The Dark Side of Value-for-Money: How Public Procurement Affects Workers' Safety in the Construction Industry

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Abstract

Studies on shading behaviour of contractors have in the past been focused on lack of product quality and other factors affecting the customer. This study of 222 publicly procured road and railroad projects aim to analyse shading behaviour from a perspective of workers safety. The study shows, though with limitations in statistical power, that the number of reported incidents related to workers' safety increases in projects with high numbers of bidders, i.e. projects under high competitive pressure, further the number of days of registered sick leave also increases with higher numbers of bidders. However, measures directly related to contractors shading behaviour do seem to increase prediction of number of accidents and sick leave days. It is suggested that public authority has to construct bid competitions in manners which does not necessarily aim at the best bargain but rather have a fair bargain approach balancing the goals of the contractor and the goals of the public client. This can be done by balancing the allocation of risks more evenly among the parties ex ante.

Keywords

Property rights, public procurement, incomplete contracting, bidding, workers' safety, construction.

INTRODUCTION

This paper is a revisit to the problems of social costs first conjectured by Ronald Coase (1960). According to the theory put forward by Coase, a firm will only reduce a negative social outcome if it is economically beneficial to do so. Put in other words, if it is cheaper for the firm to incur social costs than not to incur cost, it will, ceteris paribus, do so. The purpose of this paper is to put this assumption within the context of a public civil engineering contracts and investigate the public procurement of contracts and its effects on workers safety. This is done by examining civil engineering contracts public procured in Sweden during 2008-2011 or rather project managers' views of those contracts.

THEORETICAL FRAMEWORK

A short note on the Swedish procurement system may be warranted. The procurement system is based on the EU directives (such as 2004/17/EC, 2004/18/EC) on public procurement. The style of implementation follows the directive fairly literally. However, Sweden has extended the directives to cover below-threshold low value procurements

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also; although with adjustments in availability of negotiated procedure and the competitive dialogue. Hence, as in the public sector directive, the default procedures are the open and restricted procedures, and a free choice of procedure in procurement within the utilities sector (see Arrowsmith (2005) for detailed account of the European public procurement framework). Nonetheless, every procurement is expected to follow the fundamental principles of openness, transparency, equal treatment and non-discrimination in Union law. Consequently, market signalling and collusion between bidders are, to some extent, legally restricted.

In a world of complete contracts, a public buyer would specify the contract matter exhaustively. This does not merely include specifying the characteristics of the procured product or service, but it also includes specifying every possible scenario which may rise during contract execution. In fact, it is possible to argue that not many contracts would be able to be complete in cases where contract execution is not transient (Hart and Moore, 1990). Thus, intuitively, civil engineering contracts would always be incomplete, due to their often long duration and, as one example, their tendency to span over, or under, uncertain stretches with variations in geological conditions.

CONTRACTS

A contract can be described as an agreed allocation of rights between the parties. For example, a buyer agrees to pay a seller a specific amount of money on a specific date, and the seller agrees to provide a specific service, with a specific quality during a specific time span. Thus, the seller transfers some rights (such as access to personnel, tools) to the buyer. However, if the transfer is not exhaustive (i.e. an acquisition of the seller), the seller would still hold some rights connected to the service provided. This suggests that if the contract does not state a specific quality, such as the colour of a building being constructed, the seller is free to paint the building in the colour of his own choosing (i.e. the seller has preserved the right to choose paint during contract execution). The character of an incomplete contract and its implication on property rights has been described thoroughly elsewhere (such as Williamson, 1985, Grossman and Hart, 1986, Hart and Moore, 1988, Hart, 1988, Hart and Moore, 1990, Hart, 1995) thus this theory will be left out of this paper. Yet, the theory is important in order to understand social dimensions in contracts. If we assume every public authority has an interest in social goods, then an argument that workers safety is a public value would be tautological. This assumption would indeed imply that workers safety is a component of quality in all public procurement. In fact, following Coase’s reasoning on allocation of social costs (1960), it can be argued that a public authority which do not have an inherent value of social good, would still have to include workers safety as a quality dimension since it would eventually bear the costs for the lack thereof in increased expenses for medical services, reduction in tax collection etc. Thus, workers safety ought to be of interest in public contracts.

If Coase’s (1960) argument is correct, and that firms do in fact only consume social costs when the cost of not doing so is more expensive this argument would entail that a contractor would only comply with laws and with contractual provisions regarding workers safety. However, this argument is only true if there are no costs (Coase, 1937) linked to the execution of a contract with or without efforts to secure workers safety. It is easy to imagine costs associated with no-workers-safety-execution: the firm might have to pay higher salaries due to difficulties recruiting a workforce under poor working conditions, public views may affect sales, injuries and sick leaves may decrease efficacy etc. (see Hayek 1949 for a similar reasoning). Accordingly, it could be expected that a firm would employ some efforts for workers safety in order to decrease those costs. Nonetheless, this is not the only component affecting the total sum of costs incurred during contract execution. Hart (2003), and later Blanc-Brude *et al.* (2009) has, concerning civil engineering contracts, applied contractors expected behaviour with regard to property rights and bundling/unbundling of contracts. This paper uses the same logic as in the two papers mentioned, but focuses on social costs rather than bundling of contracts. The first assumption we make is that following the assumption of profit maximisation, a firm's profit can be described as the contract sum less the actual construction costs. Of course there are many components included in construction costs, but we here divide the construction costs into three parts: General construction costs, social costs which both improve construction efficacy (such as due to lower insurance costs) and workers safety, and social costs which do not improve efficacy but which improve workers safety and the firms public standing. In profit maximisation one can expect a firm to optimise investments into social costs regarding construction efficacy but also regarding the firms' public standing (i.e. CSR and PR friendly investments will reach an optimal level for them to render higher revenues). A client can of course increase investments in social costs, by using the contract to enforce certain protection levels, but nevertheless an optimal level will be reached. This assumption ought to be uncontroversial.

UNCERTAINTIES IN CONTRACTS

According to Galbraith (1977) risk, or rather uncertainty, can be described as the information regarding a specific project, which the contractor not yet has acquired or processed, but which it has to process before completing the project. This definition can be more fine grained (such as Winch, 2010), but the characterisation will fit the purpose for this paper. In a publicly procured civil engineering project, regardless if it is a design-build (DB) or a design-bid-build (DBB), the contractor would perceive a considerable amount of uncertainty ex ante. Even when design drawings exist, the contractor would not, for example, start job scheduling or extended geological investigations until contract award. From this perspective, a bid could never be seen as a complete bid but rather a best effort bid by the contractor, based on the information readily available at the time of the bid. The risk will of course be far more extensive in fixed-price contracts than in cost-plus contracts, but regardless of financial scheme there will be a substantial risk. Contractors would be expected to compensate for this uncertainty by adding risk premiums to their bids (Samuelson, 1986). However, the default procedure in public procurement is the first first-price-sealed-bid auction. This auction type does not only promote competition on factors as component procurement and process efficacy, but the price is evaluated including the risk premium. Thus, a firm which adds a high risk premium would risk losing the contract award. Furthermore, in order to counteract high risk premiums a contractual mechanism to adjust prices when a risk actualises (Laryea and Hughes, 2011) can be agreed upon. This practice can be established for risks which are identified but for which probability cannot be estimated. Still, even when risk premiums are added those can be added only for risks which have been identified and when a known probability for their occurrence has been identified (Winch, 2010). After the award of the bid, information will be gathered and processed as the project run along, decreasing uncertainties during the process. If, during this process, circumstances arise which are connected to new costs not previously considered, one out of two scenarios would be expected to play out: if the client has accepted the risk, the client would have a cost overrun and/or a quality reduction, if the contractor has accepted the risk, it would decrease its profit margin or even run the project with red numbers. Nonetheless, this consequence would assume that contractors would not change their behaviour in spite of their inability to charge a complete risk premium nor write a complete risk compensation contract.

CONTRACTOR BEHAVIOUR

We propose that what would happen if a contractor start to lose money is that contractors would start to shade on non-contractable or non-measurable dimensions. It is worth to note that non-contractable and non-measurable, variables does not assume a dimension to be objectively unobservable, but only that the dimension is not observed or written into the contract. With regard to social cost, shading might affect workers safety, no matter the state of the law or the contract. Hart's (2003) and Blanc-Brude *et al*. (2009) assumptions described above, might describe contractors behaviour over time, or at a general branch level. However, there has been argumentation that bid competition do not reduce quality in general (Domberger, Hall and Li, 1995). Still it might be fruitful to investigate contract decisions on a local level, and decisions on a project-to-project basis. With regard to costs, i.e. social costs, which are accepted due to a reputation factor, those costs are accepted as long as they prove to generate higher revenues. When a contractor makes investments into social cost in a project, those costs could be divided up into sunk costs, and salvageable costs. Sunk costs are costs which the contractor cannot expect to be refunded (such as by higher revenue from increased sales) whereas salvageable costs are costs which could be refunded in future projects. Earlier work has shown that investments in salvageable costs in a project will only amount to the specific level where they can be expected to increase revenue (Klein and Leffler, 1981). However, the supposition made in this paper is that a contractor, when categorising costs as sunk or salvageable, and when estimating appropriate levels of salvageable costs will consider project economy as well as the firms long term economy. That is, if a contractor runs the risk of running a loss, or running with low profit margins, the contractor would opt to put non-contractible costs into sunk costs rather than into salvageable costs. The reasoning is: as uncertainty unravels, the risk of loss is becoming predictable and the probability becomes easier to assess. This phenomenon occurs as salvageable costs are rather intangible, they are difficult for project management to quantify, and to assess from a probability perspective. In this situation the contractor could be expected to react to the risk of running the project with loss, and disregard possible, but non-specific, benefits with salvageable costs. Putting this assumption into the context of workers safety, during high 'tension' between bid offer and actual incurred costs, efforts to improve workers safety would be limited to efforts with a tangible and perceived probable effect on cost reductions while reputation costs will not be consumed as they will be considered temporarily to be sunk costs. Therefore, the purpose of this paper is to investigate if these phenomena can be seen in empirical data, by comparing contract specifics with the occurrence of accidents in public civil engineering contracts in Sweden.

METHOD

The study was carried out by surveying 222 civil engineering investment projects which was procured by the Swedish Transportation Agency (and its predecessors) between 2007 and 2011. The questionnaire was administrated by the Transport Agency to project managers responsible for each investment project. Unfortunately the quality of the responses was uneven creating large number of missing-data. No systematic pattern for missing data emerged except for investment projects which were not completed at the time the questionnaire was sent out. During the statistical analysis a test-by-test case wise exclusion was adopted, with exception of the regression analysis where a mode substitution approach was used. One outlier was removed, due to what is believed to be a mistyping.

The operationalization of the concepts identified in the theoretical section above has some limitations. First it should be understood that the questionnaire were the results of negotiation between the researchers and the responsible authority regarding another purpose than this study, the wording and content of the questionnaire is not necessarily ideal with regard to the theory at hand. Second, it is difficult to assess the nature of the relationships in the theory, if they are to be expected to be linear or follow some other curve. From this, based on the mix of economical behavioural factors with observable numerically measurable variables, it is assumed that sought relationships are not necessarily linear. Nor has the observed data found to be parametrically distributed, hence variables are assumed to be ordinal rather than numerical. Missing data during categorical regression were compensated with the mode of the variable. This choice was done after a comparison with mean substitution, where the model fit was lower. Assuming missing data are randomly distributed, the choice of mode substitution is the best option during those circumstances.

The dependent variables tested were number of accidents which caused sick leave, and the number of sick leave days caused by accidents. From the questionnaire following variables were used in order to describe contract tension: increasing number of bids is thought to describe a high competitive pressure. A large difference between highest and lowest bid are thought to describe higher probability for a low-risk premium bid award, the number of errors found during delivery inspection is thought to reflect shading behaviour, thus be the result of tension. Large cost overruns reported are thought to be an indicator of tension as well as time overruns. Further, project length was put into the tested model in order to account for time span covariance with number of accidents and sick leave days.

RESULT

To test if delivery method affected workers safety a Mann-Whitney U test were performed. It showed that satisfaction with work environment was not different between using DBB and DB ($U = 851.5, p_{MC=0.911}, N_{DBB} = 124, N_{DB} = 14$). Neither did the number of accidents differ between the two delivery schemes ($U = 520.5\ , p_{MC=0.116}, N_{DBB} = 108, N_{DB} = 12$). However, number of sick leaves during the projects did differ between DBB and DB ($U = 182\ , p_{MC=0.089}, N_{DBB} = 84, N_{DB} = 6$). The variables' inter-correlations can be seen in table 1 below.The reader should take note of the large differences in group size, and interpret the statistical power with appropriate causation.

In order to investigate if the operationalized variables did predict workers safety a categorical regression analysis were performed. As mentioned above, two dependent variables were tested: number of accidents which caused sick leave days, and number of sick leave days caused by accidents. The first dependent variable showed a significant model fit $F(32, 189) = 12.9, p < 0.001$ where $R^2 = 0.686, R^2_{adj} = 0.633$, $Apparent\ Prediction\ Error\ (APE) = 0.314$. This while the dependent variable regarding number of sick leave days where significant but with a lesser fit $F(25,196) = 6.767, p < 0.001$ where $R^2 = 0.463, R^2_{adj} = 0.395,\ APE = 0.537$. Coefficients related to the two regression models can be viewed in Table 2.

There are a few points to make from the analysis of the statistical model, while our models seem to explain a significant part of the variance in variables related to workers safety (63 percent and 40 percent respectively), there are some results indicating this might be an overstatement. First, the power of the models is highly significant but rather modest, this can also be seen in the significance levels for each variable contribution, showing only number of errors and cost overruns as significant contributions for accidents, and only number of errors for the dependent variable number of sick leave days. Nevertheless, the partial correlations are higher for accidents, than for sick leave days, explaining the difference in power. Second, the dataset were, as mentioned above, of bad quality with missing data randomly scattered through the data set. The replacement of missing data during the analysis may have caused some additional covariance between the variables, strengthening the statistical results. Third, the correlation matrix in table 1, show a high inter-correlation between the two dependent variables, yet the model fit differs between the two. Fourth, there is a substantial correlation between project time span and the two variables differences in bids and cost overrun. Since project time span were included in order to account for covariance with length of the projects, this high correlation can cast doubt over where the prediction value is situated, at project time span or the two operationalized variables?

Table 1. Correlations

	n accidents	Sick leave days	n of bids	Difference in bid	N of errors	Cost overrun	Time overrun	Time span
n accidents	1,000	,921***	,222**	,441***	,269***	,369***	-,086	,474***
Sick leave days		1,000	,261**	,471***	,270**	,236**	-,194	,383***
n of bids			1,000	,028	-,086	,085	-,072	,098
Difference in bid				1,000	,169*	,469***	-,176*	,533***
N of errors					1,000	,041	,149	,153*
Cost overrun						1,000	,218**	,461***
Time overrun							1,000	,104
Timespan								1,000

Correlation coefficient Spearman's ρ. *** Correlation is significant at the 0.01 level (2-tailed). ** Correlation is significant at the 0.05 level (2-tailed). * Correlation is significant at the 0.1 level (2-tailed).

Table 2. Coefficients and Correlations in the two regression models

	β	F	p	$r_{partial}$	Importance
Dependent variable number of accidents					
Number of bids	0.095	1.663	0.176	0.165	0.020
Difference in bid	0.264	0.982	0.430	0.403	0.184
Number of errors	0.351	2.269	0.063	0.511	0.249
Cost overrun	0.424	3.177	0.009	0.576	0.292
Time overrun	-0.295	0.801	0.616	-0.437	0.026
Project Time span	0.306	1.518	0.174	0.423	0.229
Dependent variable number of sick leave days					
Number of bids	0.115	1.139	0.322	0.154	0.038
Difference in bid	0.152	0.241	0.994	0.176	0.131
Number of errors	0.291	2.288	0.047	0.345	0.269
Cost overrun	0.189	0.342	0.710	0.246	0.186
Time overrun	-0.233	1.711	0.307	-0.290	0.031
Project Time span	0.377	1.195	0.149	0.380	0.427

DISCUSSION

The statistical analysis presented above is, as noted, flawed. Given the non-parametric distribution of the dataset, many statistical tools were unavailable for the analysis which results in difficulty unbundling potential confounding variables. For example, structural equation modelling could not be employed in order to test model fits, and given the relatively few investigated projects, it is not certain that such practice would be gainful in any case. Nevertheless, a discussion might be fruitful in order to highlight future areas for research.

There seem to be a relationship between the stated operationalized variables and workers safety. A closer examination of the coefficients and partial correlations in the regression models shows that the dominant contributors are variables which ought to be correlated directly to shading behaviour, number of errors during delivery inspections, and cost overruns. It would be an exaggeration to say that those two variables are perfectly correlated to the concept of shading behaviour, but even so, they ought to be related in a relevant manner. Errors found during inspections, reflect the quality of work performed. A high quality performance ought to have fewer errors detected than a low performance job would be expected to have. Shading behaviour entails the contractor producing lower quality, especially on non-measurable variables. Since the errors actually were detected, it can be argued that those variables therefore must have been measurable. Further, it can be argued that quality might relate to project complexity or to other circumstances not in the control of the contractor, or the client. Nevertheless, if complexity causes errors, it still would not be related to workers safety since the principle for adopting workers safety standards ought to be that safety should be adapted to the project specific tasks. Hence, there should not be a relationship between errors and workers safety. E contrario, the results do support the theoretical framework; in the case where errors during inspection are related to shading behaviour directly, i.e. the errors are indications of low quality. The contractor might have been trying to ‘get away with’ the errors in cases where errors is related to the complexity of the project, i.e. complexity is related to uncertainty during bids, thus provoking shading behaviour on, among other variables, workers safety. Thus, this conclusion ought to warrant deeper investigations in the future.

Turning to the variable cost overruns; while the connection to the theoretical view at hand is fairly non-controversial, it might still be of interest to investigate the variable. The value of cost overruns is here calculated by taking the actual invoiced costs and subtracting the initial contract cost. Thus this is really a measure of the client’s cost overrun in comparison to the bid price. It could be contended that this actually would lower tension caused by unexpected events, thus lowering shading behaviour by the contractors ability to allocate costs to the client. On the other hand, the standard agreements used in the construction industry in Sweden are fairly well defined as to risk allocation. This risk allocation is presumably known by every contractor in Sweden. Provided that the cost overruns are made up by genuine errors in documentation provided under the contract, the risk would have been transferred to the client and no shading behaviour would occur. But then we should not see a relationship with workers safety. But if costs fall outside of the obvious risk allocation in the contract, then extra costs would be expected to fall on, by default, the contractor, especially if it is a fixed price contract. Every extra cost would become a negotiation between the parties for a fair solution, provided they do not want to seek a court resolution (with all costs that would entail). Thus, it can be argued, large cost overruns, would not only increase client cost, but the contractor would have to accept costs which it has not been able to negotiate successfully on. This is a circumstance that actually would result in shading behaviour according to the theoretical background of this paper. In consequence the results do, to some extent, confirm the theory. And this approach may also suggest a viable area for future studies.

The two variables dealing directly with bids: number of bids and difference between the highest and lowest bid, contribute less than the variables discussed in previous paragraph. Differences in bids do not differ to a great extent from other variables when one examines the partial correlation or the Importance coefficients, however, the statistical power of its contribution is substantially lower. The theory did state that increased competition would lower risk premiums and therefore increase the probability of running with losses, and the results have to be seen as inconclusive. Nevertheless, the different level in partial correlation on the two different variables might be within expected results. Even though market signalling enables contractors to some extent predict number of bidders, the procurement legislation restrict the ability for contractors to gain a certain estimation of the number of bidders. The differences of bids does measure variance in bid prices, where the difference ought to be correlated with difficulties calculating risk free bids.

In theory, one can expect uncertainty to be greater for contractors during a DB delivery scheme compared to a DBB scheme. Unfortunately the dataset contained too few projects using DB to facilitate any meaningful statistical analysis. A more extensive questionnaire would be needed in order to identify any differences between the schemes. Time overrun has been shown in the analysis to be negatively correlated with the dependent variables. This was not predicted in the theoretical framework. One guess would be that, when a client allows for time overruns, it relaxes the pressure on the contractor. If time overruns are allowed to some extent, the contractor might not be required to put in extra resources in order to hold the delivery schedule. This guess has not been grounded in the literature though.

The nature of future research on the issues identified in this paper has to be carefully considered. If a survey are to be conducted the questions has to be more carefully worded than was the case for the data collected for this paper. Based on the experiences here, a larger sample size would be needed too, in order to increase probability of parametric results. This would enable the use of more powerful statistical tools. Furthermore, we would suggest a deeper investigation into projects might be warranted. This would entail deeper investigations into the organisational processes leading to shading behaviour, as well as institutional drivers for shading on different levels in organisations. This might warrant a more qualitative and holistic approach to those processes, than the quantitative and objectifying approach used in this paper.

CONCLUSION

While the results in this paper should be read with caution to the limitations of the statistical reality under which the analysis has been made, this paper still highlights areas which ought to be of interest when studying workers safety. If shading behaviour does manifest itself in lower workers safety investments, this has direct consequence to regulations related to workers safety. While it can be assumed that a contract never can be complete, one can also assume that a regulation cannot be exhaustive in the sense that it would cover all potential aspects of workers safety. Thus, one can expect shading behaviour to keep occurring on those aspects not being regulated. In order to lower shading behaviour regarding social costs, one would need to either write more complete contracts or to change risk allocation between client and contractors. The former is sometimes possible, but are inherently related to increase in contracting costs. The latter, would entail moving from fixed-price contracts, to cost-plus contracts, with an increased risk exposure to the client. However, before any recommendations are made, more research is needed in order to verify the conjecture presented here, and a more detailed understanding is desirable in order to unravel relationships connected to shading behaviour.

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