent given to the winner while ensuring that at least one firm wins the project. Another variant is the third-price lottery, where the two lowest bidders are selected by lottery, and the contract price is set at the third-lowest bid.

The next subsections present these results in a simple stylized framework of an auction procedure.

2.2 A stylized framework to understand the different procedures

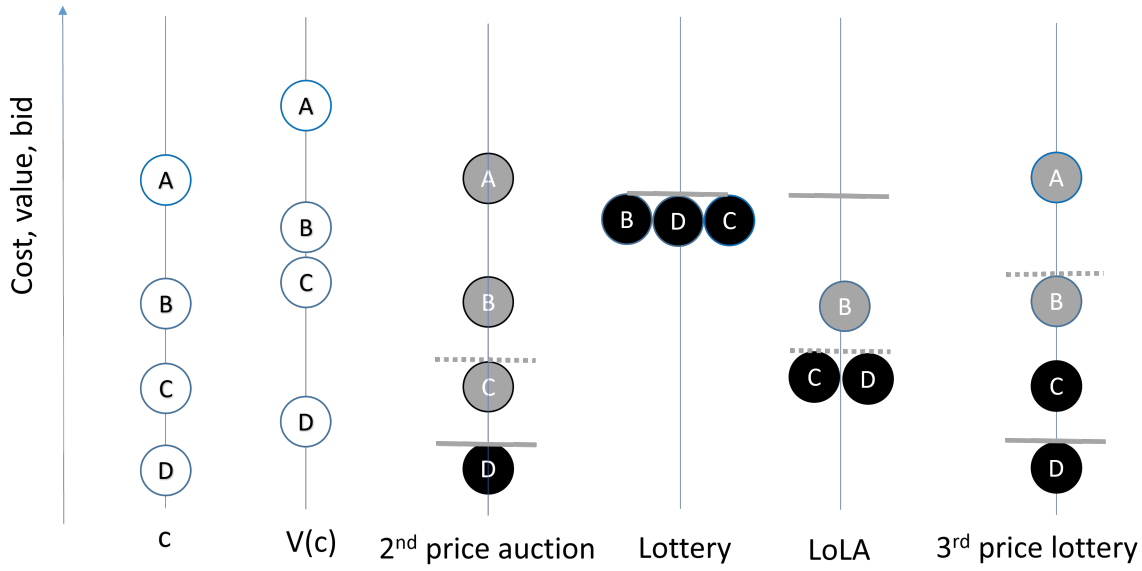
To formalize the decision-making process, consider a procurement agency (PA) selecting a single contractor among firms that have passed a pre-qualification screening stage. The contract is awarded to the firm bidding the lowest price. This approach often defines winners in concessions for water, health facilities, and toll road projects.

The model follows Lopomo *et al.* (2023), considering a common context – say the situation faced by a PA picking the firm that will build a water treatment facility, a road maintenance program, a hospital or a contract with a consulting firm – where N firms compete for a contract. Each firm $i \in \{1, 2, \ldots, N\}$ has a cost c_i to deliver the project. The value of the output to consumers is measured in terms of consumer surplus, modeled as a function $v(c_i)$, with $v'(c_i) \geq 0$.

The difficulty for the PA is tracking the evolution of consumer surplus. A firm may deliver the output at a lower cost due to efficiency or by cutting costs through lowering quality. This can lead to a recurring lemon problem where only low-quality projects are delivered when institutional capacity is limited. Similar results where obtained by Decarolis (2018), looking at limited liability instead of quality as the source of adverse selection, we discuss the link between the two models in Appendix A.

Figure 1 illustrates different procurement processes, highlighting the lemon problem where the lowest-cost firm does not generate the highest surplus. Lotteries can address

Figure 1: Rule-based procedures



this by randomizing the award process, ensuring that the firm with the highest potential surplus has a chance to win the contract.

The first two columns of the figure show the cost c for each bidder and the value $V(c)$ of the project to consumers. The next columns represent the equilibrium bids under different procedures. In this Figure, the firm with the lowest cost (c, firm D) is not the same as the firm generating the highest surplus ($V - c$, firm C). This discrepancy illustrates the lemon problem, where the standard price-based auction may not allocate the contract to the firm that maximizes consumer surplus.

2.3 Comparing Auctions with and without Lotteries

In a context where contracts are awarded through auctions, firms typically submit written bids without knowing the bids of other firms. The third column of Figure 1 illustrates the procedure when the award criterion is a second-price auction. In our case, the results are equivalent to those of a standard descending English auction, where bidders sequentially lower their bids (Milgrom and Weber, 1982).

In this setting, the winner is the firm with the lowest willingness to bid (firm D, in black). The horizontal line at the bottom represents the bid of the lowest bidder, firm D. However, under the adopted auction design, the contracted price corresponds to the second lowest willingness to bid. The dashed line represents the second lowest bid, which is the price at which the contract is agreed. In practice, this approach aims to incentivize firms to make their best bid, as they stand to gain a reasonable profit margin if their costs are indeed the lowest.

Conceptually, this implies that it is a weakly dominant strategy for all firms to state their true valuation. Firm D has nothing to gain from increasing or lowering its bid as long as it is below C. It would lose out by bidding above C and not being selected. Firm C has nothing to gain from increasing its bid above D, as it would still lose, and would lose out by bidding below D, as it would have to deliver the project for less than its cost. In sum, all firms will bid their exact cost, and this corresponds to a unique symmetric Bayesian Nash equilibrium of this game. However, this is not necessarily good news for the PA or the consumers.

This equilibrium affects the level and distribution of the potential consumer surplus associated with this procurement process. The common auctions we are analyzing lead to two potential sources of consumer surplus losses. The first arises from the need for the PA to offer some surplus to the auction winner, which is the difference between the cost of D and the cost of C. The second is linked to the lemon problem we have emphasized: not allocating the contract to firm C, which would have generated a higher surplus. It is crucial to distinguish between these two sources, as only the second can be addressed by a lottery complementing the auction.

To understand how adopting a lottery could change the outcome, consider adding a simple lottery component where the PA tries to mitigate excess costs linked to the lemon problem by setting a maximum acceptable price $\bar{p}$. This is reflected by the horizontal line at the top of the fourth column of Figure 1.

In practice, the lottery introduces randomization in the allocation of the contract among all firms bidding at or below the maximum price. This way, the PA is not always forced to select the firm with the lowest cost, even if the surplus it generates is lower. The main attraction of the lottery is that it allows the PA to focus on surplus rather than just costs. A similar change in focus has been adopted by some international organizations to include sustainability criteria in their valuation of bids.[2] The result that optimal procurement mechanisms involve a form of randomization in the presence of adverse selection problems has been established by Burguet *et al.* (2012). We show in the next subsection that it is possible to do better than a full lottery over all qualified bidders.

[2]Since 2016, the World Bank has recommended relying on "rated criteria" to evaluate quality, sustainability, and innovative aspects of bids in decision-making. The idea is to prioritize fit-for-purpose solutions over the lowest evaluated price. Since September 1, 2023, this criterion has become the default approach for most international procurement contracts, except for pharmaceuticals, vaccines, commodities, and some educational materials. See https://projects.worldbank.org/en/projects-operations/products-and-services/brief/rated-criteria.

2.4 Optimal Lottery Design

At this stage, the literature suggests that the specific form of lottery that can deliver the most comprehensive solution to address predictable adverse selection risks is a combination of a lottery and second-price auction called the Lowball Lottery Auction (LoLA) (Lopomo *et al.*, 2023). Its advantage over a simple lottery is that it ensures at least one firm will win the project by setting a higher maximum price without necessarily having to pay that price, while also limiting the rent given to the winning firm. Depending on the value the PA assigns to the producer surplus, it can vary how much it is willing to reduce the sum of consumer and producer surplus to maximize consumer surplus.

For all values assigned to the producer surplus, LoLA is the optimal mechanism because it selects a maximum price $\bar{p}$ (the solid line at the top of the fifth column of Figure 1) and a minimum price $\underline{p}$ (the dashed line), and pays the winning firm the second lowest bid – $\underline{p}$ or higher if zero or a single firm bids exactly the minimum. In practice, as in the second-price auction, at the optimum, all firms bid either their valuation or the minimum price, whichever is higher. If more than one firm bids the lowest price, a lottery determines the winner.

Another variant of the lottery, which also limits the rent given to the winning firm, is a third-price lottery, or "truncated English auction," introduced by Engel and Wambach (2006). It is similar to a second-price auction, except that the two lowest bidders (C and D in the last column of Figure 1) are selected with equal probability by a lottery. The contract is then agreed at a price corresponding to that of the third lowest bidder. A useful property of this procedure is that the firms' bids are identical to those in the second-price auction. The third-price lottery is equivalent to an open exit descending or a reverse "English" auction in which the price is decreased continuously until all but two bidders are left. The winner is then selected at random among these two, and the price is the one at which the third lowest bidder left. It is also reminiscent of the Anglo-Dutch auction (Klemperer, 2002), which is an ascending auction followed by a final sealed bid auction among the last two bidders.

2.5 Some limitations to the optimal auction-based lotteries

An important limitation of the recommendations emerging from the simple model presented above is that we assume there is no collusion among bidders. However, such cartels are prevalent in practice (see, for instance, Kawai and Nakabayashi, 2022) and may limit the benefits of using an auction procedure in the first place.

However, there is a potential role for lotteries in deterring collusion when auctions are the preferred award process. The idea is similar to a result found by Chassang and

Ortner (2019) in the case of a PA setting a minimum price in auctions: by guaranteeing a higher surplus to bidders, a procedure involving a lottery diminishes the possibilities for the cartel to punish the deviator. Thus, lotteries could also be a useful tool to deter bid-rigging cartels. However, one inconvenient aspect of lottery procedures in terms of deterring collusion is that a deviator outbidding other cartel members is not guaranteed to win the contract.

3 How Lotteries Can Improve Discretionary Procedures

While there is no detailed global data on the use of all discretionary procedures, a significant share of procurement contracts is allocated to a sole "bidder," often associated with discretionary procedures in practice. This approach, known as *single-bidding,* involves awarding a contract without any competition.

In a recent survey, the European Court of Auditors (2023) showed that, in Europe, the share of single-bidding contracts across the procurement market increased from 23.5% to 41.8% between 2011 and 2021. According to Kang and Miller (2022), in the US, these contracts correspond to about 45% of the value of federal procurement contracts. From the government and users' perspective, the main concern with this approach is that it tends to be associated with higher prices (Decarolis, 2014), often linked to corruption and higher procurement costs. Bosio *et al.* (2022) estimate the amount of bribes ranging from 8% to 25% of the value of procured goods, services, or works.

This section reviews how lotteries could lead to lower prices for some projects, goods, or services by addressing the distortions linked to moral hazard (MH) risks due to significant governance issues.

3.1 Lotteries can help overcome moral hazard problems

Before exploring the potential role of lotteries in this context, it is useful to conceptualize the distortions associated with discretionary and negotiated procurement procedures. The procurement agency (PA) aims to award a contract for a specific service or project using a "cost-plus" contract, where the firm's mark-up is assumed to be zero for simplicity. In a cost-plus contract, the firm's legally-acquired surplus is constant regardless of the cost.

The PA often delegates the procurement process to a Procurement Officer (PO), who is tasked to select the firm generating the highest surplus, $V(c) - c$, as defined in the previous section. Since the PO has private knowledge of the firms not available to the

PA, this leads to a moral hazard (MH) risk. The PO may favor a specific firm or be influenced by a firm to give it special treatment. This scenario has been documented in numerous case studies (Bosio *et al.*, 2022; Szucs, 2024).

In practice, this MH risk is often associated with corruption when governance standards are weak, impacting the cost or quality outcomes of the procurement process. This may include a wide range of tricks, such as tolerance for misleading or incorrect information, variations in the volume or quality of products or services, project descriptions written to favor a specific potential candidate, uneven access to project information by bidders, or tolerance for conflicts of interest. Since the PA and the PO are the only parties involved, identifying the distortion without further action, such as auditing or benchmarking outcomes, is difficult. However, as demonstrated by the introduction of lotteries in the allocation of customs management in Madagascar (Chalendard *et al.*, 2023), when firms can no longer guarantee the purchase of a specific outcome from a civil servant, corruption decreases.

To focus on the effects of the MH dimensions linked to the process, we assume that the PA does not value the surplus stemming from corruption. The PA's objective is to maximize consumer surplus, as the legally-acquired producer surplus is constant.

In that context, introducing lotteries between a subset of contractors selected by the PO reduces the possibility for a PO to abuse their power through corruption and the exchange of favors. However, this comes at the cost of decreasing the social benefits from their knowledge of the contract to be awarded and of the industry. The latter cost can be mitigated through a combination of lotteries, discretion, and linking the audit probability with the amount of discretion used by the PO.

The next subsections present these results in a simple stylized framework of a discrete procedure for the allocation of public contracts.

3.2 Discretion with and without a Lottery Component

To consider the impact of corruption or other MH risks, we benchmark a basic discretionary procedure against various types of lotteries and analyze how random audits of bids can reinforce lotteries or offset their weaknesses.

3.2.1 Discretionary Award Procedures

Assume there are N firms that have passed a pre-selection phase and are competing to procure a project. The value of the project to consumers, $v(c)$, is constant across firms, i.e., $v(c) = V$, and each firm $i \in \{1, N\}$ has a private cost of delivering the project, c_i,

drawn from a continuous log-concave distribution[3] with density $f(x)$ over the interval $[l, h]$. The PO selects the firm with the lowest cost, $c_{(1,N)}$.

Corruption is not universal, so with probability $1 - \sigma$, there is no corruption, and the bureaucrat reimburses the firm's cost. However, with probability σ, the PO enters a corruption pact with the firm, overestimating costs by D, resulting in an expected reimbursement of $c_{(1,N)} + D$.

Our assumption that corruption happens with probability σ could either correspond to different opportunities to extract rents through corruption or to exogenous individual differences in preference for honesty or truth-telling (Abeler *et al.*, 2019). This does not mean that the PO or the firm will admit corruption even if costs are unexpectedly high. Here, we assume corruption allows the selected firm to pretend it was in that bad state of the world and claim a higher amount. This form of corruption is similar to the idea studied in (Estache and Foucart, 2018) that it is often difficult for an outsider to distinguish corruption from bad luck and incompetence, and that POs and private firms can exploit this information asymmetry to extract a rent. Hence, it is possible for the PO and the firm to agree to report a high cost rather than the true low cost in the good state of the world, and to pocket and share the difference.

The expected consumer surplus for this discretionary procedure, $S_{d,s}$, is:

$$S_{d,s} = V - E(c_{(1,N)}) - \sigma(1 - \theta)D, \tag{1}$$

where V is the value of the project to consumers, $E(c_{(1,N)})$ is the expected value of the first order statistic of the distribution of costs, and $\sigma(1 - \theta)D$ is the extra cost of corruption for the taxpayer.

The main risk is that the efficiency gains may be captured by the firm and the PO rather than shared with consumers. Increasing the number of pre-selected bidders always benefits consumers, as costs are independently drawn from a distribution. Finding a way to mitigate the PO's informational advantage would significantly reduce MH risks, which is where lotteries can help.

3.2.2 Discretionary Lotteries

A lottery can bypass POs to pick the winning bidder among all firms that have passed the pre-selection phase. Any firm can be awarded the contract with equal probability, and the PA reimburses the actual cost incurred by the selected firm. The expected consumer

[3]Log-concavity ensures that the presence of a larger number of participants in the auction decreases the expected difference between the lowest and the second-lowest cost among the participating firms. This assumption is satisfied by most commonly-used density functions (see Caplin and Nalebuff, 1991; Anderson and Renault, 1999.

surplus if the contract is assigned at random, $S_{d,l}$, is:

$$S_{d,l} = V - E(c_i). \tag{2}$$

The trade-off between discretion and lottery is that negotiation allows the use of the PO's knowledge, while the lottery solves the MH problem of corruption but forgoes the PO's private information. With a lottery, the PA cannot select the most efficient firm, as it does not have the private knowledge of the expected cost. In contexts with high corruption risks and weak institutional capacity, the PA may prefer a standard lottery over a discretionary procedure. This happens when the cost of corruption $\sigma(1-\theta)D$ is higher than the efficiency loss from allocating at random, $E(c_i) - E(c_{(1,N)})$.

The adoption of lotteries offers a menu of options. For instance, the PA could request the PO to select the two firms generating the highest surplus, and a third party could operate a lottery to select the winning bid between those two. In this "discretionary lottery" procedure, the expected consumer surplus is:

$$S_{d,dl} = V - \frac{E(c_{(1,N)}) + E(c_{(2,N)})}{2}, \tag{3}$$

where the second term is the expected value of the average between the first and second order statistic of the distribution of costs among N participants.

The expected consumer surplus is higher under a discretionary lottery than under a discretionary procedure if:

$$\sigma(1-\theta)D > \frac{E(c_{(2,N)}) - E(c_{(1,N)})}{2}, \tag{4}$$

where the right-hand side decreases with the number of qualified bidders, N (see appendix B).

In practice, choosing the number of participants in the lottery could be done by relying on a procedure similar to the pre-qualification phase. The PA would want to maximize the number of bidders, while the PO would pick the smallest number that guarantees corruption is not an issue.

Ultimately, the main practical risk with relying on a lottery to reduce corruption and other forms of MH is that it may increase adverse selection (AS) issues. Thus, there is a need to assess the relative importance of the two issues before considering the potential attractiveness of including lotteries in the procurement toolkit of the PA.

3.3 Random Audits and Endogenous Choice of Lottery Participants

Audits play a crucial role in reducing MH, as seen in various empirical studies. For instance, in Argentina, audits reduced hospital supply prices by 15% (Di Tella and Schargrodsky, 2003). In Indonesia, road construction costs were lower when audited with

high probability (Olken, 2007). In Brazil, the probability of being audited decreased corruption-related irregularities in municipalities (Zamboni and Litschig, 2018).

Random audits of POs can reduce MH and leverage the PO's knowledge in a discretionary lottery procedure with a strict number of lottery participants. Consider situations where POs know the potential bidders well. In such cases, POs may want to select only one "truly best" firm or use a lottery to pick between equivalent projects. The PA may want to trust the PO but also hedge against missteps.

A Brazilian experience shows that this could be addressed by relying on a system inspired by semi-random audits of the POs (Ferraz and Finan, 2008). In that case, the probability of a PO being audited would vary and decrease with the number of bidders subject to randomization.

To analyze the dimensions associated with these audits, assume POs can choose between selecting a single firm (discretionary procedure) or selecting two firms (discretionary lottery). Assume corruption can only happen when a single firm is selected, and POs are audited with probability $q > 0$ only when they choose a single firm.

Let $p \in (0.5, 1)$ be the probability that the audit result is correct, and $1 - p$ the probability that it is incorrect. Let $F > 0$ be the utility cost for a PO found corrupt by the audit. In the Brazilian experience, this cost corresponds to a lower probability of re-election for politicians or a fine/reduction in promotion probability for bureaucrats.

In Appendix C, we show that if auditing costs are not too low, a policy of random audits with endogenous procedure choice can outperform a discretionary lottery with a fixed number of participants. We assume a share of "bad" POs care only about making money and the risk of being found corrupt, while "good" POs care about procurement costs and their reputation. The intuition is that there exists an audit probability such that bad POs always prefer the safety of the discretionary lottery and do not engage in corruption. Only good POs sometimes pick a single firm when the cost advantage is sufficiently important.

There are two important caveats to this simplified model. First, there must be a commitment to audit on the PA's side, perhaps by delegating the task to independent auditors. In some ways, this is what international organizations do when they contribute to the financing of projects. Indeed, as only honest POs self-select in picking a single firm whenever the PA chooses the optimal auditing probability ($q = q^*$), there is a time inconsistency problem: a Bayesian PA would not want to spend money auditing honest POs only. Besides delegation, another reason to perform audits on honest procurement officers only would be to deter incompetence (Estache and Foucart, 2018) or limited knowledge of the market, which is the subject of the lottery, as is the case in the emerging markets for renewable technologies.

Second, we looked at a simplified version of the audit in which there is only a cost when the PO is found to be corrupt, but no benefit to being found not guilty (as documented by Ferraz and Finan, 2008). Adding such benefits would strengthen the case for endogenous procedure choice as more honest POs would want to pick the lowest cost firm. In the symmetric case where the benefit of being found non-corrupt is equivalent to the cost of being found corrupt, as ($p > \frac{1}{2}$), all honest POs would pick a single firm.

3.4 Random Dictators

The effectiveness of procurement processes often depends on how decision-making authority is delegated. This includes decisions on the award procedure, winner selection, and implementation supervision. A reasonable choice is whether to rely on a single PO or a committee of several members for each procurement activity. When corruption risks are significant, a committee can help minimize undesirable outcomes and aggregate different perspectives to reduce uncertainty.

To see the potential attractiveness of committees, consider a situation where each committee member identifies the lowest bid with independent probability μ and picks a firm at random with probability $1 - \mu$. With a single decision-maker, the expected cost of the project is $\mu E(c_{(1,N)}) + (1 - \mu)E(c)$. If all members report their observations truthfully, the Condorcet jury theorem (Austen-Smith and Banks, 1996) states that when the number of committee members is sufficiently large, the probability that the committee identifies the correct bidder converges to one, and the expected cost to $E(c_{(1,N)})$. In this ideal setting, the optimal number of committee members is reached when the marginal decrease in the expected contract cost equals the cost of hiring one additional member.

However, committees face issues such as lengthy discussions and strategic behavior, including collusion. This is where random dictatorships (Gibbard, 1977) —a strategy-proof decision rule guaranteeing Pareto efficiency and ex-ante equal treatment of all committee members by implementing the decision of one member at random—may be a better option for reinforcing the potential effectiveness of committees.

In a Random Dictatorship, committee members share their expertise on different projects and communicate with each other, but instead of casting votes or reaching a consensus, they report their preferences privately to a third party, and the choice of one committee member is implemented at random. Experimental evidence also suggests that random dictatorships are not perceived as a loss of control (Estache *et al.*, 2024), preserving the benefits of autonomy (Bandiera *et al.*, 2021) and helping the PA achieve better outcomes from their procurement processes.

4 What Does the Empirical and Experimental Evidence Add?

Despite the conceptual attractiveness of the lottery approach in a number of settings, evidence on its costs and benefits is limited, as it has not been tested extensively. Uruguay and Ecuador are the only two countries known to have implemented large-scale random allocation procedures with detailed independent evaluations (Brugués *et al.*, 2024; Carrillo *et al.*, 2023; Fadic, 2020). Bangladesh has also used lotteries to award contracts, though without comparable quantitative evaluation, as assessed in a World Bank report (World Bank, 2020).

4.1 Country Case Studies

In Uruguay, the approach (known as *menor cuantía*) applies to the procurement of relatively small public works. All firms that pass a pre-qualification phase have the same probability of being selected by a centralized algorithm. Fadic (2020) studied this project, focusing on promoting the growth of local SMEs, as the lottery was tested in a context where the government valued producer surplus.

Similarly, in Ecuador, since 2009, public works below a specified value are allocated to SMEs through a random online lottery from a pool of registered and pre-qualified SMEs. Carrillo *et al.* (2023) found that the approach allowed substantial short-term increases in firm scale but did not sustain long-term growth. Notably, it did not crowd out sales to non-lottery activities. Brugués *et al.* (2024) examined the room for political interference, comparing the extent to which political connections help bidders win contracts. They found that political connections had a much lower impact on the odds of winning a contract for auctions than for discretionary contracts, and no effect on contracts allocated randomly.

The Bangladesh case is less analytically documented but reflects a country criticized for relying on lotteries for small contracts without addressing governance issues. The lottery was intended to encourage small and new bidders, but the implementation was less successful than expected. A World Bank (2020) evaluation suggested that most new and small bidders did not gain the intended advantage. The lottery implementation led to unexpected distortions, such as larger bidders creating multiple firms to increase their odds of winning. Additionally, the lack of experience led to significant project implementation issues for some new actors. In Bangladesh, e-procurement is now considered a more effective tool given the lasting governance constraints that limited the lottery option (Mahmood, 2010; World Bank, 2020).

4.2 Average Bid Auctions

While we are not aware of other large-scale explicit lottery procedures in procurement practice, a type of auction where all firms are selected at random and pay the reserve price—the Average Bid Auction (ABA)—comes close. The ABA is or was present in public procurement procedures in Chile, China, Colombia, Italy, Japan, Peru, Switzerland, and Taiwan, among others. In the US, it has been used by the Florida Department of Transport and the New York State procurement agency (Decarolis, 2018).

In one variant of the ABA, all firms bid on discounts over a reserve price. The firm whose bid is closest to the average is selected and delivers the project at its own bid price. As shown by Decarolis (2018), such procedures are effectively random and lead to higher prices. Most ABA procedures, particularly the one used in Italy, incentivize firms to bid at the reserve price. Decarolis (2018) quantified a production cost one-sixth higher in the ABA than in the first-price auction by comparing similar auctions held using the two procedures. This mixed result calls for intermediary procedures that combine the benefits of randomization in limiting the lemon problem and the benefits of classic auctions in extracting producer surplus.

5 Discussion and Alternative Procedures

5.1 Efficiency and Subcontracting

The possibility of subcontracting affects the level of efficiency and its distribution across stakeholders. Branzoli and Decarolis (2015) showed that while lotteries influence the nature of the firms selected ex-ante, they also affect the incentives to use subcontracting ex-post, leading to efficient outcomes.

Intuitively, if a lottery selects a high-cost firm, this firm could subcontract all parts of the project to the most efficient firm and pocket the difference, resulting in no loss of efficiency compared to selecting the best firm directly.

However, the possibility of subcontracting influences the distribution of any surplus achieved through efficiency improvements. A simple lottery will always be optimal if subcontracting is perfectly efficient and the PA puts the same weight on consumer and producer surplus. Otherwise, distributional disagreements may lead to suboptimal outcomes from a total social welfare perspective.

5.2 The Value of Control

An additional risk for implementing discretionary lotteries is the decreased benefits from empowering POs in discretionary procedures (Bandiera *et al.*, 2021). If POs select two or more firms instead of one, they may feel their authority carries less weight. This can be alleviated by giving POs formal control over all stages of the procedure, including ex-post negotiations and running the public lottery. Experimental research has shown that individuals have an intrinsic preference for control, even if it is often meaningless in practice (Bartling *et al.*, 2014; Owens *et al.*, 2014), and this preference extends to control over a lottery (Bouacida and Foucart, 2025). A notable exception is random dictatorships, as discussed above and in (Estache *et al.*, 2024).

5.3 The Social Acceptability of Lotteries

Besides concerns about the level and distribution of rents, lottery-based procedures may face social and political resistance, as some stakeholders may be reluctant to have their fate decided randomly (Elster, 1989; Bouacida and Foucart, 2025). Experimental evidence suggests that this reluctance can be alleviated by making the lottery less explicit. The preference for control may explain why formal lotteries are rare, while the equivalent Average Bid Auction is more widespread: the latter does not appear to be a lottery, even if it is effectively equivalent.

If a PA aims to implement lotteries and faces these concerns, it can rely on procedures equivalent to a lottery without involving formal randomization. One alternative is using an external, anonymous expert to assess the final set of projects. For example, in the third-price lottery auction, two contractors are selected, and an expert could rank them, mimicking a lottery outcome. Evidence from the allocation of research grants by expert panels shows that they rank projects in a way indistinguishable from a lottery (Graves *et al.*, 2011; Pier *et al.*, 2018), suggesting that a procurement committee could rank bids similarly.

5.4 Hybrid Procedures: Scoring Rules

Our dichotomy between discretionary and rule-based procedures does not consider the many procedures that use features of both. When the PA lacks enough information to quantify important parameters, such as dimensions of quality unobservable ex-ante or the reputation of bidders, many agencies rely on scoring auctions. In this procedure, the firm chosen to procure the good or service is selected through a scoring of specific price and quality dimensions, usually weighted to reflect their relative importance (Asker and Cantillon, 2008, 2010).

In the transport sector, hybrid procedures have been used since the 1990s in various countries (Asian Development Bank, 2018). A popular example is routine Rehabilitation and Maintenance Contracts (CREMA), which have delivered positive outcomes in efficiency and performance measures. These contracts require firms to maintain short stretches of roads for a period of 3 to 5 years (see Lancelot, 2010 for a detailed description of the Brazilian experience). Contractor selection can be based on both price and non-price criteria, and bidders can be pre-qualified or post-qualified based on technical and cost dimensions (Stankevich *et al.*, 2009).

The pragmatic "best value" approach in selecting a winner often delivers better and more sustainable road maintenance than standard "low bid" approaches because it accounts for multiple dimensions, including market and management characteristics. However, the scores and weights assigned to each criterion can be subjective. If corruption or political interference is a risk, a firm could try to influence the weight put on each criterion. In such cases, the PA could build a lottery procedure similar to the discretionary lottery to randomize this weight within certain limits, encouraging firms to offer the best project without focusing too much on the imperfect measurement of its value.

6 Conclusions

The academic literature on randomization in procurement auctions through lotteries is growing, warranting a review of key insights and ideas. These insights are gaining traction in policy circles, partly because business as usual is no longer an option due to the costly consequences of standard practices. Evidence shows about 15% higher procurement costs in advanced economies, 35% in emerging economies, and 53% in low-income developing countries (Schwartz *et al.*, 2020), not accounting for quality deceptions and other distortions associated with adverse selection and moral hazard.

The case for considering lotteries as a potential addition to the procurement toolkit is solid. Although most ideas come from theoretical or experimental work, detailed recent case studies show that a randomization approach to awarding government procurement may outperform standard options in various settings. Some case studies have produced early causal evidence on the payoffs of lotteries, which may be missing from more theoretical assessments. More applied research, including field experiments, is needed to assess the impact of varying lottery designs across governance, institutional, and sectoral settings.

The recent evolution of procurement procedures adopted by international organizations suggests a political and policy willingness to learn and improve, indicating that the timing to scale up testing of lotteries may be right. Adjustments will likely be slower than

hoped, as changes in public sector processes often are. Inherited adverse selection and moral hazard problems are not easy to eliminate, but even marginal changes can reduce the negative impact of excessively standardized rules on the effectiveness of government finance and delivery of projects, goods, and services through procurement.

More research is needed to better assess the costs and benefits of lotteries as a complement to traditional procurement approaches. This research should analyze the relevance of motivations for using lotteries and match specific designs with these motivations and contexts. It should also document the distributional consequences of achieving efficiency gains. The research agenda should address practical concerns, such as the feasibility of randomness in policy and implementation, stakeholder communication, and the political willingness to experiment with lotteries. The good news is that this research agenda will rely on the already detailed conceptual assessments of many of the multiple dimensions that can make or break the effectiveness of a procurement lottery. Hopefully, it will also be able to leverage the growing policy interest in using sandboxes to test the various implications of regulatory changes, such as the adoption of lotteries, while tracking the possible underestimated efficiency-equity trade-offs (Crampes and Estache, 2025). However, without the willingness of PAs and other key actors in the procurement market to experiment with lotteries, outcomes are likely to continue to disappoint consumers, taxpayers, and potential new bidders.

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Appendix

A Limited Liability and Adverse Selection

A firm i has a private cost of delivering the project c_i. With probability θ, the firm bears an additional cost D. The contract is awarded at a price p (the result of the auction procedure), and the costs are only privately observed by the firm.

In the Decarolis (2018) model, a firm is characterized by its type $\omega \in \{L, H\}$. Each firm has a private cost of bankruptcy (reputation, moral, legal), which is either zero (type L) or $\tau > 0$ (type H). A share μ of the firms is of type H. Only the firm knows its own type. There is also a loss of consumer surplus if the project is not delivered because the selected firm has defaulted, needed a bailout, or required renegotiation.

To keep the model tractable, we treat all events in which the winner needs to renegotiate as "defaults/bankruptcy" and assume a loss of consumer surplus equal to T in that event. We assume that all firms are risk-neutral and maximize their expected surplus.

The expected surplus of a firm, of either type, that would never default, is:

$$\pi_{H,nd} = \pi_{L,nd} = p - c_i - \theta D. \tag{5}$$

If a firm is of type H, it chooses not to default selectively when the state of the world is bad if the cost of default is sufficiently high:

$$\tau \geq p - c_i - D. \tag{6}$$

We follow Decarolis (2018) and assume this condition is always satisfied: the reputation cost τ for firms of type H is sufficiently high to ensure they always deliver. We only look at the bad state of the world when considering a possible default. The reason is that if a firm defaults in the good state of the world, it also has an incentive to do so in the bad state of the world and would therefore make no profit regardless of the bid.

However, we do not assume that a firm of type L always defaults, meaning that it is possible for a firm with no reputation concern to deliver when, even in the bad state, its cost remains below the contracted price, $p \geq c_i + D$.

In the presence of two types of firms, the smallest willingness to bid of a firm of type H is its expected cost, $b_H = c_i + \theta D$. However, because it is in a position to default when it is beneficial to do so, the smallest willingness to bid of a firm of type L is only $b_L = c_i$. Thus, either p is so high that all firms deliver in both states of the world, or the problem is similar to that described in Lopomo *et al.* (2023): all other things being equal, firms with a lower willingness to bid are also offering a lower expected value in terms of consumer surplus – in this case, because there is a strictly positive probability that they

will default. The main difference is that, in the case of limited liability, when the price paid to the firm increases, the value of the project may also increase if it reduces the risk of default.

B Number of Bidders in the Discretionary Procedure

The condition $\sigma(1-\theta)D > \frac{E(c_{(2,N)})-E(c_{(1,N)})}{2}$ is straightforward from taking the expressions of $S_{d,dl}$ and $S_{d,d}$. We see immediately that the left-hand side increases with σ and D and decreases with θ. To see that the right-hand side is decreasing in N, we use the fact that

$$E(c_{(2,N)}) - E(c_{(1,N)}) = N \int_l^h F(x)(1-F(x))^{N-1} dx,$$

using the density function of the first and second order statistics (see Paul and Gutierrez, 2004, p.105). Through Proposition 2.3 in Li (2005), we know that a condition for an increase in the number of participants to reduce the cost difference,

$$E(c_{(2,N)}) - E(c_{(1,N)}) > E(c_{(2,N+1)}) - E(c_{(1,N+1)}),$$

is that the distribution of the costs has a decreasing reversed hazard rate (DRHR), a property shared by all log-concave distributions (see, for instance, Result 2.2 in Chandra and Roy, 2001).

C Random Audit with Endogenous Procedure Choice

There are two types of POs. A share $1-\sigma$ are honest, motivated by the outcome of the procurement process, but also by the personal cost of being possibly found corrupt by an audit. Hence, an honest procurement officer prefers to pick the lowest-cost firm whenever the risk of being found corrupt due to a judicial error is low enough to compensate for the social benefit of choosing the best firm:

$$c_{(1,N)} + q(1-p)F \leq c_{(2,N)} \Leftrightarrow q \leq \frac{c_{(2,N)} - c_{(1,N)}}{F(1-p)}. \tag{7}$$

A share σ of corrupt POs cares about the possible gains from corruption and the personal cost of being found guilty, but not about the cost of procurement. These procurement officers only pick a single firm if they can make enough money from corruption: they do not care about the procurement itself and would therefore never benefit from picking the lowest-cost firm and bearing the risk of a judicial error. A corrupt procurement officer therefore chooses the discretionary lottery whenever the benefits of corruption

$(1-\theta)D$ are lower than the cost of being found corrupt:

$$(1-\theta)D \leq qpF \Leftrightarrow q \geq \frac{(1-\theta)D}{Fp} = q^*. \tag{8}$$

If the main decision the PA can take is the probability of auditing q, there exists a value q^* such that corrupt POs systematically choose to pick the discretionary lottery. Only honest procurement officers pick a single firm, whenever

$$c_{(2,N)} - c_{(1,N)} \geq q^* F(1-p) = \frac{(1-\theta)D(1-p)}{p}. \tag{9}$$

Denoting by $g(x)$ the distribution of $x = c_{(2,N)} - c_{(1,N)}$, the social cost, as compared to a first-best situation in which all procurement officers would be non-corrupt and pick the lowest-cost firm, is equal to

$$\sigma \frac{E(c_{(2,N)}) - E(c_{(1,N)})}{2} + (1-\sigma) \int_0^{\frac{(1-\theta)D(1-p)}{p}} \frac{x}{2} g(x)dx. \tag{10}$$

When compared with a compulsory discretionary lottery, the outcome is similar for dishonest POs, but the misallocation is lower for honest POs, and it only happens when the difference between the lowest and the second-lowest cost is small. Denoting the cost of auditing by γ, a random audit with endogenous procedure choice performs better than a compulsory discretionary lottery whenever

$$\int_{\frac{(1-\theta)D(1-p)}{p}}^{\infty} \frac{x}{2} g(x)dx \geq (1 - G(\frac{(1-\theta)D(1-p)}{p}))\gamma q^*. \tag{11}$$

The left-hand side is the allocative gain: all cases in which the lowest-cost firm is sufficiently better than the second-best to incentivize an honest PO to select this firm only. The right-hand side is the cost of auditing with probability q^* POs selecting a single firm, which happens with probability $1 - G(\frac{(1-\theta)D(1-p)}{p})$ where G is the cdf of g. Hence, if auditing costs are not too low, a policy of random audit with endogenous procedure choice can outperform the discretionary lottery.