Renegotiation, Discrimination and Favoritism in Symmetric Procurement Auctions

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Abstract

In order to make competition open, fair and transparent, procurement regulations often require equal treatment for all bidders. This paper shows how a favored supplier can be treated preferentially (opening the door to *home bias* and *corruption*) even when explicit discrimination is not allowed. We analyze a procurement setting in which the optimal design of the project to be contracted is unknown. The sponsor has to invest in specifying the project. The larger the investment, the higher the probability that the initial design is optimal. When it is not, a bargaining process between the winning firm and the sponsor takes place. Profits from bargaining are larger for the favored supplier than for its rivals. Given this comparative advantage, the favored firm bids more aggressively and wins more often than standard firms. Finally, we show that the sponsor invests less in specifying the initial design, when favoritism is stronger. Underinvestment in design specification is a tool for providing a comparative advantage to the favored firm.

Keywords: Auctions, Favoritism, Auction Design, Renegotiation, Corruption.

JEL classification: C72, D44, D82.

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1 Introduction

Governments and state-owned enterprises around the world spend substantial sums to purchase goods, services and infrastructure projects.[1] How that spending is carried out is a major issue. Governments, supranational entities and international organizations choose and recommend procurement procedures intended to foster competition among suppliers that allow the public sector to receive more value for the money.

Those procedures are usually designed to make the competition open, fair, and transparent. In particular, they try to prevent procurement authorities from favoring a specific set of bidders over others. Local authorities, for example, may prefer that contracts be awarded to local suppliers. This home bias, though, is detrimental to competition and may reduce total welfare. Since the mid-1990s, the European Union has been actively promoting equal treatment for all European suppliers, not only by creating a single public-procurement market with uniform procedures but also by eliminating differences in standards or technical regulations set by national governments for health and safety reasons, which may act as entry barriers for some suppliers. Similarly, a number of WTO members have signed the Government Procurement Agreement, which requires that suppliers from all signatory countries be treated equally. In general terms, the main objective is to promote the use of symmetric procurement auctions, i.e. those that treat all bidders equally, irrespective of their nationality or other specific characteristics.[2]

In spite of all these efforts to level the playing field, there is evidence that home bias in procurement is still a prominent phenomenon.[3] Herz and Varela-Irimia (2020) use data

[1]Public procurement, excluding public corporations, represents about 13% of GDP in OECD countries. See *stats.oecd.org* and Bosio et al. (2022), which reports that procurement accounts for 12 percent of global GDP -i.e. around $11 trillion.

[2]Other justifications for favoring some bidders over others are sometimes used –e.g. promoting SMEs, treating minority-owned business preferentially– but they are unrelated to our focus in this paper.

[3]This does not mean that these policies for promoting competition in procurement are fully ineffective. Mulabdic and Rotunno (2022) document border effects in government procurement contracts using a database of 62 countries between 1995 and 2015. They also show that government home bias has decreased over time, and that the WTO's Government Procurement Agreement and the EU's single market policy have narrowed the home bias more in service contracts than in goods.

from 1.8 million European public procurement contracts awarded between 2010 and 2014 to estimate a gravity model of bilateral procurement flows. They conclude that firms located in the home region of the tendering authority are about 900 times more likely to be awarded a contract than foreign firms.[4]

In this paper, we highlight the role of contract renegotiation as a key limiting factor to equal treatment in procurement auctions. Even when the contract is awarded through a symmetric auction, if that contract has to be renegotiated later on, there is scope for discrimination. If procurement authorities value some suppliers higher than others, they will tend to treat the former more favorably when renegotiating. Furthermore, such unequal treatment will impact the procurement process as a whole. If renegotiation is likely, those bidders that expect better renegotiation terms will anticipate their future larger surplus and bid more aggressively in the initial procurement auction. Favored bidders will win more often, capturing a larger share of the procurement market. Even though the auction itself may be symmetric, the procurement process as a whole is not.

The authority might also be tempted to specify the contract to be auctioned off in such a way that renegotiation is more likely. We show that this may indeed be the case. The original contract may be less complete than it could be, so that renegotiation becomes more probable. Needless to say, this enhances the advantage that any favored bidder may hold over her rivals.

Therefore, renegotiation may act as a channel to discriminate among bidders whenever there is *favoritism* –i.e. when the procurement authority cares about the welfare of a specific set of bidders.[5] In general, favoritism leads to the use of procurement auctions where bidders are treated unequally. Favored bidders are given some advantage over their rivals, e.g. price preferences or quotas. When discrimination is prohibited by higher-level regulations, as in the EU example, the renegotiation channel we focus on could be key. In addition,

[4] García-Santana and Santamaría (2023), using a very large database of procurement contracts awarded in France and Spain, show that national governments have a national bias, while subnational governments have a local bias.

[5] For example, favoritism towards local suppliers (home bias) may arise since they pay more local taxes and generate more local employment, which could be particularly valued by local authorities.

this bias may follow from some forms of *corruption*, such as those where the procurement authority favors some of the potential suppliers due to relationships that go beyond a specific auction –e.g. family or long-term business connections. In such a case, using an explicitly discriminatory auction format would not be possible, and, again, renegotiation may be the main tool to treat bidders unequally.

There is evidence that the renegotiation channel provides scope for discrimination. For example, Ryan (2020) analyzes procurement auctions for the largest power projects in India from 2006 to 2012, and shows that renegotiation generates a competitive advantage for "connected" firms, i.e. those firms that seem to have a greater influence on the government since they have been better treated in the past.[6] Long-term power procurement contracts in India are subject to widespread renegotiation due to cost shocks. Bidders are allowed to index their bids to future costs like the price of coal. However, "connected" firms expect that their influence with the government will allow them to change bid prices in the event of a cost shock and do not insure by indexing their bids. Thus, renegotiation is due both to exogenous coal price shocks and to some bidder's endogenous choice to bear this coal price risk. "Connected" firms index less of the value of their bids in power auctions ex ante and renegotiate more ex post. In line with our paper, these firms offer power below cost due to the expected value of later renegotiation and may underbid firms with the lowest cost of production.

Our work is related to the literature on renegotiation and cost overruns in procurement. We borrow from Bajari and Tadelis (2001) and Ganuza (2007) the setting where the sponsor does not know the optimal design of the project ex-ante. She invests in reducing the likelihood that the design fails and renegotiation follows, which would generate additional costs. Their focus, though, is different. Bajari and Tadelis (2001) are mainly interested in the choice between fixed-price contracts (better for cost-reduction incentives) and cost-sharing contracts (better for reducing ex-post transaction costs). We ignore this dimension and con-

[6] "Connected" firms are identified as those that were favored in the government's allocation of free coal to power companies in a previous, "coalgate" scandal. See Ryan (2020) for details.

centrate on fixed-price contracts, the most widely used contractual arrangement in public procurement. Ganuza (2007) analyzes a competitive procurement setting with horizontally differentiated suppliers. His main result is that systematic cost overruns may arise since the sponsor optimally underinvests in the specification of the initial design in order to promote competition (reducing suppliers' rents). While we do not consider horizontally differentiated suppliers, it is also important in our model that bidders foresee expected contract renegotiation and bid more aggressively when anticipating profits if renegotiation occurs.

Our analysis is connected as well to the literature on favoritism -e.g. Laffont and Tirole (1991), McAfee and McMillan (1989) and Naegelen and Mougeot (1998). We borrow from that literature the possibility that the sponsor values positively the profits obtained by some suppliers. In all these papers, though, the procurement authority may resort to mechanisms that do not treat all bidders equally.[7]

As we mentioned above, corruption may be another explanation for the procurement authority's biased behavior. Our work, then, relates to the literature on corruption in procurement, and in particular to Campos et al. (2020). The model in that paper also points at renegotiation as a way in which a firm may be favored. There are two main differences with our approach, though. First, they view the authority's bias as a result of a bribing contest where one potential supplier holds an advantage –a more efficient bribing technology. Here, we take the favored supplier's identity as given. Second, they examine a setting where the contract to be auctioned off is fixed, while we show that unequal treatment in renegotiation influences contract design.[8]

The rest of the paper proceeds as follows. Section 2 below lays out our model, describing how the procurement contract is designed, how the auction is carried out and how renegotiation, if necessary, may proceed. Section 3 describes the equilibrium behavior that follows.

[7]Arozamena, Shunda and Weinschelbaum (2014) characterize the optimal auction under favoritism when the sponsor is constrained to use a symmetric mechanism, in a setting without renegotiation. Arozamena and Weinschelbaum (2011) show that, when the number of bidders is endogenous, equal treatment is optimal for the sponsor.

[8]The study of how corruption may impact the design stage has been absent in the literature. See Burguet, Ganuza and Montalvo (2018) for a survey.

Section 4 discusses two variations of the basic model. Section 5 examines how relaxing some of our assumptions would alter our results. Finally, Section 6 concludes.

2 The Model

A sponsor wants to undertake a single, indivisible project. There are $N \geq 3$ potential contractors[9] that are willing to complete the project according to the sponsor's specifications. The sponsor values the project at v if it is completed – if it is not, we normalize her utility at zero. She procures the services of one of the potential contractors using a symmetric auction mechanism. We assume she uses a second-price auction. All parties are risk-neutral, and all the information described below is common knowledge

The optimal design of the project is uncertain. There is a set W of contingencies/states of nature that may arise during the project's construction. The optimal design depends on which of those contingencies actually occurs. Before the auction, the sponsor must provide potential suppliers with a contract specifying what to do for a set of contingencies/states of nature. Let $e \in [0, 1]$ be the sponsor's effort in specifying the contract, and let $W^C(e) \subset W$ be the set of contingencies that are covered in the contract as a result. The sponsor's effort entails a cost $k(e)$, with $k'(e) > 0$, $k''(e) > 0$, $k'(0) = 0$ and $k'(e)$ growing fast enough so that interior solutions always obtain. A larger value of e means that the contract includes specifications that cover a larger set of states of nature, so that $W^C(e') \subset W^C(e'')$ whenever $e' < e''$.

After the auction, and before project execution, the state of nature that determines the optimal design is realized. Let that state be $w^* \in W$. If $w^* \in W^C(e)$, following the initial contract yields the full value v to the sponsor. So as to simplify notation, we assume that $\Pr\{w^* \in W^C(e)\} = e$. If $w^* \notin W^C(e)$ (which happens with probability $1 - e$), the sponsor needs to modify the original contract to obtain v. In order to keep the model as simple as possible, we assume, as in Bajari and Tadelis (2001), that if $w^* \notin W^C(e)$, completing the

[9] In Section 5 we explore the case where there may be just two potential contractors.

project according to the original contract gives the sponsor zero utility. In that case, the sponsor engages in a renegotiation game with the firm that won the auction, so as to adapt the project to state of nature w^* and thus obtain the full value v.

Before moving on to the renegotiation process, we describe the potential contractors' cost functions. We assume that for every possible contract $W^C(e)$, firm 1's (later labeled as the "favored firm") cost of undertaking the project is $c_1 = c + \Delta$, where Δ is distributed according to a c.d.f. G which is symmetric around zero. To simplify, we assume here that G is the uniform distribution on the interval $[-B, B]$ and $B > 0$. For any $i \geq 2$, firm i's cost is $c_i = c$. Then, all firms have the same expected cost ex ante, and Δ reflects firm 1's cost advantage/disadvantage. Note that, to avoid complications that will not alter our main results, we take the case where the expected cost of completing the project, c, is independent of contract specification, as determined by e. As we will detail below, in our setup it will always be the case that $v > c + B$.

Given an effort choice e by the sponsor and the corresponding contract covering contingencies in $W^C(e)$, firm 1 learns its cost (i.e. Δ is realized) and the second-price auction takes place. Then, the winning firm and the sponsor learn w^*. If $w^* \in W^C(e)$, the initial contract is implemented. If $w^* \notin W^C(e)$, as we mentioned, the contract has to be renegotiated. In order to accomodate state of nature w^* in the previous project, the firm has to incur an additional cost $c_{w^*} < v$, and this applies equally to any of the potential contractors. Furthermore, we are assuming that adaptation costs do not depend on the exact contingency that arises, or on how different that contingency may be to other states of nature for which the contract specified what to do. In doing so, we make c_{w^*} constant and independent of e. This allows us to greatly simplify our analysis of how favoritism impacts the sponsor's incentives when specifying the contract.[10]

[10] Alternatively, we may consider that c_{w^*} is unknown at the awarding stage and is distributed according to some c.d.f. F. This would complicate our presentation, but would deliver the same results. On the contrary, making F depend on e may have an impact on our results. This is an interesting avenue for future research. How F should depend on e is not entirely clear. At first sight, one may guess that a higher specification level would lower the adaptation cost c_{w^*}. However, a more complete contract makes renegotiation less likely, but at the same time, conditioning on renegotiation taking place, it is more probable that it happens due to uncommon or very rare states of nature –which we may associate with higher adaptation costs.

We take a renegotiation setup that follows Bajari and Tadelis (2001). We model the renegotiation stage as a reduced-form game: with probability $\lambda > 0$ the sponsor makes a take-it-or-leave-it (TIOLI) offer to the contractor, and with probability $1 - \lambda > 0$ the firm makes a TIOLI offer to the sponsor. Clearly, the party making the offer will capture all surplus from renegotiation. We depart from Bajari and Tadelis (2001), though, in considering that λ is endogenous and that it is chosen by the sponsor at some cost during the renegotiation process. In particular, the sponsor bears a renegotiation cost $\beta\lambda^2/2$, where β is a parameter capturing the sponsor's relative efficiency in the renegotiation process. As $v > c_{w^*}$, it is always profitable to renegotiate the contract if $w^* \notin W^C(e)$. Even more, we assume that $v \geq c + B + c_{w^*}$, which means that it is optimal to procure the project even if it is necessary to renegotiate with the winner with probability one.

Finally, we add favoritism to the setup described so far. We assume that the sponsor cares about the welfare of firm 1, the "favored firm." Specifically, the sponsor maximizes the weighted sum of her own, "private" utility –i.e. the value she receives from the project if completed minus any cost she has to pay– and the favored contractor's expected profit.[11] Then, the sponsor's welfare, Π^S_F, is given by

$$\Pi^S_F = \Pi^S + \alpha\Pi_1,$$

where Π^S is the sponsor's "private" expected utility and Π_1 is the favored firm's expected profit. The parameter α measures the intensity of favoritism. We assume that $\alpha \in [0, 1)$, so that the sponsor values the favored bidder's profit less than her own, "private" utility.

Summarizing, the timing in the model is as follows:

1. *Contract specification:*

   - The sponsor chooses e and thereby specifies the initial contract $W^C(e)$.

[11] The way favoritism enters the sponsor's utility function is as in Arozamena and Weinschelbaum (2011) and Arozamena, Shunda and Weinschelbaum (2014). It is a special case of the setup in Naegelen and Mougeot (1998). Still, the favored contractor's profits may enter that utility function in a different way, and our qualitative results would remain valid.

2. *Procurement:*

   - Given $W^C(e)$, firm 1 learns its cost of undertaking the project (i.e. Δ is realized).

   - The second price auction takes place and the project is awarded.

3. *Renegotiation:*

   - The winning firm and the sponsor learn w^*. Two cases may occur:

   (a) If $w^* \in W^C(e)$, the initial contract is implemented.

   (b) If $w^* \notin W^C(e)$ the renegotiation process take place.

      i. The sponsor chooses λ at a cost equal to $\beta\lambda^2/2$.

      ii. The TIOLI offer takes place according to λ, and a new contract is signed for implementing w^*.

4. *The project is completed.*

We have made a number of assumptions in order to simplify the analysis. We postpone to Section 5 below a discussion of the exact role these assumptions play and to what extent our results would hold in more general cases. Now, we characterize the equilibrium in the model we have just laid out.

3 Equilibrium

3.1 Renegotiation

To start solving the model backwards, we focus first on the renegotiation stage. Suppose that $w^* \notin W^C(e)$, so that the sponsor and the winning firm need to renegotiate the contract. Given our assumptions, the renegotiation process is always successful and the optimal design for state of nature w^* is implemented. The surplus from renegotiation, $v - c_{w^*}$, is thus always generated, but how it is split depends on which of the parties makes a TIOLI offer, and on whether the winning firm is the favored one or not.

Let us start with the case where the favored firm, contractor 1, won the initial auction. Assume that the sponsor already chose a specific value of λ. If the sponsor makes the offer, which happens with probability λ, the firm will gain nothing from renegotiation, since the sponsor will set a price[12] that just compensates the adaptation cost, c_{w^*}. The sponsor thus appropriates the whole surplus. If, as happens with probability $(1-\lambda)$, it is the firm that makes the offer, the sponsor's "private" utility from renegotiation will be zero: the firm sets a price that equals v and obtains a profit of $v - c_{w^*}$. Then, the sponsor's "private" expected utility from renegotiation (for a given value of λ) is $\lambda(v - c_{w^*})$, whereas the contractor's expected profit is $(1-\lambda)(v - c_{w^*})$.

Anticipating these outcomes, and considering renegotiation costs, the sponsor selects her renegotiation effort λ. Under favoritism, she considers the favored contractor's profits when choosing how hard to renegotiate. Her problem is

$$\max_{\lambda \in [0,1]} \quad \lambda(v - c_{w^*}) + \alpha(1-\lambda)(v - c_{w^*}) - \beta\frac{\lambda^2}{2}.$$

The sponsor's objective function is, then, the weighted sum of her own "private" expected utility, $\lambda(v - c_{w^*}) - \beta\frac{\lambda^2}{2}$, and the firm's expected profit, $(1-\lambda)(v - c_{w^*})$. Her optimal renegotiation effort, $\lambda^*(\alpha)$, will be

$$\lambda^*(\alpha) = \frac{1-\alpha}{\beta}(v - c_{w^*}). \tag{1}$$

The sponsor's effort when renegotiating falls with the intensity of favoritism, α.

Let $\pi^R(\alpha)$ be the expected net profit a contractor obtains if there is renegotiation (which happens with probability $(1-e)$) and it is favored with coefficient α. This profit includes any additional adaptation costs the contractor may have to pay due to changes in the project. Given the sponsor's optimal renegotiation effort choice, we have

$$\pi^R(\alpha) = (1 - \lambda^*(\alpha))(v - c_{w^*}), \tag{2}$$

[12]This is the price the sponsor will pay in addition to the price set in the initial, second-price auction.

where $\pi^R(\alpha)$ is increasing in α. If the sponsor becomes less efficient in the renegotiation process (i.e. if β grows) $\lambda^*(\alpha)$ falls and the firm's profit, $\pi^R(\alpha)$ rises.

The total expected renegotiation cost that the sponsor will face will then be

$$c^R(\alpha) = \lambda^*(\alpha)c_{w^*} + (1-\lambda^*(\alpha))v + \beta\frac{\lambda^*(\alpha)^2}{2} = c_{w^*} + \pi^R(\alpha) + \beta\frac{\lambda^*(\alpha)^2}{2}$$

Naturally, if firm $i \geq 2$ won the auction and is involved in the renegotiation process, the same reasoning as above applies, except for the fact that $\alpha = 0$. The sponsor will then choose a larger probability of herself making a TIOLI offer,

$$\lambda^*(0) = \frac{v - c_{w^*}}{\beta}. \tag{3}$$

The firm's profit will thus be

$$\pi^R(0) = (1-\lambda^*(0))(v - c_{w^*}) \tag{4}$$

and the total renegotiation cost for the sponsor will be

$$c^R(0) = c_{w^*} + \pi^R(0) + \beta\frac{\lambda^*(0)^2}{2}.$$

We summarize our key results at this stage in the following Lemma

Lemma 1 *The sponsor's optimal renegotiation effort, $\lambda^*(\alpha)$, is decreasing in α, and the expected renegotiation profit for the favored bidder, $\pi^R(\alpha)$ is increasing in α. In particular, the sponsor renegotiates harder with nonfavored bidders, and the latter obtain a lower expected profit from renegotiation than the favored bidder –i.e. $\lambda^*(\alpha) < \lambda^*(0)$ and $\pi^R(\alpha) > \pi^R(0)$ for any $\alpha > 0$.*

Clearly, then, the sponsor treats the favored bidder better. She chooses a lower effort and thereby allows contractor 1, if it won the auction, to capture a larger portion of the renegotiation surplus. This asymmetric treatment of contractors at the renegotiation stage will be key in what follows. It turns the original symmetric mechanism into an asymmetric one.

3.1.1 Procurement Stage

After the sponsor has specified the project, $W^C(e)$, the relative efficiency parameter Δ is realized, and firms take part in the second price auction. It is a weakly dominant strategy for each contractor to bid a sum equal to the minimum price for which it would be willing to undertake the project. That is, each contractor i bids the price P_i^* that would make its expected profit from the project –including any potential profits from renegotiation– equal to zero. In the case of firm 1, then, we have

$$P_1^* - c - \Delta + (1-e)\pi^R(\alpha) = 0,$$

so that.

$$P_1^* = c + \Delta - (1-e)\pi^R(\alpha).$$

For firm $i \geq 2$,

$$P_i^* - c + (1-e)\pi^R(0) = 0.$$

so

$$P_i^* = c - (1-e)\pi^R(0).$$

All bidders anticipate their expected profits from renegotiation *and discount them in their initial bids.* But contractor 1's discount is more aggressive, since it has a renegotiation advantage.

To emphasize this point, let us compare firm 1's situation with that of any firm $i > 1$. The bidding behavior described above implies that firm 1's bid will be lower that firm i's when

$$c + \Delta - (1-e)\pi^R(\alpha) < c - (1-e)\pi^R(0),$$

or

$$\Delta < (1-e)[\pi^R(\alpha) - \pi^R(0)] \equiv \Gamma(e, \alpha)$$

$\Gamma(e, \alpha)$ is the effective cost advantage that favoritism conveys to contractor 1 due to preferential treatment when renegotiating the original contract. This advantage does not follow from the existence of renegotiation, but from the fact that the renegotiation outcome is conditional on the original winner's identity. In fact, $\Gamma(e, 0) = 0$ for any value of e. If renegotiation were anonymous, firm 1 would bid lower than its rivals and win when $\Delta < 0$, as in a second-price auction without renegotiation.

From (1), (2), (3) and (4) above, we have

$$\Gamma(e, \alpha) = (1-e)(\lambda^*(0) - \lambda^*(\alpha))(v - c_{w^*}) = (1-e)\frac{\alpha}{\beta}(v - c_{w^*})^2 > 0$$

As we would expect, firm 1's advantage is increasing in α. Note as well that, since the channel through which favoritism generates that advantage is renegotiation, $\Gamma(e, \alpha)$ is decreasing in e. When the sponsor selects a lower effort in covering contingencies contractually, renegotiation is more likely, which in turn makes firm 1's advantage more relevant and valuable.

Given our distributional assumptions, firm 1's market share –i.e. its probability of winning– is

$$\Pr[\Delta < \Gamma(e, \alpha)] = \frac{\Gamma(e, \alpha) + B}{2B}.$$

We then have the following proposition.[13]

Proposition 1 *The favored bidder wins the auction with a probability that is increasing in α and decreasing in e.*

Proposition 1 states that there is a channel through which the sponsor may improve the favored bidder's chances of winning: making renegotiation more likely by selecting a lower specification effort. We describe how this impacts her choice of e below.

[13] We are implicitly assuming that $(1-e)\frac{\alpha}{\beta}(v - c_{w^*})^2 < B$, otherwise firm 1 will always win.

Note as well that the favored bidder wins with a larger probability when B falls. Firm 1's effective cost advantage is independent of B. Under our assumptions, then, as the distribution of Δ becomes less dispersed, the probability that such advantage is decisive in determining the winner becomes larger, and the impact of favoritism grows.

Given that $N \geq 3$, for any realized value of Δ, the second-lowest bid is always made by a nonfavored contractor. Thus, our simplifying assumptions eliminate any effect favoritism may have on the price resulting from the auction, which is always

$$P^*(e) = c - (1-e)\pi^R(0).$$

In Section 5 below we discuss what may happen in cases where the price that follows from the second-price auction may also change as a result of favoritism.

3.1.2 Specification Stage

The sponsor's goal at the specification stage is to choose the contract that maximizes her ex-ante utility, given by the weighted sum of her own, "private" utility and the favored firm's profit. Anticipating equilibrium behavior in the auction, the sponsor's "private" expected utility is

$$v - P^*(e) - (1-e)C^R(e, \alpha), \tag{5}$$

where $C^R(e, \alpha)$ is the expected renegotiation cost

$$C^R(e, \alpha) = \Pr[\Delta < \Gamma(e, \alpha)]\ c^R(\alpha) + \Pr[\Delta > \Gamma(e, \alpha)]\ c^R(0).$$

Firm 1's expected profit is given by the sum of its expected profit from the second-price auction and expected renegotiation profits.

$$\begin{aligned}\Pi_1(e, \alpha) &= \Pr[\Delta < \Gamma(e, \alpha)][-E\{\Delta | \Delta \leq \Gamma(e, \alpha)\} + (1-e)(\pi^R(\alpha) - \pi^R(0))] \\ &= \Pr[\Delta < \Gamma(e, \alpha)][-E\{\Delta | \Delta \leq \Gamma(e, \alpha)\} + \Gamma(e, \alpha)]. \end{aligned} \tag{6}$$

As $\Gamma(e,\alpha)$ is decreasing in e and increasing in α, so is $\Pi_1(e,\alpha)$.

Combining (5) and (6), the sponsor's problem is

$$\max_{e} \quad \Pi_F^S(e,\alpha) = v - P^*(e) - (1-e)C^R(e,\alpha) + \alpha\Pi_1(e,\alpha) - k(e), \tag{7}$$

Given our assumptions –namely, that Δ is uniformly distributed and that the cost of renegotiating for the sponsor is quadratic– we can compute the first-order condition of (7),

$$c_{w^*} + \frac{(v - c_{w^*})^2(2-\alpha^2)}{4\beta} - k'(e) = 0 \tag{8}$$

and the corresponding second-order sufficient condition holds as well.

Let $e^*(\alpha)$ be the optimal specification level for the sponsor. In what follows, we try to establish how the optimal specification level varies with the intensity of favoritism.

3.1.3 Optimal specification selection and favoritism

How does favoritism impact the sponsor's initial effort choice in specifying the contract? As a more incomplete contract makes renegotiation more likely, we may expect that e^* would fall with α: given that the competitive advantage that the favored contractor holds is tied to the possibility that the original contract be renegotiated, with more intense favoritism the sponsor may lower e so as to make renegotiation more likely. Proposition 2 formalizes this intuition by stating that the sponsor's objective function is strictly submodular.

Proposition 2 *$e^*(\alpha)$ is strictly decreasing*

Proof. Take the first-order condition (8) as implicitly defining $e^*(\alpha)$. Then, using the implicit function theorem, we would have

$$\frac{de^*}{d\alpha} = -\frac{\frac{\partial^2}{\partial e \partial \alpha}\Pi_F^S(e,\alpha)}{\frac{\partial^2}{\partial e^2}\Pi_F^S(e,\alpha)}$$

By the second-order condition of (7), we know the denominator of this expression is negative.

Then, the sign of $de^*/d\alpha$ will coincide with the sign of $\frac{\partial^2}{\partial e \partial \alpha}\Pi_F^S(e,\alpha)$. We can then compute

$$\frac{\partial^2}{\partial e \partial \alpha}\Pi_F^S(e,\alpha) = -\frac{\alpha}{2\beta}(v - c_{w^*})^2 < 0$$

and our result follows. ■

Then, more favoritism implies a contract covering fewer states of nature, and thus makes renegotiation more likely. We provide an example of this negative relationship below.

Example 1: *Suppose* $v = 6$, $c = 2, c_{w^*} = 3, \beta = 5$, $B = 1$ *and* $k(e) = 5e^2/2$. *Then,*

$$e^*(\alpha) = \frac{3}{100}(26 - 3\alpha^2)$$

which is depicted in Figure 1 below.

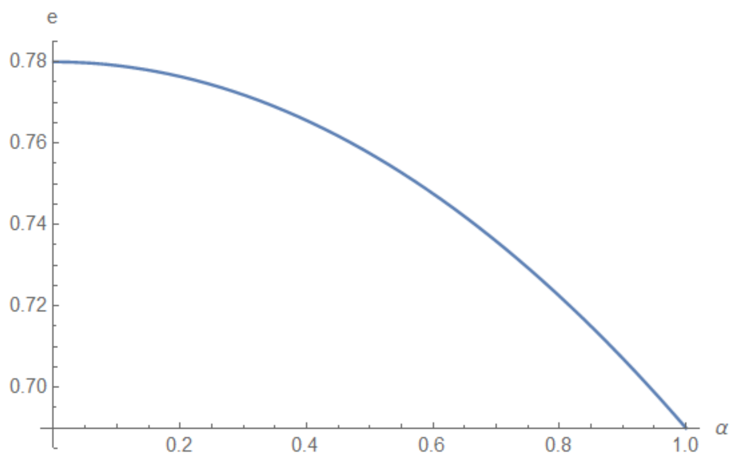

Figure 1 : Project specification and favoritism.

We have thus shown not only that the favored contractor –having a larger expected renegotiation surplus– holds a competitive advantage at the bidding stage, but also that the sponsor may increase that advantage by underinvesting in specifying the initial contract, making renegotiation more likely. Furthermore, more favoritism leads to lower incentives to invest in contract specification.

4 Two variations of the basic model

In the previous section, we have identified how renegotiation allows the sponsor to confer an advantage to the favored bidder, and how this affects equilibrium bidding behavior and contract design. We introduce now two variations of the basic model that provide interesting benchmarks when assessing the impact of differential treatment of contractors at the renegotiation stage. First, we analyze the case where, before the auction, the sponsor can commit to a renegotiation effort that is homogeneous across bidders. Then, we return to the no-commitment setting and study how our results would change if the sponsor faced a minimum-effort constraint when renegotiating.

4.1 Commitment to a homogeneous renegotiation effort: more frequent cost overruns?

In Section 3, we have shown that favoritism may lead to lower specification and more cost overruns than a situation in which the sponsor treats all firms equally. In this subsection, we provide an alternative benchmark. Here, the sponsor commits to a homogeneous renegotiation effort before the auction takes place. How does this impact the procurement process? In our original setting, it was unequal treatment at the renegotiation stage that acted as a channel for favoritism. In committing to a specific effort level -the same whichever contractor wins the auction- the sponsor eliminates that channel. Without the incentive provided by favoritism, we may expect that renegotiation, and cost overruns, will occur less frequently. We show now that this is not the case.

When the sponsor can commit to a renegotiation effort $\lambda = \lambda_c$, we have $\pi^R(\alpha) = \overline{\pi}^R = (1 - \lambda_c)(v - c_{w^*})$ for all α, and $\Gamma(e, \alpha) = 0$ for all e, α. At the same time, $C^R(e, \alpha) = c_{w^*} + \overline{\pi}^R + \beta\frac{\lambda_c^2}{2}$ and $\Pi_1(e, \alpha) = \overline{\Pi}_1$ are constant in e, α. In addition, we know that $P^*(e)$ does not depend on α. Intuitively, whichever extra expected profits from renegotiation the sponsor generated by lowering e, they would be equal for all bidders. Then, they would all discount those extra profits equally in their initial bids.

With commitment, which value of λ_c would the sponsor choose? Following our previous arguments, the expected price would be $P^*(e) = c - (1-e)\overline{\pi}^R$. At the initial stage, the sponsor would choose not only the specification level e but also her bargaining effort λ_c. She would then solve

$$\max_{e,\lambda_c} \quad -\left[c - (1-e)\overline{\pi}^R\right] - (1-e)\left[c_{w^*} + \overline{\pi}^R + \beta\frac{\lambda_c^2}{2}\right] + \alpha\overline{\Pi}_1 - k(e).$$

Which simplifies to

$$\max_{e,\lambda_c} \quad -c - (1-e)c_{w^*} - (1-e)\beta\frac{\lambda_c^2}{2} + \alpha\overline{\Pi}_1 - k(e).$$

Notice that the objective function is decreasing in λ_c. Then, it would be optimal to select $\lambda_c = 0$, and the sponsor's optimal specification choice would be

$$e_c^* \in \arg\min\{(1-e)c_{w^*} + k(e)\}.$$

Intuitively, as any renegotiation surplus bidders may have is discounted in their original bids, the sponsor has incentives to eliminate any inefficiencies associated to renegotiation. In our model, then, she reduces her effort to zero. This, in turn, leads to lower investment in specification, since $e_c^* < e^*(\alpha)$ for all $\alpha \in (0,1)$.[14] Cost overruns are then more likely as a result of commitment.

This benchmark allows us to emphasize the exact channel for discrimination we have identified in our model. The competitive process is not distorted by how frequently contracts are renegotiated or how large renegotiations are. It is distorted by unequal treatment at the renegotiation stage.

[14] This follows directly by comparing this problem's first-order condition, $c_{w^*} = k'(e_c^*)$, with the baseline model's first-order condition, (8). In the baseline model, sponsor's lack of commitment generates an additional cost when renegotiating: the cost of the effort chosen to reduce the winning firm's rents. This extra cost leads to greater incentives for the sponsor to specify the initial contract.

4.2 Minimum-effort constraints on the sponsor's renegotiation behavior

We return now to the no-commitment setting. However, we assume that, at the renegotiation stage, the sponsor's behavior may be more restricted than in our basic model. In general, we want to establish how our results would vary if the sponsor were required to exert a minimum effort level $\overline{\lambda}$ when renegotiating. This may be the result of institutional constraints.[15] We examine now the impact that such a constraint has, when it is binding, on equilibrium behavior.

First, consider the case where $\lambda^*(0) > \overline{\lambda} > \lambda^*(\alpha)$. The sponsor is constrained when renegotiating with firm 1, but not when renegotiating with other firms. This constraint, then, reduces discrimination. Introducing $\overline{\lambda}$ makes the sponsor behave, when renegotiating, as if she were less biased towards firm 1. Specifically, as if her preference were given by α' such that $\overline{\lambda} = \lambda^*(\alpha')$, where $\alpha' < \alpha$. As firm 1's cost advantage, $\Gamma(e, \alpha)$, is increasing in α, introducing $\overline{\lambda}$ reduces that advantage and the probability that firm 1 wins the auction, i.e. $Pr[\Delta < \Gamma(e, \alpha)]$. Then, the auction winner's expected cost is lower. The effect of $\overline{\lambda}$ on the sponsor's total procurement costs and her incentives to specify the initial contract are ambiguous. The new constraint increases the cost of renegotiating with firm 1 and reduces the rent firm 1 seizes at the renegotiation stage –which has weight α in the sponsor's objective function. But it also makes renegotiation with firm 1 less likely.

When $\overline{\lambda} \geq \lambda^*(0)$ the analysis is more precise. The limit removes the incentives to discriminate: $\Gamma(e, \alpha) = 0$ for all e, α, and $\Pi_1(e, \alpha) = \overline{\Pi}_1$ is constant in e, α. Furthermore, the sponsor is forced to renegotiate harder with any possible winner than he would without the limit. Her problem now is

$$\max_{e} \quad \Pi_F^S(e, \alpha, \overline{\lambda}) = v - c - (1-e)c_{w^*} - (1-e)\beta\frac{\overline{\lambda}^2}{2} + \alpha\overline{\Pi}_1 - k(e).$$

[15]For example, procurement regulations may set limits to cost overruns, such as requiring a higher authority's approval when overruns go beyond a certain portion of the original budget. In general, such regulations may be interpreted, within our setting, as intended to make choosing low renegotiation effort levels more costly.

The next proposition establishes the relationship between project specification and $\overline{\lambda}$.

Proposition 3 *If* $\overline{\lambda} \geq \lambda^*(0)$, *project specification is increasing in* $\overline{\lambda}$.

The result follows directly from the first-order condition

$$c_w^* + \beta \frac{\overline{\lambda}^2}{2} - k'(e) = 0 \tag{9}$$

More demanding constraints on renegotiation behavior would then be associated to more specification, and thus to a lower probability that renegotiation actually takes place. However, the sponsor's objective function $\Pi_F^S(e, \alpha, \overline{\lambda})$ is decreasing in $\overline{\lambda}$. Then, applying the envelope theorem, we can conclude that once discrimination is removed, i.e. when $\overline{\lambda} \geq \lambda^*(0)$, total procurement costs grow with $\overline{\lambda}$. The intuition is that, in this case, the sponsor's objective function is as if she were committing to a renegotiation effort $\overline{\lambda}$. As we described above when examining commitment, the sponsor would prefer to minimize total procurement costs by eliminating renegotiation inefficiencies, setting $\lambda = 0$ and letting bidders discount their renegotiation rents in their original bids. Total procurement costs are thus higher when the limit $\overline{\lambda}$ is set in this range, and they grow with $\overline{\lambda}$.

More stringent constraints on the sponsor's effort choice may then reduce, or even eliminate, discrimination. But once discrimination is fully removed, imposing a larger renegotiation effort may increase total procurement costs.

5 Relaxing assumptions

As mentioned above, we made a number of specific assumptions, simplifying the model in a way that allowed us to highlight how favoritism influences the whole procurement process, from contract specification to renegotiation. In this section, we discuss how relaxing those assumptions may or may not change our results.

Once the initial contract has been awarded, we took a very specific form for the renegotiation game. That form allowed us to simplify substantially the equilibrium in earlier stages of the game. However, what is key to our results is that renegotiation yields a larger profit to the favored bidder than to its rivals, and that such profit (in our notation, $\pi^R(\alpha)$) grows with α. Independently of the exact renegotiation game, then, the favored contractor will have a cost advantage $\Gamma(e, \alpha) > 0$ in the original auction, as described in our model, and that advantage will result in a lower bid in the initial auction.

Given that cost advantage, we can examine the impact of favoritism in the auction's result in different settings, so as to understand the role our assumptions play. For example, assume momentarily that $N = 2$, and also that both firms' cost distributions have a common support, $[\underline{c}, \overline{c}]$. Figure 2 below helps compare outcomes with and without favoritism.

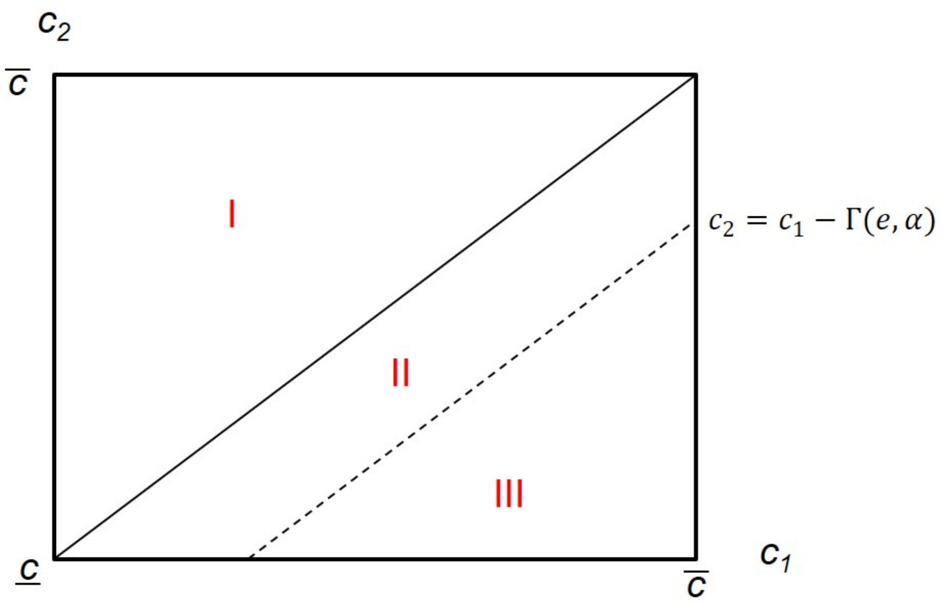

Figure 2 : Project allocation with and without favoritism.

Without favoritism (i.e. when $\alpha = 0$), firm 1 wins if $c_1 < c_2$ (region I), so the auction's result is efficient, whereas with favoritism it wins when $c_1 - \Gamma(e, \alpha) < c_2$ (I and II). Then, favoritism has no impact on price or the initial contract allocation in region I. In region II, it changes contract allocation (firm 1 wins instead of firm 2) and reduces the price set in the auction. In region III, finally, it only lowers the resulting price. Naturally, since $\Gamma(e, \alpha)$ grows with α, region II is larger (and region III smaller) when favoritism is more intense.

Expected renegotiation costs also change with favoritism. They go from $c^R(0)$ to $c^R(\alpha)$ in regions I and II, and stay the same in region III.

This extends to cases where $N \geq 2$. Then, favoritism has a three-fold impact on the outcome of the procurement process for a given project. It influences (i) the resulting allocation, (ii) the price set in the initial auction, and (iii) contractor profits and sponsor costs from renegotiation.

Our specific model simplified the analysis by taking a setting where the second effect listed above is absent. In Section 2, by assuming $N \geq 3$, under our specific cost distributions we eliminated any possible impact of favoritism on the auction's price. In essence, the favored firm's bid can never be the second lowest, and favoritism can only impact the resulting allocation. Naturally, in a more general setting both contract allocation and price can change with favoritism.

To consider a simple case where favoritism may have pricing effects, let us modify our model from Section 2 only by assuming that there is just one nonfavored firm, so $N = 2$. There are now three cases, analogous to the three regions in Figure 2. Favoritism changes neither the allocation nor the auction's price when $\Delta < 0$. When $\Delta \in (0, \Gamma(e, \alpha))$, it changes contract allocation (firm 1 wins instead of firm 2) and reduces the price set in the auction. Finally, if $\Delta > \Gamma(e, \alpha)$, it only lowers the resulting price, since firm 1 still loses, but does so while bidding lower.

Then, our analysis in Section 2 changes only in that the expected price resulting from the auction is now a function of e and α. The expected value of the losing bid is now

$$
\begin{aligned}
P^*(e, \alpha) &= E_\Delta \left[\max\{c - (1-e)\pi^R(0), c + \Delta - (1-e)\pi^R(\alpha)\}\right] \\
&= c + \Pr[\Delta > \Gamma(e, \alpha)] \; \{E\left[\Delta | \Delta \geq \Gamma(e, \alpha)\right] - (1-e)\pi^R(\alpha)\} \\
&- \Pr[\Delta < \Gamma(e, \alpha)] \; (1-e)\pi^R(0)
\end{aligned}
$$

Moving back to the specification stage, in our original setting an increase in α made reducing e more attractive to the sponsor. There is a new effect now, though, since the price that follows from the second-price auction varies as well. And the joint impact of e and α on that price is less clear. If α becomes larger, then contractor 1 bids lower. Reducing e will make him lower her bid even more. This further reduction is not so attractive in the second of the three possible cases, i.e. when $\Delta \in (0, \Gamma(e, \alpha))$, since the price falls from contractor 1's bid to her rival's bid -and the latter is independent of α. It is attractive in the third case, for $\Delta > \Gamma(e, \alpha)$, where firm 1's bid becomes the auction's resulting price. If the second case is more relevant we may have a significant countervailing effect. This happens, for example, when the initial value of α is large. The favored contractor is winning with a large probability, so the price reduction obtained in an unlikely third case is not attractive.

We would then expect results to be less precise than before. Solving the sponsor's optimal specification problem,

$$\max_{e} \quad \Pi_F^S(e, \alpha) = v - P^*(e, \alpha) - (1 - e)C^R(e, \alpha) + \alpha \Pi_1(e, \alpha) - k(e),$$

the corresponding FOC is

$$c_{w^*} + \frac{(v - c_{w^*})^2}{2\beta} \left[\frac{(1 - e)\alpha^2 (v - c_{w^*})^2}{B\beta} - \frac{(2 + \alpha)\alpha - 2}{2} \right] - k'(e) = 0$$

As before, let $e^*(\alpha)$ be the optimal specification effort for the sponsor. We provide a sufficient condition for strict submodularity of the sponsor's objective function. Note that this condition is easier to satisfy for lower values of α.

Proposition 4 *If* $\beta > \frac{2\alpha(v - c_{w^*})^2}{(1+\alpha)B}$*, then* e^* *is strictly decreasing in* α*.*

Proof. Proceeding exactly as in the proof of Proposition 2, and computing the cross derivative, we get

$$\frac{\partial^2}{\partial e \partial \alpha} \Pi_F^S(e, \alpha) = \frac{(v - c_{w^*})^2}{2B\beta^2} \left[2(1 - e)\alpha(v - c_{w^*})^2 - (1 + \alpha)B\beta \right].$$

Then, if $\beta > \frac{2\alpha(v-c_{w*})^2}{(1+\alpha)B}$, this expression is negative for any value of e. ■

The sufficient condition in Proposition 4 is easier to satisfy, for example, when renegotiation is more costly, and when the intensity of favoritism is lower. Intuitively, this condition ensures that it is not the case that bidder 1 is winning with a very large probability. Then, the sponsor keeps having incentives to favor bidder 1 more by reducing e when α grows, both because she now cares more about that bidder's welfare, and because she benefits from a lower price when bidder 1 becomes more aggressive but still loses. The sufficient condition ensures the second effect remains relevant.

The following two examples provide cases where our sufficient condition does and does not hold.

Example 2: *Suppose* $v = 6$, $c = 3$, $c_{w^*} = 2, \beta = 24$, $B = 1$ *and* $k(e) = 24e^2/2$. *The sufficient condition in the Proposition applies, and* $e^*(\alpha)$ *is strictly decreasing, as shown in Figure 3.*

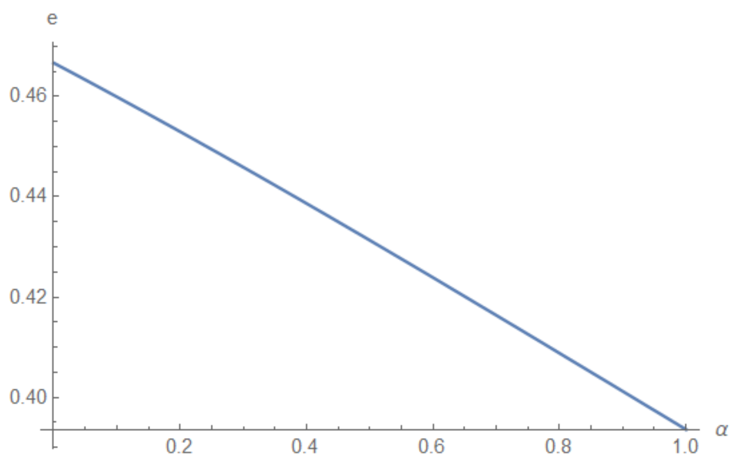

Figure 3 : Project specification in Example 2

As in the main model, where we ignore pricing effects, if the condition of Proposition 4 holds, incentives for the sponsor to specify the initial contract are lower if favoritism is stronger. The next example shows that if the sufficient condition does not hold, pricing effects may make the relation between favoritism and the incentives to specify the initial contract nonmonotonic.

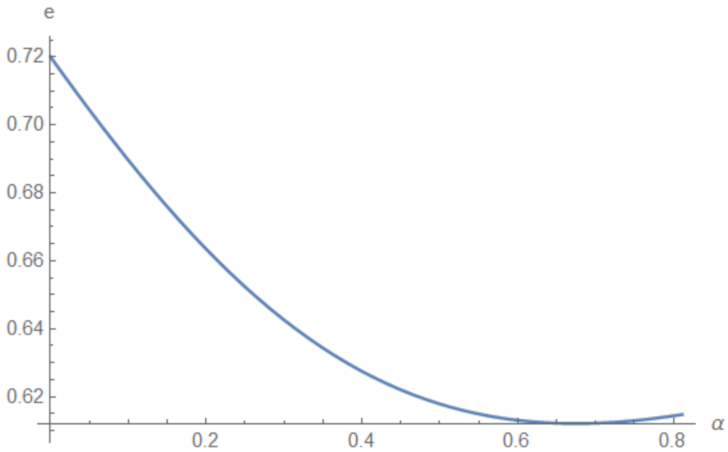

Figure 4 : Project specification in Example 3

Example 3: *Now* $v = 6$, $c = 3, c_{w^*} = 2, \beta = 5$ $B = 1$ *and* $k(e) = 5e^2/2$. *Figure 4 depicts the resulting nonmonotonic relationship between* e *and* α.

6 Conclusion

Procurement auctions are frequently regulated in a way that imposes equal treatment for all bidders. In this paper, we have argued that whenever contracts can be renegotiated, there is a channel through which a favored contractor can have an advantage. She will be treated better at the renegotiation stage, and this in turn makes the whole procurement process asymmetric. The core idea is that, given that the favored firm will receive a larger expected surplus from contract renegotiation, it will be more aggressive in the initial, symmetric bidding process, and therefore win more often. Furthermore, making renegotiation more likely by lowering investment in design specification enhances the favored firm's comparative advantage, thereby increasing its probability of winning and its profits. Under certain conditions, the initial contract will be less specified the more the sponsor cares about the favored firm's profits. Renegotiation is much harder to regulate than the procurement auction itself, so ensuring that the whole procurement process satisfies equal treatment for all bidders is equally difficult.

We have shown not only that this channel exists, but also that: i) if the sponsor could commit to a renegotiation effort, renegotiation would occur more frequently; ii) constraining the sponsor's renegotiation behavior may reduce discrimination, but when discrimination is fully removed, it may increase total procurement cost; and iii) pricing effects may lead to a nonmonotonic relationship between contract specification and favoritism.

The problem we have analyzed is complex since it involves a procurement process with heterogeneous bidders and renegotiation. We have illustrated potential supplier discrimination due to biased renegotiation using the simplest possible setting. Further research is needed for understanding the interaction between biased renegotiation, pricing effects and incentives to specify the initial contract. We have theoretically shown the existence of the channel, and the results in Ryan (2020) support that our view on the role of renegotiation is empirically relevant. We hope that future empirical research will explore in more detail how bidding behavior is determined by contract renegotiation, whether or not local firms are favored in renegotiation, and how these effects change the sponsor's incentives to invest in specifying the initial contract.

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7 Appendix: Renegotiation with uncertain adaptation cost (not for publication)

In this appendix we consider the case where the adaptation cost is unknown at the procurement stage: all parties to the auction only know that c_{w^*} is distributed on the interval $[0, v]$ (renegotiation is still always efficient) according to $F(c_{w^*})$. When $w^* \notin W^C(e)$, the sponsor and the winning firm learn the cost of changing the original design c_{w^*}. Renegotiation then proceeds as in the baseline model. The sponsor's renegotiation effort λ is identical to that in the baseline model, but now depends on α and c_{w^*}.

$$\lambda^*(\alpha, c_{w^*}) = \arg\max_{\lambda} \left[v - c_w^* - (1-\alpha)(1-\lambda)(v - c_w^*) - \beta\frac{\lambda^2}{2} \right],$$

which yields

$$\lambda^*(\alpha, c_{w^*}) = \frac{1-\alpha}{\beta}(v - c_w^*). \tag{10}$$

The sponsor's effort when renegotiating falls with the intensity of favoritism, α, and also with the adaptation cost c_{w^*}, since surplus and renegotiation rents decrease when c_{w^*} rises.

The contractor's expected net profit if there is renegotiation (before learning the adaptation cost) is

$$\pi^R(\alpha) = \int_0^v (1 - \lambda^*(\alpha, c_{w^*}))(v - c_{w^*})dF(c_{w^*}) = v - \overline{c}_{w^*} - \frac{1-\alpha}{\beta}\overline{s}, \tag{11}$$

where $\overline{c}_{w^*} = \int_0^v c_{w^*} dF(c_{w^*})$ and $\overline{s} = \int_0^v (v - c_{w^*})^2 dF(c_{w^*})$. As in the main model $\pi^R(\alpha)$ is increasing in α. Similarly, the total expected renegotiation cost that the sponsor will face will then be

$$c^R(\alpha) = \int_0^v \lambda^*(\alpha, c_{w^*})c_{w^*} + (1 - \lambda^*(\alpha, c_{w^*}))v + \beta\frac{\lambda^*(\alpha, c_{w^*}))^2}{2}dF(c_{w^*}) = \overline{c}_{w^*} + \pi^R(\alpha) + \frac{(1-\alpha)^2}{2\beta}\overline{s}$$

The bidding equilibrium at the procurement stage is the same as in the baseline model. In particular, firm 1's bid will be lower than firm i's when

$$\Delta < (1-e)[\pi^R(\alpha) - \pi^R(0)] = (1-e)\frac{\alpha}{\beta}\overline{s} \equiv \Gamma(e,\alpha)$$

$\Gamma(e,\alpha)$ is strictly positive, decreasing in e and increasing in α. It is almost identical to the same function in the baseline model –where we had $\Gamma(e,\alpha) = (1-e)\frac{\alpha}{\beta}(v - c_{w^*})^2$. By the same token, the outcome at the procurement stage, determined by $\Gamma(e,\alpha)$, is analogous to that in the baseline model.

Finally, we solve the specification stage. The sponsor' problem is

$$\max_{e} \quad \Pi_F^S(e,\alpha) = v - P^*(e) - (1-e)C^R(e,\alpha) + \alpha\Pi_1(e,\alpha) - k(e), \tag{12}$$

As in the baseline case, when adaptation costs are unknown we have $P^*(e) = c - (1 - e)\pi^R(0)$, $C^R(e,\alpha) = \Pr[\Delta < \Gamma(e,\alpha)]\ c^R(\alpha) + \Pr[\Delta > \Gamma(e,\alpha)]\ c^R(0)$, and $\Pi_1(e,\alpha) = \Pr[\Delta < \Gamma(e,\alpha)][-E\{\Delta|\Delta \leq \Gamma(e,\alpha)\} + \Gamma(e,\alpha)]$. Plugging these expressions and $\Gamma(e,\alpha)$ into the objective function and differentiating, we obtain the first-order condition

$$\overline{c}_w^* + \frac{\overline{s}(2-\alpha^2)}{4\beta} - k'(e) = 0 \tag{13}$$

Following the same arguments as in the baseline model, it can be shown that the sponsor's objective function is strictly submodular and, then, that $e^*(\alpha)$ is strictly decreasing.