CESifo *Working Paper Series*

INEFFICIENT R&D IN PUBLIC PROCUREMENT: NEGATIVE CONSEQUENCES OF A SEPARATION BETWEEN AWARD AND ACTUAL CONTRACT

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Working Paper No. 208

November 1999

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Abstract

In public procurement a temporal separation between award and actual contract allows private entrepreneurs who did not get the award to sue to become contractor. Hence, not only the award-winning entrepreneur, but also the losers will engage in relationship-specific investments. Unfortunately, in such a situation it is impossible to find fixed prices which guarantee the achievement of both efficient trade and efficient investment.

Keywords: Procurement, Incomplete Contracts

JEL-Classification: D23, H57, L51

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1 Introduction

Public procurement is a transaction between a government agency and a private seller. The award is the explicit statement of the government agency that it is willing to contract with a particular seller. Economic procurement models always see this award as the agency's part in the process of contracting *(simultaneity)*. In practice, however, a *temporal separation between award and actual contracting* can be found in France, Italy and Belgium, and has recently been intensively discussed in Germany.[1] A reference by an Austrian court concerning the question of whether EC law requires such a separation is pending before the European Court of Justice.

The separation between award and actual contracting has both positive and negative consequences. It is a *positive consequence* that an inefficient award can be corrected in the time interval between award and contracting: the award binds the procurement agency unless it is revoked by a court who has received a signal that the award was given to an inferior seller. This positive side is predominant in the lawyers' discussion on the topic;[2] to my knowledge there is only one economic paper on the efficiency increases resulting from such a possible revocation of an award, namely Bös and Kolmar (1999).

In contrast, the present paper is exclusively devoted to a particular *negative consequence*, namely a double inefficiency which is caused by the separation between award and contract:

(i) Since the award does not definitely determine the contractor, not only the award-winning seller has an incentive to relationship-specific investments, but also other potential sellers who see a chance to gain the contract in a law suit. However, all relationship-specific investments of sellers who do not get the contract are pure waste.

(ii) Since it is not a priori clear whether the agency will sign the contract with the award-winning seller or with some competitor, the sellers do not get the correct incentives for the efficient extent of relationship-specific investments. (It will be shown that this is not necessarily underinvestment as one would a priori expect.)

Both inefficiencies could be eliminated if there were only one seller. However, regulations all over the world require procurement agencies to ask for more than one offer if the sum to be spent exceeds a particular threshold level. These regulations refer to the most important cases of public procurement and are actively propagated as a means to reduce procurement costs by bidders' competition and to avoid favoritism. Accordingly, in the present paper we apply a two-seller approach which is the simplest setting in which the above-mentioned double inefficiency arises.

An economic theory of public procurement is particularly interesting if the government buys advanced-technology goods which are tailor-made for particular public purposes. In this case the production stage is preceded by an R&D investment stage which is necessary

[1] See the discussion in Pietzcker (1998), 456-8 with many references to the relevant juridical literature.

[2] If the award is a part of contracting, then the losers in the auction can only sue for damages. In contrast, the losers can sue to become contractor if award and actual contract are separated in time.

to develop the good which fits the government's demand, and these investments are valuable only with respect to this government demand – they are relationship-specific.[3] The incentives for these investments are most interesting in an incomplete-contract setting which is a good description of many cases of government procurement.[4] If we consider the R&D investments as individual efforts, it is plausible to assume that the amount of these investments is non-verifiable before a court. The same holds for the benefits of the project in question, since subjective valuations are non-verifiable. Even the production costs often are non-verifiable, since a private seller has many possibilities of cost padding. In such a case the ex-ante conditions of the future relationship between procurement agency and private seller cannot be described completely, neither in the award nor in the contract: both are 'incomplete' in the sense of Hart and Moore (1988,1999).[5]

In this context the well-known hold-up problem arises.[6] When the award is made and when the contract is written, the precise division of the net surplus from trade cannot be fixed. Hence, the initial contract will be renegotiated when the net value of the project finally has become clear. At this point in time, however, the R&D investments are sunk and do not influence the outcome of the renegotiations. This hold-up induces underinvestment. In the present paper we will apply Hart and Moore's (1988) hold-up model. They deal with private trade of a profit-maximizing seller and a profit-maximizing buyer. We replace the profit-maximizing buyer with a welfare-maximizing procurement agency, introduce a temporal separation between award and actual contract and assume that one potential seller gets the award, and that a second potential seller sues for the contract. As in Hart and Moore, we assume that the parties sign an at-will contract, that is, both parties must be willing to trade not only at the moment of contracting, but also when the initial contract terms are being renegotiated. Note, however, that in our context the assumption of an at-will contract is innocuous. Our negative result depends on the wrong investment incentives which the separation of award and actual contract provides to the sellers; and these wrong incentives operate in the same way in at-will contracts, specific-performance contracts á la Aghion et al. (1994) or in option contracts á la Nöldeke and Schmidt (1995).

In this paper we show that efficiency at the investment stage is not achieved if award and actual contract are temporally separated. The basic features of the model are presented in section 2 which presents the sequencing of the game, characterizes incomplete award and incomplete contract and exhibits a benchmark planning solution of the problem. The core of the paper, section 3, presents the equilibrium analysis. It is shown that the decision on trade is always efficient, however, efficiency at the investment stage cannot be attained. Unfortunately, this result is very robust as shown in section 4 for various extensions of the model, such as a different benchmark for efficiency, different objective functions of the procurement agency, the replacement of at-will contracts with option contracts, and the choice of different prices for different sellers. A brief summary concludes the paper.

[3]This is particularly relevant for military procurement. See Kovacic (1991) and Rogerson (1989).
[4]See, for example Bös and Lülfesmann (1996,1997).
[5]See the recent discussion between Hart and Moore (1999) and Maskin and Tirole (1999).
[6]This problem was first articulated by Klein et al. (1978) and by Williamson (1975, 1979).

2 The model

2.1 The players and the stages of the game

We consider a government procurement agency which purchases an indivisible project from a private seller. The purchase of the project will synonymously be called 'trade.' Two identical sellers offer their services, only one of them will become the contractor. The assumption of identical sellers has been made to focus the analysis on the negative incentive effects the separation between award and contract exerts on the relationship-specific investments. As soon as sellers of different quality are introduced into the analysis, the positive consequences of correcting inefficient awards must explicitly be modeled and, accordingly, a very complicated trade-off has to be considered instead of the simple model treated in the present paper.[7] Moreover, assuming identical bidders greatly simplifies the notation since we can typically forego any explicit indexation of variables with respect to seller 1 or seller 2. Note that the message of the paper is also valid if the sellers are not identical.

We assume that neither the procurement agency nor the court can observe that the sellers are identical with respect to their ability to complete the project. Agency and court receive signals from the sellers on which they base their decisions. These signals disguise the fact that the sellers are identical. By way of example, the agency might be impressed by a seller's ability to present impressive blueprints of the planned project, by a seller's personal appearance, or even by a seller's ability to lie. The court might be influenced by the same criteria, but also by the specific eloquence of a lawyer. As economists we do not explicitly model how these non-economical signals are responsible for the decisions of the agency and the court, respectively. For the purpose of this paper it is sufficient to assume that at the beginning of the game the agency gives the award to one of the sellers because it believes that he is better qualified for the project. It is also sufficient to assume that the court confirms or revokes the reward because it believes in the higher economic qualification of one of the sellers. However, we introduce an asymmetry in the court's decision: with probability $b > 0.5$ the award is confirmed; with probability $1 - b < 0.5$ it is revoked. This asymmetry is caused by the formal and material difficulties the plaintiff faces when substantiating his claim before the court.[8]

The sequencing of events is the following:

• at date 0, there are price negotiations between the agency and each individual seller. The sellers do not collude. On the basis of these negotiations the agency fixes one (and only one) price which is to be paid for the project plus one (and only one) price to be paid if the project is not fulfilled;[9]

• at date 1, one of the sellers gets the award which gives him the right to the actual contract unless the court decides otherwise. For brevity, we call the award-winning seller

[7]When writing Bös and Kolmar (1999), we tried to model this trade-off explicitly, but failed because of the complexity of the approach.

[8]To simplify the analysis we assume that it is costless to go to court.

[9]The case of different prices for various sellers is treated in an extension, subsection 4.4 below.

the 'winner' and the other seller the 'loser;'

• at date 2, the other seller goes to the court to sue for the contract;

• at date 3, both sellers choose relationship-specific investments;

• at date 4, the court decides who is entitled to the contract;

• at date 5, the contract is signed by the entitled seller and by the government agency. The contracting seller has to accept the conditions of the award as stipulated at date 1;

• at date 6, nature determines the actual realizations of the costs which the contracting seller will have to spend to complete the project;

• at date 7, the final decision on trade is made; possibly the trade price is renegotiated;

• at date 8, the project is completed (if agreed upon), and the payments are provided. The game ends here unless there are disputes on delivery and on payments, which would be decided at date 9. However, in the subgame-perfect equilibrium no such disputes occur.

The government agency is a risk-neutral welfare maximizer which explicitly considers the shadow costs of public funds that are necessary to finance the expenditures. The sellers are risk-neutral profit maximizers. At dates 0 to 3, agency and sellers maximize expected values of their objectives, perfectly anticipating the subgame-perfect continuation of the game. At date 7, the agency and the contracting seller decide on trade on the basis of the given benefit and the actual realization of the costs, as drawn by nature. The investment costs are sunk at this date and do not enter the player's objective functions. Precise definitions of the various objective functions will be given as the presentation of the paper unfolds.

2.2 Benefits, Costs, and Investments

If the project is completed and sold to the government agency, this implies benefits to the agency and costs to the private contractor. We assume that the benefits are the same regardless of which seller produces the project: they are denoted by the deterministic variable v. On the other hand, the costs are stochastic: with probability π_i the actual cost realization is drawn by nature; the support of this draw is the same for both sellers, namely $c_1 < ... < c_i < ... < c_I,\ I \geq 2$.

Since both sellers have a chance to get the contract, they both have an incentive to invest in *relationship-specific assets* e. The investment-cost function $\psi(e)$ is strictly convex and fulfills the Inada conditions. The investment e is scaled so that it lies in $[0, 1]$. Higher investments increase the probability of nature drawing low costs. Following Hart and Moore (1988), we define this probability as follows:

$$\pi_i(e) = e\pi_i^+ + (1-e)\pi_i^-, \qquad i = 1, ..., I. \tag{1}$$

π^+ und π^- are probability distributions over $(c_1, ..., c_I)$ and π_i^+/π_i^- is decreasing in i *(monotone likelihood ratio property)*. Choosing a particular investment determines a linear combination of the probability distributions. The monotone likelihood ratio property ensures first-order stochastic dominance. Hence, any seller prefers the better distribution π^+ which he can achieve better by higher investments. This implies that higher investments decrease expected costs. The definition of the probability distribution $\pi(e)$ implies that the first derivatives are constant and that they sum up to zero:

$$\pi_i' = \pi_i^+ - \pi_i^-; \qquad \Sigma_{i=1}^I \pi_i' \ = \ 0. \tag{2}$$

Note that the procurement agency does not invest. We deal with relationship-specific investments of the sellers only (*one-sided investments*). If in such a setting we had only one seller instead of two candidates, it would be possible to sign a fixed-price contract which guarantees both efficient trade and efficient investment, as in Bös and Lülfesmann (1996, appendix). Thus, the restriction to one-sided investments assures that any inefficiency result is only caused by the temporal separation of award and actual contract (and the two-seller approach which results from this separation).

2.3 Incomplete award and incomplete contract

At all stages of the game all actors have symmetric information:

– all actors share the same priors with respect to the expected costs, and at the same time they come to know the actual realization of costs;

– the sellers' investments are observable by all actors, including the government agency;

– common knowledge are the benefit v, the support of c, and the probabilities $\pi_i(e)$ and b.

However, even if the players of a game observe a particular variable, it may be impossible to verify this variable before a court and, consequently, neither award nor contract can be conditioned on this variable. We assume that e, c and v are non-verifiable. This is in line with the usual literature on incomplete contracts. The relationship-specific investments e can be considered as effort levels whose non-verifiability is a standard assumption. The agency's valuations v may be influenced by subjective value judgments which are non-verifiable. Possible accounting tricks are usually taken as a justification for the assumption of non-verifiable costs.

Therefore, the only verifiable events are the following:

(i) trade or no trade. Recall that we deal with the sale of one unit of an indivisible good, the project. Hence, $q = 1$ and $q = 0$ denote 'trade' and 'no trade,' respectively.

(ii) payments of the government agency: if there is trade, the procurement agency pays a price of p_1; if there is no trade, the private contractor gets a compensation of p_0.[10]

Since award and contract can only be conditioned on verifiable events, they can only take the following form:

$$q = 1 \quad \Leftrightarrow \quad p = p_1, \tag{3}$$

$$q = 0 \quad \Leftrightarrow \quad p = p_0. \tag{4}$$

As already mentioned in the introduction such an award and such a contract are incomplete in the Hart-Moore sense and may be completed by renegotiations after nature has

[10]This compensation could be negative, in which case the contracting seller has to pay for the privilege to be the agency's contractor. The private sellers will we willing to accept such a negative price p_0 if at dates 1 and 2, respectively, the expected surplus from trade outweighs p_0.

drawn the actual realization of costs. Note that award and contract contain the same prices p_0 and p_1. This reflects the contracting seller's obligation at date 5 to accept the prices that were contained in the award at date 1 and result from the bargaining at date 0.

In models of this type the net price $p := p_1 - p_0$ drives the efficiency results, whereas the absolute levels of the prices p_0, p_1 drive the distributional results, that is, the sharing of ex-ante rents among the players. This paper is devoted to efficiency. We do not deal with distribution. We assume that the absolute levels of prices are chosen in such a way that the participation constraints of agency, winner and loser are fulfilled. As an example, the reader may think of a bargaining game which is played by the procurement agency and the winner at date 0: in this game they share the expected gains by choosing prices p_0 and p_1. As a result the expected utilities of the agency and of the winner are weakly positive. We now assume that at the chosen prices, the expected utility of the loser also is weakly positive. This is the only interesting case to consider; if the loser's expected utility were negative, he would not go to the court and sue for the contract and the problem of the paper is gone.

2.4 Benchmark: the planning solution

In this subsection, we consider a government which does not engage in public procurement, but 'does it alone.' Both investment costs and project costs are born by the government, paid from distortionary taxation. Therefore, the shadow costs of public funds λ must be taken into account.[11] Note that in this benchmark there is no waste caused by relationship-specific investments of sellers who do not get the contract. And the government chooses the welfare-maximizing level of investments. Hence, this benchmark eliminates both parts of the double inefficiency mentioned in the introduction to this paper.

Applying backward induction, let us first define *project efficiency* which refers to the decisions made at date 7. Project efficiency requires that the project is performed if and only if this increases welfare:

$$q^* = 1 \quad \Leftrightarrow \quad v \geq c_i(1+\lambda), \tag{5}$$
$$q^* = 0 \quad \Leftrightarrow \quad v < c_i(1+\lambda), \tag{6}$$

where v and c_i are the realizations of benefit and costs accrueing to the government.

Second, we define *investment efficiency* which refers to the welfare-optimal choice of the investments e.[12] We have:

$$e^* \in \operatorname{argmax}_e \mathcal{W} = \sum\nolimits^+ \pi_i(e)(v - c_i(1+\lambda)) - (1+\lambda)\psi(e), \tag{7}$$

where here and in the following Σ^+ denotes a sum over i for all terms which fulfill $v \geq c_i(1+\lambda)$. We obtain the following first-order condition which is necessary and sufficient

[11] According to empirical estimations, in developed countries $\lambda \in (0,1)$, where values between zero and 0.5 can be found more often. See, in particular, Ballard et al. (1985), 136, and Jones et al. (1990), 28-30.

[12] Note that in the benchmark there is no involvement of the court; accordingly, the probabilities b and $1-b$ do not play any role in the definition of investment efficiency.

for a unique and interior solution $e^* > 0$:[13]

$$\mathcal{W}_e = 0: \ \sum\nolimits^{+} \pi_i' \left(v - c_i(1+\lambda)\right) = (1+\lambda)\psi'(e). \tag{8}$$

The resulting investment e^* will be used as benchmark to be compared with the actual investments which at date 3 are chosen by the sellers.

Third, let us define an *optimal award*. It is attained if in the subgame-perfect equilibrium the price p, chosen at date 1, induces both investment efficiency and project efficiency.

3 Equilibrium analysis

3.1 The decision on trade (date 7)

The decision on trade is taken by the government agency and by the contracting seller. The other seller has already left the stage. The players would like to trade if[14]

$$v - c_i \geq \lambda p^R \qquad \text{(agency's condition)}, \tag{9}$$

$$p^R \geq c_i \qquad \text{(seller's condition)}, \tag{10}$$

where the net price p^R is either the initial net price $p_1 - p_0$ or a renegotiated net price $p_1^R - p_0$.

We first note that there will be no trade if $v < (1+\lambda)c_i$: combining equations (9) and (10), we recognize that mutual agreement to trade requires $(v - c_i)/\lambda \geq p^R \geq c_i$. If $v < (1+\lambda)c_i$, this requirement cannot be met.

Let us next consider how the plans of the players match if $v \geq (1+\lambda)c_i$. We assume that in such a case the definite price p^R is determined by a renegotiation game á la Hart and Moore (1988). In their paper, a renegotiation technology is employed where messages can be exchanged between the parties which in fact are renegotiation offers sent to each other. These renegotiation offers can voluntarily be revealed to the court in the case of a dispute. As a result of this renegotiation technology, it can be shown that in subgame-perfect equilibrium the party, which agrees to efficient trade under the initially contracted price, holds all the bargaining power in the renegotiation. The utility of the other party is depressed to its default payoff, that is, to the payoff of the no-trade case. Given the initially contracted price p, the following three situations can occur:

(i) $p > (v - c_i)/\lambda \geq c_i$
At this high price, the seller wants to trade, however, the agency is not interested. Therefore, the seller offers a lower price p^R which makes the agency indifferent between trade and no trade, that is, $p^R = (v - c_i)/\lambda$.

[13]Formally, the existence of an interior solution is ensured since expected welfare as defined in (7) is concave in the investment and the Inada conditions are assumed to be fulfilled.

[14]Recall that the government agency is a welfare maximizer. Therefore, it treats the payments p_0, p_1^R as pure transfers. Only the shadow costs of financing these payments matter. Hence, the agency wants to trade if $v - c_i - \lambda p_1^R \geq -\lambda p_0$ which gives condition (9).

(ii) $(v - c_i)/\lambda \geq p \geq c_i$
Here, both players are willing to fulfill the contract at the initially contracted price. No renegotiation occurs.

(iii) $(v - c_i)/\lambda \geq c_i > p$
At this low price, the seller is not interested in trade, in contrast to the agency. Hence, the agency offers a higher price p^R which makes the seller indifferent between trade and no trade, that is, $p^R = c_i$.

It can clearly be seen that project efficiency is obtained, if necessary, by downward or upward renegotiation of the trade price.

3.2 The investment decision (date 3)

An investment decision is made by both sellers since both have a chance to become contractor and to earn the production rent which may result from completion and delivery of the project. Given the price which has been set in the award, they anticipate the continuation of the game and maximize the expected profit. For any seller this expected profit depends on the probability of becoming the actual contractor, that is b for the seller who has got the award, and $1 - b$ for the other one. Each seller, therefore, chooses the following investment level:

$$\hat{e} \in \text{argmax}_e \, U^S = \beta \, \sum^+ \pi_i(e) \, max\{min\{p - c_i, \frac{v - c_i(1+\lambda)}{\lambda}\}, 0\} + \beta p_0 - \psi(e), \quad (11)$$

where β takes the value b for the award-winning seller and $1 - b$ for the loser. The profit-maximizing investments follow from the marginal conditions:

$$\beta \, \sum^+ \pi_i' \, max\{min\{p - c_i, \frac{v - c_i(1+\lambda)}{\lambda}\}, 0\} = \psi'(e). \quad (12)$$

Hence, there are two positive investment levels, a higher level of the winner and a lower level of the loser.[15] The winner invests more because his expected rent from the production stage is larger. This can easily be proved. Define $h(e) := \partial U^S / \partial e = 0$. The implicit function theorem yields

$$\frac{d\hat{e}}{d\beta} = -\frac{\partial h/\partial \beta}{\partial h/\partial e} = -\frac{\sum^+ \pi_i' \, max\{min\{\,\cdot\,\}, 0\}}{-\psi''} > 0, \quad (13)$$

since the numerator is positive from the f.o.c. and the denominator is negative because of the strict convexity of the investment-cost function.

It is immediately clear that one part of our double inefficiency prevails: both sellers invest, one of these investments necessarily will be pure waste. What about the second part of the double inefficiency? Is there a price p which guarantees that the contracting seller chooses the efficient investment level?

[15] Our assumptions guarantee that a unique interior maximum exists for each seller.

3.3 The decision on price p (date 0)

If there were only one seller ($\beta = 1$), the following procedure could be applied to find a price p which gives the correct incentives to the profit-maximizing seller to choose the welfare-maximizing investments e^*. We would have to choose a price which simultaneously fulfills the benchmark condition (8) and the profit condition (12). Therefore, in the case of a single seller, we would have to solve (8) and (12) for ψ' and equate the resulting terms to obtain:[16]

$$\sum\nolimits^+ \pi_i' \, (v/(1+\lambda) - c_i) \stackrel{!}{=} \sum\nolimits^+ \pi_i' \, max\{min\{\,\cdot\,\}, 0\}. \tag{14}$$

There exists a unique positive price p^* which fulfills this equation. The proof is as follows. First, consider $p \leq c_1$. This low price induces underinvestment ($\hat{e} = 0$). The right-hand side of equation (14) is equal to zero and, therefore, lower than the left-hand side. Then assume $p \geq (v - c_1)/\lambda$. This high price induces overinvestment. The right-hand side of equation (14) is larger than the left-hand side. Since effort increases continuously in the price, the intermediate-value theorem implies that there exists a unique price which fulfills equation (14).

However, in this paper this procedure cannot be applied. There is only one price p contained in both the award and the contract, but there are two sellers who choose their investments according to different first-order conditions (12). And it is not a priori clear which investor will finally sign the contract. The procurement agency, in this situation, does not have enough instruments to guarantee that the contracting seller will have chosen the welfare-maximizing investment level.[17] Therefore, it is impossible to find an optimal award which guarantees the achievement of investment efficiency.

An interesting question remains to be answered. Will the contracting seller have underinvested or overinvested? A first superficial inspection seems to suggest that he will have underinvested: the award-winning seller no longer has a guarantee that he will be the contractor, which should induce him to underinvest. And a contracting seller, who previously had not won the award, could also be expected to have underinvested because at the moment of investing he also was not sure that he would end up signing the contract.

This seemingly plausible argumentation is erroneous. Implicitly it assumes that in the award the agency has chosen a price p^* which would induce a *single seller* ($\beta = 1$) to efficient investments. If the *two sellers* of our model face this price p^*, both of them will of course underinvest, since their expected rents from the production stage are lower than a single seller's. However, why should the procurement agency choose this price p^*? After all, the agency's objective function at date 0 is not equal to the benchmark objective (7) because the agency explicitly anticipates the involvement of the court and the possible renegotiation of the trade price, none of which is relevant for the benchmark objective function.

[16] For this procedure compare Bös and Lülfesmann (1996).

[17] In subsection 4.4 we explicitly consider the case where the procurement agency chooses different prices, one for the award-winning seller and one for the loser. Unfortunately, this extension fails to eliminate the double-inefficiency problem.

There are many possible ways how the price p may have been chosen at date 0, for instance, solutions of various bargaining games. As already mentioned, none of these models is able to guarantee investment efficiency (there is one price only for two incentive problems). *Therefore, it is meaningless to develop an explicit model of the price decision at date 0.* However, it is of interest to present a *simple example* which shows that both under- and overinvestment may occur. For this purpose note that the agency's expected utility at date 0 is a linear combination of the utility which accrues if the winner signs the contract and if the loser signs the contract, the weights being b and $1-b$. Therefore, let us assume that a price $\widehat{p}(\phi)$ has been chosen which fulfills the following condition:

$$\sum^{+} \pi_i' \; (v/(1+\lambda) - c_i) = \phi \sum^{+} \pi_i' \, max\{min\{\,\cdot\,\}, 0\}, \tag{15}$$

where ϕ depends on the bargaining strength of the agency in the negotiations with winner and loser at date 0. To understand the investment incentives which result from such a price, let us begin with two borderline cases. If ϕ were equal to $1-b$, the loser would have the correct incentives and choose the efficient investment level. Hence, efficient investments would be attained if the court revokes the award. However, there would still be a probability of more than 50% that the winner becomes the contractor. If this were the case, the incentives given by $\widehat{p}(1-b)$ would have been too high and the contractor would have overinvested. If, on the other hand, ϕ were equal to b, the winner would have the correct investment incentives and efficiency would be attained if the court confirms the award. However, there would still be a probability that the loser becomes the contractor in which case the incentives given by $\widehat{p}(b)$ would have been too low and the contractor would have underinvested. Therefore, in the most probable case of an intermediate ϕ, that is $1-b < \phi < b$, the loser will have an incentive to underinvest, whereas the winner will have an incentive to overinvest.

Summarizing, we obtain the following proposition:

PROPOSITION *Separation of award and actual contracting causes the following double inefficiency:*
(i) The non-contracting seller cannot be discouraged from wasteful relationship-specific investments;
(ii) It cannot be guaranteed that the contracting seller chooses the efficient investment level. It cannot be said whether the contracting seller underinvests or overinvests.

4 Extensions

4.1 A benchmark which includes alternative supplies

Until now we have assumed that nature draws a realization of the costs of the contracting seller, but not of the other seller. This is a highly realistic setting. The non-contracting seller drops out of the game when the contract is written and, accordingly, we only know the probabilities of his costs, however, his actual cost realization is not drawn by nature and, therefore, unknown to all parties of the game. However, this is not the only possible setting. As an alternative, let us consider procurement cases where nature determines the cost realizations of both sellers. Then the benchmark must be redefined so as to include this additional information. For this purpose, we rewrite the sequencing of events as follows:

- date 0: prices p_0 and p_1 negotiated;
- date 1: award given to one of the sellers;
- date 2: the other seller goes to the court;
- date 3: relationship-specific investments of both sellers;.
- *date 4: nature determines the realizations of the costs of both sellers;*
- date 5: court decision;
- date 6: contract;
- date 7: final decision on trade; possibly renegotiation;
- date 8: completion of the project, payments.

Given this sequencing of events, project efficiency requires (i) that trade takes place if and only if it increases welfare, that is, a valuable project exists, and (ii) that the project generating the higher net value is realized. This implies:

$$q^{1*} = 1 \quad \Leftrightarrow \quad \max\{v - c_i^1(1+\lambda), v - c_i^2(1+\lambda), 0\} = v - c_i^1(1+\lambda), \tag{16}$$
$$q^{2*} = 1 \quad \Leftrightarrow \quad \max\{v - c_i^1(1+\lambda), v - c_i^2(1+\lambda), 0\} = v - c_i^2(1+\lambda), \tag{17}$$
$$q^{o*} = 0 \quad \Leftrightarrow \quad \max\{v - c_i^1(1+\lambda), v - c_i^2(1+\lambda), 0\} = 0, \tag{18}$$

where q^{h*} is the quantity sold by seller $h = 1, 2$, q^{o*} is the zero quantity, and c_i^h are the actual realizations of costs. On the basis of this project-efficiency criterion, the agency selects the private contractor.

This project efficiency is not necessarily attained by the decision taken by agency and private contractor at date 7. They will decide to trade whenever $v \geq (1+\lambda)c_i^{pc}$, where pc stands for 'private contractor'; otherwise there is no trade. However, this does not necessarily meet the conditions of the benchmark. Since benefits and costs are not verifiable before the court, at date 5 any potential seller may be the contractor. Thus the court may force the agency to contract with that seller who provides the lower net value. And then the trade decision between agency and private contractor violates project efficiency.

4.2 Alternative objective functions of the procurement agency

The negative results of this paper hold as well if the procurement agency is not the genuine welfare maximizer assumed until now. Let us first assume that the agency applies cost-benefit analysis, comparing benefits v and social costs of the payments $(1+\lambda)p$. However, the agency ignores that the prices are transfers to the seller and it also ignores the costs of the seller. At date 7, therefore, the agency wants to trade if $v \geq (1+\lambda)p^R$. It is easy to see that there is no trade if $v < (1+\lambda)c_i$, otherwise we have three cases of trade as with the welfare-maximizing agency.[18] Hence, project efficiency is achieved. However, applying the same arguments as in section 3, it is immediately obvious that investment efficiency is not attained.

Let us next consider an agency which is not interested in any shadow costs and behaves exactly like a private buyer. At date 7, this agency wants to trade if $v \geq p^R$. In this case, there may be trade although $v < (1+\lambda)c_i$.[19] Consider, for instance a situation where $c_i < p < v < (1+\lambda)c_i$. In this case both agency and seller want to trade although this is inefficient. Hence, if the agency behaves like a private buyer, the achievement of project efficiency is no longer guaranteed. Matters have become worse because the agency ignores the shadow costs of public funds.

4.3 Option contracts

Let us assume that the government procurement agency can unilaterally insist on the delivery of the contracted good after its precise costs have become known. Unfortunately, such an option contract does not help to solve our special problem. Option contracts á la Nöldeke and Schmidt (1995) are useful to attain project and investment efficiency by *both-sided* investments, because the date-3 objective function of one player becomes equal to welfare minus a term which does not depend on its own investments. However, it is not our problem that we have efficiency for one-sided investments and lack efficiency in the case of both-sided investments. Hence, option contracts are not a way out of our problem.

4.4 Different prices for various sellers

In section 3 we have assumed that any potential seller gets the same contract (whose conditions are stipulated in the award). This raises the question of whether investment efficiency can be achieved if the procurement agency writes different contracts depending on whether the award-winning seller signs the contract or the successful claimant who had sued for the contract. Obvious candidates for such a policy are prices $\widehat{p}(b)$ and $\widehat{p}(1-b)$ which simultaneously fulfill the benchmark condition (8) and the respective profit conditions (12), that is, prices which solve the following system of two equations:

$$\sum{}^{+} \pi_i' \left(v/(1+\lambda) - c_i\right) = \beta \sum{}^{+} \pi_i' \, max\{min\{\,\cdot\,\}, 0\}; \qquad \beta = \{b, 1-b\}. \tag{19}$$

At date 0 the procurement agency would have to give the award to one of the sellers stipulating a price $\widehat{p}(b)$. At the same time it would have to make a conditional commitment to the other seller which guarantees him a contract with price $\widehat{p}(1-b)$ if he wins the lawsuit. Such a policy would guarantee that the private contractor invests efficiently.

However, why should the agency choose the prices $\widehat{p}(b)$ and $\widehat{p}(1-b)$? These prices maximize the benchmark-welfare function. But the agency at date 0 has a welfare function

[18] There is only one difference: in the case where the trade price is renegotitiated downward, we obtain $p^R = v/(1+\lambda)$. This also implies that one term in the date 3-objective functions of the sellers changes.

[19] The problem is trade occuring when it should not. If trade is efficient, $v \geq (1+\lambda)c_i$, the parties will always trade, if necessary at a renegotiated price.

which differs from the benchmark: it considers shadow costs of public funds and its expected utility is a weighted average of welfare resulting from project completion by the winner and by the loser, respectively. The agency will choose prices which maximize its personal-welfare function and will thus fail to attain the benchmark welfare. Moreover, whatever prices are chosen, both sellers invest, and the relationship-specific investments of the seller who does not get the contract are pure waste. Both parts of the double-inefficiency problem remain unsolved.[20]

5 Summary

This paper deals with a particular negative effect which in public procurement is brought about by a separation between award and actual contracting. Not only the award-winning bidder will engage in relationship-specific investments. A defeated bidder who sues for the contract and sees a chance to win, will also prepare for the contractual relation by special R&D investments. This implies a double inefficiency: (i) Non-contractors spend money on relationship-specific investments, which is a pure waste. (ii) It cannot be guaranteed that the contracting seller chooses the welfare-maximizing investment level; both underinvestment and overinvestment are possible. The negative result of the paper is very robust with respect to the specifications of the model as is shown in several extensions.

Acknowledgements

I gratefully acknowledge helpful comments by Martin Kolmar and Jost Pietzcker. Needless to mention, all remaining errors are mine. Financial support by SFB 303, University of Bonn, is gratefully acknowledged.

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[20]Matters become even worse if we consider a benchmark which includes alternative supplies (subsection 4.1). Here, it is still possible that the court makes a wrong decision and forces the agency to sign the contract with a seller who accomplishes a project with net benefit lower than that of the other seller. Then, project efficiency is not reached.

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