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BUREAUCRATS AND PUBLIC PROCUREMENT

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Abstract

This paper deals with a Niskanen type of public-procurement agency. It is shown that the procurement game should be separated into an investment game and a project game, the first game to be played before nature determines the actual realizations of benefit and costs of the project, the second game to be played afterward. In the first game the relationship-specific investments of agency and seller are determined, in the second game the decision on the production of the project is taken. In contrast to many other incomplete-contract papers, in our Niskanen setting it is meaningless to write one and only one contract which refers to both investment and production. Welfare-optimal procurement of the project can be attained under relatively weak assumptions; welfare-optimal investments of the seller (and only of the seller) may result under special circumstances; welfare-optimal investments of both agency and seller cannot be reached.

JEL Classification: D23, D73, H57.

Keywords: Bureaucracy, Procurement, incomplete contracts.

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1 Introduction

This paper deals with the purchase of a public project. The parliament sponsors a procurement agency which, in turn, pays a private seller who provides his services. As in Niskanen's (1971,1975) model,[1] the parliament is willing to appropriate money for the completion of the project up to its evaluation of the social benefit of the project. The agency is a budget-maximizing bureaucrat.[2] It wants to maximize its power which can be achieved best if it spends as many dollars as possible. The private seller is a profit maximizer. Given these objectives of parliament, agency and seller, we expect the result to be far from welfare optimality. However, in this paper we show that under particular circumstances welfare optimality may result.

At the beginning of their relationship the procurement agency and the private seller face a situation of uncertainty about the actual realizations of benefit and costs of the project. However, the probabilities of higher benefit and of lower costs can be influenced by relationship-specific investments of the seller and of the agency. The seller's investments consist of specific innovative activities, for instance the development of a particular technology for military interceptor planes, or a special design for a particular building for elderly handicapped people. However, the agency is also interested in investing because the parliament's benefit of the project determines the agency's budget and, therefore, the agency directly benefits from an increase in the probability of higher benefits. The specific investments of the agency typically refer to complementary goods which are essential in ensuring the success of the project. By way of example, one can think of investment in the development of a new approach control radar which makes landing of a military interceptor plane more secure, or the development of special infrastructure if a new hospital is to be built.

The seller provides two services: his specific investments and the production of the project. We shall assume that it is the same seller who provides both services.[3] This is the most interesting problem. Otherwise, in a first stage seller A would be paid

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[1] For a simple explanation of Niskanen's model see, for instance, Mueller (1989), pp. 250-254.

[2] The assumption of a budget-maximizing procurement agency is in contrast to several other incomplete-contract models on public procurement, for instance Bös and Lülfesmann (1996) and Bös (2000), which assume a welfare-maximizing procurement agency.

[3] In various public-procurement guidelines it is forbidden that the same firm provides both the R&D investments and the completion of the project. These provisions aim at a promotion of competition because many smaller firms may be specialized in R&D or in project implementation.

for the investment costs and in a second stage seller B would be paid for the project, and these two stages would not be connected. It is just the connection between the investment and the project stage which constitutes the really interesting problem: since the relationship-specific investments have to be made before nature's draw, the investors face a hold-up problem.[4] The final distribution of rents will only be determined after nature's draw, when it is finally decided whether the project is carried out or not. However, at this moment the costs of the specific investments are sunk and no party can argue that it deserves a higher share of the ex-post surplus because of its high specific investments. This is anticipated by the agency and the seller and constitutes a tendency toward underinvestment.

If only one seller provides his services to the agency, it seems natural that only one contract is written which refers to both relationship-specific investments and the production of the project. However, in our model this is not meaningful because of the procurement agency's Niskanen-type of behavior. In our setting, agency and seller should write two contracts: one with respect to the investments of the seller, and one with respect to the production of the project.[5] These two contracts are supported by two budgets which are appropriated by the parliament: an investment budget and a project budget. Why is this the only meaningful setting in our model? Consider, for the sake of the argument, that agency and seller write a single contract which refers to both investment and production of the seller. A particular problem arises when it comes to the question how the production costs should be taken into account in this single contract. The procurement agency must never contractually promise to pay a price which may exceed its budgetary possibilities at the moment when the project finally is carried out. Therefore, the procurement contract cannot stipulate a fixed ex-ante price unless the agency chooses a meaninglessly low price which would correspond to the lowest budget the agency could expect after the draw of nature. Since the agency is a budget maximizer, it will never choose this low-price strategy, but will force the seller to accept a price which exhausts the total budget as it will be set by the parliament after the draw of nature.[6] Of course, this is fully

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[4] The hold-up problem was first articulated by Klein et al. (1978) and by Williamson (1975, 1979).

[5] In the practical application the procurement agency should enter into a public-private partnership, writing a long-term skeleton contract which states that the parties' total relationship consists of two short-term contracts: if the investment contract is satisfactorily executed, agency and contractor continue in their cooperation and write the project contract.

[6] Any project budget which is set before the draw of nature would be adjusted by downward or upward renegotiations after the draw of nature, because the parliament would not be willing to pay more than its actual benefit from the project (downward renegotiation) and the agency,

anticipated by the seller. Accordingly, it is not meaningful for the parties to write an ex-ante contract which stipulates one and only one price which is to be paid after the completion of the project and refers to both investment and production costs of the seller. The agency would insist in stipulating a stochastic ex-ante price which would be equal to the total budget appropriated by the parliament after the draw of nature. As a compensation for accepting such a stochastic price the seller would have to be given the right to rescind the contract after nature's draw, that is, when he finally learns the actual price and the actual production costs, he would be allowed to withdraw from the contract if the price does not cover the production costs. However, if ex ante a stochastic price is stipulated and the seller has an ex-post right of withdrawal, this is equivalent to a situation without any contractual arrangement about the project price. The only meaningful contract at the beginning of the relationship between agency and seller is an incomplete contract which stipulates a lump-sum payment. If this payment is positive, it is a compensation for the specific investments of the seller. If it is negative, the seller has to pay for his participation in the procurement game (and he will be willing to pay if his specific-investment costs are lower than the expected profit from the production stage). The contract about the completion of the project is only written after the draw of nature. Then the procurement agency offers a project price and the seller may decide not to sign such a contract if this price does not cover his production costs.

Summarizing, in this paper the relationship between parliament and agency is characterized by two budgets. The investment budget refers to the investment costs of the agency and of the seller. The project budget finances the costs of the completion of the project. Similarly, the relationship between agency and seller is governed by two contracts. The investment contract refers to the lump-sum payment stipulated at the beginning of the relationship. The project contract refers to the completion of the project.

This setting is in contrast to the usual theory of incomplete contracts, such as Hart and Moore (1988), Aghion, Dewatripont and Rey (1994), and Nöldeke and Schmidt (1995). In these papers the buyer and the seller write one and only one contract at the beginning of their relationship, that is, before the agents' uncertainty about benefit and costs is dissolved by a draw of nature. Typically, in this ex-ante contract two

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knowing the actual realization of the parliament's benefit will always go for a budget which fully exploits the parliament's willingness to pay (upward renegotiation). Anticipating this, the only meaningful procedure for the parliament is to set the project budget after the draw of nature.

prices are stipulated: a price p_1 to be paid if the project is completed, and a default price p_0 if this is not the case. After nature has revealed the actual realizations of benefit and costs, the prices p_1 or p_0 may be renegotiated. In contrast, in our paper the two prices are contracted upon at different stages of the game. p_0 is stipulated in a contract which is signed when the procurement agency starts with the planning of the particular project; it is not a default price, but is paid or encashed by the agency when the investment stage of the game ends. p_1 is stipulated in a contract written after nature has revealed the actual realizations of benefit and costs. The budget-maximizing attitude of the bureaucratic procurement agency implies that it always fully exhausts the parliament's budget; and since both contracts are written under certainty, neither agency nor seller face any incentive to change any price at a later stage: there is no renegotiation in our model.

The paper is organized as follows. Section 2 presents the sequencing of the game, the observability and verifiability assumptions, a detailed description of the interplay between the parliament and the procurement agency, and, finally, the second-best benchmark which serves as the basis of comparison for the actually played game. Then, in section 3 we deal with the equilibrium analysis. We begin with the *project game*, where parliament and agency determine the price to be paid for the project, and the seller decides whether to sign the project contract or not. Subsequently, we analyze the *investment game,* where agency and seller choose their relationship-specific investments on the basis of an investment contract which, in turn, is based on the parliament's investment budget. A brief summary concludes.

2 The model

2.1 Benefits, costs, and investments

If the public project is carried out, the parliament's benefit is B. At the beginning of the game, the actual benefit is not yet known. This is modelled by assuming that the actual realization of benefit is determined by a draw of nature. If the project is not carried out, its benefit is zero. The production costs of the project are denoted by C; there are no costs if the project is not carried out. At the beginning of the game the costs are stochastic; nature draws the actual cost realization at a later stage of the game. There are many possible realizations of benefit and costs which can be ordered as follows:

$$\underline{B} = B_1 < ... < B_i < ... < B_I = \overline{B}; \qquad I \geq 2, \tag{1}$$

$$\overline{C} = C_1 > ... > C_j > ... > C_J = \underline{C}; \qquad J \geq 2. \tag{2}$$

Nature draws the actual realizations of benefit and costs from the above lists of deterministic variables. The probability that a particular benefit or cost realization is drawn depends on relationship-specific investments a of the agency and e of the seller. For convenience, these investments are normalized to the zero-one interval. Following Hart and Moore (1988) we specify the following probabilities of benefit and costs:

$$\pi_i(a) = a\pi_i^+ + (1-a)\pi_i^-, \qquad \text{(benefit)}, \tag{3}$$

$$\sigma_j(e) = e\sigma_j^+ + (1-e)\sigma_j^-, \qquad \text{(costs)}. \tag{4}$$

The probability distributions π^+ and π^- are defined over $(B_1, ..., B_I)$, and π_i^+/π_i^- is increasing in i (monotone likelihood ratio property). Analogously, σ^+ and σ^- are probability distributions over $(C_1, ..., C_J)$, and σ_j^+/σ_j^- is increasing in j. A particular choice of investment determines a linear combination of two probability distributions and our assumptions imply that higher investments increase expected benefit and reduce expected costs, respectively. From the definitions of the probability distributions $\pi(a)$ and $\sigma(e)$ it follows directly that the first derivatives are constant and that they sum up to zero:

$$\pi_i' = \pi_i^+ - \pi_i^-; \qquad \sigma_j' = \sigma_j^+ - \sigma_j^-; \qquad \textstyle\sum_{i=1}^{I} \pi_i' = \sum_{j=1}^{J} \sigma_j' = 0. \tag{5}$$

The relationship-specific investments are costly. We define investment-cost functions $\mu(a)$ and $\psi(e)$ and assume that both functions are convex in their arguments and that the Inada conditions are fulfilled.

2.2 The stages of the game

The sequencing of events is illustrated in table 1.

date 0	investment budget	investment game
date 1	investment contract, agency's investments	
date 2	seller's investments	
date 3	draw of nature	
date 4	project budget	project game
date 5	project contract	
date 6	completion of project	

Table 1: Sequencing of events

At *date 0* the investment game is opened: the parliament appropriates the investment budget $b \geq 0$. A negative budget cannot be appropriated because of the procurement agency's limited liability. This investment budget covers the costs of the agency's investments $\mu(a)$ and a lump-sum payment p_0 to be encashed or paid by the seller. This investment budget is split into its two components by a decision of the procurement agency at *date 1.* Since choosing $\mu(a)$ implies the choice of a, the agency acts as a Stackelberg leader in the investment game; it chooses its investments prior to the seller. The agency's decision on how to split the investment budget into $\mu(a)$ and p_0 is the basis of the investment contract which is signed by the seller unless the stipulated lump sum p_0 violates his participation constraint. This constraint is based on the agency's commitment not to choose another seller for the project game which definitely must be given at date 1.[7] Then, at *date 2* the seller chooses his relationship-specific investments. The agency pays or encashes the lump sum p_0. The investment game ends. Only then, at *date 3* the actual realizations of benefit and costs are determined by a draw of nature. The uncertainty is thus dissolved and at *date 4* the project game is opened: the parliament sets the project budget according to nature's draw. The agency fully extracts this budget which, therefore, is available for the seller as the price to be paid for the completed project. On the basis of this price and his knowledge of the actual costs at *date 5* the seller decides whether to sign a contract about the completion of the project. If he makes

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[7] Recall footnote 5 above.

a negative decision, the game ends. Otherwise, at *date 6* the project is produced, and the seller is paid for the completed project.[8]

2.3 Observability and verifiability

The supports of B and C, and the probabilities $\pi(a)$ and $\sigma(e)$ are common knowledge, that is, they are known to parliament, procurement agency and seller. The same holds for the investment-cost functions.

The actual realizations of benefit and costs, as determined by nature, are observable as follows: The benefit B is known to the parliament and to the procurement agency, it does not matter whether it is also known to the seller. The costs C, however, in this model are assumed to be private knowledge of the seller, that is, the producer is the only one who knows the production costs. In Niskanen's original two-person model of a sponsor and a bureaucrat, the bureaucrat produces the good and only he knows the costs. We have extended Niskanen's model to a three-person setting, and it seems natural to assume that, once again, only the producer knows the costs. Note, however, that the results of the paper remain unchanged if we assume that both seller and procurement agency know the costs (as long as the parliament does not know them).[9] The actual amount of relationship-specific investments which the agents choose may be private or public information; this does not influence the results of the paper.

The above informational assumptions show that the parliament does not need the agency because it is better informed about the production costs. However, the agency is the only one which is able to prepare the project by appropriate relationship-specific investments. (Moreover, there is always the usual justification that in practice a parliament cannot do everything itself; it always needs a special agency which looks into the particulars of a public project.)

Let us next turn to the verifiability assumptions which are important because any contract can only be conditioned on variables which are verifiable before a court. In this paper we assume that the relationship-specific investments a and e are nonverifiable since they are effort levels which contain many subjective elements. We

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[8] Disputes on delivery and on payments would be decided upon after the end of a game, either the investment game or the project game. However, in the subgame-perfect equilibrium no such disputes occur.

[9] This is proved at the end of subsection 3.1 below.

also assume that the costs C are non-verifiable. Usually, cost padding or possible accounting tricks are taken as a justification for the assumption of non-verifiable costs. And, as usual in most models on incomplete contracts, we assume that B is non-verifiable. After all, the evaluation of the benefit of the project is a subjective attitude of the parliament. Note, however, that a budget of $B/(1+\lambda)$ is an officially published figure, which therefore clearly can be verified before a court. Furthermore, the completion of the project and all payments are verifiable.

2.4 The interplay between parliament and procurement agency

Parliament and procurement agency are modelled according to Niskanen (1971, 1975). A modern formulation of the Niskanen model has to impute to the parliament a lexicographic preference ordering with respect to allocative efficiency and payments.[10] The parliament first wants to attain allocative efficiency, therefore at date 4, it favors the completion of the project iff

$$B_i \geq (1+\lambda)C_j, \tag{6}$$

where λ are the shadow costs of public funds. If the project is completed, its costs C_j have been realized. Unfortunately, when it has to appropriate the project budget at date 4, the parliament cannot observe the actual cost realization which is private information of the seller. Since payments are only second-ranked part of the parliament's lexicographic preference ordering, however, it does not bother if it has to pay more than the actual costs as long as the first-ranked objective of allocative efficiency is not violated.[11] Therefore, the parliament is willing to spend up to $B_i/(1+\lambda)$ dollars if the project is carried out. This can be captured by the following constraint:

$$\textit{project budget} \leq \frac{B_i}{1+\lambda}. \tag{7}$$

The parliament's lexicographic preference ordering is exploited by the budget-maximizing procurement agency. Since the agency wants to spend as many dollars as possible, it fully extracts the parliament's willingness to pay: the agency makes a take-it-or-leave-it offer to the parliament which equates the budget to the parliament's social evaluation of the project. (This take-it-or-leave-it-offer is the core of

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[10] For the use of such a preference function see also Bös and Lülfesmann (1996). A precise formulation of the government agency's utility function would be as follows: one must define $P = P(x,y)$, where x denotes the level of allocative efficiency and y the payments to the procurement agency. In this formulation, lexicographic preferences over these two arguments can be expressed as follows: $G > \widetilde{G} \Longleftrightarrow$ (a) $x = \widetilde{x}$ and $y < \widetilde{y}$ or (b) $x > \widetilde{x}$.

[11] Therefore, the parliament does not implement any direct mechanism in order to induce the seller to reveal the actual cost realization.

Niskanen's theory of bureaucratic behavior.) The parliament accepts this offer and appropriates a budget of $B_i/(1+\lambda)$ dollars conditional upon the completion of the project.

Let us now step back and consider the interplay between parliament and procurement agency at date 0, when the investment budget is to be appropriated. The first-ranked part of the parliament's lexicographic preference ordering aims at efficient investments of both procurement agency and seller. The parliament anticipates the subgame-perfect continuation of the game, in particular the splitting of the investment budget by the agency ($b = \mu(a) + p_0$), and the final decision on the completion of the project. Since payments rank only second, the parliament would be willing to choose any budget b which maximizes

$$\mathcal{W} = \sum_{\substack{i \; j \\ B_i \geq C_j(1+\lambda)}}\!\!\sum \pi_i(a)\sigma_j(e)\Big[B_i - C_j(1+\lambda)\Big] - (1+\lambda)\Big[\mu(a) + \psi(e)\Big]. \tag{8}$$

with respect to a and e. Note, however, that the parliament has to consider the agency's limited liability which requires $b \geq 0$.

2.5 A benchmark

In this subsection we consider a fully informed parliament which wants to maximize welfare. It does not engage in public procurement, but 'does it alone.' Both investment costs and project costs are born by the parliament and paid from distortionary taxation. Therefore, the shadow costs of public funds must be taken into account. This implies that we have a second-best benchmark.

Applying backward induction, let us first define *project efficiency* which refers to the decisions made with respect to the completion of the project. Project efficiency requires that the project is carried out if and only if this increases welfare. Since we deal with procurement of an indivisible good, the project, let $q = 1$ and $q = 0$ be the quantities to be procured. Therefore, project efficiency requires:

$$q^* = 1 \quad \Leftrightarrow \quad B_i \geq C_j\,(1+\lambda), \tag{9}$$

$$q^* = 0 \quad \Leftrightarrow \quad B_i < C_j\,(1+\lambda), \tag{10}$$

where B_i and C_j are the realizations of benefit and costs as determined by the draw of nature. The investment costs are sunk at this stage and, therefore, do not influence the parliament's decision.

Second, we define *investment efficiency* which refers to the welfare-optimal choice of the investments a and e. Anticipating project efficiency we have:

$$(a^*, e^*) \in \text{argmax}_{a,e}\, \mathcal{W} = \sum_{\substack{i \\ B_i \geq C_j(1+\lambda)}} \sum_j \pi_i(a)\sigma_j(e)\Big[B_i - C_j(1+\lambda)\Big] - (1+\lambda)\Big[\mu(a) + \psi(e)\Big]. \tag{11}$$

We obtain the following first-order conditions:

$$\mathcal{W}_a = 0: \qquad \sum_{\substack{i \\ B_i \geq C_j(1+\lambda)}} \sum_j \pi_i' \, \sigma_j(e) \, \frac{B_i - C_j(1+\lambda)}{(1+\lambda)} = \mu'(a), \tag{12}$$

$$\mathcal{W}_e = 0: \qquad \sum_{\substack{i \\ B_i \geq C_j(1+\lambda)}} \sum_j \pi_i(a) \, \sigma_j' \, \frac{B_i - C_j(1+\lambda)}{(1+\lambda)} = \psi'(e). \tag{13}$$

These conditions are necessary and sufficient for a unique and interior solution $\{a^*, e^*\} > 0$.[12] Note that the benchmark implies that at date 0 a general efficiency constraint $\mathcal{W} \geq 0$ holds. Therefore, at date 0 the expected net value of the project should be weakly positive, otherwise the project should not be started at all.

3 Equilibrium analysis

3.1 The project game

At date 5, the agency knows the project budget which allows for an expenditure of p_i dollars for the completed project. The agency is always interested in having the project carried out because otherwise its budget is reduced to zero. Therefore, it wants to spend the p_i dollars which the parliament's project budget allows to spend. The agency is not interested in spending less, and it is unable to spend more. Therefore, at date 5 the procurement agency has no freedom of decision and offers the seller a procurement contract with price p_i to be paid if the project is carried out. Note that the agency cannot take the money p_i, pay part of it to the seller and retain the rest for personal emoluments. The agency rather has to forward all of the money to the seller, since payments are verifiable and, accordingly, the agency could be sued if it used parts of the budget for other purposes than for the particular public project.

Since the agency has no freedom of decision, at date 5 only the seller's decision counts. He compares two situations: if the project is carried out, he gets p_i and

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[12] Formally, the existence of an interior solution is ensured since expected welfare as defined in (11) is concave in the investments and the Inada conditions are assumed to be fulfilled.

faces the production costs C_j. Otherwise, he has no production costs, and does not get anything. Therefore, the seller will sign the project contract if and only if [13]

$$p_i - C_j \geq 0. \tag{14}$$

Let us now step back to date 4 where the project budget p_i is determined. This is the typical situation which Niskanen had in mind when developing his model of bureaucratic behavior. Both parliament and agency have just learned the actual realization of the benefit of the project. The agency knows that the parliament is willing to appropriate up to $B_i/(1+\lambda)$ dollars for the completion of the project, recall the parliament's constraint (7). Therefore, the agency makes a take-it-or-leave-it offer which equates the expenditures for the completed project to $B_i/(1+\lambda)$. The parliament accepts this offer of the agency and the project budget is passed with expenditures of

$$p_i = \begin{cases} B_i/(1+\lambda) & \text{if } q = 1, \\ 0 & \text{if } q = 0. \end{cases} \tag{15}$$

Note that B_i is the project evaluation of the parliament, whereas $p_i(1+\lambda)$ are the social project costs which the parliament faces. The actual project costs C_j do not matter for the parliament. It does not know them, and they are not explicitly relevant for the project budget, because the Niskanen parliament cares only about the evaluation of the project and not about the seller's costs. When setting the project budget at date 4, the parliament anticipates that the agency will offer the seller a project contract with $p_i = B_i/(1+\lambda)$. It also anticipates that at date 6 p_i dollars will be paid to the seller if the project is carried out, and *0* dollars if it is not carried out.

Let us finally investigate whether the decisions of parliament, agency and seller attain project efficiency. The seller signs the contract iff $p_i \geq C_j$. The project budget has fixed the expenditures for the completed project as to $p_i = B_i/(1+\lambda)$. Hence, although the seller does not know it, he signs the contract iff

$$\frac{B_i}{1+\lambda} - C_j \geq 0, \tag{16}$$

which is equivalent to

$$B_i \geq C_j(1+\lambda). \tag{17}$$

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[13] This is also the participation constraint of the seller at date 5; the participation constraint of the agency is $p_i \geq 0$ which is always fulfilled.

Therefore, the seller signs the contract and the project is carried out if and only if this is welfare-optimal according to our benchmark model. Project efficiency is guaranteed.

There is an important difference between the project game of this paper and Niskanen's original model. In Niskanen's model the budget of the bureaucrat is expanded until the parliament's evaluation (budget) is equated to the costs of the project.[14] In our setting we have a third player, namely the seller, and he retains the difference between the parliament's benefit and the production costs as an ex-post rent. This result is rooted in the agency's budget-maximizing behavior. The highest budget the agency can attain is given by the parliament's benefit $B_i/(1+\lambda)$. Therefore, the agency will always make sure that the project budget is just equal to this benefit. Since payments are verifiable, however, the agency cannot encash a budget of $B_i/(1+\lambda)$, pay C_j to the seller and retain the rest for personal emoluments. It always has to spend all of the project budget, whence it is the seller who gets the ex-post rent. It is remarkable that this mechanism works regardless of whether the agency knows the production costs or not. If the agency knows the costs, it will not plead for a lower budget of C_j, but for the higher budget of $B_i/(1+\lambda)$. And it will have to pay all of $B_i/(1+\lambda)$ to the seller because payments are verifiable. Therefore, a procurement agency which observes the actual production costs will 'throw away' this information because it could only lead to a reduction of the project budget which is unwanted by the agency. (This shows that all of our results hold as well if the agency knows the production costs, which proves our statement in subsection 2.4 above.)

3.2 The seller's investment decision (date 2)

When choosing his relationship-specific investments the seller anticipates the continuation of the game and maximizes the expected profit given the agency's investments. His objective function at date 2 is as follows:

$$U^S = \sum_{\substack{i \; j \\ B_i \geq C_j(1+\lambda)}} \!\!\!\!\! \sum \; \pi_i(a)\,\sigma_j(e)\,\frac{B_i - C_j(1+\lambda)}{(1+\lambda)} \;+\; p_0 \;-\; \psi(e), \tag{18}$$

where the lump sum p_0 is included in the objective function because it is encashed or paid by the seller at date 2. The seller's choice of specific investments is determined

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[14] Ignoring Niskanen's demand-constrained case.

by the following marginal condition:

$$\sum_i \sum_j_{B_i \geq C_j(1+\lambda)} \pi_i(a)\, \sigma_j' \frac{B_i - C_j(1+\lambda)}{(1+\lambda)} = \psi'(e) \tag{19}$$

which is equivalent to the benchmark welfare condition (13). Therefore, the seller's investment choice will lead to investment efficiency iff the procurement agency has chosen efficient investments at date 1.

Unfortunately, however, only by chance will the agency choose efficient investments as we shall see in the analysis of the agency's decision at date 1. We can distinguish between two different cases:

- The agency has chosen positive, but inefficient investments, $a > 0$. In this case the seller will overinvest if the agency has overinvested, and underinvest if the agency has underinvested. The reason is the following. The agency's overinvestment increases the expected production rent of the seller and, therefore, the seller has an incentive to invest more than welfare-optimal.[15] An analogous argument holds if the agency underinvests. Which of these two cases holds, will be seen when we explicitly treat the agency's investment decision at date 1.
- Assume that $\pi(a) = \pi$ for all a. The agency has no incentive to invest and $a = 0$. In this particular case of *one-sided investments* we attain investment efficiency, and since project efficiency is always guaranteed, the (second-best) welfare optimum is achieved.

3.3 Agency investments and the investment contract (date 1)

At date 1, the agency splits the parliament's investment budget into a budget for its own investments $\mu(a)$ and a lump sum p_0 to be paid to, or encashed from, the seller. However, at date 1 the agency knows that the parliament's investment budget amounts to zero (as we shall prove when stepping back to the discussion of the parliament's decision at date 0). This implies that the budget for specific investments of the agency can only be financed from payments of the seller.

We assume that the agency is in a stronger position than the seller. Therefore, the investment contract at date 1 is based on a take-it-or-leave-it offer the agency

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[15] In formal terms: the agency's overinvestment implies an increase of the left-hand side of (19), which induces a higher value of the right-hand side, $\psi'(e)$ and, hence, a higher investment e than in the benchmark optimum.

makes to the seller. Since the agency is a budget maximizer, it wants to maximize its utility which consists of the sum of its two budgets,

$$U^A = \sum_{\substack{i \\ B_i \geq C_j(1+\lambda)}} \sum_j \; \pi_i(a)\, \sigma_j(e)\, \frac{B_i}{1+\lambda} \; + \; \mu(a). \tag{20}$$

When maximizing this objective function with respect to a and p_0, the agency has to consider the investment-budget constraint and the seller's participation constraint:[16]

$$p_0 + \mu(a) = 0, \tag{21}$$

$$U^S \geq 0. \tag{22}$$

What are the results of this optimization approach? The agency is interested in attaining the highest possible amount of investments a, because higher investments increase both the agency's expected net benefit from the project game and the agency's investment budget (which are the two components of the agency's utility U^A). This can be achieved if the agency extracts all of the seller's ex-ante rents, equating U^S to zero by a negative p_0, that is, by requiring the seller to pay for the participation in the procurement game. The payment of the seller is then used to finance the investment costs of the procurement agency,

$$|p_0| = \mu(a). \tag{23}$$

The full extraction of the seller's ex-ante rents implies that the seller's payment amounts to

$$|p_0| \; = \sum_{\substack{i \\ B_i \geq C_j(1+\lambda)}} \sum_j \; \pi_i(a)\, \sigma_j(e)\, \frac{B_i - C_j(1+\lambda)}{(1+\lambda)} \; - \; \psi(e), \tag{24}$$

where the value of e is given by (19). The right-hand side of (24) must never become negative, otherwise the seller's participation constraint would be violated.

Since at date 1 the agency has to decide on its own investment budget $\mu(a)$ and on the seller's lump sum p_0, the extent of its investments is effectively determined at date 1. This implies that the agency serves as a Stackelberg leader in the investment game, choosing its investments one stage before the seller. We recognize that the lump-sum payment p_0 is negative, that is, the seller has to pay for the participation in the procurement game. In this case the agency will always overinvest (and so will

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[16] The agency's participation constraint does not cause any problems. As can be seen from equation (20), the agency is always willing to sign the investment contract.

the seller). This can be shown as follows. $U^S = 0$ implies (24). From the definition of welfare in equation (8) we can deduce that

$$\sum_i \sum_j_{B_i \geq C_j(1+\lambda)} \pi_i(a)\, \sigma_j(e)\, \frac{B_i - C_j(1+\lambda)}{(1+\lambda)} \;-\; \psi(e) \;=\; \frac{\mathcal{W}(a, e^*(a))}{1+\lambda} + \mu(a). \tag{25}$$

Substituting into (24) we obtain

$$|p_0| \;=\; \frac{\mathcal{W}(a, e^*(a))}{1+\lambda} + \mu(a). \tag{26}$$

The procurement agency, however, has fixed a payment of the seller according to

$$|p_0| \;=\; \mu(a). \tag{27}$$

These two conditions are compatible if $\mathcal{W}(\cdot)/(1+\lambda) = 0$. As illustrated in figure 1, this is the case at $a = \tilde{a}$, which always implies overinvestment of the agency.

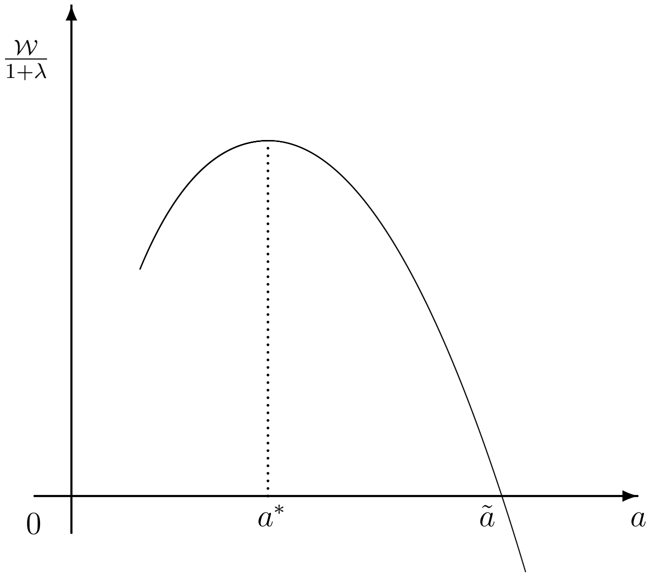

Figure 1: Overinvestment of procurement agency

3.4 The investment budget (date 0)

At date 0, the parliament wants to choose that budget b which yields ex-ante efficient investments of agency and seller. Anticipating the agency's overinvestment problem at date 1, therefore, the parliament would like to reduce the agency's investment incentives. This could be achieved by an investment budget $b < 0$. However, the limited liability of the procurement agency only allows an investment budget of $b \geq 0$. Therefore, the parliament cannot chose an investment budget which induces the first best. Instead, it chooses the lowest possible budget, $b = 0$, and has to accept the overinvestment of the agency (and of the seller).

3.5 Does the general efficiency constraint $\mathcal{W} \geq 0$ hold? (date 0)

The whole game should only be played if at date 0 the general efficiency constraint $\mathcal{W} \geq 0$ holds. Does the behavior of the parliament guarantee that this constraint is always met? Unfortunately, this is not the case. Since it has a positive expectation of the benefit of the project, the parliament will always start the project, even if this expectation falls below the sum of the expected production costs of the project and the investment costs of the agency and the seller. The general efficiency constraint will only hold if the project is characterized by a high expected social benefit and relatively low expected production costs and specific investment costs.

4 Summary

Bureaucratic behavior of public-procurement agencies a priori seems to exclude the possibility of welfare-optimal procurement. However, as this paper shows, this is not necessarily the case:

- First, if we assume one-sided investments of the seller, the seller will choose welfare-optimal investments and the project will only be carried out if this is welfare-improving. Hence, we have complete (second-best) welfare optimality in the case of one-sided investments.[17]

- Second, both-sided investments of agency and seller can be attained if the seller pays a lump sum for the right to participate in the procurement game which lump sum is used to finance the investments of the agency. Both agency and seller will necessarily overinvest in this case. This result is driven by the fact that the bureaucratic procurement agency maximizes its budget given the parliament's willingness to pay up to its evaluation of the benefits of the project. Project efficiency will be achieved in this case: after the investment costs have been sunk, only projects will be carried out whose social benefit (weakly) exceeds the production costs.

The positive results of the paper are driven by the parliament's choice to appropriate a project budget equal to the social benefit of the public project. The parliament knows that the bureaucratic procurement agency will never choose a smaller budget

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[17] Assuming that $\mathcal{W} \geq 0$ at date 0.

than these social benefits (regardless of whether it knows the production costs or not); it will pass on this budget to the seller whence the seller is offered a price which is equal to the social benefit of the project. Since the seller will only sign the project contract if this price is cost-covering, he decides in favor of the project if this is welfare-improving and otherwise does not sign the project contract. Therefore, the seller earns an ex-post rent which gives the correct incentives to induce his project-efficient decision. These ex-post rents, therefore, must not be taken away from the seller. On the other hand, the procurement agency can fully extract the ex-ante rents of the seller by stipulating a negative lump sum to be paid by the seller for the right to participate in the procurement game.

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