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Empirical analysis of unbalanced bidding on Swedish roads

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Abstract

Based on anecdotal evidence, claims are made that unbalanced bidding is a major problem in the construction industry. This concept refers to a sealed price auction setting with asymmetric information and unit prices, where information rents are extracted. Theoretical literature has shown that it is rational for an informed contractor to skew unit prices. However, empirical studies on the magnitude of the problem are lacking. As the first quantitative study based on European data, it is shown that unbalanced bidding exists, but in small magnitudes. The result is in line with earlier studies from the US.

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Unbalanced bidding, asymmetric information, information rent

JEL Codes

D22, D82, D86, H57, L47, L92

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1.0 Introduction

Transport infrastructure is often defined as a public good and therefore provided by a public entity. There are three ways for the government to undertake this responsibility. It can use in-house personnel, public procurement to buy the service from the market or let private contractors finance and take responsibility for providing infrastructure using a long-term agreement (i.e. Public Private Partnerships, PPP). Which setting to use has been approached theoretically by Hart et al. (1997) and Shleifer (1998), but the empirical answers are ambiguous (see e.g. Jensen and Stonecash, 2005; Alonso et al., 2015; Hensher, 2015; Odolinski and Smith, 2016). This paper focuses on the public procurement setting (see e.g. Spagnolo, 2012; Tadelis, 2012), where a first-price sealed-bid auction is common when the government is providing transport infrastructure (Gupta, 2001).

Incomplete contract theory (Grossman and Hart, 1986; Hart and Moore, 1989) has shown that first-best contracts are hard to achieve. Asymmetric information enables informed bidders to extract information rents through strategic pricing. Such strategies include predatory pricing (Baumol, 2003), ex post renegotiations via the hold-up problem (Goldberg, 1976), quality shading (Hart et al. 1997) and unbalanced bidding (Stark, 1974).

Unbalanced bidding is a potential pitfall when the public client uses unit price contracting (UPC). If present, this is manifested by the client paying too much for the final product. Unbalanced bidding comes from the contractor being better informed than the client (i.e. asymmetric information), which the former uses to their advantage.

The concept is usually portrayed as a major problem of the construction industry. Experts often claim that “this is how it is done in the industry”. This perception is based on anecdotal evidence. Most of the academic papers are theoretical, showing that it is rational for an informed contractor to use unbalanced bidding. However, there is a lack of empirical studies supporting these claims. The magnitude of unbalanced bidding is not known.

This paper sets out to empirically examine the problem of unbalanced bidding. A database of 15 Swedish road projects with 2 772 unique item observations is used to approach the theory. This is the first study, to our knowledge, to use a statistical approach on European data.

The paper starts by introducing the concept of unbalanced bidding, and follows this with a description of research on the topic. Section 4 describes the data, after which the model is introduced. The results are presented in section 6, followed by a robustness check of the marginal cost proxy and the conclusions.

2.0 The concept of unbalanced bidding

The usual way for public clients to procure infrastructure is to use a unit price contact (UPC). With such a contract, the client prepares and takes juridical responsible for the design. Competitive bids from contractors are unit price vectors, related to a bill of quantities stipulated by the client. The vector product of prices and quantities makes up the total price –often the lowest price. Although this way of procuring is transparent and simple, it also permits strategic behaviour that results in non-efficient equilibriums. Apart from the client setting the quantities in a strategic manner (Mandell and Brunes, 2014), a more evident problem is the contractors behaving strategically in the bidding process: i.e. unbalanced bidding.

There are two types of unbalanced bidding discussed in the literature; "front/back loading" and error exploitation. A prerequisite for both types is the bidder being better informed than the client. Front loading suggests that the contractors mark up unit prices on quantities that are scheduled for early completion, trading off quantities for late completion (Arditi and Chotibhongs, 2009; Skitmore and Cattell, 2011). Error exploitation involves the contractor using misestimation in the client's bill of quantities by raising unit prices on underestimated quantities and lowering unit prices on overestimated quantities. This paper refers to unbalanced bidding of the latter type. An example from road construction can be used to describe this type of unbalanced bidding.

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 m^3 of gravel and 150 m^2 of pavement. Assume that the contractors differ with regard to costs and information, where Contractor 2 has a higher marginal cost on both inputs in comparison to Contractor 1. However, Contractor 2 also 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 1 Ex ante bill of quantities and bids

Ex ante	Bill of quantities	Contractor 1's bid (uninformed)	Contractor 2's bid (informed)
Provision of gravel	100 m^3	10	12
Pavement	150 m^3	10	8,5
Total bid		2 500	2475

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 2 Contractor 2 submits the lower total bid and wins the contract

Ex post	Actual quantities	Contractor 1's bid (uninformed)	Contractor 2's bid (informed)
Provision of gravel	110 m^3	10	12
Pavement	145 m^3	10	8,5
Final cost for the client		2 550	2553

Due to unbalanced bidding, the most efficient contractor does not win the contract and the client ends up paying an information rent to Contractor 2.

However, assuming that the contractor is risk neutral, the optimal way of skewing the bid is to hand in zero-unit prices on the most overestimated quantity and maximise the unit prise on the most underestimated quantity, as in Table 3.

Table 3 Contractor 2 being risk neutral

Ex ante	Actual quantities	Contractor 1's bid (uninformed)	Contractor 2's bid (informed)
Provision of gravel	110 m^3	10	25
Pavement	145 m^3	10	0
Final cost for the client		2 500	2 750

Such bidding behaviour would maximise the ex post profit.

3.0 Research on unbalanced bidding

The earliest papers on unbalanced bidding include Gates (1967) and Starks (1974), who conceptualised the concept. Since then, two types of model regarding unbalanced bidding have evolved. The first group of models aims at providing practical guidance for clients to detect (Arditi and Chotibhongs 2009) and contractors to optimise (Cattell et al. 2010; Cattell et al. 2008; Yizhe and Youjie 1992) unbalanced bidding. These are practical models intended to help practitioners.

The second type of model is directed at a theoretical audience and concerns market efficiency. These are models typically found in economics, trying to predict bidding behaviour and socio-economic efficiency. The two most prominent models were developed by Athey and Levin (2001) and Ewerhart and Fieseler (2003). Both models are based on asymmetric information between client and contractor and on risk-neutral contractors and result in corner solutions. This refers to a situation in equilibrium where the contractors hand in zero-unit prices for all quantities but the one that will increase the most, the most underestimated quantity (i.e. the example shown in Table 3). Mandell and Nyström (2013) introduced risk aversion to this model and found an internal solution to the contractors' bidding behaviour.

Hence, there are rational arguments for an informed contractor to skew the bid. This is not the same as the contractors actually doing it.

There are two empirical studies that look at evidence of unbalanced bidding. Both use data from road construction in the US. Although not the focus of the paper, Bajari et al. (2014) show that a 10 per cent quantity overrun will raise the corresponding unit price 0.5 per cent, which they conclude is a modest amount. De Silva et al. (2015), using data from road construction in Texas, US, do not find any correlation between deviations in quantities and prices.

The following sections will present an analysis looking at whether unbalanced bidding is present in Sweden.

4.0 Data

The data for this study are gathered from the Swedish Transport Administration (Trafikverket). It is based on 15 road construction projects procured by Trafikverket between 2006 and 2010. All projects are road investments, geographically spread across Sweden. Each project is made up of, on average, 186 ex ante specified quantities (items). These are estimated quantities by the client of what it takes to build the specific road. Hence, data consists of 15 projects and 2 789 unique observations of quantities and unit prices.

Data has been collected in the form of so-called MSS files. These comprise a standardised Excel sheet that all project leaders in Trafikverket use. The Excel sheet includes all quantities used in a project, both estimated (ex ante) and final (ex post). Estimated quantities are defined in different units; metres and square and cubic metres. The file also includes unit prices and additional information such as project characteristics, additional orders and changes. There are seven firms with winning bids in the data.

Following Bajari et al. (2014) and De Silva et al. (2015), the two main variables for analysing unbalanced bidding is to relate changes in quantities to changes in prices. This is measured as relative prices and relative quantities. Relative prices are defined as follows:

$$100\,\frac{p_{ik}-\bar{p}_k}{\bar{p}_k}, \tag{1}$$

where p_{ik} is winning bidder *i's* price for item k and $\bar{p}_k$ is the average winning bids across projects for item *k*. The average $\bar{p}_k$, is an estimator of the 'norm' price of item *k*. Bajari et al. (2014) and De Silva et al. (2015) are using engineer estimates or Blue Book prices, but these are not available in Sweden. Therefore, (1) is based on the winning bids in this data. This runs the risk of producing a biased proxy of the marginal cost should all winning bidders skew their bids. The engineer estimates and Blue Book prices are the same measure, but the risk of being biased diminishes with more observations. A robustness check of the average price used are undertaken in section 7.

Relative quantities are defined as the relative change between ex ante and ex post quantities, expressed as:

$$100\,\frac{q_{ik}^{p}-q_{ik}^{a}}{q_{ik}^{a}}, \tag{2}$$

where q_{ik}^{a} is ex ante quantities and q_{ik}^{p} ex post quantities.

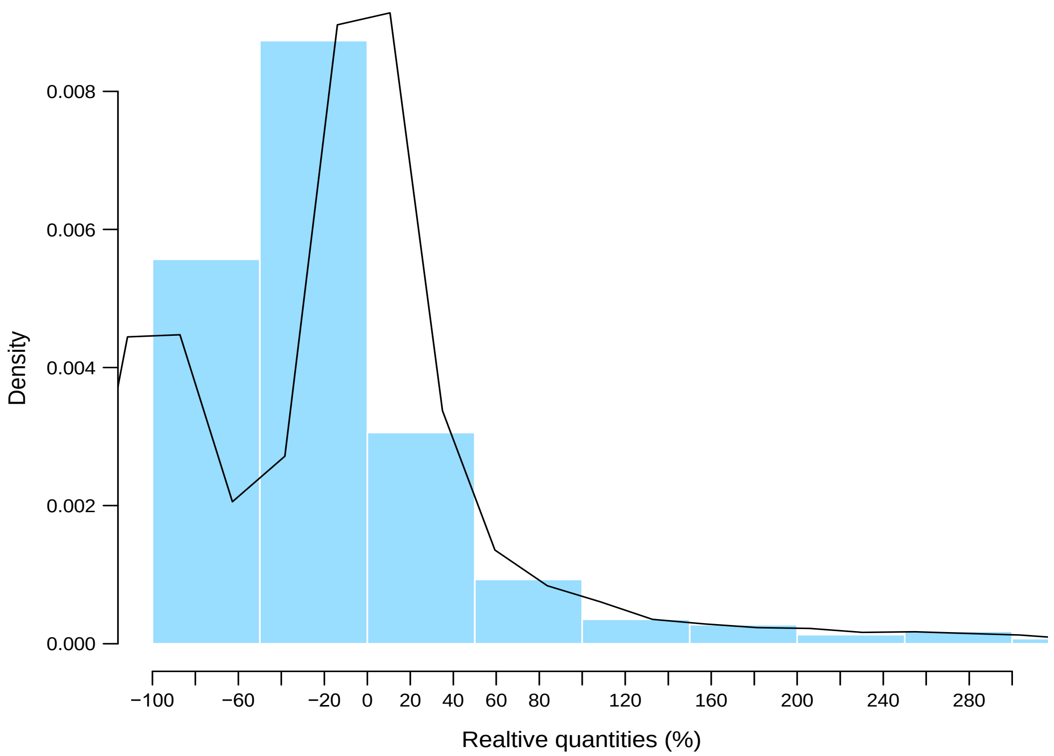
Table 4 presents summary statistics, showing that relative quantities can change quite dramatically. The average change in quantities is 35.9 per cent but the most extreme increase is over 12 000 per cent. Also note that some quantities specified in the UPCs were not used in the production at all. Resulting in -100 per cent change. There are also large deviations in prices set by different winning bidders. One bid is 3363 per cent larger than the average.

Table 4 Summary statistics

	N	Mean	St. Dev.	Min	Max
Relative prices	2,788	-0	122.7	-100	3,363
Relative quantities	2,773	35.9	453.7	-100	12,307
Size of projects (1000 SEK)	15	42 384	43 039	1 528	132 663

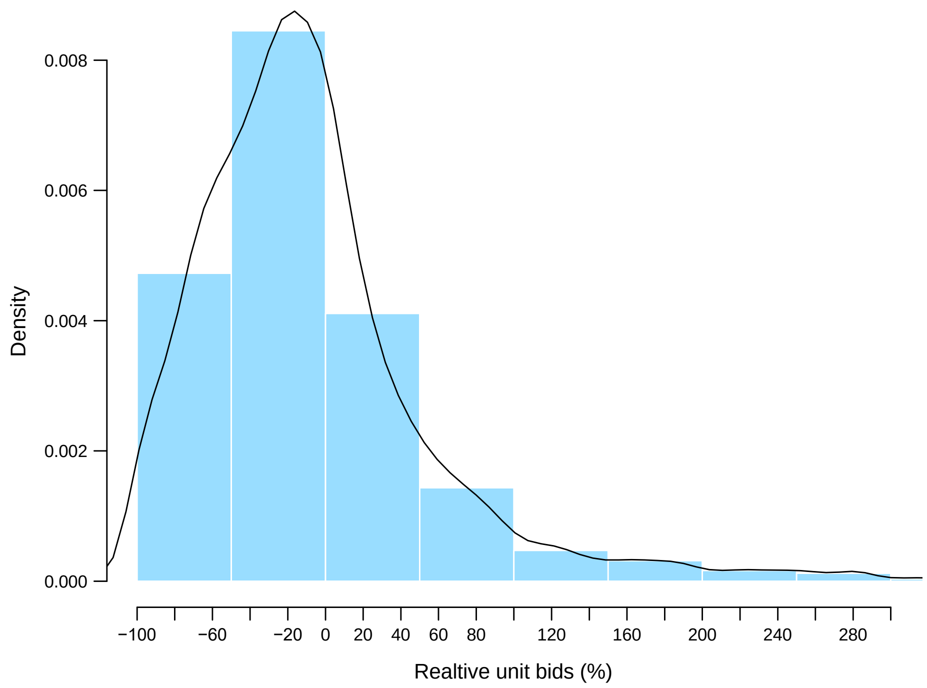
Figure 1 gives a better picture of the whole distribution of relative quantities. For example, more quantities decrease than increase.

Figure 1 Estimated density distribution of the relative change between ex post and ex ante quantities



Relative prices show a similar pattern, where some bids are much higher than the average bid but the majority of bids are below the average bid (Figure 2).

Figure 2 Estimated density distribution of relative unit bids (prices)



The observed values of both variables show patterns that would be expected if bidders were practising unbalanced bidding. Deviations of quantities in both directions enable profitable skewing for an informed contractor. About 30 per cent of the quantities do not have any deviation, while 28 per cent are over- and 42 per cent underestimated. Prices also show great variation in both directions.

5.0 Empirical model

To examine the existence of unbalanced bidding in Sweden, this study follows Bajari et al. (2014) and De Silva et al (2015). This is done by estimating the relationship between relative unit bids with the difference in ex ante and ex post quantities. The following regression model is used:

$$Y_{ik} = \alpha + \gamma Z_{ik} + \varepsilon_{ik}, \tag{3}$$

where Y_{ik} is the relative price for item k, given by the winning bidder i specified in eq. (1). The variable Z_{ik} is the relative quantities as defined by eq. (2).

The simple regression model in eq. (3) corresponds to the model used by Bajari et al. (2014) and De Silva et al. (2015). Here, however, the dependent variable and the variable of interest are expressed in percentage terms to simplify the interpretation. If the parameter γ is positive, it indicates that bidders are skewing prices. Thus, quantity overrun implies overpricing and underrun implies under-pricing. A more general specification is also used, where firm-specific variables are included:

$$Y_{ik} = \alpha + \sum_{g=2}^{G} \alpha_g Dg_i + \gamma_1 Z_{ik} + \sum_{g=2}^{G} \gamma_g Dg_i \times Z_{ik} + \varepsilon_{ik}, \qquad (4)$$

Firm dummies, where Dg_i, equals one if g=i and zero otherwise, α is the intercept and ε_{ik} is an error term. The effect of skewing for Firm 1, the reference firm, is γ_1, for any other firm (g=2,…,G) the effect is $\gamma_1+\gamma_g$. Hence, if $\gamma_g>0$, the firm g skews prices to a larger extent than the reference firm. If $\gamma_1=0$, the reference-level firm does not skew prices.

As pointed out by both Bajari et al. (2014) and De Silva et al. (2015), the items of the same project are very likely dependent, which also makes the errors dependent across project items. Therefore, Bajari et al. (2014) and De Silva et al. (2015) make inferences based on project-clustered standard errors. In their case this is rather straightforward, as the large number of projects enables the asymptotic theory for standard errors. The issue becomes more complicated with only 15 projects. Cameron et al. (2008) show that small-sample refinement can be achieved through bootstrap-based methods, in particular the wild bootstrap method. When trying this method with our data, it tends to break down. The few times it works, the same results as with standard cluster inference with degrees of freedom correction for small samples are found, as suggested by Cameron and Miller (2015). Therefore, the latter method is used throughout the paper.

Bajari et al. (2014) and De Silva et al. (2015) also make estimations with item-code fixed effects. De Silva et al. (2015) do not comment on the fixed effects and Bajari et al. (2014) justify this action only by allowing for “heteroskedasticity within an item code”. This paper has chosen not to include these fixed effects, as there is a potential problem of erasing any between-item-code effects. If a firm expects a lower ex post quantity of one item and a higher ex post quantity of a second item, then unit prices will be lowered and raised accordingly. If item fixed effects are included, this between-item effect of skewing is erased. Nevertheless, versions both with and without will be presented below, where the former will capture a potential between effect.

6.0 Results

In this section, the results from estimations of models in eq. (3) and eq. (4) are presented. Estimations for the complete data material as well as for a subset consisting only of earthwork, excavation and filling will be presented. Testing the subset of earthwork, excavation and filling is based on anecdotal evidence that these parts of the contracts are especially exposed to unbalanced bidding. The results for the complete data material are given in Table 6 and the subset in Table 7.

Table 5 Regression results

	Dependent variable:		
	r_p		
	(1)	(2)	(3)
r_q	0.0001	0.022***	0.021***
	(0.003)	(0.003)	(0.0002)
Firm2			-0.309
			(5.455)
Firm3			27.470
			(26.530)
Firm4			3.405
			(2.820)
Firm5			-14.895***
			(2.483)
Firm6			-2.480
			(17.380)
Firm7			-30.317
			(28.094)
r_q:Firm2		-0.019***	-0.021***
		(0.006)	(0.005)
r_q:Firm3		0.177***	0.159***
		(0.008)	(0.001)
r_q:Firm4		-0.022***	-0.022***
		(0.004)	(0.003)
r_q:Firm5		0.003	0.007
		(0.012)	(0.005)
r_q:Firm6		-0.025***	-0.024***
		(0.002)	(0.002)
r_q:Firm7		0.056	-0.017***
		(0.070)	(0.002)
R2	0	0.007	0.013

Adjusted R2	0	0.003	0.007
Firm reference level:		Firm 1	
Observations	2,772	2,772	2,772
Note:	*p<0.05, **p<0.01, ***p<0.001; standard errors in parentheses		

In line with Bajari et al. (2014) and De Silva et al. (2015), the R2 values are low when all items are included, as seen in Table 5. The R2 values are higher for the subset regression (see Table 6). This indicates that the firms pay extra attention to the subset codes. Table 5 does not indicate unbalanced bidding to any larger extent, as seen in specification 1. However, allowing for firm differences in skewing by including the interactions, then there are firms with significant unbalanced bidding behaviour (specifications (2) and (3)).

Table 6 Regression results for excavation and filling

	Dependent variable:		
	r_p		
	(1)	(2)	(3)
Constant	0.129	20.251	12.841
	(2.298)	(12.292)	(20.327)
r_q	-0.001	0.009	0.003
	(0.003)	(0.016)	(0.015)
Firm2			7.540
			(16.823)
Firm3			161.737***
			(26.185)
Firm4			-24.779*
			(11.620)
Firm5			-50.793***
			(14.821)
Firm6			-22.871*
			(11.020)
Firm7			-9.244

			(21.440)
r_q:Firm2		-0.012	-0.006
		(0.038)	(0.036)
r_q:Firm3		0.690***	1.114***
		(0.165)	(0.160)
r_q:Firm4		-0.009	-0.002
		(0.016)	(0.016)
r_q:Firm5		0.312*	0.073
		(0.130)	(0.149)
r_q:Firm6		-0.012	-0.005
		(0.016)	(0.016)
r_q:Firm7		0.041	-0.058
		(0.061)	(0.058)
Year dummies	No	Yes	Yes
R2	0	0.096	0.217
Adjusted R2	-0.001	0.082	0.199
Firm reference level:		Firm 1	
Observations	717	717	717
Note:	*p<0.05, **p<0.01, ***p<0.001; standard errors in parentheses		

Focusing on specification (3), Firm 1 (the reference level) skews quite moderately. When a quantity changes ex post by 1 per cent then Firm 1, on average, increases prices by 0.021 per cent according to the regression. For Firm 3, a 1 per cent ex post change gives about (0.021+0.159=) 0.18 per cent increase in prices. Firm 5 is not significantly different from Firm 1, the reference firm. Firms 2, 4, 6 and 7 do not significantly skew at all. As an example, the effect of relative quantities on prices is slightly negative for Firm 6, (0.021-0.024=-0.003), but insignificant when the sum of the coefficients is tested. Reasons for why some firms are not unbalancing their bids could be less information and/or more risk aversion.

Furthermore, Firm 3 also stands out, with overall higher bids than other contractors – for example, it has on average 66.7 per cent higher bids than Firm 1 according to regression (3) in Table 6. Firm 7 has an even higher estimated value, but there is too much uncertainty attached to this estimate – for example, the lower limit of the 95 per cent confidence interval is -83 per cent. These large deviations in price may look unrealistically large, but, although all projects are road projects, they may differ vastly in character. For example, building a tunnel is relatively risky and should imply overall higher pricing compared to more standard projects.

When looking at the results for the sub-sample of earthwork, excavation and filling, the results change slightly. Firm 3 skews more, while there is no evidence that the other firms unbalance at all on these activities. For Firm 3, if quantities increase by 1 per cent, prices are on average 1.11 per cent higher.

Item-code fixed effects are also tested, resulting in lower R2-values decreases, indicating that these effects are not relevant (see results in the Appendix).

The overall pricing on the subset of activities varies quite much across firms, as can be seen in Table 6. For Firm 3, these quantities seem to be where information rents are made. On average, they price these quantities 162 per cent higher than Firm 1. This may appear unrealistically high but, as shown in Table 4, some quantities firms may be thousands of per cent above the average bidder.

Figure 3 and 4 presents predicted relative difference in prices due to relative differences in quantity. Figure 3 is for all items and Figure 4 for the sub-sample. Note that Firm 3 stands out from the other firms.

Figure 3 Predicted relative price difference given the relative difference in quantity ex ante to ex post (per cent)

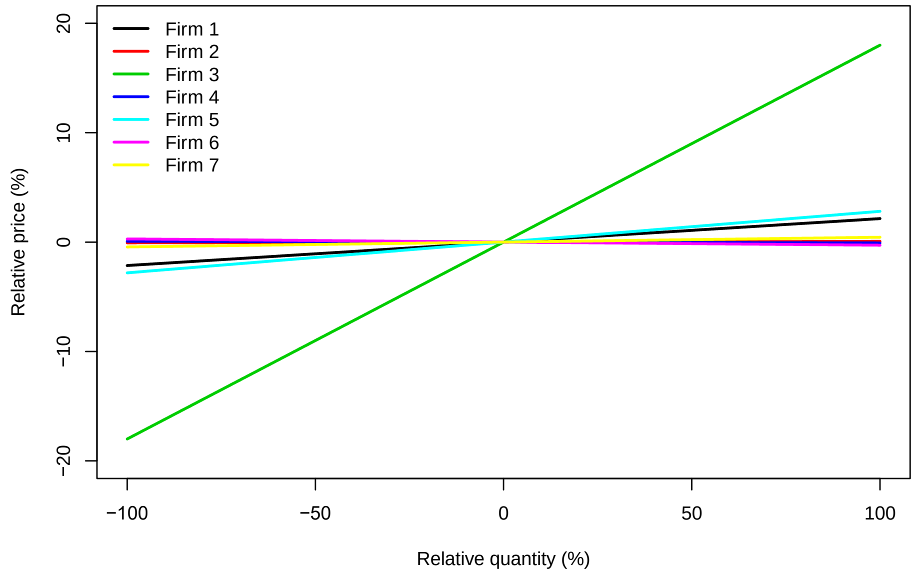
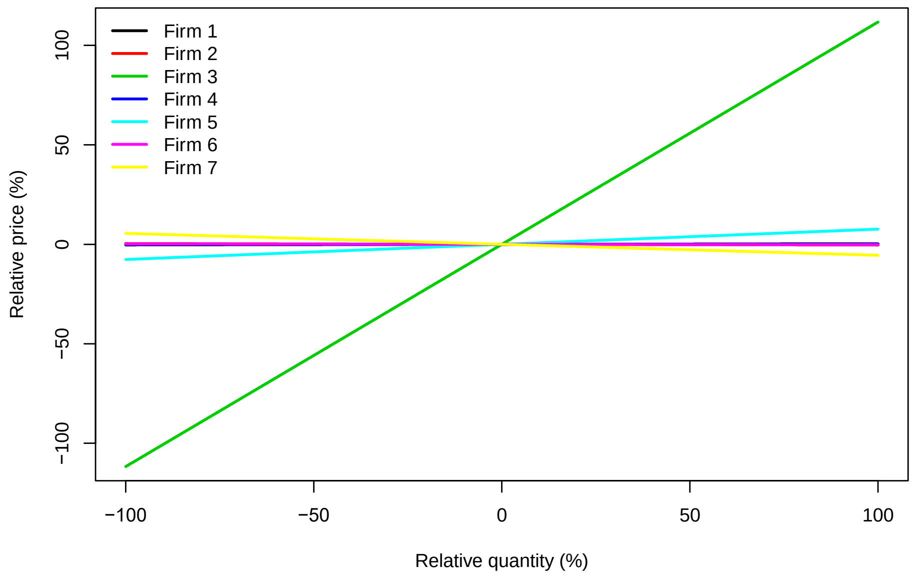


Figure 4 Predicted relative price difference given the relative difference in quantity ex ante to ex post (per cent) (only excavation and filling)



Firm 3 can also be used as an example of the information rent in a specific project by applying the estimates. This gives an ex ante bid of 136 995 euro and the ex post cost of 145 915 euro, amounting to an information rent of 8 920 euro.

7.0 Robustness check

In order to check the potential problem of biased average unit prices, this section replaces the average winning unit prices with prices from another database on reinvestments of highways in Sweden (see Table 7). The only difference from the previous analysis is that relative prices are calculated with different average prices. However, since not all items of the investment projects existed for the reinvestments projects, the sample size decreases by about 50 per cent.

Table 7 Regression results

	Dependent variable:		
	r_p2		
	(1)	(2)	(3)
r_q	-0.001	0.027^{**}	0.035^{***}
	(0.006)	(0.009)	(0.000)
Firm2			-4.073
			(6.641)
Firm3			5.521
			(19.848)
Firm4			-12.334
			(8.110)
Firm5			46.156^{*}
			(21.104)
Firm6			42.640
			(52.773)
Firm7			-97.463^{***}
			(22.001)
r_q:Firm2		-0.126^{***}	-0.140^{***}

		(0.038)	(0.037)
r_q:Firm3		0.478***	0.398***
		(0.032)	(0.0004)
r_q:Firm4		-0.028*	-0.032***
		(0.012)	(0.010)
r_q:Firm5		0.151	0.123
		(0.119)	(0.112)
r_q:Firm6		-0.031***	-0.041***
		(0.008)	(0.008)
r_q:Firm7		0.105*	0.038***
		(0.053)	(0.001)
R2	0	0.012	0.018
Adjusted R2	-0.001	0.004	0.006
Firm reference level:		Firm 1	
Observations	1,488	1,488	1,488
Note:			*p<0.05, **p<0.01, ***p<0.001; standard errors in parentheses

The results when applying different estimates of unit prices are similar to the main specification (see eq.1). However, Firm 3 seems to unbalance even stronger (compared to Table 5). This is expected if the averages used in the original analysis are biased. As discussed earlier, if all firms skew the same unit prices, there will a bias towards zero – that is, relative prices look unbalanced. The interaction term for Firm 2 in Table 8 indicates a negative skew, which has no logical bearing in theory. This is regarded as a peculiarity of the sample that remains when applying prices from the projects.

Table 8 Regression results for excavation and filling

	Dependent variable:		
	r_p2		
	(1)	(2)	(3)
r_q	0.001	0.129	0.461

	(0.008)	(0.982)	(0.940)
Firm2			-14.116
			(54.384)
Firm3			144.321*
			(71.709)
Firm4			-65.942
			(36.567)
Firm5			-103.580*
			(41.483)
Firm6			-85.941*
			(33.981)
Firm7			-100.748
			(64.155)
r_q:Firm2		-0.165	-0.499
		(0.985)	(0.942)
r_q:Firm3		2.869**	2.781**
		(1.041)	(0.995)
r_q:Firm4		-0.129	-0.463
		(0.982)	(0.940)
r_q:Firm5		0.595	0.048
		(1.065)	(1.034)
r_q:Firm6		-0.130	-0.461
		(0.982)	(0.940)
r_q:Firm7		-0.065	-0.445
		(0.991)	(0.948)
Year dummies	No	Yes	Yes
R2	0	0.228	0.32
Adjusted R2	-0.003	0.202	0.285
Firm reference level:		Firm 1	
Observations	330	330	330

Note: *p<0.05, **p<0.01, ***p<0.001; standard errors in parentheses

The results for the subset of activities in Table 8 makes the original results even stronger. No firm, apart from Firm 3, skews prices systematically. The biggest difference to the original results is the magnitude of the skewing of Firm 3, which has doubled. This again is what might be expected if the averages used in the original results are biased. Another explanation could be that the sample of activities shrinks because not all activities in the original analysis existed in the reinvestment projects. In this case the remaining activities would be a subsample that Firm 3 exploits for skewing.

8.0 Conclusion

There is a consensus among experts in the construction industry that unbalanced bidding is a huge problem. This is based on anecdotal evidence, with no solid empirical foundation. Apart from the inefficiency perspective, there is often a moral argument against unbalanced bidding. Contractors taking advantage of their superior information and substandard UPCs are portrayed as immoral. But if a contractor were not to skew in a rational manner, they would be called to account by the shareholders of the company for not maximising profit. Hence, the moral argument is not valid.

However, there is little point in discussing the problem of unbalanced bidding unless one knows the extent of the issue. This first quantitative study using European data confirms the results of earlier American studies: unbalanced bidding is not a major issue.

This study shows that unbalanced bidding exists in the Swedish road construction market. However, despite its portrayal in the debate it is not a widespread phenomenon. Although several firms skew their bids, the magnitude of the skew is small.

One firm stands out from the rest. When making the analysis on all items, this firm increases prices by on average 0.16 per cent when quantities are anticipated to increase by 1 per cent. Looking at the subsample of excavation and filling, this skewing is slightly stronger. An anticipated increase of quantities of 1 per cent entails a 1.11 per cent increase in unit prices. However, this is still quite a moderate skew.

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Appendix

Fixed effects estimations

Tabel 9 Fixed effects estimation on the complete data material

	Dependent variable:		
	r_p		
	(1)	(2)	(3)
r_q	0.0001	0.024***	0.022***
	(0.003)	(0.004)	(0.004)
Firm2			-1.808
			(11.991)
Firm3			33.110
			(40.495)
Firm4			2.187
			(7.554)
Firm5			-18.394*
			(8.944)
Firm6			-4.692
			(17.649)
Firm7			-43.732
			(42.496)
r_q:Firm2		-0.022**	-0.021*
		(0.007)	(0.009)
r_q:Firm3		0.180***	0.153***
		(0.016)	(0.013)
r_q:Firm4		-0.024***	-0.023***
		(0.005)	(0.005)
r_q:Firm5		0.005	0.014
		(0.017)	(0.013)
r_q:Firm6		-0.027***	-0.025***
		(0.004)	(0.005)
r_q:Firm7		0.049	-0.017

		(0.083)	(0.021)
Item-code fixed effects	Yes	Yes	Yes
Year dummies	No	Yes	Yes
R2	0	0.009	0.017
Adjusted R2	-0.128	-0.123	-0.117
Firm reference level:		Firm 1	
Observations	2,772	2,772	2,772
Note:			*p<0.05, **p<0.01, ***p<0.001; standard errors in parentheses

Tabel 10 Fixed effects results when only codes that start with "CB" or "CE" are included

	Dependent variable:		
	r_p		
	(1)	(2)	(3)
r_q	-0.002*	0.010***	0.001
	(0.001)	(0.001)	(0.001)
Firm2			7.795
			(4.332)
Firm3			163.261***
			(8.253)
Firm4			-35.833***
			(5.958)
Firm5			-58.274***
			(6.161)
Firm6			-31.783***
			(5.400)
Firm7			-14.670
			(8.156)
r_q:Firm2		-0.017*	-0.009
		(0.007)	(0.008)
r_q:Firm3		0.733***	1.142***

		(0.163)	(0.019)
r_q:Firm4		-0.010***	-0.0005
		(0.001)	(0.001)
r_q:Firm5		0.482***	0.268***
		(0.045)	(0.032)
r_q:Firm6		-0.011***	-0.003*
		(0.001)	(0.001)
r_q:Firm7		0.044***	-0.043***
		(0.011)	(0.004)
Item-code fixed effects	Yes	Yes	Yes
Year dummies	No	Yes	Yes
R2	0	0.117	0.245
Adjusted R2	-0.16	-0.041	0.102
Firm reference level:		Firm 1	
Observations	717	717	717

Note: *p<0.05, **p<0.01, ***p<0.001; standard errors in parentheses