The balance of unbalanced bidding

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Abstract

Based on anecdotal evidence, claims are made that unbalanced bidding is a serious problem in the construction industry. This concept is based on a situation with a contractor being more informed than the client. The asymmetry in information can be used by the contactor to skew unit prices in the ex ante bid and in order to enhance the ex post profit. This is done by increasing the unit price of a quantity that is expected to go up and lower the unit price of a quantity expected to decrease. Research regarding unbalanced bidding has to a large extent focused on models to assists clients in detecting and contractors in optimising the skew. There is also theoretical literature on efficiency losses of unbalanced bidding. The latter models show that it is rational for an informed contractor to raise unit prices on relative underestimated quantities. However, empirical studies that capture the magnitude of the problem are lacking. This paper sets out to fill that void. The analysis is based on a unique dataset of 15 Swedish road investments and 2,795 observations. Data consist of ex ante unit prices and quantities that are related to the final (ex post) quantities. By looking for a positive correlation between these variables and controlling for other affecting variables, the hypothesis of unbalanced bidding can be empirically tested. Along earlier studies on US data, this paper, using more project specific control variables concluded that the effect is even smaller or non-existent.

1. Introduction

Unbalanced bidding is one potential pitfall of unit price contracting (UPC). If present in a construction project, the concept generates information rents and therefore inefficiencies. This is manifested by the client paying too...

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much for the final product. Unbalanced bidding comes from the contractor being better informed than client (i.e. asymmetric information), which the former uses to their advantage. There is no moral aspect to such a behavior. The contractor acts according to the tendering documents provided by the client. On the contrary, if the contractor were not act on substandard UPCs then they have to answer to the shareholders of the company.

The concept is usually portrayed as a big problem in the construction industry. Experts often claim that “this is how it is done in the industry”. This perception is mainly based on anecdotal evidence. Most of the academic papers are theoretical, showing that it is rational for an informed contractor to use unbalanced bidding. There is however a lack of empirical studies supporting these claims and theoretical papers.

This paper sets out to empirically determine the problem of unbalanced bidding. The question is whether this pricing strategy exist on the Swedish road construction market A database of 15 Swedish road projects with 2 795 unique observations is used to test the existence of unbalanced bidding. This is the first larger study with a statistical approach that is done in the Nordic countries.

The paper starts with an introduction to the concept of unbalanced bidding, followed by a short review of the academic literature on the concept. Then the introduction continues with the variables and data used to test whether unbalanced bidding exists, followed by the analysis and the conclusions.

2. The concept of unbalance bidding

There are two types of unbalanced bidding discussed in the literature; unbalanced bidding through “front loading” the bids and unbalanced bidding based on information rents regarding quantities. The common denominator is that the contractor is better informed than the client and can use this information to his advantage. Hughes (1982) distinguished the former type of unbalancing as finance cost/cash flow unbalancing in contrast to the error exploitation unbalancing. Cash flow unbalancing involves the contractors marking up prices on quantities that are scheduled for early completion trading off quantities for late completion (Arditi and Chotibhongs, 2009; Skitmore and Cattell, 2011).

This paper refers to unbalanced bidding based on asymmetric information regarding quantities i.e. error exploitation. The usual example is taken with a unit price contract (UPC), where the client provides a bill of quantities in the ex ante tendering stage. This in contrast to a Design and Build contract (DB), where the contractor is responsible for both design and construction. Rather than providing a list of quantities of how the e.g. road should be built as in the UPC, the client describes in broad terms what is wanted (simplified, a road from A to B) and let the contractor do the thinking. UPC is still the most common contract in the construction industry.

When faced with at UPC, an informed contractors can then skew unit prices accordingly to their own estimation of the quantities. If the contractor expect a quantity to go down, then they will raise the unit rice and the other way around in order not to raise the price of the total bid. The following numerical example of this can be found in Mandell and Nyström (2014).

Assume that there are two inputs to building a road, provision of gravel and pavement. The ex ante bill of quantities for the project estimates 100 m³ of gravel and 150 m² of pavement. Assume that the contractors differ in costs and information. Contractor 2 exhibits higher marginal costs on both inputs than Contractor 1 but has private information, which Contractor 1 does not. Contractor 1 bids her marginal cost at unit prices of 10. Contractor 2 can then use her superior information regarding the ex post quantities and skew unit prices accordingly. As depicted in table 1, Contractor 2 submits the lower total bid and wins the contract.

<table>
<thead>
<tr>
<th>Ex ante</th>
<th>Bill of quantities</th>
<th>Contractor 1’s bid (uninformed)</th>
<th>Contractor 2’s bid (informed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provision of gravel</td>
<td>100 m³</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Pavement</td>
<td>150 m²</td>
<td>10</td>
<td>8.5</td>
</tr>
<tr>
<td>Total bid</td>
<td>2 500</td>
<td>2475</td>
<td></td>
</tr>
</tbody>
</table>
The project starts and Contractor 2’s prediction, i.e. that the quantities of gravel will increase and pavement decrease, turns out to be correct. As seen in Table 2, Contractor 2’s skewing of prices, based on her expectation of changing quantities, enables her to win the contract and earn higher revenue.

<table>
<thead>
<tr>
<th>Ex post quantities</th>
<th>Contractor 1’s bid (uninformed)</th>
<th>Contractor 2’s bid (informed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provision of gravel</td>
<td>110 m³</td>
<td>10</td>
</tr>
<tr>
<td>Pavement</td>
<td>145 m³</td>
<td>10</td>
</tr>
<tr>
<td>Final cost for the client</td>
<td>2 550</td>
<td>2553</td>
</tr>
</tbody>
</table>

Hence, due to unbalanced bidding, the most efficient contractor does not win the contract. The client ends up paying an information rent to Contractor 2, i.e. a higher cost than if the more efficient contractor 1 wins.

However, assuming that the contractor is risk neutral, the optimal way of skewing the bid is to hand in zero-unit prices except on the most underestimated quantity. Such bidding behavior would maximize the ex post profit in following way, see table 3.

<table>
<thead>
<tr>
<th>Ex ante quantities</th>
<th>Contractor 1’s bid (uninformed)</th>
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</tr>
</tbody>
</table>

This pricing strategy comes with a high risk. If the expected estimation of the informed contractor fail, there a big costs to bare.

### 3. Research on unbalanced bidding

The earliest papers on unbalanced bidding includes Gates (1967) and Starks (1974), who conceptualized the concept. Since then two branches of theoretical modeling regarding unbalanced bidding have evolved. The first group of models aims at providing practical management for clients to detect (Arditi and Chotibhongs 2009), and for contractors to optimize (Cattell et al. 2010; Cattell et al. 2008; Yizhe and Youjie 1992), unbalanced bidding. These are practical models in order to help practitioners in their day-to-day job with preparing (contractors) and evaluating (clients) bids.

The second type of models are directed towards theoretical audience and has to do with market efficiency. These are typical models in economics, with the purpose of predicting bidding behaviour and thereby socio-economic efficiency. The two most prominent models include Athey and Levin (2001) and Ewerhart and Fieseler (2003). Both models are based on asymmetric information between client and contractor, risk-neutral contractors and end up in corner solutions. This refers to a situation where the contractors hand in zero-unit prices for all quantities but the mostly underestimated in equilibrium (the example shown in table 3). Mandell and Nyström (2014) introduced risk aversion to this model and found an internal solution to the contractors bidding behaviour. This means that the contractor do not skew the bid to the extreme with zero-bids.

Hence, there are rational arguments for an informed contractor to skew the bid. This is not the same as the contractor actually doing it. There are some empirical papers on this matter. Bajari et al (2014) focus on the extent of
adaptation costs in road construction but also include data on skewed bids. They find a statically significant result, that a 10 percent quantity overrun will raise the corresponding unit price with 0.5 percent. The authors conclude that unbalanced bidding is not a major determinant in preparing bids. Miller (2014) show that ex post revisions have an effect on the unit prices from subcontractors. The following sections will present and analyse unbalanced bidding in Sweden.

4. The data and variables

To approach the empirical question whether unbalanced bidding is a problem, we want to correlate deviations in priced to deviations in quantities with control variables. This paper will be based on data gathered from The Swedish Transport Administration (Trafikverket). The database is based on 15 completed road constructions projects procured by Trafikverket. All data have been collected in the form of the so called MSS-file. This is a standardized excel sheet that all project leaders in Trafikverket use. The excel sheet include all quantities used in a project, both estimated (ex ante) and final (ex post). Quantitates are defined in different units; meter, square and cubic meters. Trafikverket’s project leaders use this file to fill in quantities throughout the projects. The file also includes unit prices and additional information such as project characteristics, additional orders and changes.

From this material we were able to create variables of interest. The deviation in quantities is defined as following way

\[
\Delta q = \frac{q_{ep} - q_{ea}}{q_{ea}} ,
\]

where, \(q_{ep}\) are quantities ex post and \(q_{ea}\) are ex ante. This gives a normalized measurement of deviation, which is necessary since the units differ between quantities. When no deviations occur, the figure takes on the value zero. The lowest possible figure is -1, which is when estimated quantities has not been used at all.

Deviations in unit prices are defined in the same way

\[
\Delta p = \frac{p_A - p_{ave}}{p_{ave}} ,
\]

where, \(p_A\) are the actual unit price and \(p_{ave}\) are the average unit price from all 15 projects regarding that type of quantity. If all quantities are skewed in the same direction measurement of deviation is problematic. This potential problem is dealt with later.

Descriptive statistics of the database is presented in table 4.

<table>
<thead>
<tr>
<th></th>
<th>Max</th>
<th>Min</th>
<th>Ave</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project size (sek)</td>
<td>132 663 000</td>
<td>1 528 000</td>
<td>42 384 244</td>
<td>15</td>
</tr>
<tr>
<td>Number of quantities per project</td>
<td>439</td>
<td>65</td>
<td>186</td>
<td>2 795</td>
</tr>
<tr>
<td>Unit prices</td>
<td>1 010 000</td>
<td>0</td>
<td>3 097</td>
<td>2 795</td>
</tr>
<tr>
<td>Deviations prices (percentage point)</td>
<td>2 919 %</td>
<td>-100 %</td>
<td>-1 %</td>
<td>2 795</td>
</tr>
<tr>
<td>Deviations quantities (percentage point)</td>
<td>12 308 %</td>
<td>-100 %</td>
<td>35 %</td>
<td>2 795</td>
</tr>
</tbody>
</table>

Table 4 shows that the projects have quantity deviations in both directions i.e. the actual quantities are both higher and lower than the estimated. This initial finding enables unbalanced bidding. However Mandell and Nyström (2014) show that opposite deviations of quantities is not a necessary condition for unbalanced bidding. Although it is
always preferable for an informed contractor to skew on opposite deviations it can also be done relative deviations in the same direction i.e. a bid can be skewed even though the actual quantities only go up (or down). This is however not relevant in this data since the quantities goes both up and down.

The descriptive data also present a large spread in the material for both quantities and prices. This indicates a need to wash the data for outliers. A limit is set for deviations in prices and quantities at 1 000 percent. Also excluding observations without any deviation in quantities gives at dataset with 2 543 observations.

5. Analysis

Based on the data presented above, this paper set out to test the hypothesis that unbalanced bidding exist in Trafikverket’s projects. To confirm the existence of unbalanced bidding, a positive relationship should prevail between deviations in p and deviations in q. This would indicate that contractors raise unit prices on underestimated quantities and lower unit prices on overestimated quantities. The scatter diagram of the observations is presented in Fig. 1.

\[
\Delta p_i = \alpha + \beta_1 \Delta q_i + \mu_i \quad i = 1, \ldots, 2543, \quad (3)
\]

where $\Delta p$ is defined in eq. 1, $\Delta q$ is defined in eq.2 and $\mu$ is the error term. However, no significant correlation is found between these variables.
However, control variables need to be included in order to properly test the correlation. The model is tested using four control variables. These variables are aspects that could affect the contractors’ ability or willingness to skew the bids.

The first variable is the size of the post. This is defined as the ex post quantity multiplied with the unit price, which gives a proxy for the importance of the post. The rationale is that the contractor will pay more attention to big monetary posts. It might also be the case small deviations in quantities are hard to detect. This control variable was not significant when the regression was run.

Another issue tested was additional work and changes in the projects. A contractor may very well estimate big flaws in the tendering documents and predict big changes outside the quantity adjustments. These can be exemplified by the contractor knowing that it is not possible to build the tendered bridge and that the client must build a tunnel instead. These sort of big changes can affect the contractors’ willingness to skew in the sense that they submit a low total price and earn money on extra work. The model has controlled for extra work and changes, which was not significant.

The third variable tested comes from a potential problem with data and has to do with the average unit price used for the deviation measurement. The average unit price is based on all unit prices of the 15 projects regarding a specific quantity. A problem occurs if all unit prices are skewed, which entails that the average also is skewed. In order to control for this problem, two variables were created. Both variables indicate if the the deviation of the quantities for all of the projects related to the average unit price were over- or underestimated. The first variable can be defined in the following way

\[
bias_{ave} = \frac{q_{ea}}{q_{ep}},
\]

where \(q_{ea}\) are quantities ex ante and \(q_{ep}\) are quantities ex post. \(bias_{ave}\) indicate if the unit price is expected to be over- or underestimated based on the deviation in the aggregated quantities per unit price. This variable is created in order to find biases in the average price. A dummy variable indicating over- or under estimated was also tried. None of the variables were significant.

Finally, project specific variables such as firm, geographical placement of project, type of road, project time, length of road and year of project start were included. None of the variables were significant.

Hence, in trying to find correlation between deviations in \(p\) and deviations in \(q\) this dataset fails. Despite running several OLS with control variables, no significant relationship could be found.

6. Conclusion

There is a consensus among experts in the construction industry that unbalanced bidding is a huge problem. This is mainly based on anecdotal evidence. There is a lack of empirical studies using larger datasets and statistical analysis to approach this concept. Bajari et al (2014) conclude that that unbalanced bidding is not a major determinant in preparing bids. As the first Swedish study based on quantitative analysis, the problem of unbalanced bidding cannot be found regarding road construction. Important control variables have been included but no significant correlation can be found between deviations in unit prices and deviations in quantities. Reasons for the lack of empirical support for unbalanced bidding can be several. A potential explanation is that the contractors do not have more information that the client. This is the underlying assumption for skewing bids, which might not be fulfilled. Another explanation is the transaction cost for preparing skew bids. It might take a long time for the calculator to go through all quantities and find misestimating. This cost may extend the expected profit of skewing. Also the risk of skewing bids are larger than what the contractor is willing to bare.
References