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Kris De Jaegher
Michal Šoltés
Vítězslav Titl

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Easing Renegotiation Rules in Public Procurement: Evidence from a Policy Reform*

Kris De Jaegher† Michal Šoltés‡ Vitezslav Titl§

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Abstract

Public procurement contracts are necessarily incomplete and require frequent ex-post renegotiation. In this paper we first develop a stylized theoretical model of the effects of renegotiation policies on firms' bidding strategies and, consequently, on the winning bids and final prices of contracts. We then use a Czech policy reform to empirically test the model's predictions. Our findings show that *(i)* eased renegotiation rules lead to a decrease in the average winning bids; however, *(ii)* average final prices of contracts remain at the pre-reform level as the extra renegotiated price compensates for the drop in winning bids. We do not find convincing evidence of a decrease in productivity of the winning firms, but we do provide suggestive evidence of a change of contract allocation towards firms with higher bargaining power.

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†Utrecht University School of Economics, Utrecht University, Kriekenpitplein 21-22, 3508 TC Utrecht, The Netherlands (Email: k.dejaegher@uu.nl)

‡Department of Economics, Faculty of Law Charles University, nám. Curieových 901/7, 116 40 Prague, Czech Republic (Email: soltesm@prf.cuni.cz)

§Utrecht University School of Economics, Utrecht University; Department of Economics, Faculty of Law, Charles University; LEER, Faculty of Economics and Business, KU Leuven (Email: v.titl@uu.nl)

1 Introduction

Public procurement accounts for about 12% of GDP and roughly 25% of general government spending in OECD countries (OECD, 2016, 2019). Uncertainty about the scope of work and final costs makes public procurement contracts incomplete, and justifies allowing them to be renegotiated (Jung, 2016). Indeed, renegotiation is a legitimate and widespread phenomenon in many jurisdictions: in the US, for instance, about 10.5% of federal public procurement contracts are renegotiated ex-post (Brogaard et al., 2021). However, changes in the rules regulating renegotiation are likely to change the prospects of winning the competition, and thus the bidding strategies of firms and outcomes of the procurement markets. Moreover, when renegotiation is allowed, inefficiency may arise because bidders no longer win because of their lower costs, but because their larger bargaining power leads them to expect larger benefits from renegotiation (Chang et al., 2016).

In this paper, we explore a policy reform in the Czech Republic that, with the aim of harmonizing with EU directives,[1] eased the rules for renegotiation in case of cost overruns, and we study how allowing renegotiation affects average winning bid, average final price, and allocation of public procurement contracts. Before the reform, if cost overruns occurred, procurers had to either launch a new procurement competition open to all firms or initiate the so-called negotiated procedure without publication, which was reserved for rare situations.[2] The reform allowed procurers to adjust the initial contract without launching a new competition. The eased renegotiation rules applied to all contracts initiated after the reform, and also to existing contracts awarded no more than three years before October 2016. Due to their proneness to cost overruns, construction contracts have been affected disproportionately more.

To study the consequences of the reform on the market of public procurement, we develop a theoretical model of the procurement market in which firms compete in a first-price auction and the winner faces a risk of a cost overrun. We use the model to show how the changes in firms' behavior induced by policy settings propagate into public procurement outcomes. We study three policy settings, which correspond to situations induced by the reform. In setting I, the pre-reform setting, renegotiation of an awarded contract is impossible, and firms know this when submitting their bids. Should a cost overrun occur, the winning firm incurs it. Firms consider this risk and factor in the expected cost overrun when placing their bids.

[1] Article 72 of the 2014/24/EU Directive prescribes when renegotiation of a public procurement contract is permitted. This European directive had to be transposed into national laws by April 2016.

[2] The latter was reserved for unexpected circumstances when the cost overruns were technically or economically inseparable from the initial contract.

In setting II, renegotiation turns out to be possible, but bidding firms did not know this when submitting their bids. Their bidding strategies thus continue to factor in the expected cost overrun and are identical to bids from setting I. However, the average final price of contracts increases as some contracts are indeed renegotiated.[3] Finally, in setting III, renegotiation is possible, and firms are aware of this when bidding. Should a cost overrun occur, the winning bidder and procurer renegotiate the terms of the awarded contract. The winning firm does not bear the cost overrun alone and may anticipate profits when the cost overrun occurs. As a result, firms' bidding strategies are less precautionary. The model generates a set of clear predictions about the change in average winning bid and average final price across the different settings.

To empirically test the outlined predictions, we use a universe of Czech procurement contracts above circa EUR 80,000 for supplies of goods and services and above EUR 240,000 for construction works[4] from the 2014–2017 period. We first show that the reform increased the share of renegotiated contracts especially in the construction industry. About 40% of construction contracts awarded a year after the reform were renegotiated, while the rate of renegotiated contracts in other industries remains negligible.[5] We then use construction contracts as the treatment group and estimate several difference-in-differences specifications using the reform as a source of identifying variation.

Consistent with the model's predictions, we show that the possibility of renegotiation decreases the average winning bid by 3.1 percentage points of the estimated value of the contract. Furthermore, the eased legal restrictions increased the average price only temporarily i.e., only for contracts awarded before the reform that could have been renegotiated ex-post. These contracts correspond to setting II, in which firms learn about the possibility of renegotiation only after the contracts were awarded. In contrast, we found no effect on the average final price of contracts awarded after the reform. We conclude that the decrease in the average winning bid caused by the reform offsets the increase in the average final price caused by the renegotiation. Overall, easing the rules for renegotiation did not increase the average final price of procurement contracts in the long run.

Finally, we study whether the reform had an inefficiency effect. To do so, using Orbis data on Czech firms, we calculate firm-year specific productivity measures for

[3]Empirically, while the majority of renegotiated contracts led to a higher price, in a few contracts the final price after renegotiation decreased.

[4]In Czech law as well as in the European Directive 2004/18/EC, construction works are referred to as public works, while other public procurement contracts are referred to as supplies and services. In the remainder of the paper, we use the terms *construction works*, *construction contracts*, *construction projects*, and the *construction sector* interchangeably with the legal term *public works*.

[5]Since our data end in December 2019 and we thus do not observe all contracts terminated, we likely underestimate the true rate of renegotiation.

all Czech firms.[6] We then employ the same difference-in-differences specifications as before to assess the effect of the eased renegotiation rules on the productivity of winning firms. Our findings indicate that the reform did not lead to a significant decrease in the average productivity of winning firms. While most of the point estimates are negative, none reach statistical significance. We thus did not find evidence that the reform had a negative impact on the productivity of winning firms. However, we do observe evidence suggesting that firms with a higher propensity to renegotiate prior to the reform tend to win contracts more frequently after the reform.

Our paper is part of an empirical literature that looks at the effect on procurement outcomes of post-bidding alterations to procurement contracts. Observations in this literature point in different directions. Decarolis (2014) studies the introduction of first-price auctions for Italian public works and observes lower bids but also lower performance in the form of longer delays. The author explains this as adverse selection of firms with higher benefits of changing the contract, who can then recuperate their lower bids through alterations.[7] Similarly, Ryan (2020), studying Indian power contracts, finds that politically better connected firms lower their bids, anticipating higher benefits when renegotiating; moreover, such firms increase the probability of renegotiation by not indexing their bids to future energy prices.[8] However, Bajari et al. (2014) observe for Californian highway pavement contracts that the bids of bidders who can expect contract alterations for which they receive positive compensations, go up rather than down. The authors attribute this to adaptation costs firms incur when making alterations (i.e. "disruptions to the normal flow of work" [p.1289], and "haggling, dispute resolution, and opportunistic behavior" [p.1289] induced by renegotiation). While positive compensations would lead bidders to decrease their bids, this is more than compensated for by large adaptation costs.[9]

These papers also differ in the method used to measure the effect of alterations. Bajari et al. (2014) and Jung (2016) compare contracts according to their levels of alterations, with the challenge of controlling for contract characteristics. Ryan (2020) uses a structural model and counterfactual simulation to estimate the effect of strict contract

[6] 98% of the contracts and 96% of estimated value of contracts is allocated to Czech firms.

[7] Cameron (2000) provides a similar explanation for results obtained by comparing US states with rigid and flexible systems for power purchase contracting. She observes that in rigid systems, bids are lower, but the probability of a contract breach is higher. The author explains that rigid systems ironically cause more alterations in selecting firms that are more likely to default.

[8] Baltrunaite (2020), Baranek and Titl (2020), Schoenherr (2019) and Titl and Geys (2019) show that firms with political connections enjoy various forms of preferential treatment. Renegotiation of a procurement contract can be one way for politically connected firms to extract additional rents. Indeed, Brogaard et al. (2021) find that, in the U.S., firms with connections bid low initially and then renegotiate contract conditions such as prices, deadlines etc. They find that connected firms were three times more likely to successfully renegotiate procurement contracts ex post.

[9] Using a similar approach, Jung (2016) confirms this result for Vermont road construction works, though lower adaptation costs are estimated.

enforcement. Our paper is in line with literature that looks at the effect of institutional changes (Cameron, 2000; Decarolis, 2014), and is unique in studying a natural experiment with a switch from not allowing renegotiation of cost overruns to allowing it. The experience with this natural experiment is useful for policy makers in any country considering reforms that ease or tighten renegotiation rules in public procurement. This is particularly relevant for other European Union member states that have otherwise comparable legal frameworks based on the same EU Directive.

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 predictions. In Section 4, we present the empirical examination of the predictions about the changes in the average winning bid and the average final price. We also discuss changes in the allocation of awarded contracts in section 4. Section 5 concludes and lays out the policy implications of our findings.

2 Institutional Design

Since its transition from a communist centrally-planned economy to a market-based economy in the early 1990s, the Czech Republic has been one of the most prosperous countries in the region. The current GDP *per capita* in PPP is comparable to Spain and Italy. However, in 2010, the National Economic Council of the Czech Government identified weak institutions as one of the crucial factors hindering economic growth. The lack of a strong and stable institutional framework also applies to the public procurement law.

We study a reform[10] that came into effect on October 1st, 2016, and introduced a clear and simple renegotiation procedure for public procurement contracts. Before the reform, if a cost overrun occurred and renegotiation was needed, the procuring authority had to launch a new competition open to all firms or a less transparent procedure called "negotiated procedure without publication". The latter was possible only if additional public works or supplies and services were necessary due to unexpected circumstances and a new contract was technically or economically inseparable from the initial contract. Under these conditions the contract could be awarded to the same firm. The additional expenses could not exceed 30% of the price of the initial contract.[11] In practice, it was difficult to assess whether the circumstances for "negotiated procedure without publication" were satisfied. Procurer officers, therefore, tended to apply this procedure only in emergency situations such as natural disasters.

[10]The reform was implemented as Act No. 134/2016 Coll. on public procurement.

[11]Furthermore, the procurer had to provide reasons why an open competition could not be launched (such as too little time available).

The 2016 reform implemented European directives[12] into the Czech legislature and enabled adjustments to the awarded contracts without launching a new competition.[13] A modification of the contract must not be substantial, i.e. the modification does not change the nature of the contract.[14] Furthermore, the value of modification must be lower than the financial limit for an above-threshold public contract and lower than 10% of the initial price of the contract for services and supplies, and 15% for public works.

After the deduction of the price for public works, services and supplies, that have not been performed, the total price increase must not exceed 30% of the original price of the contract. Importantly for our research design, the new renegotiation rules also applied to ongoing public procurement contracts initiated no more than 3 years before the reform came into effect.

3 Theory

3.1 Model

The following stylized model sketches the situation before and after the reform. A procurer (he) wants to buy an object with value v to him and faces n risk-neutral bidders, with $n \geq 2$. The winning bidder (she) is determined through a sealed-bid first-price auction, in which each bidder i submits a bid simultaneously with all other bidders, and where the bidder with the lowest bid p_x^A sells the object to the procurer (where x refers to settings I, II or III - see below).[15] The individual bidder's net expected cost of delivering the object, denoted c_x, is independently and identically distributed over the range $[c_x^{\min}, c_x^{\max}]$, according to the cumulative distribution function $F_x(c_x)$, with corresponding density function $f_x(c_x)$. Bidders know their own net expected cost and how the net expected costs of other bidders are distributed. The procurer initially knows only the distribution of bidders' net expected costs.

We consider three institutional settings. In setting I, before bidding, each bidder observes her cost c^A in the absence of a cost overrun. Before delivering the object, the

[12] Directives 2014/24/EU, 2014/25/EU, and 2014/23/EU.

[13] According to the explanatory memorandum, the law aims to set new clear rules to prevent corruption, ensure effective use of public funds and make finalization of public procurement faster, while keeping the transparency and fairness of the competition high.

[14] The modification is substantial if, for example, it changes which firms can participate in the competition and it leads to a substantial extension of the range of performance.

[15] In reality, the auction may take the form of a unit-price auction in which the procurer determines a vector of quantities that the winning bidder needs to deliver, and 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.

winning bidder with probability π finds out that she can only deliver the object when incurring a cost overrun c^B. After the winning bidder is determined but before the object is delivered, the procurer observes the cost c^A of the winning bidder, whether she incurs a cost overrun, and when she does incur a cost overrun, the size c^B of the cost overrun.[16] A specific feature of setting I is that when the winning bidder faces a cost overrun, she cannot renegotiate, and needs to deliver the object (which is only possible when incurring the cost overrun) at her winning bid p_{I}^A. This is why the individual risk-neutral bidder assesses her net expected cost to equal $c_{\mathrm{I}} = c^A + \pi c^B$ at the time of placing her bid.

In setting II, just as in setting I, both the procurer and the bidders expect that renegotiation is not possible. It follows that $c_{\mathrm{I}} = c_{\mathrm{II}}$. However, when the winning bidder faces a cost overrun of delivering the object, unexpectedly she can renegotiate at a cost d and obtain an extra price p_{II}^B for incurring the cost overrun. If the winning bidder does not incur the cost overrun when it is required to deliver the object, the procurer only obtains value $v - v^B$, so that v^B is the procurer's willingness-to-pay for the cost overrun.

We assume now that for a winning bidder who renegotiates, $p_{\mathrm{II}}^B = \alpha v^B + (1-\alpha)\cdot 0$. The parameter $\alpha \in [0,1]$ reflects the winning bidder's bargaining power. When the winning bidder has maximal bargaining power ($\alpha = 1$), and 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 the procurer's willingness to pay v^B for incurring the cost overrun.[17] When the bidder has minimal bargaining power ($\alpha = 0$), she cannot bargain for an extra price for her incurring the cost overrun (which her initial bid was supposed to cover anyway), and delivers the object at her winning bid p_{II}^A. The winning bidder renegotiates when $\alpha v^B + (1-\alpha)\cdot 0 \geq d$, and does not renegotiate otherwise, where we assume bidder types that prefer renegotiating to exist.

In setting III, renegotiation is also possible, but contrary to setting II, bidders and procurer correctly anticipate that a winning bidder can renegotiate at a cost d, and obtain an extra price p_{III}^B for incurring the cost overrun. It is now assumed that $p_{\mathrm{III}}^B = \alpha v^B + (1-\alpha)c^B$. A winning bidder with maximal bargaining power when facing a cost overrun and when renegotiating continues to charge the procurer v^B extra; however, when she has minimal bargaining power the winning bidder who faces a cost overrun and renegotiates now instead obtains an extra price c^B, as her initial bid was now only placed for delivering the object at a cost c^A. The net expected cost of a bidder who does not expect to renegotiate when winning and incurring the cost overrun now continues

[16] 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 reveal 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).

[17] 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 $v^B < 0.3p^B$.

to equal $c_{\text{III}} = c^A + \pi c^B$, whereas the net expected cost of a bidder who does expect to renegotiate when winning and incurring the cost overrun now equals $c_{\text{III}} = [c^A + \pi c^B] - \pi[\alpha v^B + (1-\alpha)c^B - d]$, where this cost is corrected for the profit the winning bidder expects from renegotiating. Note that while this corrected cost makes sense from the perspective of the firm, from the perspective of efficiency what continues to matter is who has the lowest $[c^A + \pi c^B]$. Because of this, contrary to what is the case in settings I and II, setting III can lead to an inefficient allocation. Whereas in settings I and II the bidder with the lowest $[c^A + \pi c^B]$ necessarily wins the auction, in setting III this need not be the case: a winning bidder who does not have the lowest $[c^A + \pi c^B]$ can still win the auction if her bargaining power is sufficiently high for her to still experience the lowest net expected cost. This in turn can lead to a higher average final price. We illustrate this in the following simplified example with perfect information where bidders observe each other's net expected costs. Then the winning bidder is the one with the lowest net expected cost, and places a bid equal to the net expected cost of the bidder with the second-lowest net expected cost (or bids a tiny amount below that).[18] In the example, inefficiency in setting III is combined, as compared to setting I, with a lower winning bid, but a higher average final price paid by the procurer overall when the expectation of paying an extra price for the cost overrun is included.

Example 1. Let there be two bidders 1 and 2 who differ only in their cost in the absence of a cost overrun, with $c_1^A < c_2^A$, and in their bargaining power, with $\alpha_1 < \alpha_2$ (where subscripts 1 and 2 refer to the bidders). It is then the case that $c_{\text{I},1} < c_{\text{I},2}$, meaning that in the efficient allocation bidder 1 should win the auction. Also, it is the case that $p^B_{\text{II},1} < p^B_{\text{II},2}$ and $p^B_{\text{III},1} < p^B_{\text{III},2}$, so that in settings II and III the extra price that can be renegotiated is each time larger for bidder 2 than for bidder 1. Let all extra prices exceed the renegotiation cost d incurred by a renegotiating bidder. Assume that $c_{\text{III},1} > c_{\text{III},2}$: in spite of bidder 1 having lower production costs, the bargaining power of bidder 2 is so large that in setting III bidder 2 has the lowest net expected cost. Then, in settings I and II bidder 1 wins the auction (efficiency) at a winning bid $c_{\text{I},2}$, whereas in setting III bidder 2 wins the auction (inefficiency) at a winning bid $c_{\text{III},1}$.[19] As $c_{\text{III},1} < c_{\text{I},1}$ and $c_{\text{I},1} < c_{\text{I},2}$,

[18] By the revenue equivalence theorem, with risk neutral bidders whose costs are independently distributed, any competitive mechanism used to determine the price of the object (including the first-price mechanism) will lead on average to an equilibrium price equal to the highest price at which demand (fixed at one unit) equals supply, i.e. an equilibrium price equal to the second-lowest net expected cost (Milgrom and Weber, 1982, p.1093).

[19] To see why, note first that the bidder with the lowest net expected cost in equilibrium always wins the auction. If the other bidder won, she would have bid at most her net expected cost; but the former bidder could then always outbid the latter. Furthermore, note that the bidder with the lowest net expected cost will always bid just marginally below the bid of the bidder with the second-lowest net expected cost, so that in equilibrium the two bids are nearly equal. A range of Nash equilibria exists with two nearly equal bids that range from the lowest to the second-lowest net expected cost (this prevents the bidder with the lowest net expected cost being outbid, or winning but at a loss). Finally, note that bidding

it follows that the winning bid is lower in setting III. The average final price in setting I is $c_{\mathrm{I},2}$, in setting II it is $c_{\mathrm{I},2} + \pi p^B_{\mathrm{II},1}$, and in setting III it is $c_{\mathrm{III},1} + \pi p^B_{\mathrm{III},2}$. Given that $c_{\mathrm{III},1} > c_{\mathrm{III},2}$, it follows that $c_{\mathrm{I},1} - \pi[\alpha_1 v^B + (1-\alpha_1)c^B - d] > c_{\mathrm{I},2} - \pi[\alpha_2 v^B + (1-\alpha_2)c^B - d]$ if and only if $c_{\mathrm{I},1} - \pi[\alpha_1 v^B + (1-\alpha_1)c^B - d] + \pi[\alpha_2 v^B + (1-\alpha_2)c^B] > c_{\mathrm{I},2} + \pi d$. As in the latter inequality the left-hand side is the average final price in setting III and the first term of the right-hand side is the average final price in setting I, it follows that the average final price is larger in setting III than in setting I.

3.2 Predictions

We first develop predictions for the simplified case with perfect information and then show that these predictions extend to the case with imperfect information set out in the modeling section (for details, see Appendix A). We compare average winning bid, probability of renegotiation, unconditional average extra price, and average final price across the three settings.

Compare first the average winning bid in settings I, II and III. In settings I and II, the winning bids are equal, because ex ante bidders do not expect the settings to be different. In setting III, if the winning bidder faces a second-lowest bidder of a type that does not renegotiate (because her bargaining power is low and/or her cost overrun is low), the winning bidder's bid is again the same as in settings I and II. However, if she faces a second-lowest bidder of a type that renegotiates, the winning bidder's bid is strictly lower that in either settings I or II, because the renegotiating bidder corrects her cost for the profit of renegotiating. As long as for some bidders the extra price obtained from renegotiating exceeds the cost, on average the winning bid in setting III is strictly lower than in settings I or II (for a formal proof, see Appendix A). Intuitively, the profits of renegotiating are competed away with lower bids.

Prediction 1. *The average winning bid in setting III (= post-reform period) is lower than the average winning bid in settings I and II (= pre-reform period).*

Compare next the probability of renegotiation in settings I, II and III. In setting II, the probability of renegotiation is larger than in setting I, because in the latter setting renegotiation was impossible. The probability of renegotiation is larger in setting III than in setting II because the lower limit on the extra price is higher in setting III, which means that for additional types the extra price obtained from renegotiation exceeds the cost.

below one's net expected cost is a weakly dominated strategy for the bidder with the second-lowest net expected cost as it leads to a loss in case of still winning the auction. Thus focusing on Nash equilibria without weakly dominated strategies, only the Nash equilibrium where the two bidders bid nearly the second-lowest net expected cost remains.

Prediction 2. *The probability of renegotiation is largest in setting III, lower in setting II, and the lowest in setting I.*

Additionally, compare the unconditional average extra price across the settings (which includes the possibility that the extra price is zero). The unconditional average extra price is larger in setting II than in setting I simply because renegotiation is not possible in setting I. Because of our assumption that bidders with minimal bargaining power can renegotiate a higher extra price in setting III than in setting II, the unconditional average extra price is also larger in setting III than in setting II. First, additional bidder types renegotiate (extensive margin) as they find out that the extra price they can obtain exceeds the renegotiation cost. Second, bidder types who were already renegotiating can now bargain a higher extra price (intensive margin).

Prediction 3. *The unconditional average extra price is largest in setting III, lower in setting II, and the lowest in setting I.*

Finally, the average final price is larger in setting II than in setting I because of the higher extra price and the equal average winning bid. Intuitively, in setting II bidders do not lower their bids anticipating renegotiation, but can then still renegotiate, boosting the average final price. However, the relation between the average final price in settings III and II is ambiguous. On the one hand, the average winning bid is lower in setting III than in setting II; on the other hand, the unconditional average extra price is larger. However, we can still predict that for sufficiently large bargaining power of the bidders (in which case the fact that the lowest extra price that can be obtained is larger in setting III than in setting II does not make very much difference), the average final price in setting III is smaller than in setting II, so the fact that the bids are lower in setting III dominates. Intuitively, in setting II the average final price overshoots because of the unexpected possibility of renegotiation, and this overshooting is corrected in setting III, where the profits from renegotiating are anticipated, resulting in lower bids.

Prediction 4. *The average final price in setting II is larger than in setting I.*

Prediction 5. *Assuming sufficiently large bargaining power of the bidders, the average final price in setting III is smaller than in setting II.*

The combination of the latter two predictions suggests that the change in average final price from setting I to setting III is ambiguous. Indeed, as Example 2 shows, it is possible that the average final price decreases or remains the same. Intuitively, on top of the profits of renegotiation being competed away by lower bids, the fact that the winning bidder may face losing bidders who have a larger bargaining power puts the winning

bidder at less of an advantage. For this reason, winning bidders may have lower profits in setting III than in setting I.

Example 2. Consider the same setting as in Example 1, but let it be the case that $c_{\text{III},1} > c_{\text{III},2}$ (where we continue to assume that both bidders prefer renegotiating after winning): in spite of bidder 2 having larger bargaining power, bidder 1 now continues to have the lowest net expected cost in setting III. Then in all settings, bidder 1 wins the auction (efficiency). In settings I and II, she does so at a bid $c_{\text{I},2}$, and in setting III at a bid $c_{\text{III},2}$, so that the winning bid is lower in setting III. The average final price in setting III equals $c_{\text{I},2} - \pi[\alpha_2 v^B + (1-\alpha_2)c^B - d] + \pi[\alpha_1 v^B + (1-\alpha_1)c^B]$. As long as d is relatively small; given that $\alpha_2 > \alpha_1$ it follows that the average final price is smaller in setting III than in setting I.[20]

We note now that these results for the benchmark with perfect information are not changed when bidders do not know each other's net expected costs. Transposing standard results about first-price auctions to procurement (Krishna, 2009), it is well-known that in the symmetric Nash equilibrium each risk-neutral bidder places a bid equal to the expectation of the second-lowest net expected cost among the $n-1$ other bidders, conditional on her having the lowest net expected cost. The results extend to the case of imperfect information simply because average bids are the same in the case with imperfect information as in the case with perfect information. The details of the case with asymmetric information are worked out in Appendix A, which also includes a robustness analysis.

In Example 1 a less cost-efficient bidder wins in setting III, and the average final price increases compared to setting I. In Example 2, the most cost-efficient bidder continues to win in setting III, and the average final price decreases. This could lead one to conclude that when the average final price does not increase it indicates that setting III does not lead to inefficiency. To stress that this conclusion is incorrect, and that a non-increasing average final price is compatible with inefficiency, we add Example 3 with imperfect information, which has both a lower average final price and inefficiency. Example 3 can be seen as combining Examples 1 and 2, with a bidder not knowing which of these two scenarios apply.

Example 3. Consider a variant of Examples 1 and 2 where the type of bidder 1 continues to be common knowledge among the two bidders, and where bidder 2 continues to know her own type. However, bidder 1 does not know the type of bidder 2 (in particular, bidder 1 does not know bidder 2's bargaining power). It is common knowledge that

[20] If d is relatively large, then the average final price is instead larger. Note that in a competitive market with many bidders, d is in any case relatively large, as with a large number of bidders the second-lowest net expected cost is only marginally above the lowest net expected cost, so that the average final price in setting III approaches $c_{\text{I},2} + \pi d$, and is necessarily larger than in setting I.

with probability q_W bidder 2 is of the type described in Example 1 (state W); with the complementary probability $1 - q_W$ bidder 2 is of the type described in Example 2 (state L). Thus, while bidder 2 has larger bargaining power than bidder 1, only with probability q_W does this suffice for bidder 2 to have lower net expected cost than bidder 1; denoting by $\alpha_{2,s}$ bidder 2's bargaining power in state s, with $s = W, L$, it is the case that $\alpha_1 < \alpha_{2,L} < \alpha_{2,W}$. Bidder 1 now bids (a tiny bit below) the net expected cost of bidder 2, conditional on bidder 2 having the largest net expected cost, or $c_{\mathrm{I},2} - \pi(\alpha_{2,L} v^B + (1 - \alpha_{2,L}) c^B - d)$. Bidder 2 in state W in turn bids a tiny amount below this bid. Bidder 2 wins in state W, and bidder 1 in state L. The average final price therefore approaches $c_{\mathrm{I},2} - \pi(\alpha_{2,L} v^B + (1-\alpha_{2,L}) c^B - d) + q_W(\alpha_{2,W} v^B + (1-\alpha_{2,W}) c^B) + (1-q_W)(\alpha_1 v^B + (1-\alpha_1) c^B)$. Inefficiency is thus obtained with positive probability (as long as q_W is positive); moreover, as long as d is not too large, a range of small but positive q_W exists such that the average final price is lower than or equal to the final price $c_{\mathrm{I},2}$ in setting I.

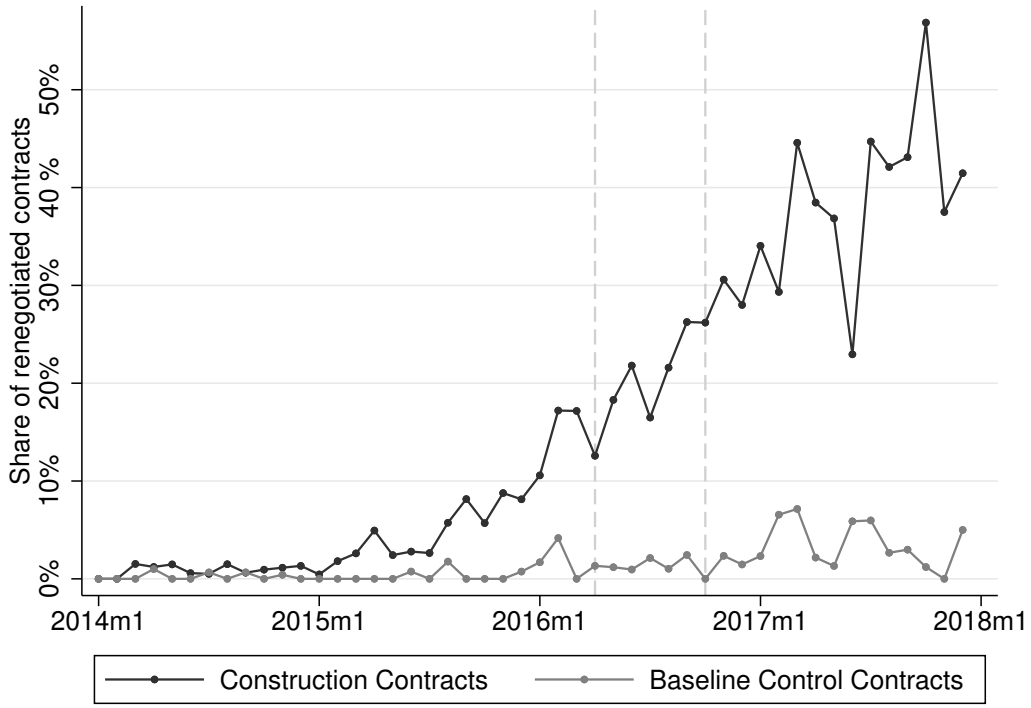
4 Empirical Evidence

4.1 Data

We use the universe of Czech public procurement contracts with an expected value above the thresholds of circa EUR 80,000 for public service contracts and EUR 240,000 for public works. By law, procurement authorities are required to publish detailed information about all contracts with an expected value above the aforementioned thresholds in an online system. Furthermore, many procurers choose to voluntarily report contracts below these thresholds. Overall, our initial dataset contains 18,874 contracts that accrue to CZK 517 billion (EUR 22 billion) in total expected value. The dataset covers detailed information about each contract, including project industry classifications (CPV codes), engineering estimates of value, initial prices, final prices, numbers of competitors, and identities of contractors and procuring authorities.

Figure 1 shows shares of renegotiated contracts on contracts awarded between January 2014 and December 2017 in the treatment and the baseline control group (4 industries - *industrial machinery*, *technical services*, *transportation*, and *energy*). The shares gradually increase over time, and at 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 of renegotiated contracts among the non-construction sectors remains around 5% on average. The gradually increasing trend observed even before the eased renegotiation rules came into effect is caused by the eased rules being applied also to existing contracts awarded no more than 3 years before the reform. Presumably, the

Figure 1: **Share of Contracts Renegotiated by Industry over Time**



Notes: Figure shows shares of renegotiated contracts by industry between January 2014 and December 2017 by the date when the contract was awarded. Two grey dashed vertical lines indicate April and October 2016 when the reform came into power and into effect, respectively. The baseline control group consists of contracts in *industrial machinery*, *technical services*, *transportation*, and *energy*.

share of contracts affected by the reform was thus increasing in time before the reform, reaching 100% on October 2016.

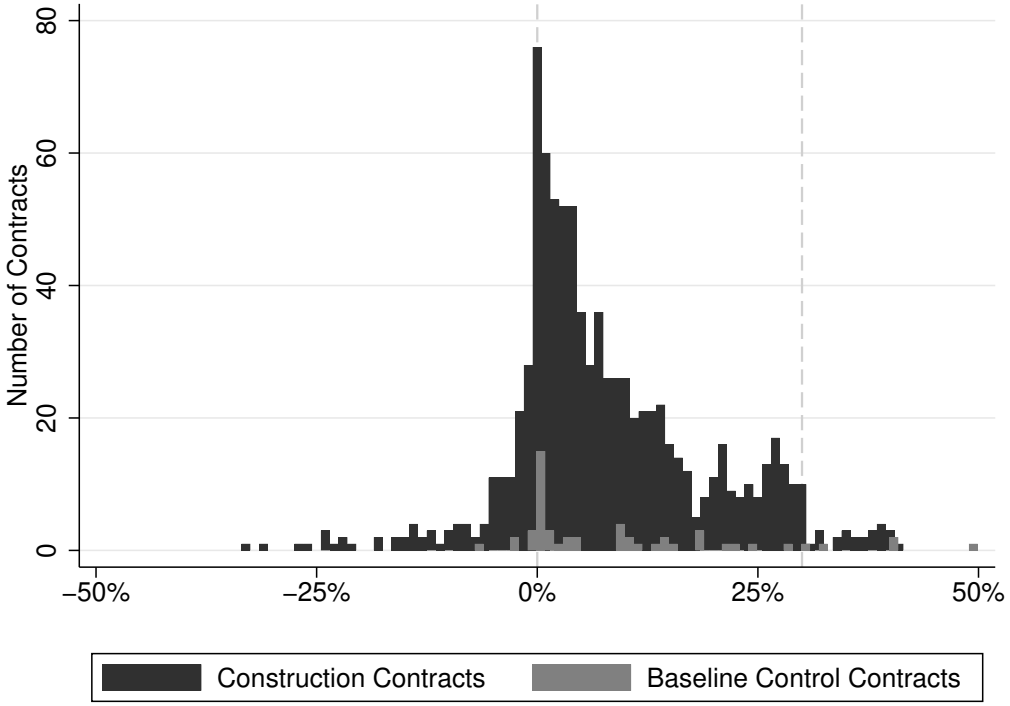
Over the period studied we observe 937 renegotiated contracts in either the construction (885) or baseline control group (52) contracts.[21] Among the 937 renegotiated contracts, the average change in price was a 7.9% increase compared to the winning bid. The average renegotiation is slightly higher among the baseline control group (9.2%) but the difference is not statistically significant. Figure 2 shows the histogram of relative increases in prices compared to the winning bids. Roughly 18% of renegotiation leads to a lower final price than the initial winning bids. In the majority of cases, renegotiation leads to an increase between 0% and 30%.

4.2 Empirical Strategy

To identify the causal effect of the reform on the outcomes studied, we rely on the difference-in-differences approach. We face several challenges. First, a standard problem

[21] There are additionally 66 renegotiated contracts in *other* industries.

Figure 2: **Frequency of Relative Renegotiated Amount**



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

with procurement data is that every contract is awarded only once, and therefore it is impossible to observe the same contract under different policy settings. To compare comparable observations we define our main outcome variables (the winning bid and final price) as a share of the estimated value price. Each procurement competition announced contains an estimated value of the contract determined by professionals. The estimated value is used to determine which public procurement procedure needs to be applied.[22] Using the estimated value as a benchmark for contract price has become a standard in the literature (see e.g. Bajari et al., 2014; Titl and Geys, 2019). In Appendix B we show that our results are robust to alternative specifications that use final and winning price in absolute terms and control for the expected value.

Second, to define the treatment group, we rely on the argument that contracts in the construction sector are more predisposed to cost overruns. While the reform did not explicitly target construction contracts, it aimed to enable renegotiation in situations where

[22]The estimated value and the tender documentation are written by experts (IT department, civil engineers) and then advanced to the department or personnel responsible for the tender.

cost overruns occurred. These are more likely to happen in construction, where information asymmetry and a lack of information is omnipresent, for example about soil quality. Neither public authorities nor suppliers can take into account unpredictable future events related to, for instance, weather. Furthermore, construction contracts tend to last longer and are thus more prone to exogenous shocks. The problem tends to be even more prominent in repair and renovation contracts when the tender documentation is based on old, often imprecise records. The exposure to the reform is thus disproportionately larger among construction contracts than in other sectors. Therefore, the identifying variation is induced by the different exposure to the reform and different prevalence of the need for renegotiation among the construction contracts and contracts in the control group.

Third, our dataset lacks information about when the contract was renegotiated and terminated, which makes it impossible to precisely classify contracts into the studied settings. Instead, we approximate the classification using the date when the contract was awarded.

4.3 Average Winning Bid

We first show that the eased renegotiation rules decreased the average winning bids. Our theoretical model predicts that in the post-reform period (setting III), the average winning bid is lower than in the pre-reform period (settings I and II). We use a difference-in-differences approach to estimate the average treatment effect on the treated (ATT) of the reform on *Bid Ratio*, defined as a ratio of the winning bid and the estimated value of the contract. Figure 3 shows that over the period studied, *Bid Ratio* among construction contracts is systematically lower than among non-construction contracts, but it tends to increase among both groups. In our primary specification, we focus on April 2016, when the policy change came into power.[23] Figure 3 documents a drop in the *Bid Ratio* in both construction and non-construction contracts. The visual inspection suggests that the drop was more pronounced among construction contracts.

In our primary specification, we estimate the following regression

$$Bid\ Ratio = \delta_1\ T + \delta_2\ Construction + \beta\ Construction * T + \gamma X + \varepsilon, \qquad (1)$$

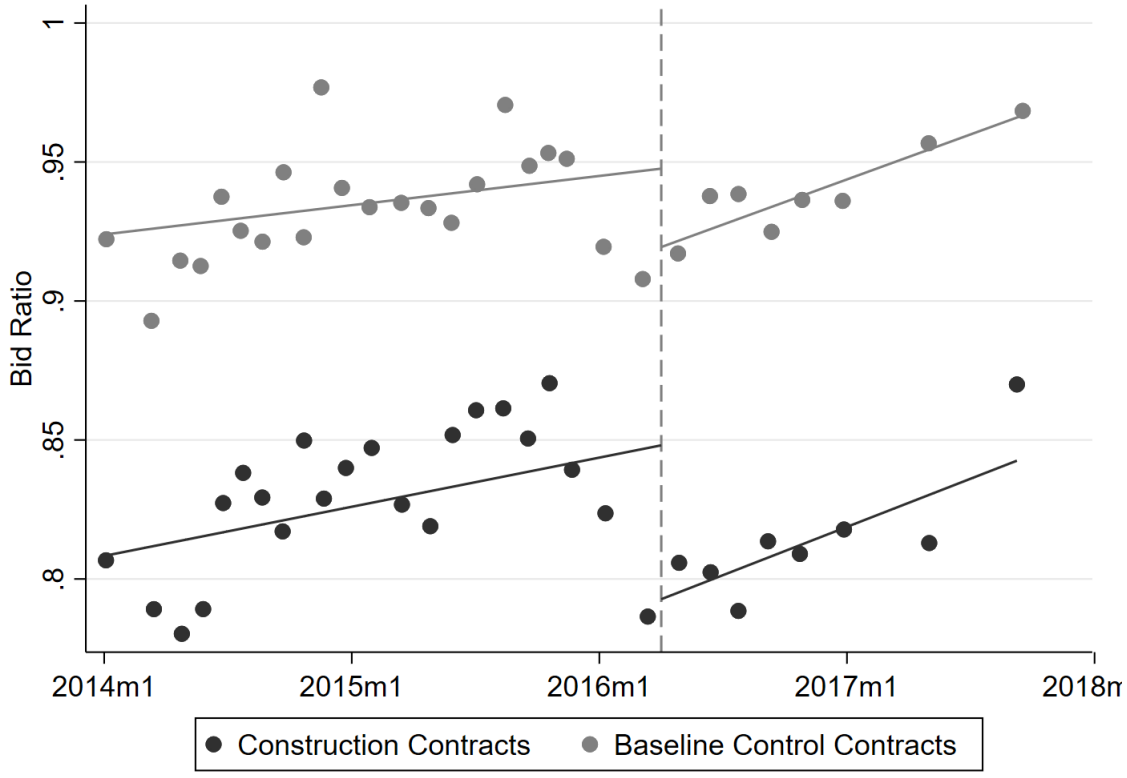
where *Construction* and T are indicator variables that equal 1 for construction contracts and post-reform period, respectively, and X controls for selection methods and public procurement procedure.[24] The coefficient of our interest is β. To interpret β as a

[23] It is possible that the first behavioral response appeared already in March 2016.

[24] The control variables are operationalized as a set of dummy variables for each type of selection

causal ATT effect, we assume that the so-called parallel trend assumption holds, i.e., in the absence of the policy change the *Bid Ratio* would evolve the same for construction and non-construction contracts. The assumption is supported by Figure 3, which shows parallel trends in *Bid Ratio* in the pre-treatment period.

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



Notes: This figure shows the evolution of the *Bid Ratio* over time, before and after the policy change in the construction and baseline control group. The pre-reform period suggests a similar trend (including seasonality) between both groups of contracts. 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 4-digit and 6-digit CPV codes (δ_k in regression 2). Note that controlling

method and each public procurement procedure, respectively. There are two selection methods: lowest price contracts and scoring auctions know as "Most Economically Advantageous Tenders" (MEAT). The procurement procedures include mainly open procedure (56% of the contracts in our data), negotiated procedures (21%), approaching bidders (18%), restricted procedure (4%), and others, such as competitive dialog or innovation partnership, which account for less than 1% of all contracts (see Directive 2004/18/EC for details about these procedures). In Appendix B we show that our results are robust to omitting the controls for the type of selection method and public procurement procedure. We do not include other control variables, such as the number of bidders, as they may represent so called bad controls.

for a more granular structure of industries prevents us from identifying the coefficient for *Construction* as we do in regression 1. Instead, we estimate a unique coefficient for each narrowly defined industry level.

$$Bid\ Ratio = \delta\ T + \beta\ Construction * T + \gamma X + \delta_k + \varepsilon. \tag{2}$$

We further report four additional robustness exercises. First, instead of the *Bid Ratio* we use the logarithm of the winning bid as the outcome variable while controlling for the logarithm of the estimated value of the contract (for a similar approach, see e.g. Lewis and Bajari, 2011). Second, we use a 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 available as the control group. Third, we replicate all the exercises on a restricted sample of contracts with non-negative renegotiation. Fourth, we omit the type of procurement procedure and evaluation criteria from the regressions.

4.3.1 Results

In three specifications presented in Table 1 the estimated effect is negative and statistically significant. In the specification presented in the first column the point estimate of the effect is -2.6 percentage points of the estimated value. In the two remaining specifications in the second and third columns the point estimates suggest even larger, more negative, effects.

Table 1: **Effect of the Introduction of Renegotiation on *Bid Ratio***

	Bid Ratio	Bid Ratio	Bid Ratio
Post Reform	0.003	0.007	0.010**
	(0.005)	(0.005)	(0.005)
Construction	-0.113***		
	(0.003)		
Post Reform × Construction	-0.026***	-0.031***	-0.032***
	(0.006)	(0.006)	(0.006)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	13,572	13,502	13,263

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table shows results from three difference-in-differences specifications. The outcome variable *Bid Ratio* is defined as the ratio of the winning bid over the estimated value of the contract. 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 winning bid prices and the effect is still interpreted as ATT. In all three specifications the effect is negative and statistically significant. The reform decreased the average winning bid by between 3.3% and 4%. The full results are presented in Table 7 in Appendix B. We further re-estimate the three regression introduced with *Bid Ratio* as the outcome variable using all available contracts as a control group. The estimated ATT effects range between -2.9 percentage points and -3.1 percentage points of the estimated value: for more details see Table 11 in Appendix B. Table 15 in Appendix B shows estimates from the same three specifications using only contracts with non-negative renegotiation. The results remain identical. Finally, to provide estimates robust to a potential problem of so-called bad controls, we estimate three specifications without controlling for the type of procurement procedure and evaluation criteria. Table 19 in Appendix B shows that the results remain robust.

Overall, all specifications provide robust evidence that the introduction of eased renegotiation rules decreased the average winning bid among construction contracts. The effect is consistently around 3 percentage points of the estimated value and around 3.5% of the average winning bids.

An important concern of our empirical specification is that a part of the control group was also exposed to the legal possibility of renegotiation. In particular, Figure 5 shows

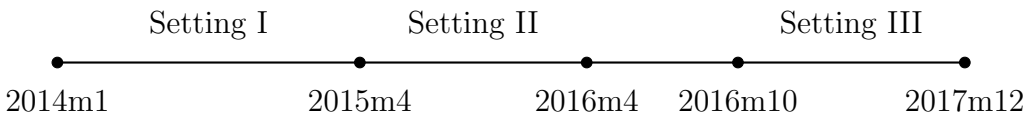
that some contracts in the control group (less than 5%) awarded after the reform have been renegotiated. This mechanism works against our estimates as it tends to attenuate the true effect. Our estimates thus likely constitute a lower bound on the causal effect on the winning bids.

Result (**Prediction 1**). *The eased renegotiation rules decreased the average winning bid. The point estimates range around 3 percentage points of the estimated value.*

4.4 Average Final Price

We next analyze the effect of the reform on the average final prices in the three policy settings. Since we do not know the date when the contract was renegotiated and terminated it is impossible to precisely determine to which setting (either I or II) a contract belongs. To address the issue we classify contracts into setting II if they were awarded within a year before the reform i.e., between April 2015 and April 2016, and are thus likely to last after the reform was implemented. Contracts awarded before April 2015 are then classified as setting I. We cannot rule out that some contracts in settings I and II are misclassified, and different renegotiation rules apply to them. We are, however, certain that any contract awarded after the reform came into effect follows the rules of setting III.

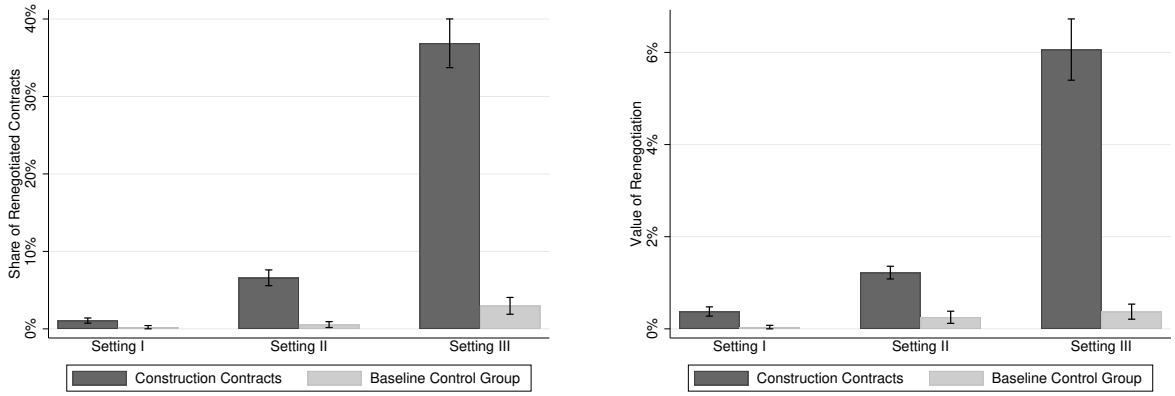
Figure 4: **Timing and Three Settings of Contracts**



Notes: This figure shows the definitions of our settings. Setting I consists of contracts awarded between January 2014 and April 2015. Setting II consists of contracts awarded between April 2015 and April 2016. Finally, setting III consists of contracts awarded between October 2016 and December 2017.

The share of renegotiated contracts and the value of renegotiation by industry and setting suggest that our classification is aligned with the model's predictions. Figure 5 shows that renegotiation practice differs by industry (treatment status) and setting. Both the share of renegotiated contracts and the ratio of renegotiated value to the estimated value of all contracts show that renegotiation is prevalent in setting III among construction contracts, as almost 40% of contracts were renegotiated, and the renegotiated amount for these contracts is about 6% of their estimated value. 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 a rather negligible share and value of renegotiated contracts. Assuming that the classification is reasonably accurate then Figure 5 confirms Predictions 2 and 3.

Figure 5: **Share and Value of Renegotiation by Treatment Status and Settings**



(a) Panel A: Share of Renegotiated Contracts

(b) Panel B: Value of Renegotiation

Notes: This figure shows the renegotiation practice by industry and setting. Panel A shows the 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 settings and in non-construction contracts.

4.4.1 Average Final Price in Settings I and II

We start by comparing the final prices of contracts in settings I and II. 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 *Price Ratio* to be higher among construction contracts in setting II.

Similarly to the previous section, we estimate a difference-in-differences specification using the baseline control contracts, with all non-construction contracts used as a control group in a robustness exercise presented in Appendix B. Our primary specification corresponds to regression 1 and we implement two specifications controlling for a more granular structure of industries, corresponding to regression 2.

We find evidence that the reform increased the average final price among construction contracts in setting II. The point estimates from different specifications systematically exceed 1.5 percentage points of the estimated value of contracts, suggesting a significant increase in the average final price. The first column of Table 2 reports results from our primary specification. Due to the reform the average final price of construction contracts in setting II is 1.5 percentage points of the estimated value higher than it would have been without the related rules for renegotiation. The point estimates in the alternative specifications in the second and third columns suggest even larger effects.

Table 8 in Appendix B reports results from specifications using logarithms of $FinalPrice$ as the outcome variable. In all the specifications, the point estimates range above 2% and

are statistically significant. Table 12 in Appendix B reports results from regressions using all non-construction contracts as the control groups and provides additional evidence of a positive effect. In two specifications the effect is statistically significant and around 1.5 percentage points of the estimated value of the contract. Using a sample of non-negative renegotiation yields estimates of the effect numerically identical to our main specifications. For the full results see Table 16 in Appendix B. Finally, Table 20 shows results from a specification in which we do not control for the type of procurement procedure and evaluation criteria. The point estimates are again positive, statistically significant and tend to be even larger than in our main specifications.

Table 2: **Effect of Renegotiation on the Average *Final Price Ratio* between Settings I and II**

	Price Ratio	Price Ratio	Price Ratio
Setting II	0.014***	0.010*	0.011*
	(0.006)	(0.006)	(0.006)
Construction	-0.127***		
	(0.005)		
Setting II × Construction	0.015**	0.022***	0.017**
	(0.007)	(0.007)	(0.007)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	9,193	9,118	8,881

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports results from three difference-in-differences specifications between contracts in settings I and II. In all specifications we control for selection methods and procedure of the procurement auction.

Result (**Prediction 4**)**.** *The unexpected possibility of renegotiation in setting II increases the average final price by between 1.5 to 2.2 percentage points of the estimated value.*

4.4.2 Average Final Price in Settings II and III

We next compare the average final price in settings II and III. While our model predicts an ambiguous relation between these prices, we have hypothesized a decrease in the average final price in setting III compared to setting II. In all three specifications reported in Table 3, the point estimate is negative. The first column shows an effect of -1.1 percentage points of the estimated value of contracts. The effect, however, is not

statistically significant. Once we control for a more granular structure of industries, the effect becomes more negative (-1.9) and marginally statistically significant.

Table 3: **Effect of Renegotiation on the Average *Final Price Ratio* between Settings II and III**

	Price Ratio	Price Ratio	Price Ratio
Setting III	0.003	0.005	0.010
	(0.007)	(0.007)	(0.008)
Construction	-0.113***		
	(0.005)		
Setting III × Construction	-0.011	-0.019**	-0.019*
	(0.009)	(0.010)	(0.010)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	5,226	5,144	4,960

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports results from three difference-in-differences specifications between contracts in settings II and III. In all specifications we control for selection methods and procedure of the procurement auction.

Four types of robustness exercises presented in Appendix B provide a similar picture. First, Table 9 shows results from regressions using a logarithm of the average final price as the outcome variable while controlling for the estimated value of the contract. Similarly to the main specification, all point estimates are negative, and two are statistically significant. Using all contracts as a control group yields statistically insignificant but qualitatively similar results as the main specifications. Table 13 shows that in all three specifications the point estimate is between -1.1 to -1.4 percentage points. Finally, using a sample of non-negative renegotiation and not controlling for the type of procurement procedure and evaluation criteria yield qualitatively the same results. For the full results, see Tables 17 and 21, respectively.

Result (**Prediction 5**). *Once the bidding price adjusts to the possibility of renegotiation the average final price decreases by 1 and 2 percentage points of the estimated value.*

4.4.3 Average Final Price in Settings I and III

Finally, we compare the average final price in settings I and III. Note that our model does not yield a clear prediction. On the one hand, a larger extent of renegotiation in

setting III tends to increase the average final price; on the other hand, the winning bids after the reform tend to be lower, and thus there is scope for renegotiation of the initial contract.

We find no difference between the average final price in settings I and III. All three main specifications, reported in Table 4, suggest a null effect. We further conduct the same twelve robustness exercises as in the previous comparisons. They all show a null effect. The results are reported in Tables 10, 14, 18, and 22 in Appendix B.

Table 4: **Effect of Renegotiation on the Average *Final Price Ratio* between Settings I and III**

	Price Ratio	Price Ratio	Price Ratio
Setting III	0.020***	0.019***	0.024***
	(0.007)	(0.007)	(0.008)
Construction	-0.129***		
	(0.005)		
Setting III × Construction	0.002	-0.002	-0.007
	(0.009)	(0.010)	(0.010)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	7,009	6,933	6,723

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports results from three difference-in-differences specifications between contracts in settings I and III. In all specifications we control for selection methods and procedure of the procurement auction.

Result. *Once the bidding strategies adjust, the eased renegotiation rules no longer affect the average final price.*

Overall, we show that the average final price in construction contracts increases only temporarily in setting II when renegotiation is possible, but bidders have not adjusted their bidding strategy yet. The average final price in setting III then decreases back and remains statistically indistinguishable from the average final price in the pre-reform level in setting I.

4.5 Winning Firms' Productivity

From a welfare perspective, the efficiency of the procurement mechanism, and with it the productivity of awarded firms is one of the main concerns of policy makers.[25] It is therefore important to assess whether the reform had an inefficiency effect. We quantify the effect of the reform on the average productivity of awarded firms by first calculating the Czech firms' productivity using the Orbis database and then estimating the effect of the eased renegotiation rules on the average productivity level in a difference-in-differences design.

To estimate Czech firms' productivity, we utilize the Orbis database and calculate the firm-year level log productivity of the firms awarded contracts in public procurement. For the main specification, the parameters of the productivity function were estimated using the Wooldridge method on a sample of firms with more than 100 employees. In Appendix B we present additional results using a productivity measure estimated on a sample of firms with more than 50 employees and employing the Levinsohn-Petrin method. For more details on productivity estimates see Appendix C. For each measure of productivity we normalize firms' log productivity using pre-reform industry specific mean and standard deviation and run the same three main specifications of difference-in-differences as in the previous exercises.

The effect on productivity tends to be negative but negligible and statistically insignificant. Table 5 shows the main three specifications. All three point estimates are statistically indistinguishable from a null effect. Tables 24 and 25 in Appendix B show results using the two additional measures of productivity. Point estimates of the effect of the reform on the average productivity varies between -0.06 to 0.01 of standard deviations of pre-reform log productivity with 8 of 9 estimates being marginally negative. None of them, however, is statistically significant. We thus can rule out that the reform had a noticeable negative effect on the average of the productivity of the awarded firms.

[25]Note that recent literature suggests that policymakers can utilize public procurement to pursue goals beyond economic efficiency. These additional objectives may include promoting sustainability, addressing environmental concerns and addressing gender-related issues.

Table 5: **Winning Firms' Productivity**

	Productivity	Productivity	Productivity
Post Reform	-0.035	0.018	0.009
	(0.080)	(0.083)	(0.083)
Construction	0.026		
	(0.053)		
Post Reform × Construction	0.010	-0.036	-0.047
	(0.095)	(0.096)	(0.094)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	2,432	2,380	2,280

Standard errors in parentheses

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

Notes: This table shows results from three difference-in-differences specifications. The outcome variable Productivity is a normalized (using pre-reform mean and standard deviation) measure of productivity estimated using the Wooldridge method on a sample firms with more than 100 employees. Since the measures of productivity are estimated at a granular CPV level, we find the specifications with more granular industry FE to be more credible. In each specification we control for the type of procurement procedure and the type of evaluation criteria.

4.6 Firms' Bargaining Power

Our model further implies that after the reform bidders' bargaining power becomes more important in determining the allocation of contracts. The higher the bargaining power, the higher the probability of being awarded the contract. As long as the cost-efficiency and bargaining power of bidders are not sufficiently positively correlated the eased renegotiation rules may shift the allocation of contracts awarded towards bidders with higher bargaining power, as is the case in **Example 1** and **Example 3**.

Unfortunately, we do not observe firms' bargaining power. Instead, we work with firms' propensity to renegotiate, defined as the share of renegotiated contracts awarded before the reform. We restrict the sample to firms that were awarded at least 3 contracts in the pre-reform period.[26] Only 10% of all firms awarded at least 3 contracts in the period studied renegotiated at least one contract before the reform. The share is twice as large among construction contracts. We refer to such a firm as a *Renegotiator*.

We argue that more-frequently renegotiating firms have, on average, higher bargaining

[26]In Appendix B, we replicate the same exercise with firms that were awarded at least 4 contracts.

power. A firm's decision to initiate renegotiation depends positively on the expected gain from renegotiation. Therefore, on average, firms with higher bargaining power are supposed to renegotiate their contracts more often. This argument is consistent with the proposed model, in which firms enter renegotiation if their expected gain exceeds the cost of renegotiation and do not renegotiate otherwise. If we assume that the occurrence of cost overruns is not driven by the identity of a winning bidder, then a higher frequency of renegotiation implies higher bargaining power of the firm.[27]

In the difference-in-differences setting, we look at the effect of the reform on the share of contracts awarded to *Renegotiator* firms. We replicate the same three main specifications used in the previous exercises. The results presented in Table 6 are generally consistent with our predictions. The estimated effects are all positive between 2.2 and 6.2 percentage points, suggesting that more contracts are awarded to firms with higher bargaining power.

Table 6: Change of Allocation of Contracts

	Renegotiator	Renegotiator	Renegotiator
Post Reform	-0.003	0.009	0.014
	(0.017)	(0.017)	(0.018)
Construction	0.401***		
	(0.011)		
Post Reform × Construction	0.062***	0.034*	0.022
	(0.021)	(0.021)	(0.021)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	10,327	10,264	10,096

Standard errors in parentheses

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

Notes: This table shows results from three difference-in-differences specifications. The outcome variable *Renegotiator* is a dummy variable, which equals 1 for construction contracts that were awarded as the ratio of the winning bid over the estimated value of the contract. In each specification we control for the type of procurement procedure and the type of evaluation criteria.

There are several caveats to these results. A *Renegotiator* is defined based on pre-reform behavior among firms awarded at least three contracts. The fixed and time-invariant

[27]Since most of the renegotiation led to higher final prices, we infer it is mostly firms who initiate the renegotiation and not the procurement authority.

definition of a *Renegotiator* has two implications for our estimates. On the one hand, *Renegotiator* firms must have been competitive and won a contract (just) before the reform, as most of the renegotiated contracts were in Setting II. Consequently, they just might have been more likely to win contracts in the post-reform period even if the reform did not take place. The effect is even amplified by the unknown control group of firms that may not even compete on the public procurement market anymore. This tends to increase the estimated parameter. On the other hand, if a firm with high bargaining power started competing on the public procurement market after the reform, it would still be considered to be part of the control group in our exercise. This mechanism attenuates the estimated parameter.

Second, since we do not observe all bidding firms, it is impossible to determine whether the potential effect comes from discouragement of firms with a lower bargaining power or only through more aggressive bidding of these *Renegotiator* firms. Overall, we interpret the results only as suggestive evidence and do not claim that shift of allocation of contract towards firms with higher bargaining power is a causal effect of easing the renegotiation rules.

Furthermore, our data are not informative about what makes a firm a *Renegotiator*. There are several possible explanations. For example, renegotiation and resulting increases in final price can be a channel of corruption, political connections or any other form of favoritism (see e.g. Brogaard et al., 2021), the bargaining power can relate to market structure, to the technical requirements for the fulfilment of the contract, and to a more capable legal department. Alternatively, since it is the relative bargaining power of firms and the procuring authority that counts even exogenous shocks such as an upcoming election may increase firms' bargaining power.

The null effect on winning firms' productivity and the shift in contract allocation towards *Renegotiators* allows for two potential explanations. First, the results observed are consistent with a competitive environment with several high-productivity firms, in which case the difference between potential winners is insignificant. Winning firms with greater bargaining power are then not necessarily substantially less efficient. Second, it is also plausible that the differences in bargaining power are not substantial enough to allow cost-inefficient firms to win after the reform. In this case, our suggestive evidence of a shift of contract allocation towards firms with greater bargaining power may be attributed to the limitations of our method for measuring bargaining power.

5 Concluding Remarks

Public procurement contracts are necessarily incomplete and they frequently require renegotiation. The scope for renegotiation of public procurement contracts is often strictly regulated by public procurement laws. This paper studies the consequences of easing renegotiation rules on procurement outcomes. We develop a stylized theoretical model that describes firms' bidding strategies and how they adjust their strategies in response to the renegotiation rules. The model predicts that easing of renegotiation rules induces bidders to change their bidding strategies, in turn affecting the average winning bid and the average final price. We use exogenous variation induced by a Czech reform that allowed winning firms to renegotiate to test the predictions of the model.

We show that this reform substantially increased the share of renegotiated contracts, suggesting that the winning firms obtained additional profits from being allowed to renegotiate. Yet, at the same time, we observe that the average winning bids decreased after the reform. Consistent with our model we argue that this is a consequence of firms' less precautionary bidding in anticipation of these additional profits. Interestingly, we find that the reform had no long-run effect on the average final price of contracts. After a temporal increase in the average final price caused by contracts awarded before the reform but renegotiated after it the average final price returned to its pre-reform level. This suggests that the additional profits to the winning firm of renegotiating were dissipated by lower bidding, so from this perspective procurers were not harmed by the reform.

From a welfare perspective, inefficiency could still be obtained because after the reform firms could win because of having large bargaining power rather than only because of being cost efficient. As our theoretical model shows, the fact that average final price did not increase after the reform does not exclude that there is inefficiency: when cost-efficient firms do still win they may do so at a lower price, because their advantage compared to firms with high bargaining power has decreased; this lower price can compensate the higher price that results when cost-inefficient firms win instead. As observing that the average final price does not increase is not sufficient to conclude that the reform has no inefficiency effect, we directly test for the inefficiency effect of the reform. We do so first by looking at the effect of the reform on the average level of productivity of winning firms. Here we do not find any significant effect, suggesting no inefficiency effect of the reform. Nevertheless, we provide some suggestive evidence that the allocation of contracts shifted towards firms with higher bargaining power. We conclude that either the differences in costs between potential winners are not very large, so that after the reform the fact that bidders with greater bargaining power are more likely to win does not mean that winning firms have significantly higher costs, or, alternatively, that differences in bargaining power

are not large enough to make cost-inefficient firms win after the reform, in which case our suggestive evidence on bargaining power is due to an imperfect measurement method.

Welfare effects that we do not consider in the paper are, first, that the reform shifted the risk from the bidders to procurer, as bidders could renegotiate compensation for the cost overrun and the procurer faced a more risky final price. In as far as the procurer is arguably less risk averse than the bidding firms (who may have owners that cannot diversify), the shift in risk because of the reform is welfare improving. Second, we only partially consider the transaction costs caused by allowing for renegotiation. Our model does consider the transaction costs of the bidders in the form of the cost of renegotiation incurred by them. The fact that bidders renegotiate often after the reform, and that the average final price does not go up, suggests that this part of the transaction costs is not very large. This does not exclude, however, that the procurer faces large transaction costs of eased renegotiation rules, which we have not considered, and which could potentially decrease welfare.

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6 Appendix A

We first provide more details for the setting with imperfect information, consecutively determining 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 $E[p_x^A]$.

$$b_x(c_x) = \frac{1}{[1-F_x(c_x)]^{n-1}} \int_{c_x}^{c_x^{max}} y(n-1)[1-F_x(y)]^{n-2} f_x(y)\,\mathrm{d}y \tag{3}$$

$$E[b_x] = \int_{c_x^{min}}^{c_x^{max}} \left[\frac{1}{[1-F_x(z)]^{n-1}} \int_{z}^{c_x^{max}} y(n-1)[1-F_x(y)]^{n-2} f_x(y)\,\mathrm{d}y \right] f_x(z)\,\mathrm{d}z \tag{4}$$

$$E[p_x^A] = \int_{c_x^{min}}^{c_x^{max}} \left[\int_{z}^{c_x^{max}} y(n-1)[1-F_x(y)]^{n-2} f_x(y)\,\mathrm{d}y \right] n f_x(z)\,\mathrm{d}z \tag{5}$$

We next show that the average winning bid is smaller in setting III than in setting I. In each setting average bids in the case of perfect information between bidders taken over all possible realizations of the net expected costs are identical to average bids in the case of imperfect information. This is because with imperfect information, a risk neutral bidder, across all realizations of the net expected costs where she has the lowest net expected cost, bids the average net expected cost of the bidder with the second-lowest net expected cost. For this reason, without loss of generality, we can compare the average bids across the settings in the case of perfect information. Consider a particular realization of parameters, and let these parameters be such that in setting I it is the case that $c_{\mathrm{I},1} < c_{\mathrm{I},2} < ...$, but in setting III it is the case that $c_{\mathrm{III},j} < c_{\mathrm{III},i} < ....$ It follows that in setting I the winning bid is $c_{\mathrm{I},2}$, and in setting III it is $c_{\mathrm{III},i}$. If $i = 2$, then the winning bid is smaller in setting III. If $i, j \neq 2$, then given that $c_{\mathrm{III},i} < c_{\mathrm{III},2}$ and $c_{\mathrm{III},2} \leq c_{\mathrm{I},2}$, it follows that the winning bid is again smaller in setting III. If $j = 2$, $i = 1$, then $c_{\mathrm{III},2} < c_{\mathrm{III},1} < c_{\mathrm{I},1} < c_{\mathrm{I},2}$, and the winning bid is once more smaller in setting III. Finally, if $j = 2$ and $i \neq 1$, then $c_{\mathrm{III},2} < c_{\mathrm{III},i} < c_{\mathrm{III},1} < c_{\mathrm{I},1} < c_{\mathrm{I},2}$, and the winning bid is again smaller in setting III.

We next show that the probability of renegotiation is larger in setting III than in setting II. First, note that in setting III, each bidder type, conditional on winning, is weakly more likely to renegotiate. The only way for the average probability of renegotiation to be smaller in setting III is that bidders who do not renegotiate in setting III (and who therefore also do not renegotiate in setting II) become more likely to win in setting III than in settings I or II. But this is not possible.

We finally show that the unconditional average extra price is larger in setting III than

in setting II. Conditional on winning, each given bidder is more likely to renegotiate in setting III than in setting II, and when renegotiating achieves a higher extra price. At the same time, a type that does not renegotiate in either of these settings, cannot become more likely to win in setting III.

We next reflect on the extent to which the predictions in subsection 3.2 depend on the assumptions we make. First, we have assumed that the winning bid does not affect the bidder's bargaining position. In the institutional setting that 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 this constraint is not binding because the value to the bidder of the procurer incurring the cost overrun does not exceed this fraction. Yet, if the constraint is binding, then bidders have an incentive to bid more to raise the maximum extra price that they can bargain for. However, as Figure 2 shows, few renegotiated contracts hit the constraint.

Second, 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 to the procurer (for procurement with renegotiation modeled in this way, see Fugger et al. (2019)). In this sense, one could argue that the minimal p^B that the winning bidder can obtain from renegotiating is c^B, in both settings II and III.[28] If this is the case, if the change from setting II to setting III does not change how bidders are ordered according to their net expected costs 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 for the possibility of a cost overrun. We reflect this in the assumptions by assuming a lower minimal renegotiated price 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 II than in setting III.

Third, 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) - even though this is compatible with the event of a cost overrun, rather than no cost overrun, being common to all bidders. In a common-value model all bidders' costs are instead the same, but they individually receive noisy signals about them. In such a

[28]This is equivalent to the generalized Nash bargaining solution, with zero disagreement payoff of the winning bidder, and disagreement payoff $v - v^B$ for the procurer. The generalized Nash bargaining solution can be justified as being the result of a sequential bargaining process, with the parameter α reflecting the bidder's discount factor, determining her patience during the bargaining. For a similar argument in the context of procurement and renegotiation, see Herweg and Schwarz (2018). Alternatively, following (Waehrer, 1995), α 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.

model, bidders have an incentive to adjust their bids upward to avoid the 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 have both private and common elements, so we cannot exclude such an additional effect of the change in an institutional setting.

Fourth, 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 due to adaptation costs. 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. (2014)). Our model is thus based on the assumption that the benefits prevail.

Fifth, 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.

Sixth, 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.

Seventh, we have assumed firms are risk neutral. This assumption makes sense when firms are involved in many contracts, and are therefore able to spread their risks. However, when procurement contracts are large this assumption makes less sense. Let the risk for the firm concern the size of the cost overrun c^B of the other firms rather than the cost c^A in the absence of a cost overrun. The ability to renegotiate reduces the net expected cost of the cost overrun where, in the extreme, the benefit of renegotiating would exactly compensate the cost overrun so that the firm faces cost c^A whether or not there is a cost overrun. In this case, setting I is risky, but setting III is not. When firms are risk averse, this leads to lower bidding in setting I than risk neutral firms would do, as risk averse firms facing risk bid lower to insure themselves against the risk of losing the auction

Krishna (2009). At the same time, if renegotiation eliminates this risk, the bid is not lowered in setting III. For this reason, one would expect a higher average final price in setting III than in setting I, but this is not what we observe in the data. This suggests that risk aversion is not a driving factor.

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7 Appendix B

7.1 Robustness Exercises

Table 7: **Effect of Eased Renegotiation Rules on Winning Bids (log)**

	Win. Bid (log)	Win. Bid (log)	Win. Bid (log)
Estimated Value (log)	1.003***	1.011***	1.003***
	(0.002)	(0.002)	(0.002)
Post Reform	0.003	0.008	0.013**
	(0.006)	(0.006)	(0.006)
Construction	-0.140***		
	(0.004)		
Post Reform × Construction	-0.033***	-0.039***	-0.040***
	(0.007)	(0.007)	(0.008)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	13,572	13,502	13,263

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table shows results from three difference-in-differences specifications using an algorithm of the winning bid as the outcome variable. In each specification, we control for the (log of) the estimated value, the type of procurement procedure and the type of evaluation criteria.

Table 8: **Effect of Renegotiation on the Average Final Price (log) in Settings I and II**

	Final Price (log)	Final Price (log)	Final Price (log)
Estimated Value (log)	1.001***	1.009***	1.001***
	(0.002)	(0.002)	(0.003)
Setting II	0.017***	0.012*	0.013*
	(0.007)	(0.007)	(0.007)
Construction	-0.152***		
	(0.006)		
Setting II × Construction	0.020**	0.029***	0.022**
	(0.008)	(0.008)	(0.009)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	9,193	9,118	8,881

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table shows results from three difference-in-differences specifications using the log of final price as the outcome variable. In each specification we control for the (log of) the estimate price, the type of procurement procedure, and the type of evaluation criteria.

Table 9: **Effect of Renegotiation on the Average Final Price (log) in Settings II and III**

	Final Price (log)	Final Price (log)	Final Price (log)
Estimated Value (log)	1.007***	1.016***	1.010***
	(0.003)	(0.003)	(0.003)
Setting III	0.000	0.001	0.008
	(0.008)	(0.009)	(0.009)
Construction	-0.138***		
	(0.007)		
Setting III × Construction	-0.015	-0.026**	-0.026**
	(0.011)	(0.011)	(0.012)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	5,226	5,144	4,960

Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table shows results from three difference-in-differences specifications using the log of final price as the outcome variable. 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 (log) in Settings I and III**

	Final Price (log)	Final Price (log)	Final Price (log)
Estimated Value (log)	1.000***	1.008***	1.001***
	(0.002)	(0.003)	(0.003)
Setting III	0.022***	0.020**	0.026***
	(0.008)	(0.009)	(0.010)
Construction	-0.153***		
	(0.006)		
Setting III × Construction	0.005	-0.002	-0.005
	(0.011)	(0.012)	(0.012)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	7,009	6,933	6,723

Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table shows results from three difference-in-differences specifications using the log of final price as the outcome variable. 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 Eased Renegotiation Rules on *Bid Ratio* (All Contracts)**

	Bid Ratio	Bid Ratio	Bid Ratio
Post Reform	0.008**	0.007*	0.008**
	(0.003)	(0.004)	(0.004)
Construction Alt	-0.089***		
	(0.003)		
Post Reform × Construction Alt	-0.030***	-0.031***	-0.029***
	(0.005)	(0.005)	(0.005)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	18,261	18,095	17,661

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports results from three different difference-in-differences specifications using an algorithm of the winning bid as the outcome variable. 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 12: **The Effect of Renegotiation on Final Price in Settings I and II (All Contracts)**

	Price Ratio	Price Ratio	Price Ratio
Setting II	0.020***	0.014***	0.014***
	(0.004)	(0.004)	(0.005)
Construction Alt	-0.102***		
	(0.004)		
Setting II × Construction Alt	0.009	0.018***	0.014**
	(0.006)	(0.006)	(0.006)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	12,207	12,041	11,635

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table shows results from three difference-in-differences specifications using Price Ratio as the outcome variable. The control group consists of all contracts. In each specification we control for the type of procurement procedure, and the type of evaluation criteria.

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

	Price Ratio	Price Ratio	Price Ratio
Setting III	0.001	-0.003	-0.001
	(0.005)	(0.006)	(0.006)
Construction Alt	-0.093***		
	(0.005)		
Setting III × Construction Alt	-0.008	-0.011	-0.007
	(0.008)	(0.008)	(0.009)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	7,381	7,209	6,846

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table shows results from three difference-in-differences specifications using Price Ratio as the outcome variable. The control group consists of all contracts. 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 Settings I and III (All Contracts)**

	Price Ratio	Price Ratio	Price Ratio
Setting III	0.021***	0.015***	0.018***
	(0.005)	(0.006)	(0.006)
Construction Alt	-0.103***		
	(0.004)		
Setting III × Construction Alt	0.001	0.002	-0.001
	(0.008)	(0.009)	(0.009)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	9,390	9,226	8,848

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table shows results from three difference-in-differences specifications using Price Ratio as the outcome variable. The control group consists of all contracts. In each specification we control for the type of procurement procedure, and the type of evaluation criteria.

Table 15: **Effect of Eased Renegotiation Rules on *Bid Ratio* (Positive Renegotiation)**

	Bid Ratio	Bid Ratio	Bid Ratio
Post Reform	0.003	0.007	0.010**
	(0.005)	(0.005)	(0.005)
Construction	-0.113***		
	(0.003)		
Post Reform × Construction	-0.027***	-0.033***	-0.033***
	(0.006)	(0.006)	(0.006)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	13,426	13,355	13,116

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports results from three different difference-in-differences specifications using Bid Ratio as the outcome variable. The sample is restricted to contracts with non-negative renegotiation. In each specification we control for the type of procurement procedure, and the type of evaluation criteria.

Table 16: **The Effect of Renegotiation on the Average Final Price in Settings I and II (Positive Renegotiation)**

	Price Ratio	Price Ratio	Price Ratio
Setting II	0.014***	0.010*	0.011*
	(0.006)	(0.006)	(0.006)
Construction	-0.127***		
	(0.005)		
Setting II × Construction	0.015**	0.022***	0.017**
	(0.007)	(0.007)	(0.007)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	9,167	9,091	8,854

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table shows results from three difference-in-differences specifications using Price Ratio as the outcome variable. The sample is restricted to contracts with non-negative renegotiation. In each specification we control for the type of procurement procedure, and the type of evaluation criteria.

Table 17: **The Effect of Renegotiation on the Average Final Price in Settings II and III (Positive Renegotiation)**

	Price Ratio	Price Ratio	Price Ratio
Setting III	0.003	0.005	0.009
	(0.007)	(0.007)	(0.008)
Construction	-0.112***		
	(0.005)		
Setting III × Construction	-0.010	-0.019*	-0.019*
	(0.010)	(0.010)	(0.010)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	5,155	5,075	4,890

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table shows results from three difference-in-differences specifications using Price Ratio as the outcome variable. The sample is restricted to contracts with non-negative renegotiation. In each specification we control for the type of procurement procedure, and the type of evaluation criteria.

Table 18: **The Effect of Renegotiation on the Average Final Price in Settings I and III (Positive Renegotiation)**

	Price Ratio	Price Ratio	Price Ratio
Setting III	0.020***	0.019**	0.023***
	(0.007)	(0.007)	(0.008)
Construction	-0.128***		
	(0.005)		
Setting III × Construction	0.004	-0.001	-0.006
	(0.010)	(0.010)	(0.011)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	6,950	6,873	6,665

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table shows results from three difference-in-differences specifications using Price Ratio as the outcome variable. The sample is restricted to contracts with non-negative renegotiation. In each specification we control for the type of procurement procedure, and the type of evaluation criteria.

Table 19: **Effect of Eased Renegotiation Rules on *Bid Ratio* (No Controls)**

	Bid Ratio	Bid Ratio	Bid Ratio
Post Reform	0.004	0.007	0.008
	(0.005)	(0.005)	(0.005)
Construction	-0.111***		
	(0.003)		
Post Reform × Construction	-0.025***	-0.031***	-0.029***
	(0.006)	(0.006)	(0.006)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	14,058	13,989	13,744

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports results from three different difference-in-differences specifications using Bid Ratio as the outcome variable. Compared to the main specifications, we do not control for the type of procurement procedure and the type of evaluation criteria.

Table 20: **The Effect of Renegotiation on the Average Final Price in Settings I and II (No Controls)**

	Price Ratio	Price Ratio	Price Ratio
Setting II	0.011*	0.007	0.008
	(0.006)	(0.006)	(0.006)
Construction	-0.128***		
	(0.005)		
Setting II × Construction	0.023***	0.028***	0.022***
	(0.007)	(0.007)	(0.007)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	9,281	9,204	8,969

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table shows results from three difference-in-differences specifications using Price Ratio as the outcome variable. Compared to the main specifications, we do not control for the type of procurement procedure and the type of evaluation criteria.

Table 21: **The Effect of Renegotiation on the Average Final Price in Settings II and III (No Controls)**

	Price Ratio	Price Ratio	Price Ratio
Setting III	0.009	0.010	0.011
	(0.007)	(0.007)	(0.008)
Construction	-0.105***		
	(0.005)		
Setting III × Construction	-0.010	-0.017*	-0.012
	(0.009)	(0.009)	(0.010)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	5,595	5,511	5,320

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table shows results from three difference-in-differences specifications using Price Ratio as the outcome variable. Compared to the main specifications, we do not control for the type of procurement procedure and the type of evaluation criteria.

Table 22: **The Effect of Renegotiation on the Average Final Price in Settings I and III (No Controls)**

	Price Ratio	Price Ratio	Price Ratio
Setting III	0.020***	0.016**	0.018**
	(0.006)	(0.007)	(0.008)
Construction	-0.128***		
	(0.005)		
Setting III × Construction	0.013	0.007	0.006
	(0.009)	(0.009)	(0.010)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	7,384	7,310	7,098

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table shows results from three difference-in-differences specifications using Price Ratio as the outcome variable. Compared to the main specifications, we do not control for the type of procurement procedure and the type of evaluation criteria.

Table 23: **Change of Allocation of Contracts**

	Renegotiator	Renegotiator	Renegotiator
Post Reform	-0.003	0.008	0.012
	(0.018)	(0.018)	(0.019)
Construction	0.430***		
	(0.011)		
Post Reform × Construction	0.053**	0.029	0.018
	(0.022)	(0.021)	(0.023)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	9,601	9,534	9,375

Standard errors in parentheses

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

Notes: This table shows results from three difference-in-differences specifications using a dummy for contracts that were awarded to a good renegotiator as the outcome variable. The dummy is 1 if the contract was awarded to a firm that ranked among firms that managed to renegotiate a contract in the pre-reform period.

Table 24: **The Effect of Renegotiation on the Productivity of Winning Firms**

	Production	Production	Production
Post Reform	-0.016	0.014	-0.030
	(0.080)	(0.082)	(0.083)
Construction	0.001		
	(0.052)		
Post Reform × Construction	-0.033	-0.059	-0.015
	(0.094)	(0.095)	(0.094)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	2,432	2,380	2,280

Standard errors in parentheses

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

Notes: This table shows results from three difference-in-differences using the standardized (using industry level pre-treatment productivity) log productivity as the outcome variable. The parameters of the production function were estimated using the Levinsohn-Petrin method on a sample of firms with more than 100 employees.

Table 25: **The Effect of Renegotiation on the Productivity of Winning Firms**

	Productivity	Productivity	Productivity
Post Reform	0.024	0.051	0.055
	(0.072)	(0.074)	(0.073)
Construction	0.026		
	(0.045)		
Post Reform × Construction	-0.037	-0.048	-0.049
	(0.084)	(0.085)	(0.083)
Industry FE	No	4-digit CPV code	6-digit CPV code
N	3,269	3,207	3,091

Standard errors in parentheses

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

Notes: This table shows results form three difference-in-differences using the standardized (using industry level pre-treatment productivity) log productivity as the outcome variable. The parameters of the production function were estimated using the Wooldridge method on a sample of firms with more than 50 employees.

8 Appendix C

To estimate firms' productivity, we utilize Czech firm data from the Orbis database and deflator data from Horvát and Webb (2020). Following Gal (2013), we estimate industry-specific production functions at the NACE 2 level using the control function approach. Due to data availability considerations, we combine several NACE 2 industrial levels. Our outcome variable is the adjusted operating revenue turnover, taking into account the production deflator. For labor input in the production function, we use the cost of employees adjusted by the consumer price index deflator. Capital input is measured by tangible fixed assets adjusted by gross fixed capital formation deflators, which are calculated using the perpetual inventory method. To approximate intermediate inputs, we rely on a proxy measure. For a comprehensive examination of the coverage and representativeness of the Orbis data, please refer to Bajgar et al. (2020).

We employ two estimation methods: the Wooldridge method (Wooldridge, 2009) and the Levinsohn-Petrin method (Levinsohn and Petrin, 2003). To ensure comparability and similarity to firms participating in procurement competitions, we narrow down the sample to mid and large-sized firms. This approach allows us to estimate firm-year specific productivity on a subset of firms that are comparable to each other. Depending on the specifications, we exclude self-employed individuals and small-sized firms with less than 50 and 100 employees, respectively.

Lastly, we compute the predicted log productivity at the firm-year level and normalize it by using the mean and standard deviation of firms in the corresponding industry during the pre-treatment period.

Abstrakt

Smlouvy ve veřejných zakázkách jsou nevyhnutelně neúplné a často vyžadují dodatečné vyjednávání o vícepracích. V této studii představujeme teoretický model, který analyzuje vliv pravidel upravujících vyjednávání o vícepracích na nabídkovou strategii firem, na výši vítězné nabídky a na konečnou cenu zakázky. Následně využíváme reformu zákonů o vícepracích ve veřejných zakázkách v České republice k empirickému testování predikcí našeho modelu. Naše zjištění ukazují, že (i) zjednodušení pravidel pro vyjednávání o vícepracích vede ke snížení průměrných vítězných nabídek, (ii) průměrné konečné ceny zakázek ale zůstávají na předreformní úrovni, protože dodatečně vyjednaná finanční náhrada za vícepráce kompenzuje pokles vítězných nabídek. Nenašli jsme přesvědčivou evidenci o poklesu produktivity vítězných firem, nicméně data naznačují, že po reformě častěji vyhrávají firmy s vyšší vyjednávací silou.

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Phone: + 420 224 005 153
Email: office@cerge-ei.cz
Web: https://www.cerge-ei.cz/

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