# Problems and unaccounted for effects in the organization of procurement for the needs of complex projects

Lidia Plekhanova

*Lomonosov Moscow State University,
Russian Presidential Academy of National Economy and Public
Administration*

- Need for new approaches to infrastructure project management (Flyvbjerg, 2007), (Alaev, 2015)

- Need for balanced institutional support (Menard et al., 2010)

- Standard problems - cost overruns and loss of profits (Flyvbjerg, 2007)

- The cost and quality of work may depend on the procurement process (Bajari et al., 2009), (Yakovlev, 2012;2018), (Iudkevich, Pivovarova, 2010)

- The impact of procurement forms on project performance has not been well studied

Rail transport projects - benchmarks for Infrastructure planning and management (Flyvbjerg, 2007)

- Technological and organizational complexity
- Uniqueness
- The relationship of different stages and work sites
- Long planning horizon

⬇

- The impossibility of drawing up a complete technical task
- The docking problem
- Rising costs and delaying deadlines
- Reduced quality of work and final product, catastrophe risks

The procurement form matters?

Malitskaia (2014), Künneke et al. (2010), Flyvbjerg (2007), Finger et al. (2005)

*The impossibility of drawing up a complete technical task =>*

- Company A announces a purchase for the design of a system in the subway of the city of X

- Company B, which traditionally performs similar work in city Y, decides to expand the sales market and takes part in the tender

- Company B wins the competition by offering a good price, performs the work, closes the contract and even receives an impressive positive profit.

- Both sides act strictly within the law

*What's wrong?*

- Company A was forced to accept works B, since they were formally performed in accordance with the specification (incomplete), but in practice the system does not integrate into the specified infrastructure.

- The result is a redesign of the system "under a different name" in a few years.

- Adaptation – the customer more carefully sharpens the requirements for "his" contractors, who know the specifics of the object from experience, and rejects "strangers"

*\* interviews with industry experts*

*The impossibility of drawing up a complete technical task =>*

- Company A wins auction for section 1 engineering system

- Company B wins auction for section 2 and 3 engineering system

- Both companies supply software and hardware complexes in accordance with the specification

- *What's wrong?*

- Companies A and B are launching the system on their sections (part of the functions)

- Integration of solutions is necessary for the full launch of the system at all sections

- Integration work is not provided for by contracts

- During the auction, both companies have significantly dropped in price and are not ready to bear the costs of an unforeseen adaptation

- The systems operate in a limited mode

*The solution?*

Expanding the practice of purchasing from a collective participant? Competition vs. Complementarity.
(according to Federal Law №44 it is allowed only for a narrow list of works, according to Federal Law №223 it is not forbidden)

*\* interviews with industry experts*

| | REQUEST FOR PROPOSALS | VS | AUCTION |
|---|---|---|---|
| Accounting for reputational characteristics | + | | − |
| Bidding stage | − | | + |
| Deviation from the initial price | ↓ | | ⬇⬇ For "simple" goods in highly competitive conditions |
| Models of opportunistic behavior | Corruption schemes (including manipulation of the evaluation methodology) | | Collusion at auctions with low competition in the market. The presence of corruption schemes and collusion can mutually enhance their spread |
| Customer's risks | ↑ Price | | ↓ Quality |

*The effectiveness of the auction according to price and quality criteria in the class of projects under consideration is lower compared to the request for proposals form and decreases with increasing complexity of the contract.*

Data: 577 observations on procurement for the needs of projects at Moscow Metro facilities for the period 2014-2016

(collected from zakupki.gov.ru )

444 contracts for the supply of technological equipment and construction materials

133 contracts for construction, design and repair work

| | Request for proposals | Auction |
|---|---|---|
| % of the total number of contracts | 17% | 83% |
| Average number of applications submitted | 1,50 | 1,63 |
| Average number of admitted applications | 1,07 | 1,43 |
| Average % drop in price | 6,74% | 3,77% |
| Average contract delay rate (%) | 65,54% | 82,23% |
| % of terminated contracts | 12% | 22% |

1. Estimation of the levels of competition and relative savings depending on the type of procedure:
   We assume that the level of competition at the auction is endogenous (the presence of an unobservable factor affecting the setting of the price and the number of admitted participants) => The method of instrumental variables:

$$\boldsymbol{Discount} = \alpha_1 + \alpha_2\widehat{N} + \alpha_3\mathrm{T} + \alpha_4\mathrm{C} + \alpha_5Y + \varepsilon$$

$$N = \beta_1 + \beta_2\mathrm{Z} + \beta_3\mathrm{T} + \beta_4\mathrm{C} + \beta_5Y + \xi$$

**Discount** − % drop relative to the reserve price

$N$ − number of admitted bidders

$\widehat{N}$ − the estimate of the number of participants obtained at the first step of the regression evaluation

**Z** − instrument: number of applications submitted

T − vector of variables characterizing the type of purchase, the subject of the contract, the complexity of the contract

C − vector of variables characterizing the presence of signals about the possible presence of corrupt behavior/favoritism/collusion

Y − year of purchase

2. Estimation of the contract execution delay

3. Estimation of the probability of the contract termination

| Variables | (1) | | | (2) | | |
|---|---|---|---|---|---|---|
| | N_accepted OLS | Discount OLS 1st st. | Discount Poisson 1st st. | N_accepted OLS | Discount OLS 1st st. | Discount Poisson 1st st. |
| N_common | 0.68*** (0.05) | | | 0.68*** (0.05) | | |
| $\widehat{N}$ | | 5.84*** (1.04) | 5.03*** (0.55) | | 5.83*** (1.03) | 5.00*** (0.54) |
| Auction | 0.28*** (0.09) | **-6.95*** (1.18)** | **-6.62*** (1.28)** | 0.12 (0.10) | **-4.19*** (1.22)** | **-3.98*** (1.31)** |
| Subject | 0.06 (0.06) | 0.17 (0.98) | 0.42 (0.95) | -0.38** (0.16) | 7.48*** (2.54) | 7.38** (2.92) |
| Closeness | -0.0001 (0.0001) | 0.001 (0.002) | 0.001 (0.002) | -0.0001 (0.0001) | -0.004*** (0.002) | 0.001 (0.002) |
| Reserve price | -0.0001 (0.0001) | -0.005*** (0.002) | -0.005*** (0.001) | -0.0001 (0.0001) | 0.002 (0.002) | -0.004*** (0.001) |
| Delay_dessigion | 0.01** (0.003) | -0.01 (0.05) | 0.01 (0.05) | 0.01** (0.003) | -0.01 (0.05) | 0.01 (0.05) |
| Frequency | 0.005 (0.005) | -0.35*** (0.06) | -0.35*** (0.06) | 0.004 (0.005) | -0.33*** (0.06) | -0.33*** (0.06) |
| Changes, Y15, Y16 | … | … | … | … | … | … |
| Subject × Auction | | | | 0.55*** (0.17) | **-9.23*** (2.80)** | **-8.79*** (3.07)** |
| Constant | -0.11 (0.22) | 6.99* (3.85) | 7.80* (4.64) | 0.07 (0.21) | 4.01 (3.97) | 4.98 (4.68) |
| Observations | 577 | 577 | 577 | 577 | 577 | 577 |
| Adjusted R² | 0.67 | 0.29 | 0.26 | 0.68 | 0.31 | 0.27 |
| Residual Std. Error | 0.58 | 8.57 | 8.75 | 0.57 | 8.43 | 8.71 |
| F Statistic | 120.25*** | 21.999*** | 21.23*** | 113.31*** | 25.369*** | 20.03*** |

- the % drop in price in the case of an auction is lower, compared to the request for proposals
- the most pronounced "-" effect when choosing an auction for work contracts
- results partially confirm hypothesis №1

Discount – an indicator of relative savings

N_common – number of submitted applications

N_accepted – number of accepted applications

Delay_dessigion, Frequency, Changes – signals about corruption / favoritism

Closeness, Reserve price – contract characteristics

Auction = 1, auction / 0, request for proposals

Subject = 1, work / 0, supply

| Variables | (1) | | | (2) | | |
|---|---|---|---|---|---|---|
| | N_accepted OLS | Discount OLS 1st st. | Discount Poisson 1st st. | N_accepted OLS | Discount OLS 1st st. | Discount Poisson 1st st. |
| N_common | 0.69*** | | | 0.68*** | | |
| | (0.06) | | | (0.06) | | |
| $\widehat{N}$ | | 5.87*** | 5.07*** | | 5.83*** | 5.09*** |
| | | (1.25) | (0.64) | | (1.25) | (0.63) |
| Auction | 0.15 | **-4.13*** | **-3.91*** | 0.26* | -1.14 | -0.81 |
| | (0.10) | **(1.26)** | **(1.37)** | (0.14) | (1.66) | (1.70) |
| Complexity | 0.0003 | -0.01* | -0.01 | 0.01 | 0.29* | 0.30* |
| | (0.001) | (0.01) | (0.01) | (0.01) | (0.17) | (0.16) |
| Closeness | -0.0002 | 0.0005 | -0.0001 | -0.0002* | -0.004** | 0.001 |
| | (0.0002) | (0.002) | (0.002) | (0.0001) | (0.002) | (0.002) |
| Reserve price | -0.0002* | -0.004** | -0.004** | -0.0001 | 0.001 | -0.004** |
| | (0.0001) | (0.002) | (0.002) | (0.0002) | (0.002) | (0.002) |
| Delay_dessigion | 0.01* | -0.09* | -0.07** | 0.01* | -0.09** | -0.08** |
| | (0.004) | (0.05) | (0.03) | (0.004) | (0.04) | (0.03) |
| Frequency | 0.003 | -0.27*** | -0.27*** | 0.003 | -0.27*** | -0.26*** |
| | (0.01) | (0.07) | (0.07) | (0.01) | (0.07) | (0.07) |
| Changes, Y15, Y16 | … | … | … | … | … | … |
| Complexity × Auction | | | | -0.01 | **-0.30* | **-0.32** |
| | | | | (0.01) | **(0.17)** | **(0.16)** |
| Constant | 0.16 | 8.37 | 9.31 | 0.04 | 5.10 | 5.83 |
| | (0.20) | (5.44) | (6.45) | (0.22) | (5.55) | (6.58) |
| Observations | 445 | 445 | 445 | 445 | 445 | 445 |
| Adjusted R$^2$ | 0.68 | 0.28 | 0.26 | 0.68 | 0.29 | 0.28 |
| Residual Std. Error | 0.57 | 8.35 | 8.46 | 0.57 | 8.28 | 8.33 |
| F Statistic | 95.38*** | 17.05*** | 16.38*** | 87.12*** | 16.83*** | 16.65*** |

- the % drop in price in the case of an auction is lower, compared with the request for proposals
- the effectiveness of the auction by the price criterion decreases with increasing complexity of the contract
- the results confirm hypothesis №1
- the results are resistant to specification and sampling

| Variables | Delay_contract | | | |
|---|---|---|---|---|
| | Контракты на работы и поставку | | Только контракты на поставку | |
| | (1) | (2) | (3) | (4) |
| Auction | 0.34*** | 0.39*** | 0.40*** | 0.46*** |
| | (0.11) | (0.13) | (0.13) | (0.15) |
| Subject | 0.26** | 0.39** | | |
| | (0.12) | (0.16) | | |
| Complexity | | | 0.005** | 0.01 |
| | | | (0.002) | (0.01) |
| | -0.0001 | -0.0001 | -0.0000 | -0.0000 |
| | (0.0003) | (0.0003) | (0.0002) | (0.0002) |
| Closeness | -0.002*** | -0.002*** | -0.003*** | -0.003*** |
| | (0.0003) | (0.0003) | (0.001) | (0.001) |
| Delay_dessigion | -0.004 | -0.003 | -0.0000 | -0.0001 |
| | (0.004) | (0.004) | (0.01) | (0.01) |
| Frequency | 0.02 | 0.02 | 0.03* | 0.03* |
| | (0.01) | (0.01) | (0.02) | (0.02) |
| Auction×Subject | | -0.17 | | |
| | | (0.22) | | |
| Auction×Complexity | | | | -0.01 |
| | | | | (0.01) |
| Reserve price , Changes, Y15, Y16 | … | … | … | … |
| Constant | 1.37*** | 1.31*** | 1.30*** | 1.24*** |
| | (0.25) | (0.23) | (0.25) | (0.29) |
| Observations | 465 | 465 | 347 | 347 |
| Adjusted $R^2$ | 0.13 | 0.13 | 0.13 | 0.13 |
| Residual Std. Error | 1.13 | 1.14 | 1.16 | 1.16 |
| F Statistic | 8.82*** | 7.96*** | 6.77*** | 6.09*** |

- in the case of an auction, higher rates of delay in the execution of contracts

- the results confirm hypothesis №2

- the results are resistant to sample changes

| Variables | Terminate | | | |
|---|---|---|---|---|
| | Контракты на работы и поставку | | Только контракты на поставку | |
| | (1) | (2) | (3) | (4) |
| Auction | 0.15 | -0.04 | -0.001 | 0.01 |
| | (0.23) | (0.25) | (0.25) | (0.35) |
| Subject | -0.65*** | -5.05 | | |
| | (0.19) | (159.76) | | |
| Complexity | | | 0.01*** | 0.01 |
| | | | (0.003) | (0.02) |
| Reserve price | | | | |
| | 0.0002 | 0.0002 | -0.002* | -0.002* |
| | (0.0005) | (0.0005) | (0.001) | (0.001) |
| Closeness | 0.002*** | 0.002*** | 0.002*** | 0.002*** |
| | (0.0003) | (0.0003) | (0.0004) | (0.0004) |
| Frequency | 0.01 | 0.01 | 0.04** | 0.04** |
| | (0.02) | (0.02) | (0.02) | (0.02) |
| Auction × Subject | | 4.52 | | |
| | | (159.76) | | |
| Auction × Complexity | | | | -0.001 |
| | | | | (0.02) |
| Delay_dessigion, Changes, Y15, Y16 | … | … | … | … |
| Constant | -2.04*** | -1.86*** | -1.63*** | -1.64*** |
| | (0.47) | (0.49) | (0.52) | (0.58) |
| Observations | 577 | 577 | 445 | 445 |
| Log Likelihood | -231.73 | -229.70 | -176.99 | -176.99 |
| Akaike Inf. Crit. | 483.46 | 481.39 | 373.98 | 375.98 |
| R2 McFadden | 0.18 | 0.19 | 0.24 | 0.24 |

- the results do not allow us to confirm hypothesis №3

- reasons: non-inclusion of a large number of significant unobservable factors

- Auction in comparison with the request for proposals:

- a higher indicator of the real level of competition;

- a lower indicator of relative savings;

- lower efficiency by the criterion of compliance with the terms of the contract.

  Possible mechanisms: collusion vs corruption (various incentive structures), adverse selection.

- The auction loses its effectiveness according to the price criterion with the increasing complexity of the contract.

- Possible mechanisms: "insurance" for ex-post adaptation, lack of economies of scale, barriers to market entry.
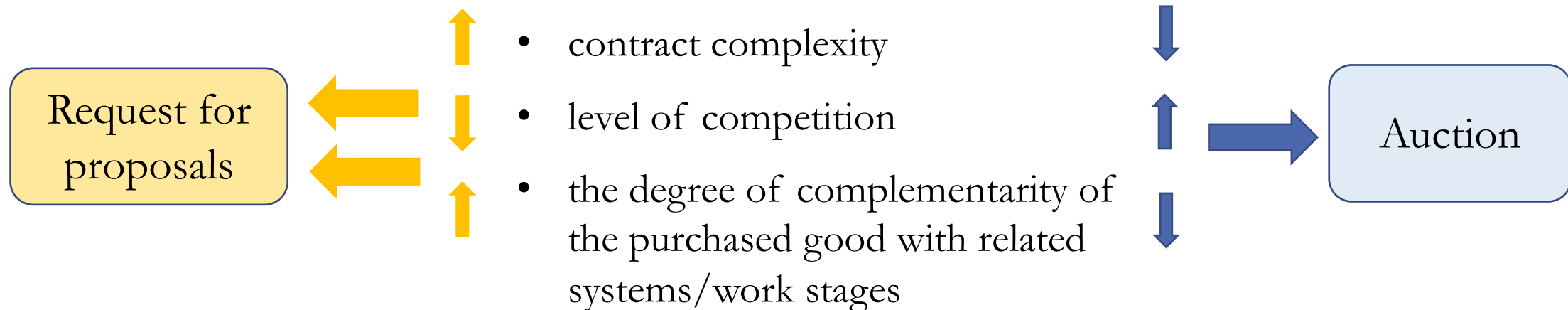
Model limitations

1. Heterogeneity of subjects of contracts and types of work
2. The scope of the technical specification as a proxy for the level of complexity of the contract is not an ideal tool
3. The delay in the execution of the contract as a proxy for an indirect quality indicator is associated simultaneously with an increase in the cost of the project and with quality indicators, which makes it difficult to obtain a reliable quantitative assessment
4. Non-inclusion of other significant factors in the model

Directions of research development

1. Studies on more extensive and homogeneous samples
2. Improving methods of accounting for the complexity of contracts
3. Identification of additional measurable factors affecting the effectiveness of each form of procurement
4. With an increase in available data, the use of machine learning, matching, and benchmark forecasting methods
5. Modeling the consequences of choosing procedures taking into account institutional changes

- The directions of the influence of the choice of the procurement procedure on the cost and timing of work are revealed
- It has been demonstrated that the auction does not justify the expectations for increasing the budgetary efficiency of procurement, and can also lead to a loss of quality in the case of complex contracts

Possible practical recommendations:

Request for proposals

- contract complexity
- level of competition
- the degree of complementarity of the purchased good with related systems/work stages

Auction

lplekhanova@outlook.com