# Renegotiation in Public Procurement*

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**Abstract**

Public procurement accounts for about 12% of GDP in OECD countries. Public procurement contracts are incomplete, which leads to frequent ex-post renegotiation. In this paper, we study how allowing renegotiation affects the bidding behaviour of firms and the final prices of public procurement contract. We develop a theoretical model that yields predictions about the firm behaviour under different renegotiation policy regimes. Subsequently, we test the predictions empirically. Our findings show that *(i)* firms adjust their bidding strategy and bid more aggressively, i.e. winning bids decline, however; *(ii)* final prices of contracts after renegotiation remain unchanged as firms take the policy change into account. Finally, we observe that firms with more experience in public procurement and larger firms renegotiate procurement contracts with higher probability.

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# 1 Introduction

Public procurement accounts for about 12% of GDP and roughly 25% of general government spending in OECD countries (OECD, 2016, 2019). Renegotiation of public procurement contracts is in many jurisdictions a widespread phenomenon. In the US, about 11% of public procurement contracts are renegotiated ex-post. Renegotiation is a legitimate tool, because public procurement contracts are incomplete. Changes in the rules regulating renegotiation are likely to change the bidding behaviour of firms. Lower likelihood of successful renegotiation will lead to insurance-like behaviour against potential future additional costs, i.e. an increase in the average bids.

A rather limited body of empirical literature studying renegotiation in public procurement emerged recently. Bajari et al. (2014a) shows that firms incorporate the adaptation costs that come with renegotiation in their bidding strategies. They estimate that the adaptation costs account for 7.5-14% of the winning bids. This suggests that more careful and costly ex-ante planning and less renegotiation might be efficient due to these sizeable adaptation costs. Ryan (2020) studies the effects of contract enforcement on the efficiency of investment in India. He finds that less renegotiation (better contract enforcement) is pro-competitive and leads to higher initial bids but lower overall markets and production cost decline. The decline of production cost is due to allocation of procurement contracts to lower-cost bidders instead bidders with high renegotiation expectation (Ryan, 2020). Firms with political connections are shown to enjoy various preferential treatment on the procurement market (Baltrunaite, 2020; Baranek and Titl, 2020; Schoenherr, 2019; Titl and Geys, 2019). Renegotiation of a procurement contract can be one of the ways to extract additional rent for political connected firms. And indeed Brogaard et al. (2021) find that, in the U.S., firms with connections bid low initially and then renegotiate the contract conditions such as prices, deadlines etc. They find that connected firms were three times more likely to successfully renegotiate procurement contracts ex-post Brogaard et al. (2021).

In this paper, we study how a reform that makes renegotiation simple and gives more discretion into the hands of procurement officers influence the behaviour of bidding firms and the public procurement market outcomes. We proceed in two steps. First, we develop a theoretical model of the procurement market. We then distinguish between three situations. In the first setting, renegotiation of price is not possible. This corresponds to the situation three years and longer before the reform we study in this paper. Before this reform, only launching of a new procurement competition open to all firms was a solution within reach unless very strict conditions about urgency and technical infeasible were satisfied. So, it was not really a renegotiation of the initial contract in fact and

the supplier of the "renegoatiated" part of the contract could be a different firm than the initial supplier. Furthermore, procurement contracts awarded before the reform with delivery after the reform could be renegotiated. This correspond to out setting II, i.e. the bidders expect that renegotiation is not possible in the bidding stage, however; the rule changes later after the award and renegotiation becomes possible. In period III, renegotiation is possible and bidders know it already in the bidding stage. The theoretical model provides predictions about the bidding behaviour and the average final prices for the three settings.

Second, we examine the predictions empirically. We use datasets from Czechia and exploit the Czech reform from 2016 for identification purposes. Our strategy is based on difference-in-differences approach. This is possible because the reform affects procurement contracts in the construction sectors (treated group) while other sectors remain intact (control). Our main findings show following the reform *(i)* firms adjust their bidding strategy and bid more aggressively, i.e. winning bids decline, however; *(ii)* final prices of contracts after renegotiation remain unchanged as firms take the policy change into account. Finally, we observe that firms with more experience in public procurement and larger firms renegotiate procurement contracts with higher probability. The contribution of this paper lies in documenting the causal effects of changes in the renegotiation rules on the bidding behaviour and on the final prices of public procurement contracts and documenting which firms are more successful in contract renegotiation.

We structure the remainder of the paper in the following way. Section 2 describes the institutional design of the procurement market in Czechia and the reform. Section 3 describes the theoretical model and its prediction. In Section 4, we present the empirical examination of the predictions about the changes in the bidding strategies and the final prices. Sections 5 is concerned with the welfare implication of the observed effects. Section 6 concludes and lays out the policy implications of our findings.

# 2 Institutional Design

The economy of the Czech Republic underwent the transition from a communist centrally-planned economy to a modern market-based economy in the early 1990s. Since then, it has been one the most prosperous countries in the region with the current GDP per capita in PPP comparable to Spain or Italy. In 2010, The National Economic Council of the Czech Government identified weak institutions as one of the crucial factors hindering economic growth while this contrasted to strong outcomes in the areas of the stability of the macroeconomic environment, good education system, and the flexibility of the labor markets.[1] This is one of the reasons why the Czech act on public procurement has been reformed repeatedly in the last two decades.

This paper makes use of one of the many reforms, which was concerned with the changes of the rules regarding renegotiation. This reform of the Act on Public Procurement[2] came into power on October $1^{st}$ 2016. It introduced a clear and simple procedure to renegotiate public procurement contracts. Before the reform, if renegotiation was needed, procuring authority had to launch a new contract open to all firms or launch a very strictly regulated procedure called "negotiated procedure without public". The latter was only possible if there was a serious reason for additional cost increase due to unexpected circumstances and the additional works were technically or economically inseparable from the initial contract. A contracting authority also had to provide reasons why an open competition could not be launched (such as too short time available). In reality, this meant that this procedure was reserved only for special emergency situations such as natural disasters. This made renegotiation virtually impossible in Czechia, although it is common in other developed countries. The 2016 reform was meant to change this and to incorporate Directive 2014/24/EU into the Czech legislature. After the reform came into paper, renegotiation was made possible with the price change capped at 30% of the estimate cost or of the winning bid, whichever is lower. The reform allows "real" renegotiation of procurement contracts, i.e., changes of the initial contract and not launching new contracts in a special regime. The condition is that the adjustment of the initial contract must be more economical or a new contract is not technically feasible, which is much easier to satisfy than the previous conditions. The new renegotiation rules applied also to public procurement contracts awarded 3 years before the reform came into power and were still ongoing.

[1] For details, see the report `https://www.vlada.cz/assets/media-centrum/aktualne/vyrocni-zprava_NERV.pdf`.

[2] Act No. 134/2016 Coll.

# 3 Theory

## 3.1 Model

In a stylized model, consider a procurer who wants to buy an object with value $v$ to him, and faces $n$ bidders, with $n \geq 2$. The winning bidder is determined through a sealed-bid first-price auction, in which each bidder $i$ simultaneously with all other bidders submits a bid $b_i$, and where the bidder with the lowest bid $p^A$ sells the object to the procurer.[3]

The type $t$ of each bidder type is independently and identically distributed over the range $[0, 1]$, according to the cumulative distribution function $F(t)$, with corresponding density function $f(t)$. Type 0 is the most cost-efficient, and type 1 the least cost-efficient type. After bidders have placed their bids, but before the object is delivered by the winning bidder, the costs of the winning bidder become common knowledge, as well as whether or not the winning bidder faces a cost overrun for delivering the object, and when it is faced, the size of the cost overrun.[4] In particular, with probability $1 - \pi(t)$, bidder type $t$ does not face a cost overrun, and the cost of bidder type $t$ equals $c^A(t)$. With the complementary probability $\pi(t)$, bidder type $t$ faces a cost overrun, and her cost of delivering the object with value $v$ to the procurer equals $c^A(t) + c^B(t)$, meaning that $c^B(t)$ is the size of the cost overrun. In this case, when the winning bidder does not incur the cost overrun, the procurer only obtains value $v - v^B$, as the item is not fully provided.

We consider three different institutional settings. In setting I, the winning bidder cannot renegotiate when she incurs the cost overrun, and when winning the auction needs to deliver the object at her winning bid $p_{\mathrm{I}}^A$ (where subscript I refers to setting I). The ex-ante expected payoff of a winning bidder of type $t$ now equals $p_{\mathrm{I}}^A - [c^A(t) + \pi(t)c^B(t)]$, where $c_{\mathrm{I}}(t) = c^A(t) + \pi(t)c^B(t)$ is the bidder's ex ante expected cost, which we assume to increase continuously in $t$. For instance, this is the case if both the cost without a cost overrun ($c^A(t)$), the probability of a cost overrun ($\pi(t)$), and the size of the cost overrun ($c^B(t)$) itself are larger for less cost-efficient types.

In setting II, just as in setting I, both the procurer and the bidders expect that renegotiation after a bidder has won the auction and turns out to face a cost overrun is

[3] In reality, the auction may take the form of a unit-price auction, where the procurer determines a vector of quantities that the winning bidder needs to deliver, and where a bid consists of a vector of prices at which a bidder wants to deliver these quantities (e.g. Herweg and Schwarz (2018), Ryan (2020)). In this case, bidders can be considered as having a pseudo-type, calculated as a weighted sum of their cost of delivering the quantities (Asker and Cantillon, 2008). Our analysis can be reinterpreted in these terms.

[4] This may be because the procurer can infer information about the bidder's type from the bid that she placed (Shachat and Tan, 2015), because the preparations that the winning bidder makes for delivering the object reveals her type (e.g. (Herweg and Schwarz, 2018); (Chang, 2019)), or because the fact that the winning bidder initiates renegotiation induces the procurer to scrutinize this bidder (Wang, 2000).

not possible, so that the individual bidder expects that she needs to deliver the object at her winning bid, even if she incurs the cost overrun. The ex-ante expected payoff of a winning bidder therefore takes exactly the same form as in setting I, and equals $p^A_{\text{II}} - [c^A(t) + \pi(t)c^B(t)]$ (where subscript II refers to setting II), as bidders expect renegotiation not to be possible. It follows that the ex ante expected cost of a winning bidder equals $c_{\text{II}}(t) = c^A(t) + \pi(t)c^B(t)$, where $c_{\text{II}}(t) = c_{\text{I}}(t)$. However, when the winning bidder faces a cost overrun of delivering the object, unexpectedly she can now still renegotiate at a cost $d$, and obtain an extra price $p^B_{\text{II}}$ for her incurring the cost overrun, where $p^B_{\text{II}} = \alpha(t)v^B + (1 - \alpha(t)) \cdot 0$. The bidder's bargaining power is reflected by parameter $\alpha(t) \in [0, 1]$.[5] When the winning bidder has maximal bargaining power ($\alpha(t) = 1$), given that when she refuses to incur the cost overrun the procurer only obtains value $v - v^B$ from the object, she can additionally charge to the procurer his willingness to pay $v^B$ for her incurring the cost overrun.[6] When the bidder has minimal bargaining power ($\alpha(t) = 0$), she cannot bargain for an extra price for her incurring the cost overrun (which her initial bid was supposed to cover for anyway), and delivers the object at her winning bid $p^A_{\text{II}}$. A winning bidder of type $t$ renegotiates when $\alpha(t)v^B + (1 - \alpha(t)) \cdot 0 \geq d$. For the time being we assume that $\alpha(t)$ is a continuous function with $\alpha'(t) < 0$ such that the most cost-efficient bidder types also have the largest bargaining power, where we assume that $\alpha(0)v^B + (1 - \alpha(0)) \cdot 0 > d$, and $\alpha(1)v^B + (1 - \alpha(1)) \cdot 0 < d$. It follows that a critical $t_{\text{II}}$ exists such that all types with $0 \leq t \leq t_{\text{II}}$ renegotiate, whereas all types $t_{\text{II}} < t \leq 1$ do not renegotiate. The average renegotiated price $E[p^B_{\text{II}}]$ therefore equals:

$$E[p^B_{\text{II}}] = \int_0^{t_{\text{II}}} \alpha(y)v^B \, \mathrm{d}y \tag{1}$$

In setting III, bidders and procurer correctly anticipate that the winning bidder can renegotiate when facing a cost overrun. For bidder types that are expected to renegotiate, the winning bid is expected not to cover for the event where the bidder needs to incur a cost overrun, as an extra price is then negotiated when the cost overrun occurs. A winning bidder with a cost overrun again can renegotiate at a cost $d$, and obtain an extra price $p^B_{\text{III}}$ for her incurring the cost overrun, where this time $p^B_{\text{III}} = \alpha(t)v^B + (1 - \alpha(t))c^B(t)$. It continues to be the case that a winning bidder with maximal bargaining power when

[5] This is equivalent to the generalized Nash bargaining solution, with zero disagreement point of the winning bidder, and disagreement point $v^B$ for the procurer. The generalized Nash bargaining solution can be justified as being the result of a sequential bargaining process, with the parameter $\alpha(t)$ reflecting the bidder's discount factor, determining his patience during the bargaining. For a similar argument in the context of procurement and renegotiation, see Herweg and Schwarz (2018). Alternatively, following (Waehrer, 1995), $\alpha(t)$ is interpreted as the probability that the bidder can make a take-it-or-leave it offer, where with the complementary probability the procurer can make a take-it-or-leave-it offer.

[6] In the reform we consider, the winning bidder can charge at most 30% of her initial bid extra. Our stylized model is in line with this reform when $v^B < 0.3p^B$.

facing a cost overrun and renegotiating charges the procurer $v^B$ extra; however, when having minimal bargaining power, the winning bidder who faces a cost overrun and renegotiates now instead obtains an extra price $c^B(t)$, as her initial bid was placed only for delivering the object at a cost $c^A(t)$.

We assume that $\alpha(t)v^B + (1-\alpha(t))c^B(t)$ decreases continuously in $t$, with $\alpha(0)v^B + (1-\alpha(0))c^B(0) > d$ and $\alpha(1)v^B + (1-\alpha(0))c^B(1) < d$. Thus, we assume that even if less cost efficient types have higher cost overruns ($(c^B)'(t) > 0$), they are still less likely to renegotiate because of their lower bargaining power (i.e., $\alpha(t)$ decreases sufficiently sharply in $t$). It follows that a critical $t_{\text{III}}$ exists such that all types with $0 \leq t \leq t_{\text{III}}$ renegotiate, whereas all types $t > t_{\text{III}}$ do not renegotiate, where $t_{\text{III}} > t_{\text{II}}$. The average renegotiated price $E[p^B_{\text{III}}]$ equals:

$$E[p^B_{\text{III}}] = \int_0^{t_{\text{III}}} [\alpha(y)v^B + (1-\alpha(y))c^B(y)]\,\mathrm{d}y \tag{2}$$

The ex ante expected payoff of a winning bidder with $t_{\text{III}} < t \leq 1$ now equals $p^A_{\text{III}} - [c^A(t) + \pi(t)c^B(t)]$, whereas the ex ante expected payoff of a winning bidder with $0 \leq t \leq t_{\text{III}}$ equals $p^A_{\text{III}} - [c^A(t) + \pi(t)c^B(t)] + \pi(t)[\alpha(t)v^B + (1-\alpha(t))c^B(t)]$. Effectively, the expected net cost $c_{\text{III}}(t)$ of the winning bidder of type $t$ equals $[c^A(t) + \pi(t)c^B(t)] - \pi(t)[\alpha(t)v^B + (1-\alpha(t))c^B(t) - d]$ when $0 \leq t \leq t_{\text{III}}$, and equals $[c^A(t) + \pi(t)c^B(t)]$ when $t_{\text{III}} < t \leq 1$. We assume that $[c^A(t) + \pi(t)c^B(t)] - \pi(t)[\alpha(t)v^B + (1-\alpha(t))c^B(t) - d]$ increases in $t$. As renegotiating bidders with a higher $t$ were assumed to have both higher $[c^A(t) + \pi(t)c^B(t)]$, and lower profit from renegotiating (lower $[\alpha(t)v^B + (1-\alpha(t))c^B(t) - d]$), this assumption makes sense as long as $\pi(t)$ does not increase too sharply. Overall, the expected net cost $c_{\text{III}}(t)$ of a winning bidder now increases in $t$, with additionally a discontinuous increase in $c_{\text{III}}(t)$ around $t_{\text{III}}$, where $c_{\text{III}}(t) = c_{\text{II}}(t) = c_{\text{III}}(t)$ for $t_{\text{III}} < t \leq 1$, and $c_{\text{III}}(t) < c_{\text{II}}(t) = c_{\text{I}}(t)$ for $0 \leq t \leq t_{\text{III}}$. Under the given assumptions, the switch from setting I and II, to setting III preserves the manner in which bidders are ordered according to their expected net costs.

## 3.2 Predictions

Transposing standard results about first-price auctions to procurement, it is well-known that in the symmetric Nash equilibrium, each risk-neutral bidder $i$ places a bid equal to the expected second-lowest cost among the $n$ bidders, conditional on bidder $i$ having the lowest cost (Krishna, 2009). In this way, the winning bidder on average makes maximal profits, while just still winning the auction from the second-lowest bidder. Given this fact, in settings $x = \text{I}, \text{II}, \text{III}$, considering the expected net cost $c_x(t)$, we can now consecutively determine the equilibrium bid $b_x(t)$ of the bidder of type $t$, the average bid $E[b_x]$, and

the average winning bid in the auction $E[p_x^A]$.

$$b_x(t) = \frac{1}{[1-F(t)]^{n-1}} \int_t^1 c_x(y)(n-1)[1-F(y)]^{n-2} f(y)\,\mathrm{d}y \tag{3}$$

$$E[b_x] = \int_0^1 \left[ \frac{1}{[1-F(t)]^{n-1}} \int_t^1 c_x(y)(n-1)[1-F(y)]^{n-2} f(y)\,\mathrm{d}y \right] f(t)\,\mathrm{d}t \tag{4}$$

$$E[p_x^A] = \int_0^1 \left[ \int_t^1 c_x(y)(n-1)[1-F(y)]^{n-2} f(y)\,\mathrm{d}y \right] n f(t)\,\mathrm{d}t \tag{5}$$

Moreover, the average renegotiated price $E[p_x^B]$ is given by equations (1) for setting II and (2) for setting III, whereas in setting I, $E[p_{\mathrm{I}}^B] = 0$. The average final price $E[p_x]$ in setting $x$ is now the sum of the average winning bid and the average renegotiated price, or $E[p_x] = E[p_x^A] + E[p_x^B]$. Finally, the (ex ante) probability of renegotiation $\Pi_x$ in setting $x$ with $x = \mathrm{II}, \mathrm{III}$ is determined by the probability that the winning bidder is of type $t$ with $0 \leq t \leq t_{\mathrm{III}}$, or

$$\Pi_x = \int_0^{t_x} \left[ \int_0^t f(y)\pi(y)\,\mathrm{d}y \right] (n-1)[1-F(t)]^{n-2} f(t)\,\mathrm{d}t \tag{6}$$

Our predictions about comparisons between the settings now follow directly, and are summarized in Table 1. The probability of renegotiation is larger in setting II than in setting I, simply because renegotiation was not possible in setting I. The probability of renegotiation is larger in setting III than in setting II because the lower limit on the renegotiated price was argued to be higher in setting III, which means that for additional types the benefit from renegotiation exceeds its cost.

In settings I and II, as bidders do not expect renegotiation to be possible, expected net cost for a bidder of type $y$ equals $c_x(y) = [c^A(y) + \pi(y)c^B(y)]$ for $x = \mathrm{I}, \mathrm{II}$. The average winning bid is therefore the same in these two settings. In setting III, given that only bidders with type $t$ such that $0 \leq t \leq t_{\mathrm{III}}$ renegotiate, a bidder with type $t \geq t_{\mathrm{III}}$, conditional on her winning, does not expect the second-lowest bidder to renegotiate, so that she expects a second-lowest bidder of type $y$ to have expected net cost $c_x(y) = [c^A(y) + \pi(y)c^B(y)]$. However, a bidder with type $t < t_{\mathrm{III}}$ expects a bidder of type $y$ to have expected net cost $c_x(y) = [c^A(y) + \pi(y)c^B(y)]$ when $y > t_{\mathrm{III}}$, and to have expected net cost $[c^A(y) + \pi(y)c^B(y)] - \pi(y)[\alpha(y)v^B + (1-\alpha(y))c^B(y) - d]$ when $t < y <\leq t_{\mathrm{III}}$. In other words, given our assumption that the more cost-efficient bidders renegotiate, such a bidder has a lower expected net cost as she corrects the cost downward to account for the benefit of renegotiation; moreover, such a bidder, when placing her bid, allows for the possibility that the second-lowest bidder also renegotiates and has a lower expected net cost. For this reason, in setting III, the average winning bid is lower than in settings

Table 1: Predictions

| | Setting I compared to II | Setting II compared to III |
|---|---|---|
| Probability of renegotiation | $\Pi_{\text{II}} > \Pi_{\text{I}} = 0$ | $\Pi_{\text{III}} > \Pi_{\text{II}}$ |
| Average winning bid | $E[p^A_{\text{II}}] = E[p^A_{\text{I}}]$ | $E[p^A_{\text{III}}] < E[p^A_{\text{II}}]$ |
| Average renegotiated price | $E[p^B_{\text{II}}] > E[p^B_{\text{I}}] = 0$ | $E[p^B_{\text{III}}] > E[p^B_{\text{II}}]$ |
| Average final price | $E[p_{\text{II}}] > E[p_{\text{I}}]$ | $E[p_{\text{III}}] \lesseqgtr E[p_{\text{II}}]$ |

*Notes*: Predictions from our stylized theoretical model on key variables in three institutions settings. In setting I, renegotiation upon a cost overrun is not possible. In setting II, renegotiation is possible, but was not expected to be possible ex ante. In setting III, renegotiation is possible, and this was anticipated ex ante.

I and II.

The average renegotiated price is larger in setting II than in setting I simply because renegotiation is not possible in setting I. The average renegotiated price is larger in setting III than in setting II because on the one hand, additional bidder types renegotiate (namely those types between $t_{\text{II}}$ and $t_{\text{III}}$), and on the other hand, bidder types who were already renegotiating now can bargain a higher price. Finally, the average final price is larger in setting II than in setting I because of the higher renegotiated price and the equal average winning bid. However, the relation between the average final price in settings III and II is ambiguous because on the one hand, the average winning bid is lower in setting III than in setting II, but on the other hand the average renegotiated price is larger.

We now reflect on the extent to which the predictions in Table 1 depend on the assumptions we take. First, we have assumed that in each of the settings, bidders are ordered in the same manner according to their expected net costs, so that each bidder type has the same probability of winning the auction across auctions. This means that changing the setting does not lead to inefficiency. Related to this, we have assumed that a range of the most cost-efficient bidders renegotiate when incurring a cost overrun. We now note that none of our predictions in Table 1 depend on these assumptions. As long as a winning bidder with minimal bargaining power is able to negotiate a higher extra price in setting III than in setting II, additional types will renegotiate in setting III, and the probability of renegotiation will be higher. Any winning bidder who prefers to renegotiate cost overruns, in case it is possible that bidders with higher net costs renegotiate, will set a lower bid in setting III than in setting II; a bidder who expects this not to be possible, will bid the same as in setting II. But this means that the average winning bid is lower in setting III than in setting II. Moreover, as in setting III additional types renegotiate, and as types who already renegotiated in setting II are able to negotiate a higher extra price,

the average renegotiated price continues to be higher in setting III. Finally, because the average winning bid in setting III is lower than in setting II but the average renegotiated price is higher, it continues to be ambiguous whether the average final price is larger or not. Still, it seems intuitive that, if setting III self selects as winners cost-inefficient bidders with large cost overruns that happen also to have large bargaining power, the final price will be larger in III than in setting II (for a similar mechanism, see Chang et al. (2016)).[7] Our predictions are thus based on the assumption that the change in institutional setting does not create large inefficiencies.

Second, we have assumed that the winning bid does not affect the bidder's bargaining position. In the institutional setting we study, the maximal extra price the winning bidder can renegotiate is set at a fraction of the winning bid. Our model implicitly assumes that his constraint is not binding because the value to the procurer of the winning bidder incurring the cost overrun does not exceed this fraction. Yet, if the constraint is in fact binding, then bidders have on the one hand an incentive to bid lower because the profit of renegotiating means a lower net cost, but on the other hand have an incentive to bid more to raise the maximum extra price that they can bargain. It can be checked that as long as bidders' bargaining power is not too large, the latter effect does not prevail.

Third, the winning bidder who faces a cost overrun may be seen as bargaining with the procurer for providing an extra service with value $v^B$ to him, and cost $c^B(t)$ to the procurer (for procurement with renegotiation modeled in this way, see Fugger et al. (2019)). In this sense, one could argue that these should be the disagreement points, both in settings II and III. If this is the case, then the probability of renegotiation is identical in settings II and III, as well as the average renegotiated price; the average final price is then lower in setting III than in setting II. Yet, intuitively, the extra price that the winning bidder can bargain for in setting II is lower, given that the winning bid was already supposed to cover the extra service. We reflect this in the assumptions by assuming a lower disagreement point for the winning bidder. The predictions remain the same when reflecting this intuition by assuming that each bidder type has lower bargaining power, or a higher cost of renegotiation, in setting III than in setting II.

Fourth, we have assumed that bidders' costs are privately and independently drawn from the same distribution (cf. Wang (2000); Shachat and Tan (2015); Herweg and Schwarz (2018)). In a common-value model, all bidders' costs are instead the same, but they individually receive noisy signals about them. In such a model, bidders have an

[7] Ryan (2020) constructs a model where bidders lower their bids anticipating the benefits of renegotiation. Moreover, he finds evidence for Indian power contracts that firms with good connections to government deliberately do not index their bids to input prices in order to reap the benefits from renegotiation, and that this leads to inefficiency. Bidders also bid more aggressively if they are able to default when their costs turn out to be too high Harstad and Rothkopf (1995); as plausibly less cost-efficient firms default more often, this could again lead to self selection of cost-inefficient bidders as winners.

incentive to adjust their bids upward to avoid winner's curse, where a bidder wins the auction because of having received a low cost signal. Allowing bidders to renegotiate then makes the consequences of falling subject to the winner's curse less severe, and makes bidders bid more aggressively (see Waehrer (1995); Harstad and Rothkopf (1995); Roelofs (2002)). In any real-world setting, bidders' costs may both have private and common elements, so that we cannot exclude such an additional effect of the change in institutional setting.

Fifth, we have focused on the positive profit that bidders may have from the possibility of a cost overrun. Yet, one could also conceive of cost overruns leading to more costs than benefits to the winning bidder. In this case, in the logic of our model, bidders would in setting III adjust their bids upwards rather than downwards (for a model along these lines, and empirical evidence in the context of Californian highway contracts, see Bajari et al. (2014b)). Our model is thus based on the assumption that the benefits prevail.

Sixth, we have focused on bidder-initiated renegotiation, after the winning bidder incurs a cost overrun. Yet, it is conceivable that the winning bidder instead has lower costs than initially expected, where these costs become known by the procurer after the auction, so that the procurer may instead at a cost initiate renegotiation to decrease the price (Wang (2000); Shachat and Tan (2015)). Our model is based on the assumption that this is not the driving force in our setting.

Seventh, we have focused on renegotiation triggered by information on the costs of the winning bidder. Yet, renegotiation may also take place because after the auction, it becomes common knowledge what exact commodity the procurer needs. In this case, as shown by (Ganuza, 2007), the procurer may underinvest in finding out the exact commodity he needs before the start of the auction. Even though this means a higher renegotiated price, such underinvestment is optimal to the procurer because it makes the bidders more homogeneous in the bidding process, thus increasing competition.

# 4 Empirical Evidence

## 4.1 Data

Our analysis is conducted on public procurement data from Czechia. The procurement legislation ensures that throughout the country the same rules apply and also that procuring authorities have to publish details about contracts in an online system. The data from this system are used in this paper. This includes all public procurement contracts with the value above the thresholds of circa 87,000 USD for public service contracts and 261,000

USD for public works. A large number of public procurement with the value below these thresholds are also in the system.

Table 2: Descriptive Statistics - Dataset of Public Procurement Contracts

| | mean | sd | p25 | p75 |
|---|---|---|---|---|
| Estimated cost | 3.04e+07 | 1.67e+08 | 4990000 | 2.04e+07 |
| Bid | 2.66e+07 | 1.51e+08 | 4358000 | 1.75e+07 |
| Final price | 2.74e+07 | 1.64e+08 | 4485000 | 1.78e+07 |
| Rel. price | .8945629 | .1739229 | .7753828 | .9992429 |
| *N* | 18,874 | | | |

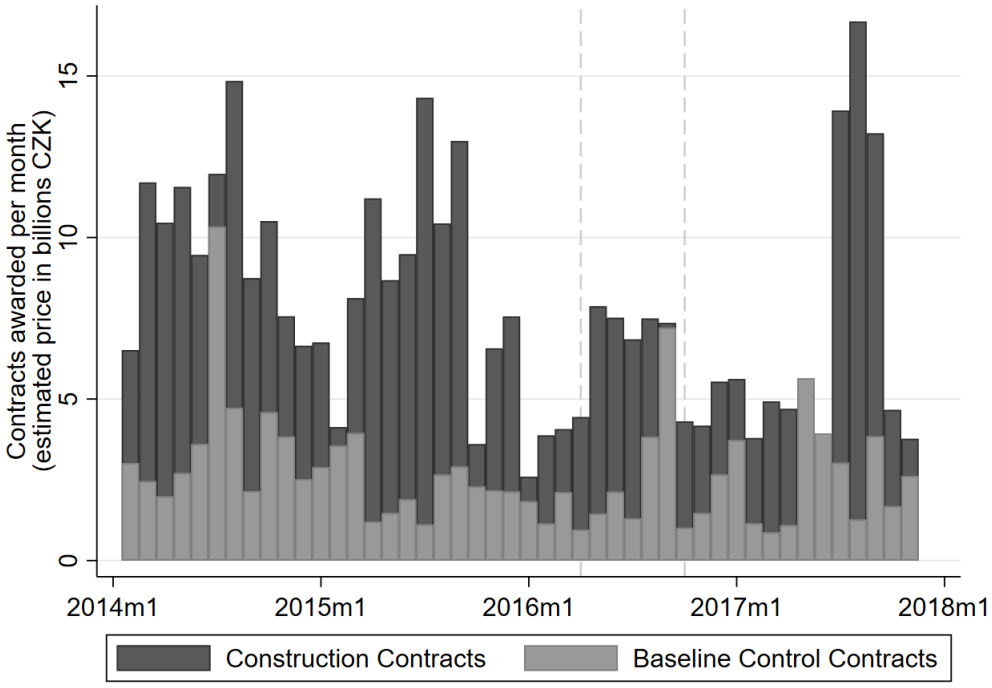
*Notes*: These are descriptive statistics of contract-level procurement data. The price and estimated costs are in thousands of CZK. Note that for the number of bidders, there are few missing observations and the total number of observations is 33,251.

Our dataset contains 18,874 contracts that accrue to 517 billion CZK (24 billion USD) in total value. The dataset covers detailed information about each contract including project industry classifications (CPV codes), engineering estimate of costs, initial prices, final prices, numbers of competitors, and identities of contractors and procuring authorities. Basic summary statistics on these variables are provided in Table 2.

## 4.2 Descriptive Statistics

To create a group of control contracts, we rely on contracts in similar industries. In our preferable specification, the control group consists of contracts in *Industrial machinery*, *Technical services*, and *Energy*. We refer to this group of contracts as the baseline control contracts. Contracts in construction i.e., treated contracts represent 46% of all contacts in the studied period, where as the baseline control contracts 26%. Over the studied period (contracts awarded between January, 2014 and December, 2017), there have been 8,877 construction contracts and 5,152 baseline control contracts. See Figure **??** for the value of the contracts awarded per month by industry. To provide more robust evidence, we extend the baseline control group by including all contracts awarded in the studied period. The results are presented in Appendix.

Consistently with the intention of the policy reform, renegotiation occurs mostly in construction, while non-construction contracts are renegotiated rarely. Figure 1a shows shares of renegotiated contracts over time in both groups for contracts awarded between January, 2014 and December, 2017. The share of renegotiated construction contracts




*Notes*: This figure shows the expected price of contracts awarded in a given month by industries between January, 2014 and December, 2017. Non-construction contracts represent contracts in *Industrial machinery*, *Technical services*, and *Energy*.

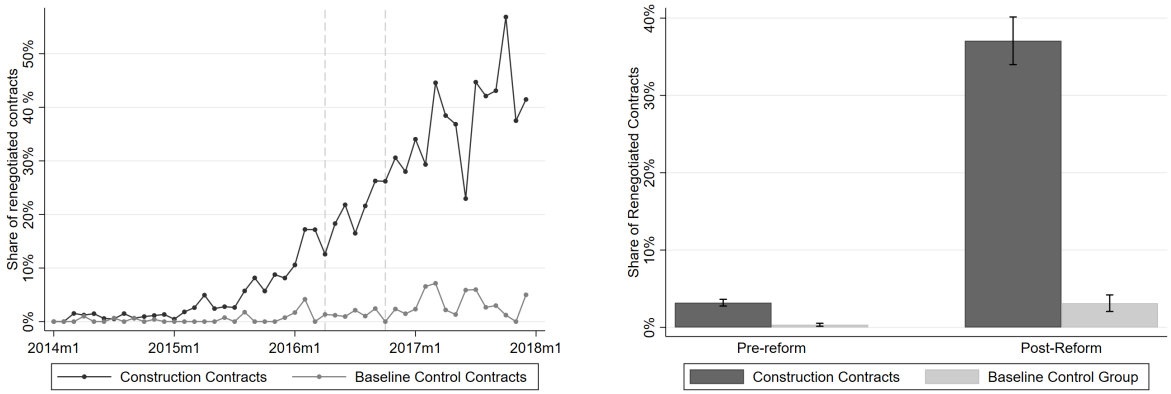
gradually increases over time and in the end of the observed period i.e., two years after the reform, the share of renegotiated construction contracts fluctuates around 40%. Conversely, the share renegotiated contracts among the non-construction ones remain around 5% on average. The drawback of our data and Figure 1a is that the time axis measures when the contract was awarded and it is thus not informative about when the renegotiation happened and whether contracts were eligible for renegotiation.

Figure 1b shows frequency of renegotiated contracts by groups and the pre- and post-reform periods. It confirms that the share of renegotiated construction contract increased by more than 30 percentage points after the reform, while the increase among contracts in the control group is only about few percentage points.

Since the reform allowed renegotiation for any contract that has been awarded at latest 3 years before the renegotiation, also contract awarded in the pre-reform period could have been renegotiated. For example, from all the contracts awarded in October, 2015 only contacts longer than 2 years could have been renegotiated. However, for a group of contracts awarded in October, 2016, any contracts longer than 1 year could have been renegotiated. Shares of contracts that could have been renegotiation i.e., were exposed to the policy change in the pre-reform period are likely increasing over time.

Shares of renegotiated contracts at the end of time period are likely underestimated due to survival bias, as many of the contracts could have been renegotiated after our dataset ends.

Figure 1: Share of Contracts Renegotiated by Industry




(a) Panel A: Evolution Over Time

(b) Panel B: Share of Renegotiated Contracts

*Notes*: Panel A shows shares of renegotiated contracts by industry between January 2012 and December 2017 by the date when the contract was awarded. Two gray (dashed) vertical line indicate when the amendment was adopted in April, 2016 and its effect from October, 2016. It is possible to entry in renegotiation even for contracts awarded before the amendment adoption. Panel B shows shares of renegotiated contracts by industry in pre-reform period (before April, 2016) and in post-reform period (after October, 2016). The baseline control group consists of contracts in *Strojírenské produkty*, *Technické služby*, *Doprava*, and *Energie*.

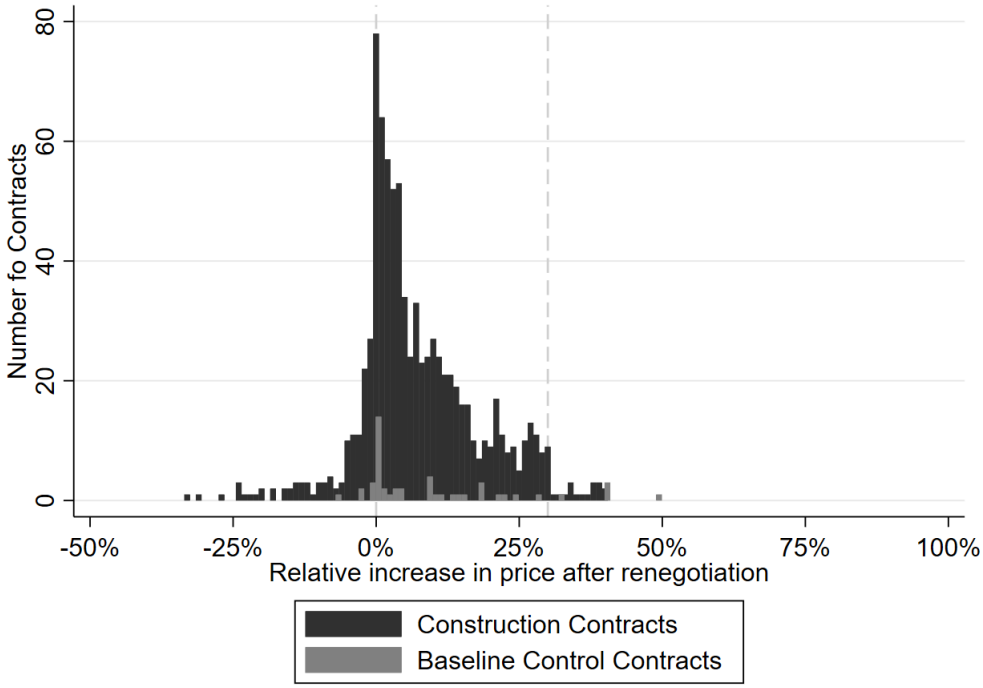
Over the studied period, we observe 937 renegotiated contracts in either construction (885) or baseline control group (52) contracts.[8] Among the 937 renegotiated contracts in either construction or non-construction industries, the average change in the price was a 7.9% increase compared to the winning bid. The average renegotiation is slightly higher among baseline control group (9.2%) but the difference is not statistically significant. Figure 2 shows histogram of relative increases in prices compared to winning bids. Roughly 18% of renegotiation lead to lower final price than the initial winning bids. In majority of cases, renegotiation leads to an increase between 0% and 30%.

## 4.3 Winning Bids

We first show that the possibility of renegotiation decreased the average winning bids. We use the differences-in-differences approach to estimate the average treatment effect on treated (ATT). In the primary specification, we estimate the effect on *Bid Ratio* defined as a ratio of the winning bid and the estimated price of the contract.

[8]There are additional 66 renegotiated contracts are in *other* industries.

Figure 2: Frequency of Relative Renegotiated Amount




*Notes*: Figure shows frequency of renegotiated amount by industry between January 2014 and December 2017 by a date when the contract was awarded. The gray (dashed) vertical line indicate the threshold of 30% that limits the legal option of renegotiated amount.

### 4.3.1 Empirical Strategy

Figure 3 shows the evolution of $BidRatio$ for construction and non-construction contracts over time. Over the studied period, the *Bid Ratio* tend to increase in both groups of contracts with the construction contracts being systematically lower. In our primary specification, we focus on April, 2016 when the the policy change was adopted.[9] Figure 3 documents a decline in the $BidRatio$ in both construction and non-construction contracts. The visual inspection suggests that the drop was more pronounced among construction contracts. After the drop both time series resume in their increasing trends.

Our first empirical specification is the following regression

$$Bid\ Ratio = \delta_1\ T + \delta_2\ Construction + \beta\ Construction * T + \gamma X + \varepsilon, \tag{7}$$

where $Construction$ and $T$ are indicators for construction contracts and post-reform

[9]It is possible that the first reaction appears already in March 2016.

time period, respectively, $X$ controls for selection methods and procedure of the procurement auction. The coefficient of our interest is $\beta$. The outcome variable is a ratio of winning bids to the estimated price. To interpret $\beta$ as a causal ATT effect, we assume that in the absent of the policy change the bid to the estimated price ratio would evolve the same for construction and non-construction contracts. This is the so-called parallel trend assumption. The assumption is supported by Figure 3 which shows parallel trends in *Bid Ratio* in the pre-treatment period.

Figure 3: Evolution of *BidRatio* in Construction and Non-construction Contracts


*Notes*: This figure shows evolution of *Bid Ratio* over time before and after the policy change in construction and baseline control group. The pre-reform period suggests similar trend between both groups of contracts. Furthermore, they even exhibit similar seasonality. After the reform, the *Bid Ratio* declined more among construction contracts.

In two alternative specifications we control for more granular industrial fixed effects at the level of industry 4 and industry 6 ($\delta_k$) (see Regression 8). Note that controlling for more granular structure of industries does not allows us to identify the coefficient for *Construction* as we do in Regression 7. Instead, we estimate a unique coefficient for each of the narrowly defined industry level.

$$Bid\ Ratio = \delta\ T + \beta\ Construction * T + \gamma X + \delta_k + \varepsilon. \tag{8}$$

We add two additional robustness exercises. First, instead of *Bid Ratio* we use a logarithm of winning bid ($Winning\ Bid\ (log)$) as an outcome variable while controlling for a logarithm of the estimated price. Second, we use different control group. While we believe that the primary control group consists of contracts similar to construction industries, as a robustness exercise we also use all contracts as a control group. With these two specifications, we re-estimate Regressions 7 and 8.

### 4.3.2 Results

In all three specifications, the average treatment effect on treated is negative and statistically significant. The possibility of legal renegotiation decreased the average winning bids. In our primary specification, presented in column (1) of Table 3, the point estimate of the effect is -2.6 percentage points of the estimated price. In alternative specifications, presented in columns (2) and (3), the point estimate is even negative and of -3.1 and -3.2 percentage points of the estimated price, respectively.

Table 3: Effect of the Introduction of Renegotiation on *Bid Ratio*

| | (1) | (2) | (3) |
|---|---|---|---|
| | Bid Ratio | Bid Ratio | Bid Ratio |
| T=1 | 0.003 | 0.007 | 0.010** |
| | (0.005) | (0.005) | (0.005) |
| Construction=1 | -0.113*** | | |
| | (0.003) | | |
| T=1 × Construction=1 | -0.026*** | -0.031*** | -0.032*** |
| | (0.006) | (0.006) | (0.006) |
| Industry FE | No | Level 4 | Level 6 |
| N | 13572.000 | 13502.000 | 13263.000 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

*Notes*: This table shows that the possibility of renegotiation decreased the average winning bid. The outcome variable (*Bid Ratio*) is the ratio of winning bid over the estimated price of a public procurement contract. Depending on the specification, the average treatment effect on treated ranges between -2.6 and to -3.2 percentage points of the estimated price. In each specification, we control for the type of procurement procedure and the type of evaluation criteria.

We next report results from the same three specifications using a logarithm of $WinningBids$

as the outcome variable. The parameter of interest corresponds to a percentage change in average bidding prices and the effect is still interpreted as ATT. In all three specifications the effect is negative and statistically significant. The possibility of legal renegotiation decreased the average winning bids by between 3.3% and 4%. The exact figure depends on specification. The results are presented in Table 8 in Appendix.

We also report results from specifications that use all contracts as a control group. We re-estimate the three regressions introduced before with $BidRatio$ as an outcome variable. The estimated ATT effects range between -2.9 percentage points and -3.1 percentage points of the estimated price. For more details see Table 12 in Appendix.

Overall, 9 different specifications provide robust evidence that the introduction of legal renegotiation decreases the average winning bids among construction contracts. The effect is consistently around 3 percentage points of the estimated price and around 3.5% of the average winning bids. Note that the proportion corresponds to the fact that the estimated price on construction contracts is systematically higher than the winning bids.

**Result 1.** *The possibility of legal renegotiation decreased the average winning bid by roughly 3 percentage points of the estimated price and about 3.3% to 4% of the average winning bid.*

An important concern of our empirical specification is that a part of the control group was exposed to the legal possibility of renegotiation as well. In particular, Figure **??** shows that about 5% of contracts awarded after the reform have been renegotiated. This mechanism works against our estimates, as it tends to attenuate the true effect of the introduction of the legal renegotiation on the average winning bids. Our estimates are thus likely the lower bound of the causal effect of introduction of the possibility of renegotiation on the winning bids.

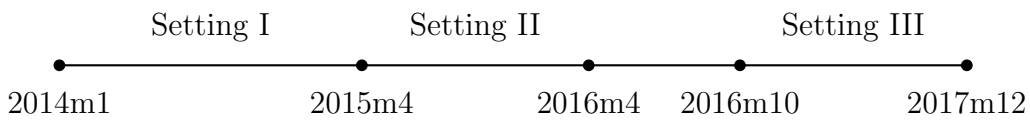
## 4.4 Final Price

We next analyse final prices in three different settings. Ideally, the empirical exercises would correspond to the theoretical model and compare the average final price in three different settings according to the possibility of renegotiation. In *Setting I*, no contracts can be renegotiated and bidders are aware of that when submitting their bids. In *Setting II*, renegotiation is not possible when bidders submit their bids, but becomes possible in the course of the contract. Finally, in *Setting III* renegotiation is possible and bidders are aware of that.

Unfortunately, we have only the award date of a contract, it is thus impossible to determine a corresponding setting for each contract perfectly. It is clear that any contract

awarded after the policy change follows the rules of *Setting III*. With *Setting I* and *II* it is more complicated, as the decisive date for right classification is when the contract ends. Contracts that end before the policy changed cannot be renegotiated and belong to *Setting I*, whereas contracts that end after the policy changed can be potentially renegotiated and thus belong to *Setting II*. To overcome this challenge, we classify contracts into *Setting II* if they were awarded within a year before the reform i.e., between April, 2015 and April, 2016. The reaming contracts are then classified as *Setting I*. We cannot rule out that some contracts are misclassified.[10]

Figure 4: Timing and Three Settings of Contracts




Notes: This figure shows how definitions of *Settings*. *Settings I* consists of contracts awarded between January, 2014 and April, 2015. *Settings II* consists of contracts awarded between April, 2015 and April, 2016. Finally, *Settings III* consists of contracts awarded between April, 2016 and December, 2017.

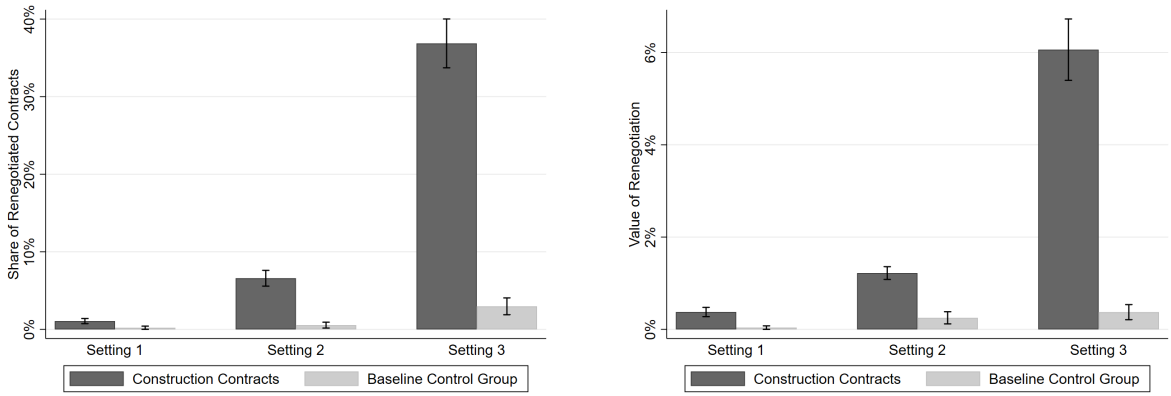
Share of renegotiated contracts and the value of renegotiation by industries and settings suggest that our classification is reasonably accurate. Figure 5 shows that renegotiation practice differs by industries and settings. Both share of renegotiated contracts and the ratio of renegotiated value to estimated price of all contracts show that the renegotiation is important mostly in *Setting III* among construction contracts, as almost 40 % of contracts were renegotiated and the renegotiated amount is about 6% of value of the contracts. The second highest share of renegotiated contracts is among construction contracts in *Setting II* followed by non-construction contracts in *Setting III*. The remaining combinations of Settings and industries show rather negligible share and value of renegotiated contracts.

### 4.4.1 Setting I vs. Setting II

We start with a comparison of final prices of contracts in *Setting I* and *Setting II*. The *Settings* differ in the proportion of renegotiated construction contracts. In *Setting I*, 1% of construction and 0.2% of non-construction contracts were renegotiated, while in *Setting II* it was 6.5% and 0.5%, respectively. Based on our theoretical model, we expect the *Price Ratio* i.e., the final price to the expected price ratio, to be higher among construction contracts in *Setting II*.

[10]The fact that for long contracts that are inaccurately classified as *Setting I* even though they end after the reform was in effect, it is arguably only a several months at the end of the contracts when renegotiation is possible, moderates the concerns.

Figure 5: Share and Value of Renegotiation by Industries and Settings




(a) Panel A: Share of Renegotiated Contracts

(b) Panel B: Value of Renegotiation

*Notes*: This figure shows realization of renegotiation by industries and Settings. Panel A shows share of contracts that were renegotiated, while Panel B shows the relative value of contracts that were renegotiated (ratio of amount renegotiated in all contracts to the value of all contracts). Both panels document that renegotiation in *Setting III* among construction contracts was significantly more pronounced than in other Setting and non-construction contracts.

To estimate the effect, we rely on the differences-in-differences strategy. Similarly to the previous section, we estimate the effect using the baseline control contracts (4 industries - *Strojírenské produkty*, *Technologické služby*, *Doprava*, and *Energie*.) and all non-construction contracts as a robustness exercise. Results of the latter are presented in Appendix. Our primary specification corresponds to Regression 7. Additionally, we implement two specification controlling for more granular industries which correspond to Regression 8.

We found evidence that the reform increased the final price among construction contracts in *Setting II*. The point estimates from different specifications systematically exceed a 1.5 percentage points of the estimate prices, the results thus suggest that a significant increase in the final price. The first column of Table 4 reports results from our primary specification. Due to the policy reform, the final price of construction contracts in *Setting II* is by 1.5 percentage points of the estimated price higher than it would have been without the policy reform. The alternative specifications in the second and third columns suggest even larger effects that our primary specification.

Table 9 in Appendix reports results from specifications using logarithms of $FinalPrice$ as an outcome variable. In all the specifications, the point estimates are around 2% and statistically significant. Finally, Table 13 reports results from differences-in-differences using all non-construction contracts as a control group and provides additional evidence of statistically significant effect of around 1.5 percentage point of the estimated price.

Table 4: Effect of Renegotiation on Final Price between *Settings I* and *II*

| | (1) | (2) | (3) |
|---|---|---|---|
| | Price Ratio | Price Ratio | Price Ratio |
| T=1 | 0.014*** | 0.010* | 0.011* |
| | (0.006) | (0.006) | (0.006) |
| Construction=1 | -0.127*** | | |
| | (0.005) | | |
| T=1 × Construction=1 | 0.015** | 0.022*** | 0.017** |
| | (0.007) | (0.007) | (0.007) |
| Industry FE | No | Level 4 | Level 6 |
| N | 9193.000 | 9118.000 | 8881.000 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

*Notes*: This table reports results from three different DD specifications between contracts in *Setting I* and *Setting II*. *T* is a dummy variable which equals 1 for contracts from *Setting II* and 0 for *Setting I*. In all specifications, we control for selection methods and procedure of the procurement auction.

**Result 2.** *Ex-post possibility of renegotiation increases the final price by between 1.5 to 2.2 percentage points of the estimated price.*

### 4.4.2 Setting II vs. Setting III

We next compare the final prices in *Setting II* and *Setting III*. Results from differences-in-differences are reported in Table 5. In all three specifications, the point estimate is negative. The first column shows effect of -1.4 percentage points of the estimated price. The effect, however, is not statistically significant. Once we control for more granular structure of industries, the effect become more negative (-2 and -2.1 p.p) and marginally statistically significant.

Table 5: Effect of Renegotiation on Final Price between *Settings II* and *III*

| | (1) | (2) | (3) |
|---|---|---|---|
| | Price Ratio | Price Ratio | Price Ratio |
| T=1 | 0.003 | 0.005 | 0.010 |
| | (0.007) | (0.007) | (0.008) |
| Construction=1 | -0.113*** | | |
| | (0.005) | | |
| T=1 × Construction=1 | -0.011 | -0.019** | -0.019* |
| | (0.009) | (0.010) | (0.010) |
| Industry FE | No | Level 4 | Level 6 |
| N | 5226.000 | 5144.000 | 4960.000 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

*Notes*: This table reports results from three different DD specifications between contracts in *Setting II* and *Setting III*. *T* is a dummy variable which equals 1 for contracts from *Setting III* and 0 for *Setting II*. In all specifications, we control for selection methods and procedure of the procurement auction.

Two robustness exercises provide similar picture. First, Table 10 shows results from regressions using a logarithm of the final price as the outcome variable, while controlling for the estimated price. Similarly to the main specification, the point estimates are negative in all three specifications and statistically significant in two specifications with more granular structure of the industries. Finally, using all contract as a control group yields statistically insignificant, but qualitatively similar results as the main specifications. In particular, Table 14 shows that in all specifications the point estimate is between -1.1 to -1.4 percentage points.

**Result 3.** *Once the bidding price adjust to the possibility of renegotiation, the final price decreased. However, the effect is small and only marginally significant.*

### 4.4.3 Setting I vs. Setting III

Finally, we compare the average final price in *Setting I* and *Setting III*. Note that our theory does not provide us with any prediction. On the one hand, the final price in *Setting III* can be increased by renegotiation, on the other hand, the final price in *Setting I* already contains the compensation of potential overrun cost.

We find no difference between the final price in *Setting I* and *Setting III*. All there

main specifications, reported in Table 6, suggest null effect. Similarly. all robustness exercises reported in Table 15 and 11 show null effect.

Table 6: Effect of Renegotiation on Final Price between *Settings I* and *III*

| | (1) | (2) | (3) |
|---|---|---|---|
| | Price Ratio | Price Ratio | Price Ratio |
| T=1 | 0.020*** | 0.019*** | 0.024*** |
| | (0.007) | (0.007) | (0.008) |
| Construction=1 | -0.129*** | | |
| | (0.005) | | |
| T=1 × Construction=1 | 0.002 | -0.002 | -0.007 |
| | (0.009) | (0.010) | (0.010) |
| Industry FE | No | Level 4 | Level 6 |
| N | 7009.000 | 6933.000 | 6723.000 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

*Notes*: This table reports results from three different DD specifications between contracts in *Setting I* and *Setting III*. $T$ is a dummy variable which equals 1 for contracts from *Setting III* and 0 for *Setting I*. In all specifications, we control for selection methods and procedure of the procurement auction.

**Result 4.** *Once the bidding strategies adjust, the possibility of renegotiation no longer affect final price.*

Overall, we show that the average final price in construction contracts increased in *Setting II*, when the renegotiation was possible but the winning bids did not take that in to account. The average final price in *Setting III* then decreased again and remain statistically indistinguishable from the average final price in *Setting I*.

Allowing renegotiation increases the average final price only if firms do not take that into account. Once firms adjust their bidding strategies, the winning bids decrease and so does the average final price.

# 5 Firm Heterogeneity and Welfare

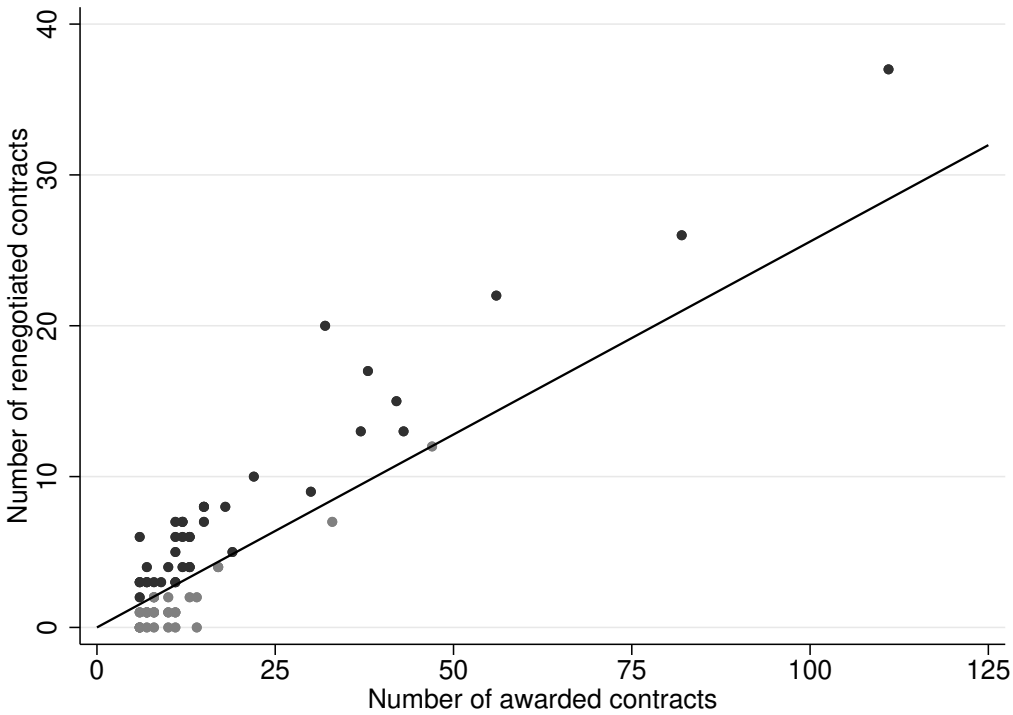
We next discuss welfare consequences of the reform. The change in the regulation of renegotiation might have welfare implications. In the first step to understand this issue, we study the heterogeneity of firms with respect to their success in renegotiating contracts.

In Figure 6, we show a scatter plot of the number of awarded contracts on the number of renegotiated contract per firm. The sample is limited to the firms that have been awarded more than 5 construction contracts in the post-treatment period. The firms above the black line displayed as black dots renegotiate contracts more often than to the unconditional probability of renegotiation (25%) predicts. Conversely, dots below the line represent firms that renegotiate less frequent than firms do on average. Note a cluster of firms awarded more than 40 construction contracts with frequent renegotiation. The figure suggests that firms with more construction contracts also renegotiate more frequently. This is supported by OLS regression of

$$Prob\,Renegotiation = \alpha + \gamma Number\,Contracts + \varepsilon,$$

with the estimate of $\gamma$ is 0.34 and also the explanatory power of the model is quite high with $R^2 = 0.87$.

Figure 6: Frequency of Renegotiated Contracts




*Notes*: The figure display heterogeneity on probability of renegotiation. Each firm with at least 5 construction contracts in post treatment period is represented by one dot. The black line corresponds to the probability of renegotiation (25%). 100 contracts correspond to roughly 5 % of all construction contracts awarded in post-treatment period.

In Table 7, we study the associations of between firm characteristics and the probabil-

ity of renegotiation. Our findings suggest that past experience and the size of a company are good predictors of the probability while this is not the case for profitability. These results suggest that some firms are more successful in renegotiation than others. In the future version of the paper, we aim to study how the composition of suppliers changes with the change of the renegotiation rules. This will help us making causal claims about the efficiency implication of the reform.

Table 7: Predictor of success in renegotiation

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | Prob Reneg | Prob Reneg | Prob Reneg | Prob Reneg |
| Past experience | 0.0148** | | | |
| | (0.0068) | | | |
| Log(Total Assets) | | 0.0120* | | |
| | | (0.0066) | | |
| Employee intensity | | | 0.00575*** | |
| | | | (0.0001) | |
| Profitability | | | | -0.000444 |
| | | | | (0.0013) |
| N | 944 | 643 | 585 | 559 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

*Notes*: The outcome variable is the ratio of the number of renegotiated procurement contracts over the total number of procurement contracts won by a particular firm.

# 6 Conclusion

Public procurement contracts account for about 12% of GDP and roughly 25% of general government spending in OECD countries. In most countries, these contracts are often renegotiated ex-post.

In this paper, we study how allowing renegotiation affects the bidding behaviour of firms and the final prices of public procurement contract. We develop a theoretical model that yields predictions about the firm behaviour under different renegotiation policy regimes. Subsequently, we test the predictions empirically on a (virtually) complete procurement dataset. Our findings show that *(i)* firms adjust their bidding strategy and bid more aggressively, i.e. winning bids decline, however; *(ii)* final prices of contracts after renegotiation remain unchanged as firms take the policy change into account. Finally, we observe that firms with more experience in public procurement and larger firms renegotiate procurement contracts with higher probability.

In the future version of the paper, we will expand the discussion on welfare implications. We aim to study which characteristics predicts success after the reform as opposed to pre-reform, which will give us the opportunity to make stronger claims about the efficiency implication of allowing renegotiation. This will allow us to draw policy recommendations regarding the procurement legislation.

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# Appendix

## 6.1 Empirical Evidence

Table 8: Effect of the Introduction of Renegotiation on log of *Winning Bids*

| | (1) | (2) | (3) |
|---|---|---|---|
| | Winning Bid (log) | Winning Bid (log) | Winning Bid (log) |
| Estimated Price (log) | 1.003*** | 1.011*** | 1.003*** |
| | (0.002) | (0.002) | (0.002) |
| T=1 | 0.003 | 0.008 | 0.013** |
| | (0.006) | (0.006) | (0.006) |
| Construction=1 | -0.140*** | | |
| | (0.004) | | |
| T=1 × Construction=1 | -0.033*** | -0.039*** | -0.040*** |
| | (0.007) | (0.007) | (0.008) |
| Industry FE | No | Level 4 | Level 6 |
| N | 13572.000 | 13502.000 | 13263.000 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

*Notes*: The outcome variable is a logarithm of the winning bid. In each specification, we control for the (log of) the estimated price, the type of procurement procedure, and the type of evaluation criteria.

Table 9: Effect of Renegotiation on Final Price in *Setting I* and *II* (Final Price)

| | (1) | (2) | (3) |
|---|---|---|---|
| | Final Price (log) | Final Price (log) | Final Price (log) |
| Estimated Price (log) | 1.001*** | 1.009*** | 1.001*** |
| | (0.002) | (0.002) | (0.003) |
| T=1 | 0.017*** | 0.012* | 0.013* |
| | (0.007) | (0.007) | (0.007) |
| Construction=1 | -0.152*** | | |
| | (0.006) | | |
| T=1 × Construction=1 | 0.020** | 0.029*** | 0.022** |
| | (0.008) | (0.008) | (0.009) |
| Industry FE | No | Level 4 | Level 6 |
| N | 9193.000 | 9118.000 | 8881.000 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

*Notes*: The outcome variable is a logarithm of the final price. $T$ is a dummy variable which equals 1 for contracts from *Setting II* and 0 for contracts from *Setting I*. In each specification, we control for the (log of) the estimate price, the type of procurement procedure, and the type of evaluation criteria.

Table 10: Effect of Renegotiation on Final Price in *Setting II* and *III* (Final Price)

| | (1) | (2) | (3) |
|---|---|---|---|
| | Final Price (log) | Final Price (log) | Final Price (log) |
| Estimated Price (log) | 1.007*** | 1.016*** | 1.010*** |
| | (0.003) | (0.003) | (0.003) |
| T=1 | 0.000 | 0.001 | 0.008 |
| | (0.008) | (0.009) | (0.009) |
| Construction=1 | -0.138*** | | |
| | (0.007) | | |
| T=1 × Construction=1 | -0.015 | -0.026** | -0.026** |
| | (0.011) | (0.011) | (0.012) |
| Industry FE | No | Level 4 | Level 6 |
| N | 5226.000 | 5144.000 | 4960.000 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

*Notes*: The outcome variable is a logarithm of the final price. $T$ is a dummy variable which equals 1 for contracts from *Setting III* and 0 for contracts from *Setting II*. In each specification, we control for the (log of) the estimate price, the type of procurement procedure, and the type of evaluation criteria.

Table 11: Effect of Renegotiation on Final Price in *Setting I* and *III* (Final Price)

| | (1) | (2) | (3) |
|---|---|---|---|
| | Final Price (log) | Final Price (log) | Final Price (log) |
| Estimated Price (log) | 1.000*** | 1.008*** | 1.001*** |
| | (0.002) | (0.003) | (0.003) |
| T=1 | 0.022*** | 0.020** | 0.026*** |
| | (0.008) | (0.009) | (0.010) |
| Construction=1 | -0.153*** | | |
| | (0.006) | | |
| T=1 × Construction=1 | 0.005 | -0.002 | -0.005 |
| | (0.011) | (0.012) | (0.012) |
| Industry FE | No | Level 4 | Level 6 |
| N | 7009.000 | 6933.000 | 6723.000 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

*Notes*: The outcome variable is a logarithm of the final price. $T$ is a dummy variable which equals 1 for contracts from *Setting III* and 0 for contracts from *Setting I*. In each specification, we control for the (log of) the estimate price, the type of procurement procedure, and the type of evaluation criteria.

Table 12: Effect of the Introduction of Renegotiation *Bid Ratio* (All Contracts)

| | (1) | (2) | (3) |
|---|---|---|---|
| | Bid Ratio | Bid Ratio | Bid Ratio |
| T=1 | 0.00774** | 0.00670* | 0.00805** |
| | (0.003) | (0.004) | (0.004) |
| ConstructionAlt=1 | -0.0885*** | | |
| | (0.003) | | |
| T=1 × ConstructionAlt=1 | -0.0303*** | -0.0306*** | -0.0294*** |
| | (0.005) | (0.005) | (0.005) |
| Industry FE | No | Level 4 | Level 6 |
| N | 18261 | 18095 | 17661 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

*Notes*: The table reports results from three different differences-in-differences specifications. The control group consists of all contracts. In each specification, we control for the (log of) the estimate price, the type of procurement procedure, and the type of evaluation criteria.

Table 13: The Effect of Renegotiation on Final Price in *Setting I* and *II* (All Contracts)

| | (1) | (2) | (3) |
|---|---|---|---|
| | Price Ratio | Price Ratio | Price Ratio |
| T=1 | 0.0203*** | 0.0137*** | 0.0137*** |
| | (0.0041) | (0.0042) | (0.0045) |
| ConstructionAlt=1 | -0.102*** | | |
| | (0.0039) | | |
| T=1 × ConstructionAlt=1 | 0.00909 | 0.0180*** | 0.0140** |
| | (0.0059) | (0.0060) | (0.0062) |
| Industry FE | No | Level 4 | Level 6 |
| N | 12207 | 12041 | 11635 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

*Notes*: The control groups consists of all contracts. The outcome variable is the final to the expected price ratio, $T$ is a dummy variable which equals 1 for contracts from *Setting II* and 0 for contracts from *Setting I*. In each specification, we control for the type of procurement procedure, and the type of evaluation criteria.

Table 14: The Effect of Renegotiation on Final Price in *Setting II* and *III* (All Contracts)

| | (1) | (2) | (3) |
|---|---|---|---|
| | Price Ratio | Price Ratio | Price Ratio |
| T=1 | 0.000701 | -0.00275 | -0.00126 |
| | (0.0053) | (0.0056) | (0.0061) |
| ConstructionAlt=1 | -0.0933*** | | |
| | (0.0045) | | |
| T=1 × ConstructionAlt=1 | -0.00787 | -0.0105 | -0.00720 |
| | (0.0084) | (0.0086) | (0.0090) |
| Industry FE | No | Level 4 | Level 6 |
| N | 7381 | 7209 | 6846 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

*Notes*: The control groups consists of all contracts. The outcome variable is the final to the expected price ratio, $T$ is a dummy variable which equals 1 for contracts from *Setting III* and 0 for contracts from *Setting II*. In each specification, we control for the type of procurement procedure, and the type of evaluation criteria.

Table 15: The Effect of Renegotiation on Final Price in *Setting I* and *III* (All Contracts)

| | (1) | (2) | (3) |
|---|---|---|---|
| | Price Ratio | Price Ratio | Price Ratio |
| T=1 | 0.0208*** | 0.0150*** | 0.0176*** |
| | (0.0053) | (0.0056) | (0.0060) |
| ConstructionAlt=1 | -0.103*** | | |
| | (0.0040) | | |
| T=1 × ConstructionAlt=1 | 0.00113 | 0.00217 | -0.000963 |
| | (0.0083) | (0.0085) | (0.0089) |
| Industry FE | No | Level 4 | Level 6 |
| N | 9390 | 9226 | 8848 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

*Notes*: The control groups consists of all contracts. The outcome variable is the final to the expected price ratio, $T$ is a dummy variable which equals 1 for contracts from *Setting III* and 0 for contracts from *Setting I*. In each specification, we control for the type of procurement procedure, and the type of evaluation criteria.