Renegotiating Government Procurement Contracts

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January 10, 2006

Abstract

The paper considers a public authority wishing to carry out a major public project. As a result of competitive bidding the project is assigned to the firm with the lowest bid. The cost of the project is uncertain in the sense that it can be low or high. After the bidding process the firm observes the true cost, while the government remains uninformed. After learning about the true cost, the firm can start to renegotiate the contract by proposing an increase of the price. Such an increase is only justified in case costs are high. If the government rejects the new price proposal, a law suit follows.

This problem is modeled as a signaling game. If the prior probability of the costs being low is low (high), a pooling (separating) equilibrium occurs. In the pooling equilibrium the government always accepts the firm's proposal. In the separating equilibrium the government can apply a mixed strategy when costs are high. Then it goes to court with a certain probability. Compared to a pure strategy, the mixed strategy has the advantage that legal costs are lower.

In our economic analysis we compare the American and the English rule for sharing the litigation expenses. A main result is that under the American rule the legal expenses are lower and welfare is higher in the mixed strategy equilibrium. We also study the importance of the firm's commitment to its new price proposal.

1 Introduction

This paper studies the problem of a public authority wishing to carry out a major public project, such as, e.g., the construction of a new highway, or the provision of a new telecommunications network. As a result of competitive bidding, the project is assigned to the firm with the lowest bid. This firm then signs a contract with the public authority to carry out the project at a fixed price, equal to its bid.

It seems very reasonable that legal regulations concerning government procurement contracts allow such contracts to be renegotiated. This is the case, e.g., in Belgium where renegotiations are possible in case unforeseen events seriously damage the contractor. According to Belgian jurisdiction, problems with the soil, floods, bankruptcy of a subcontractor, unforeseen hinder by other contractors, etc., could give rise to a renegotiation of the price. As a rule, damage is said to be serious if it amounts to at least 3 % of the agreed price.

Common experience in Belgium can be summarized by the following three observations. First, disputes between the public authority and the contractor only very rarely end up in court. In most cases a new price is negotiated by mutual agreement between the contractor and the government. Second, price revisions are often very significant. Examination of 663 contracts by the Flemish government[1] for the construction of roads in the period 1990-1995 reveals that price revisions result in new prices that are on average 10% higher than the original prices. The standard error on the average is only 1.46%. Finally, there is a common belief in the administration that quite often renegotiations have nothing to do with "unforeseen events". These events are only an official pretext used by the firm to start renegotiations. In the bidding game that precedes the renegotiation game firms often submit bids below the project's estimated cost. The firms' expectation is that, by renegotiating the contract later on, they will be able to recuperate these losses. The combined result of the bidding game and of the renegotiation game is that firms expect zero economic profits.

It can safely be assumed that the same observations can be made in many other countries. In this paper we present a game theoretical model that captures the main strategic elements of the foregoing renegotiation process. The conclusions we can draw from the analysis of this game turn out to be largely consistent with the three observations made above.

The basic reference for the study of government procurement contracts is Laffont and Tirole (1994). For our purposes, however, the literature on pretrial settlements is more directly relevant. This literature studies the strategic behavior of two players, a plaintiff and a defendant. The plaintiff claims to have been injured by the defendant. The main problem is then to analyze how different bargaining procedures and informational conditions affect the likelihood and the amount of a settlement.

There is a very extensive literature on this subject. A survey of this literature, up to 1989, is given in Cooter and Rubinfeld (1989). The models analyzed

[1] The authors are indebted to J.L.Van Belle for this information.

in this literature differ from each other in several important respects. First, there is the question which player proposes a settlement. In some papers (P'ng (1983), Bebchuk (1988), Hylton (1993)) the defendant proposes a settlement. In others (Nalebuff (1987), Bebchuk (1984) Howard et al.(2000)) the plaintiff makes such a proposal. Second, there is the question of which player has private information about which aspect of the problem. In some models the plaintiff has private information (Bebchuk (1988), Reinganum and Wilde (1986), Shavell (1989), Farmer and Pecorino (1994)), while in other models the defendant has private information (Hylton (1993), P'ng (1983), Howard et al. (2000), Nalebuff (1997), Bebchuk (1984), Spier (1992)). The content of the private information can refer to the probability of one side winning the trial, to the extent of the injury, to the plaintiff's attitude toward risk, etc. Osborne (1999) makes an interesting empirical analysis of the importance of which player has private information. Thirdly, are the players assumed to be risk neutral or risk averse? Most papers assume risk neutrality for both players. A notable exception is Farmer and Pecorino (1994) who study the importance of asymmetric information in connection with the plaintiff's attitude toward risk. Perloff et al. (1996) conduct an empirical study and conclude that risk aversion plays an important role in explaining why antitrust cases settle instead of going to trial. Finally, the player who proposes the settlement can, or cannot, commit to litigation in case the proposal is rejected. In some papers (Zhang and Thoman (1999), Bebchuk (1984), Howard et al. (2000)) such a commitment is assumed.

In the above literature special attention is often also given to the strategic and welfare consequences of how litigation expenses are shared between the two parties. Does each party pay its own legal expenses (the American rule), or does the loser pay all these expenses (the English rule)? This is a major issue in, e.g., Gong and McAfee (2000) and Spier (1994) . Both studies use a framework where the allocation rule is sensitive to pretrial activity. A related issue is the importance of the type of contract between the plaintiff and its lawyer: is the lawyer paid a fixed fee or a contingency fee (Rickman (1999))?

The analysis of the renegotiation of a procurement contract has some similarity to the above literature of pretrial settlements, but it also has its own distinctive characteristics. The basic setup is as follows. The two players are the firm and the government. The firm can be assumed to correspond to the plaintiff. In some respects the government can be associated with the defendant, even though the government has not really injured the firm. Clearly, the firm has private information on the true cost of the project. For simplicity we assume that this cost can only have two realizations: low or high. The firm takes the initiative to propose a new price, which is higher than the original one. Hence, like in Reinganum and Wilde (1986), the informed player makes the pretrial proposal. A price increase is justified only if costs are high. In case the government rejects the proposal a law suit results, where the firm thus wins (loses) the trial if costs turn out to be high (low). The payoff functions are specified and interpreted within the context of a procurement contract. We also study the importance of the American versus the English rule of sharing litigation expenses. We assume that the firm commits to go to trial if the government does not accept the proposal. To study the impact of this commitment, later on we also analyze the case in which the firm does not make such a commitment. Finally, we assume that the two players are risk neutral, and that lawyers are paid a fixed fee.

The resulting model is a signaling game. We show that two types of equilibria can occur. First, a pooling equilibrium exists in which the firm - independent of the cost realization - proposes a particular settlement that is always accepted by the government. Such an equilibrium exists provided that there is a high prior probability that costs are high. In a setting where it is possible for the plaintiff to costlessly reveal his private information, Shavell (1989) obtains the same result. Second, in case of a low prior probability that costs are high, the government is more suspicious about price proposals. Then a separating equilibrium arises, in which the government starts a law suit in case costs are high. In one interesting variant of this equilibrium the government uses a mixed strategy, which - contrary to many applications in the literature - has a straightforward interpretation: the government rejects a fixed percentage of the proposed price revisions which reveal a high cost. In this way the government is able to reduce legal costs.

Using mainly the notion of Pareto-dominance, we are able to solve the problem of multiplicity of equilibria. For each value of the prior probability that costs are low, we identify a unique solution of the game.

If the firm commits to go to court in case the government rejects the proposal, the government will always accept a proposed price increase, provided that the expenses required to win the case exceed the benefit of winning the case. Such suits are called nuisance suits. We show that, in case the firm is no longer committed to go to court, there is no room for such a nuisance suit. Consequently, in the pooling equilibrium both the low and the high cost firm are better off in case they do commit. In the separating equilibrium this is also true for the low cost firm.

In case the firm's cost is high and the government loses the trial, we show that the government's litigation expenses are of great strategic importance. Increases of these expenses will raise the firm's renegotiation price, both in the pooling equilibrium and in the separating equilibrium under high costs. These expenses include reports of experts hired by the court, and opportunity costs resulting from equipment remaining idle during the litigation period. In reality these expenses can be very high, relative to the original price. We further show that the way litigation costs are shared (English or American rule) has considerable influence on the outcome. As in Shavell (1982) and Bebchuk (1984), in our mixed strategy separating equilibrium we find that the English rule raises the number of trials.

The paper is structured as follows. Section 2 describes the game. Section 3 analyzes separately all decisions that have to be taken in the game, for given beliefs. These results are used in Section 4 where the equilibria of the whole game are derived. Section 5 contains the economic analysis of the equilibria. In order to study the implications of commitment, this section also contains an analysis of the game where the firm can withdraw its proposal. Section 6 concludes.

2 Description of the renegotiation game

In this section we describe the extensive form of the renegotiation game. Suppose a public authority and a private firm have signed a contract in which the firm promises to carry out a project at a fixed price P. When realizing the project, the firm may have good luck or bad luck: its cost can be low, C^L, or high, C^H, with $C^H \rangle C^L$. Nature determines whether C^Hor C^L applies, using a commonly known probability distribution, which assigns a probability of θ to C^L, and of $1-\theta$ to C^H. The firm is assumed to know whether C^L or C^H applies. The government, however, does not know the firm's true cost. It only knows the probability distribution θ, $1-\theta$. The firm can then propose a revised price $\tilde{P}$ ($\geqslant P$). Only in case Nature has drawn C^H, a price revision is justified. When being informed about the value of $\tilde{P}$, the government does not know whether this request for a price revision is justified or not.

After being informed about $\tilde{P}$, the government can accept or reject $\tilde{P}$. If the government accepts, then in the original contract P is replaced by $\tilde{P}$. If the government rejects $\tilde{P}$, the case is brought to court. We assume that the court is able to determine the true cost of the firm. If then C^L applies, the court decides that the original price P should apply. If, however, C^H applies, the court decides that the price P must be increased to $P + \Delta C$, where $\Delta C = C^H - C^L$. The legal expenses of the firm are denoted by T_{FW} if the firm wins (C^H applies), and by T_{FL} if the firm looses (C^L applies). Similarly, the legal expenses of the government are denoted by T_{GW} if the government wins (C^L applies), and by T_{GL} if the government looses (C^H applies).

The game tree is presented in Figure 1. The symbol W indicates the government's maximal willingness to pay for the project. N refers to nature, F to the firm, and G to the government. The information set (dotted line) in the game tree indicates that the government does not know the type of the firm (high cost or low cost firm) that made the proposal.The possibility that the firm does not make a proposal $\tilde{P}$ is also explicitly included.

In the following sections it will often be useful to assume that

$$\Delta C > T_{FW} + T_{GW}. \tag{1}$$

It means that the expenses required to win a case before the court are not "too large". We will also often use the weaker inequality

$$\Delta C + T_{GL} > T_{GW}. \tag{2}$$

Clearly, (2) is implied by (1).

The game described above is a signaling game. We are interested in the perfect Bayesian equilibria of this game. It is well known that for signaling games the notion of perfect Bayesian equilibrium is equivalent to the notion of a sequential equilibrium (see, e.g., Fudenberg and Tirole, 1991, Chapter 8).

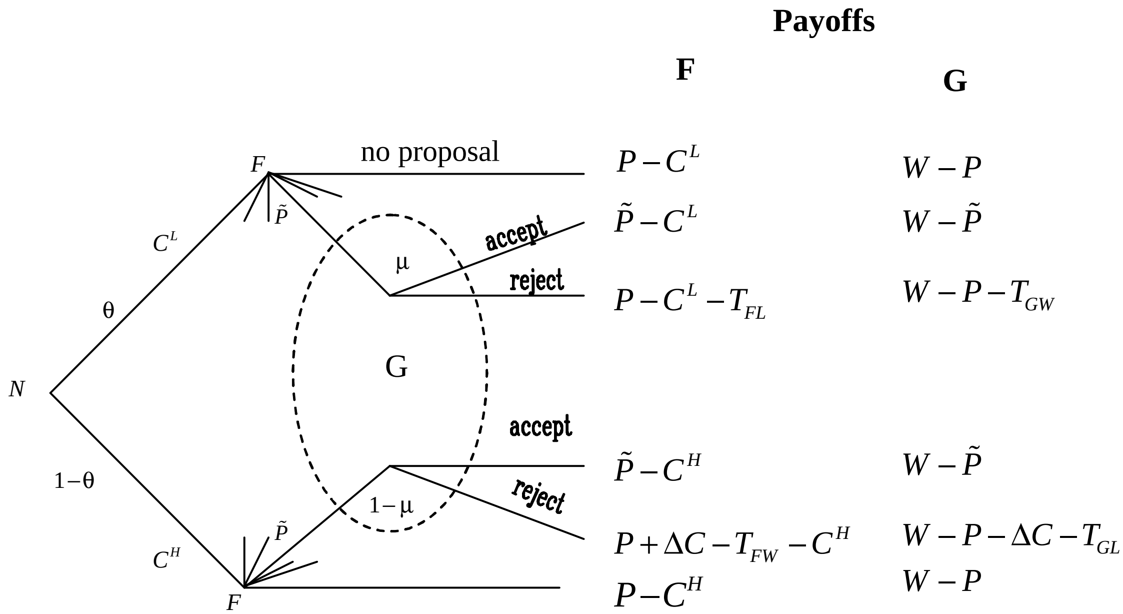

Figure 1: The game tree

A strategy for the firm states a price proposal $\tilde{P}$ for each possible type of firm. We will denote such a strategy as $\tilde{P}(C^L)$ and $\tilde{P}(C^H)$. A strategy for the government specifies, for each possible value of $\tilde{P}$ ($\geq P$), whether the government should accept or reject this proposal. We must also specify beliefs for the government. We use the notation $\mu(\tilde{P})$ to denote the probability with which the government believes that the proposal $\tilde{P}$ was made by a low cost firm. Throughout the paper we assume that the function $\mu(\tilde{P})$ is continuous in $\tilde{P}$.

At some points in this paper we employ the notion of social welfare. Social welfare is here defined as the sum of the payoffs of the two players. If the court is not involved, this sum equals the difference between the government's maximal willingness to pay and the cost of the project. If the court is involved, we have to subtract from this difference the deadweight legal expenses. These are given by $T_{FL} + T_{GW}$ if costs are low, and by $T_{FW} + T_{GL}$ if costs are high.

3 Analysis of separate decisions in the game, for given beliefs

In this section we analyze the decisions of all the players separately: the firm's choice to renegotiate or not, the firm's choice of $\tilde{P}$ if it decides to renegotiate, and the decision of the government to accept or to reject a proposal $\tilde{P}$. For the moment we analyze these decisions assuming that, for all $\tilde{P} \geq P$, the value $\mu\left(\tilde{P}\right)$ is given. In Section 4 we will consider the complete game, and take into account the implications of separating and pooling equilibria for the value of $\mu\left(\tilde{P}\right)$, for values of $\tilde{P}$ on and off the equilibrium path. In this section we further assume that the government accepts a proposal when it is indifferent between accepting and rejecting it.

We first analyze the government's acceptance-rejection decision. After that we analyze the firm's decision problem: should it renegotiate or not, and what is the optimal value of $\tilde{P}$ in case it wants to renegotiate?

3.1 Government's acceptance-rejection decision

Suppose the firm proposes a revised price $\tilde{P}$. If the government accepts this proposal, its payoff equals $W - \tilde{P}$. If the government rejects this proposal, its expected payoff is given by

$$\mu\left(\tilde{P}\right)[W - P - T_{GW}] + \left[1 - \mu\left(\tilde{P}\right)\right][W - P - \Delta C - T_{GL}] =$$

$$W - P - \left[1 - \mu(\tilde{P})\right][\Delta C + T_{GL}] - \mu(\tilde{P})T_{GW}. \quad (3)$$

The government will accept a proposal $\tilde{P}$ if and only if

$$W - \tilde{P} \geq \mu\left(\tilde{P}\right)[W - P - T_{GW}] + \left[1 - \mu\left(\tilde{P}\right)\right][W - P - \Delta C - T_{GL}].$$

This is equivalent to

$$\tilde{P} \leq P + \mu\left(\tilde{P}\right)T_{GW} + \left[1 - \mu\left(\tilde{P}\right)\right][\Delta C + T_{GL}]. \quad (4)$$

From (2) it follows that

$$P + T_{GW} \leq P + \mu\left(\tilde{P}\right)T_{GW} + \left[1 - \mu\left(\tilde{P}\right)\right][\Delta C + T_{GL}] \leq P + \Delta C + T_{GL}. \quad (5)$$

From (4) and (5) two implications can be derived. First, the government will certainly reject a proposal $\tilde{P}$ such that

$$\tilde{P} > P + \Delta C + T_{GL}. \quad (6)$$

If the government rejects a proposal and goes to court, then in the worst case it has to pay $P + \Delta C + T_{GL}$. Therefore, the government should never accept a proposal exceeding this worst case payment. Second, the government will always accept a proposal $\tilde{P}$ in the interval

$$P \leq \tilde{P} \leq P + T_{GW}, \quad (7)$$

even if it is fully convinced that the firm is of the low cost type. The legal expenses T_{GW} required to win the case before the court exceed the benefits of a reduction of $\tilde{P}$ to P. Court cases of this type are called "nuisance" suits.

For proposals $\tilde{P}$ in the interval

$$P + T_{GW} \leq \tilde{P} \leq P + \Delta C + T_{GL},$$

the government's decision to accept or reject will depend on the exact values of $\tilde{P}$ and $\mu(\tilde{P})$.

Figure 2 illustrates the government's decision. The government's payoff if it accepts $\tilde{P}$, viz. $W - \tilde{P}$, is drawn as a function of $\tilde{P}$. The government's expected payoff if it rejects $\tilde{P}$, (3), depends on the shape of the belief function $\mu\left(\tilde{P}\right)$. If, for all $\tilde{P} \geq P$, the value of $\mu\left(\tilde{P}\right)$ is constant, the government's expected utility (3) will also be constant, independent of $\tilde{P}$. Figure 2 depicts three special cases where $\mu\left(\tilde{P}\right)$ is equal to 0, θ, and 1. Figure 2 also presents the "rejection payoff" (3) for an arbitrary belief function $\mu(\tilde{P})$. This expected payoff always lies between the two horizontal lines corresponding to $\mu = 0$ and $\mu = 1$.

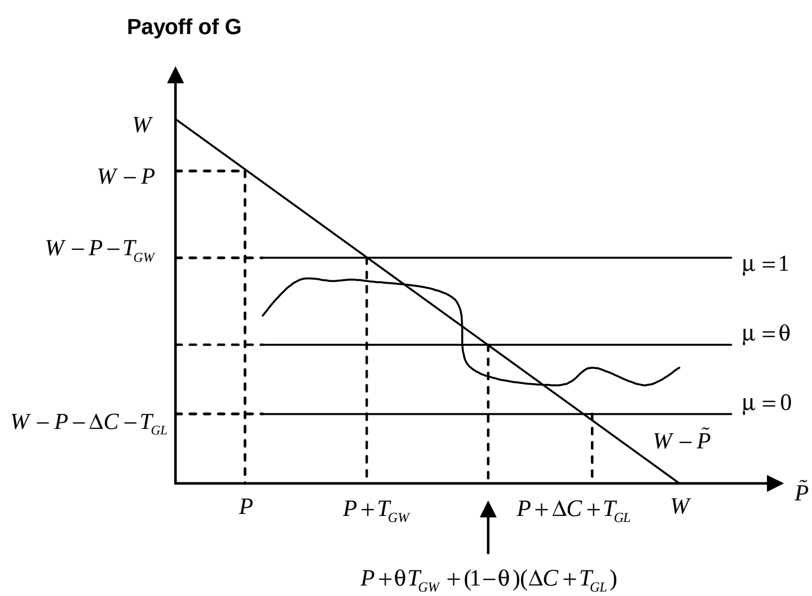

Figure 2: Government's payoffs

It is optimal for the government to accept (reject) a proposal $\tilde{P}$, if in Figure 2 the straight line $W - \tilde{P}$ lies above (below) the curve representing the rejection payoff. From this figure it is also clear that the government will always accept proposals in the interval (7), while it will always reject proposals satisfying (6).

3.2 Firm's choice to renegotiate or not

As the government will always accept proposals $\tilde{P}$ in the interval (7), it follows that the firm will always renegotiate, whatever its costs are, and that it will make a proposal $\tilde{P}$ at least equal to $P + T_{GW}$. Hence, an optimal proposal by the firm will always satisfy the inequality

$$\tilde{P} \geq P + T_{GW}. \tag{8}$$

3.3 Firm's choice of $\tilde{P}$

We now determine the firm's optimal choice of $\tilde{P}$. First, we consider the case in which costs are low. This is followed by the case of high costs.

3.3.1 Firm's choice of $\tilde{P}$ when its cost is C^L

Consider the firm's choice of $\tilde{P}$ in case its cost is C^L. The firm's payoff when the government accepts is

$$\tilde{P} - C^L. \tag{9}$$

Since the aim of the firm is to maximize its payoff, (4) and (9) imply that, if the firm wants the government to accept, the best value of $\tilde{P}$ is the highest value of $\tilde{P}$ for which the equality

$$\tilde{P} = P + \mu\left(\tilde{P}\right) T_{GW} + \left[1 - \mu\left(\tilde{P}\right)\right] \left[\Delta C + T_{GL}\right] \tag{10}$$

holds. Let us denote this highest value by $\tilde{P}^*$, which is thus characterized by[2]

$$\tilde{P}^* = P + \mu\left(\tilde{P}^*\right) T_{GW} + \left[1 - \mu\left(\tilde{P}^*\right)\right] \left[\Delta C + T_{GL}\right]. \tag{11}$$

Note that, by definition of $\tilde{P}^*$, all proposals $\tilde{P}$ such that

$$\tilde{P} > \tilde{P}^* \tag{12}$$

will be rejected. The payoff for $\tilde{P} = \tilde{P}^*$ then equals

$$P + \mu\left(\tilde{P}^*\right) T_{GW} + \left[1 - \mu\left(\tilde{P}^*\right)\right] \left[\Delta C + T_{GL}\right] - C^L. \tag{13}$$

[2] Note that $\tilde{P}^*$ is a fixed point of the function on the RHS of (10). As this function is continuous in the interval $[P + T_{GW}, P + \Delta C + T_{GL}]$, with functional values in the same interval, such a fixed point must always exist.

If the government rejects a proposal $\tilde{P}$, the firm's payoff is

$$P - T_{FL} - C^L. \tag{14}$$

From (13) and (14) we conclude that the firm's payoff will be maximized when $\tilde{P} = \tilde{P}^*$. The low cost firm wants to make a proposal which is accepted. It does not want to go to court, because then it would incur legal expenses, while the court will never allow a price increase. We summarize this result in the following lemma.

Lemma 1 *The low cost firm will always propose $\tilde{P} = \tilde{P}^*$. The government accepts this proposal.*

3.3.2 Firm's choice of $\tilde{P}$ when its cost is C^H

If the firm's cost is high, its payoff when the government accepts is equal to

$$\tilde{P} - C^H. \tag{15}$$

Expressions (4) and (15) imply that, if the firm wants the government to accept, it proposes $\tilde{P} = \tilde{P}^*$, in which case the firm's payoff equals

$$P + \mu\left(\tilde{P}^*\right) T_{GW} + \left[1 - \mu\left(\tilde{P}^*\right)\right] [\Delta C + T_{GL}] - C^H. \tag{16}$$

If the government rejects, the firm's payoff is

$$P + \Delta C - T_{FW} - C^H = P - C^L - T_{FW}. \tag{17}$$

Expressions (16) and (17) imply that the firm will propose $\tilde{P} = \tilde{P}^*$ if and only if

$$P + \mu\left(\tilde{P}^*\right) T_{GW} + \left[1 - \mu\left(\tilde{P}^*\right)\right] [\Delta C + T_{GL}] - C^H \geq P - C^L - T_{FW},$$

which is equivalent to

$$\mu\left(\tilde{P}^*\right) \leq \frac{T_{GL} + T_{FW}}{\Delta C - T_{GW} + T_{GL}}. \tag{18}$$

By (1) and (2) the RHS of (18) is positive and smaller than one. This proves the following lemma.

Lemma 2 *The high cost firm will propose $\tilde{P} = \tilde{P}^*$ if and only if (18) holds. The government accepts this proposal. If (18) does not hold, the high cost firm will make any proposal satisfying (12), which will be rejected by the government.*

4 Analysis of the complete game

We now combine the analysis of the previous section with restrictions we want to impose on the government's beliefs $\mu(\tilde{P})$. This will allow us to derive complete solutions (perfect Bayesian equilibria) of the game. In Subsection 4.1 we assume the government applies only pure strategies, while in the second subsection we allow for mixed strategies. Finally, in Subsection 4.3, we identify a unique equilibrium for each value of θ.

4.1 Optimal firm and government strategy

In this subsection, as in Section 3, we assume that the government accepts a proposal when it is indifferent between accepting and rejecting it. Expression (18) suggests that it is best to analyze two separate cases. First, let us assume that (18) holds. From the previous two lemmata we know that in this case the firm chooses the proposal $\tilde{P}^*$, as given by (11). This holds, independent of whether the cost C^L (Lemma 1) or C^H (Lemma 2) applies. The implication is that a *pooling equilibrium* results in which the firm proposes $\tilde{P}^*(C^L) = \tilde{P}^*(C^H) = \tilde{P}^*$. The government accepts this proposal. The pooling equilibrium also requires that

$$\mu\left(\tilde{P}^*\right) = \theta. \tag{19}$$

Combining this with (18) gives

$$\theta \leq \frac{T_{GL} + T_{FW}}{\Delta C - T_{GW} + T_{GL}} = \theta^*. \tag{20}$$

The firm's payoff is given by $\tilde{P}^* - C^L$ when C^L applies, and by $\tilde{P}^* - C^H$ when C^H applies. Recall that, since $\tilde{P}^*$ is the highest value of $\tilde{P}$ satisfying (10), the government rejects all proposals $\tilde{P} > \tilde{P}^*$.

We summarize these findings in the following proposition.

Proposition 1 *Assume that (20) holds. Then the following combination of strategies and beliefs constitutes a pooling equilibrium.*

Strategy of the firm :

$$\tilde{P}^*\left(C^L\right) = \tilde{P}^*\left(C^H\right) = \tilde{P}^* = P + T_{GW} + [1-\theta]\left[\Delta C - T_{GW} + T_{GL}\right],$$

Strategy of the government :
Accept a proposal $\tilde{P}$ if and only if

$$\tilde{P} \leq P + \mu\left(\tilde{P}\right) T_{GW} + \left[1 - \mu\left(\tilde{P}\right)\right]\left[\Delta C + T_{GL}\right].$$

Beliefs of the government :
The beliefs of the government satisfy

$$\mu\left(\tilde{P}^*\right) = \theta.$$

This equilibrium is illustrated in Figure 3.

Next, we suppose that

$$\mu\left(\tilde{P}^*\right) > \frac{T_{GL} + T_{FW}}{\Delta C - T_{GW} + T_{GL}}. \tag{21}$$

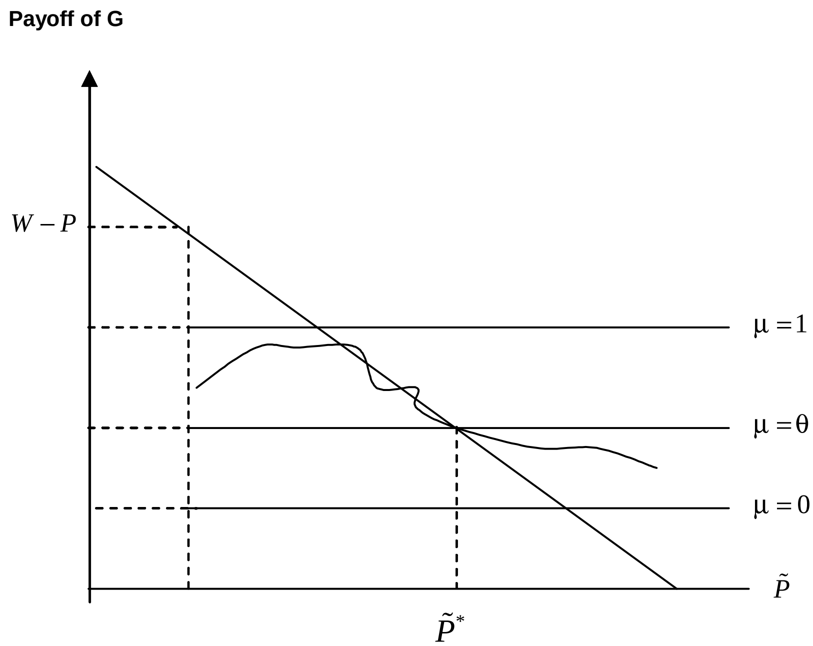

Figure 3: The government's payoff in the pooling equilibrium

Assume first that C^H prevails. Under (21) the highest proposal that the government will accept, $\tilde{P}^*$, is too low for the high cost firm. For this reason, this firm's proposal will satisfy (12), so that

$$\tilde{P}^*\left(C^H\right) > \tilde{P}^*. \tag{22}$$

The government rejects this proposal, and loses the resulting court case. The court will fix the price at $P + \Delta C$, and the firm's payoff equals (17).

When C^L prevails, it follows from Lemma 1 that the firm will propose $\tilde{P}^*(C^L) = \tilde{P}^*$. Its payoff is then $\tilde{P}^* - C^L$.

We can summarize the foregoing analysis as follows. The high cost firm will make any proposal $\tilde{P}^*\left(C^H\right)$ satisfying (22). The low cost firm will propose $\tilde{P}^*$. Therefore, firms with different costs make different proposals, which results in a *separating equilibrium*. In equilibrium beliefs have to satisfy Bayes' theorem. Therefore, the function μ must satisfy

$$\mu\left(\tilde{P}^*\left(C^L\right)\right) = 1 \tag{23}$$

and

$$\mu\left(\tilde{P}^*\left(C^H\right)\right) = 0. \tag{24}$$

Combining this with (11), we obtain that

$$\tilde{P}^*\left(C^L\right) = \tilde{P}^* = P + T_{GW}. \tag{25}$$

It follows that, when C^L prevails, all proposals exceeding $\tilde{P}^*\left(C^L\right)$ will be rejected (see (12)). The proposal $\tilde{P}^*\left(C^L\right)$ gives the payoff $P + T_{GW} - C^L$.

We can sharpen the condition for the choice of $\tilde{P}$ under C^H. Indeed, due to (24) and (11), inequality (22) now becomes

$$\tilde{P}^*\left(C^H\right) > P + \Delta C + T_{GL}. \tag{26}$$

From (2), (25) and (26) we also obtain that $\tilde{P}^*\left(C^H\right) > \tilde{P}^*\left(C^L\right)$.

Furthermore, it is easy to see that inequality (21) ultimately reduces to (1). This follows immediately from $\tilde{P}^* = \tilde{P}^*(C^L)$ and from $\mu(\tilde{P}^*) = 1$ (see (23)).

We summarize the above results in the following proposition.

Proposition 2 *The following combination of strategies and beliefs constitutes a separating equilibrium.*

Strategy of the firm:

$$\tilde{P}^*\left(C^L\right) = \tilde{P}^* = P + T_{GW}.$$

$\tilde{P}^*\left(C^H\right)$ is any value such that

$$\tilde{P}^*\left(C^H\right) > P + \Delta C + T_{GL}.$$

Strategy of the government:
Accept a proposal $\tilde{P}$ if and only if

$$\tilde{P} \leq P + \mu\left(\tilde{P}\right) T_{GW} + \left[1 - \mu\left(\tilde{P}\right)\right]\left[\Delta C + T_{GL}\right].$$

Beliefs of the government:
Beliefs $\mu\left(\tilde{P}\right)$ must satisfy

$$\mu\left(\tilde{P}^*\left(C^L\right)\right) = 1,$$

$$\mu\left(\tilde{P}^*\left(C^H\right)\right) = 0.$$

This equilibrium is illustrated in Figure 4.

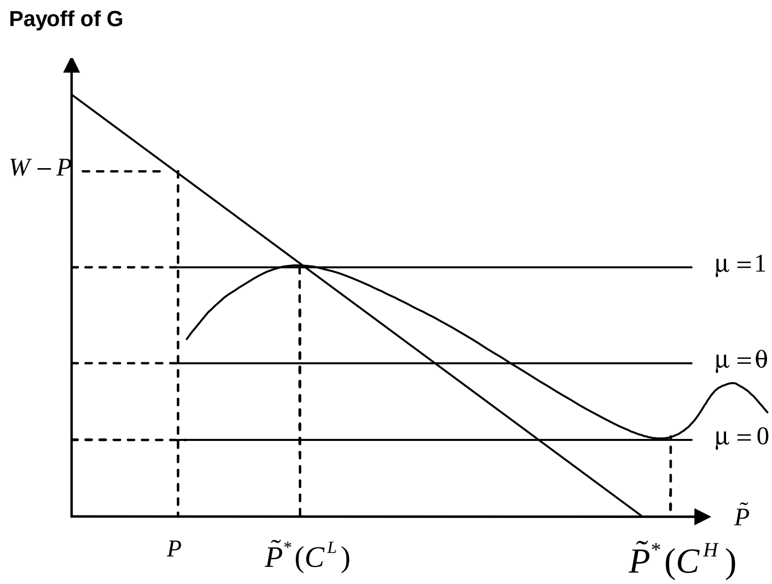

Figure 4: The government's payoff in the separating equilibrium

4.2 The separating equilibrium with mixed strategies.

In the separating equilibrium of Proposition 2 the government rejects the proposal $\tilde{P}^*\left(C^H\right)$ of the high cost firm, and the case is then brought to court. Now we want to show that, when receiving the proposal from the high cost firm, the government can save on legal expenses by applying a mixed strategy. The constraint for a separating equilibrium to work is that the low cost firm is not tempted to announce $\tilde{P}^*\left(C^H\right)$. This requires that the government's threat of going to court when the firm announces $\tilde{P}^*\left(C^H\right)$ must be sufficiently strong. In the pure strategy equilibrium of Proposition 2 this is the case: the probability that the government goes to court is one.

Allowing the government to use a mixed strategy, the probability that the government will accept the firm's proposal $\tilde{P}^*\left(C^H\right)$ is denoted by $\lambda \in [0,1]$, where λ is a decision variable of the government. Mixed strategies for the government will only be applied when the government is indifferent between accepting and rejecting a proposal, i.e., when the equality

$$\tilde{P} = P + \mu\left(\tilde{P}\right)T_{GW} + \left[1 - \mu\left(\tilde{P}\right)\right]\left[\Delta C + T_{GL}\right]$$

holds. We want this equality to hold for $\tilde{P} = \tilde{P}^*(C^H)$. Using (10) and (24), this implies that

$$\tilde{P}^*\left(C^H\right) = P + \Delta C + T_{GL}. \tag{27}$$

The government must take care that the low cost firm is not tempted to propose $\tilde{P}^*\left(C^H\right)$. This implies that λ should satisfy

$$P + T_{GW} - C^L \geq \lambda\left[P + \Delta C + T_{GL} - C^L\right] + [1-\lambda]\left[P - C^L - T_{FL}\right],$$

which is equivalent to

$$\lambda \leq \frac{T_{GW} + T_{FL}}{\Delta C + T_{GL} + T_{FL}}.$$

At the same time, to keep the litigation costs as low as possible, the government wants to fix the probability λ of accepting the firm's offer $\tilde{P}^*\left(C^H\right)$ as high as possible. We conclude that when the firm announces a renegotiation price of $\tilde{P}^*\left(C^H\right) = P + \Delta C + T_{GL}$, it is optimal for the government to accept this proposal with probability

$$\lambda = \frac{T_{GW} + T_{FL}}{\Delta C + T_{GL} + T_{FL}}. \tag{28}$$

Note that, by (2), $\lambda < 1$. It is easy to understand that it is also in the interest of the high cost firm that the government applies a mixed strategy. To the extent that the government accepts $\tilde{P}^*\left(C^H\right) = P + \Delta C + T_{GL}$, the high cost firm is better off than in the case a proposal is rejected. The net price it then receives is equal to $P + \Delta C - T_{FW}$, which is smaller than $\tilde{P}^*\left(C^H\right) = P + \Delta C + T_{GL}$. Hence, the high cost firm will propose (27).

We now have established the following proposition.

Proposition 3 *The following combination of strategies and beliefs constitutes a separating equilibrium.*

Strategy of the firm:

$$\tilde{P}^*\left(C^L\right) = \tilde{P}^* = P + T_{GW}.$$

$$\tilde{P}^*\left(C^H\right) = P + \Delta C + T_{GL}.$$

Strategy of the government:

The government accepts any $\tilde{P}$ satisfying $\tilde{P} \leq P + T_{GW}$.

The government rejects all proposals $\tilde{P} > P + T_{GW}$, with $\tilde{P} \neq P + \Delta C + T_{GL}$.

The government accepts the proposal $\tilde{P} = P + \Delta C + T_{GL}$ with probability

$$\lambda = \frac{T_{GW} + T_{FL}}{\Delta C + T_{GL} + T_{FL}}.$$

Beliefs of the government:

Beliefs $\mu\left(\tilde{P}\right)$ satisfy

$$\mu\left(\tilde{P}^*\left(C^L\right)\right) = 1,$$

$$\mu\left(\tilde{P}^*\left(C^H\right)\right) = 0.$$

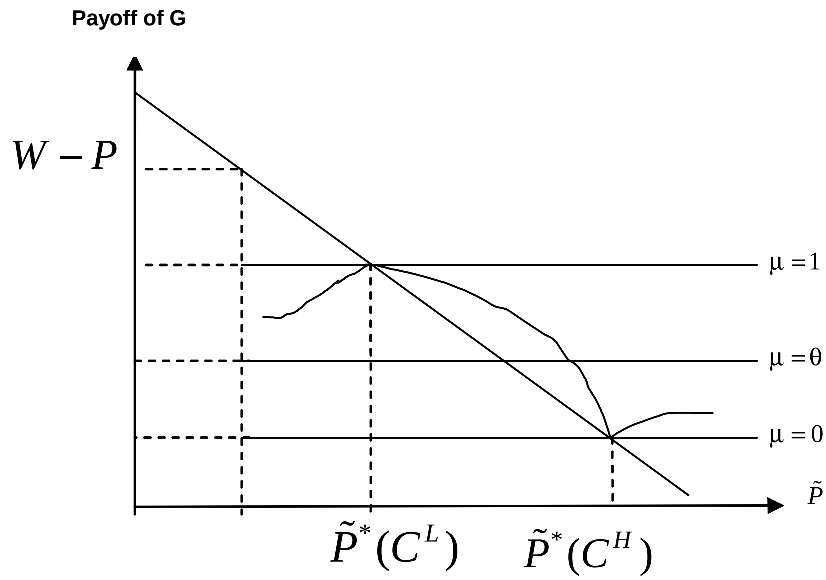

Figure 5: The government's payoff in the separating equilibrium with mixed strategies.

This equilibrium is illustrated in Figure 5.

Using (2), it follows that $\tilde{P}^*(C^H) \rangle \tilde{P}(C^L)$, which was also the case in the pure strategy equilibrium of Proposition 2.

4.3 Equilibrium Selection

From the analysis in the previous two subsections we conclude that the signaling game has multiple equilibria. For values of θ smaller than or equal to θ^* we have three different equilibria, presented in Propositions 1, 2 and 3. For values of θ exceeding θ^*, we have the two equilibria of Propositions 2 and 3. We now resolve this problem of multiple equilibria. In the end we will have, for each value of θ, a unique equilibrium[3].

As a first step we eliminate all Pareto-dominated equilibria. As far as the government is concerned, it is easy to check that the government's expected

[3] The reader can easily verify that all the equilibria described in Propositions 1, 2 and 3 also satisfy the intuitive criterion of Cho and Kreps (1987).

payment is the same in the three equilibria. In the equilibrium of Proposition 1 this expected payment equals

$$P + T_{GW} + (1 - \theta) [\Delta C - T_{GW} + T_{GL}] . \tag{29}$$

In the equilibrium of Proposition 2 this expected payment is given by

$$\theta(P + T_{GW}) + (1 - \theta) [P + \Delta C + T_{GL}] \tag{30}$$

It is easy to see that (29) is equal to (30). Finally, in the equilibrium of Proposition 3, if costs are high the government pays $P + \Delta C + T_{GL}$, irrespective of whether it accepts or rejects the firm's proposal. The total expected payment of the government is then again equal to (30).Therefore, when applying the notion of Pareto-dominance, we only have to consider the payoffs of the low cost firm and of the high cost firm, and not the payoff of the government.

It is clear now that the equilibrium of Proposition 3 Pareto-dominates the equilibrium of Proposition 2. The low cost firm and the government are indifferent between the two equilibria. The high cost firm strictly prefers the equilibrium of Proposition 3. We therefore reject the equilibrium of Proposition 2. When in the sequel we talk about the separating equilibrium, we always refer to the equilibrium of Proposition 3.

We know that the pooling equilibtium does not exist for $\theta > \theta^*$, so that only the separating equilibrium (of Proposition 3) remains. Assume now that $\theta \leq \theta^*$, and let us compare the pooling and the separating equilibrium. It is clear that the low cost firm is better off in the pooling equilibrium. The high cost firm will also be better off in the pooling equilibrium if

$$P+T_{GW}+(1-\theta)(\Delta C-T_{GW}+T_{GL}) \geqslant \lambda(P+\Delta C+T_{GL})+(1-\lambda)(P+\Delta C-T_{FW}).$$

Given the value of λ in (28), this is equivalent to

$$\theta \leq \frac{T_{GL} + T_{FW}}{\Delta C + T_{GL} + T_{FL}} = \hat{\theta}. \tag{31}$$

Comparing $\hat{\theta}$ and θ^*, it is clear that $\hat{\theta} \leq \theta^*$. It follows that for all values of θ in the interval $0 \leq \theta \leq \hat{\theta}$, the pooling equilibrium Pareto-dominates the separating equilibrium.

There remains the possibility that θ belongs to the interval $\hat{\theta} \leq \theta \leq \theta^*$. For these values of θ the low cost firm prefers the pooling equilibrium, while the high cost firm prefers the separating equilibrium. So neither equilibrium Pareto-dominates the other. We now show, however, that for values of θ in this interval, the pooling equilibrium is very unreasonable. Indeed, if the government would observe the proposal of the pooling equilibrium, it will naturally believe that this proposal was made by the low cost firm, and hence it will reject this proposal. In other words, the beliefs as specified in the pooling equilibrium are now very unreasonable. The low cost firm, expecting that the government would reject the proposal of the pooling equilibrium, will therefore follow the separating equilibrium. For the high cost firm this separating equilibrium is better than the pooling equilibrium. Therefore, we expect that the firm , whatever its cost, will always play the separating equilibrium.

Summarizing the above arguments, we obtain a unique equilibrium for each value of θ. *If θ belongs to the interval $0 \leq \theta \leq \hat{\theta}$, the pooling equilibrium will be played, while the separating equilibrium will prevail for θ in the interval* $\hat{\theta} < \theta \leq 1$.

5 Economic Analysis

In this section we first discuss the equilibria obtained in the previous section. We then consider the important issue of the allocation of litigation costs. Finally, we examine a related game in which the firm does not commit to go to court if the government rejects its proposal.

5.1 General discussion, including comparative statics

We first discuss the *pooling equilibrium of Proposition 1.* In this equilibrium the proposal $\tilde{P}^*$ is always accepted by the government, so that the parties never go to court. It is, of course, essential that a court exists, but it has no cases to handle. No litigation expenses (T_{GL}, T_{GW} ,...) are ever actually paid. At the same time, however, these expenses have a great strategic importance in determining the value of $\tilde{P}^*$ and of θ^*.

A necessary condition for this equilibrium to exist is that inequality (20) holds. This means that the probability that the firm is of the high cost type must be sufficiently high. As the government does not want a law suit with a high cost firm, the maximal proposal it is willing to accept, $\tilde{P}^*$, will be relatively high. For the high cost firm it is then better to propose $\tilde{P}^*$ than to make a proposal which is rejected. This implies that $\tilde{P}^*$ is the best proposal for any type of firm. In the pooling equilibrium $\tilde{P}^*$ is equal to

$$\tilde{P}^* = P + T_{GW} + (1-\theta)(\Delta C - T_{GW} + T_{GL}).$$

By (2) we know that $\Delta C - T_{GW} + T_{GL}$ is positive. We already noted before that a firm will always make a proposal of at least $P + T_{GW}$ (see (8)). We then see that $\tilde{P}^*$ exceeds this lower bound by $(1-\theta)(\Delta C - T_{GW} + T_{GL})$. This can also be expressed as

$$\frac{\tilde{P}^* - P}{P} = \frac{T_{GW}}{P} + (1-\theta)(\frac{\Delta C}{P} - \frac{T_{GW}}{P} + \frac{T_{GL}}{P}). \tag{32}$$

This equality represents the fraction by which $\tilde{P}^*$ exceeds P. Several interesting conclusions follow from (32). First, this fraction will increase when $\frac{T_{GW}}{P}$ increases. We already discussed the importance of T_{GW}. Second, the fraction (32) also increases when $(1-\theta)$ increases. If there is a larger probability that the firm is of the high cost type, the government will be more willing to accept a higher price proposal. Third, an increase in $\frac{\Delta C}{P}$ will also increase (32): the larger the cost difference ΔC, relative to P, the more the government is willing to accept a higher price increase. Finally, (32) also depends positively on $\frac{T_{GL}}{P}$. This is a variable of great strategic importance. The expenses T_{GL} may include (i) the cost of expert reports, ordered by the court, and (ii) the opportunity cost of capacity remaining idle during the litigation period. In real world situations these costs can become very high, relative to P. Government officials watch these costs very closely, and they would be extremely unhappy if they would ever be forced to pay these expenses. Firms, of course, will exploit this situation.

It is often claimed that in the bidding game preceding the renegotiation game the firm could afford a bid below cost, because the firm can compensate for this loss later on by making a sufficiently high proposal $\tilde{P}$. The lowest possible bid a firm can afford leads to zero expected profits. If at the time of the bidding the firm does not yet know its true cost, this requires that the original contractual price P, plus the extra receipts due to renegotiation $\tilde{P}^*-P$, are equal to expected costs $\theta C^L + (1-\theta)C^H$:

$$P + (\tilde{P}^* - P) = \theta C^L + (1-\theta)C^H.$$

Using the value of $\tilde{P}^*$, one can calculate that

$$P = C^L - \theta T_{GW} - (1-\theta)T_{GL}.$$

This implies that the winning bid P will be smaller than C^L. This will be no surprise to many contracting firms. Again, the value of T_{GL} is critical: the higher the value of T_{GL}, the greater the gap between the winning bid P and the cost C^L.

It is interesting to note that the firm's litigation expenses T_{FW} and T_{FL} do not appear in $\tilde{P}^*$. This is understandable, since $\tilde{P}^*$ is the result of a final decision process of the government, in which the firm's legal expenses play no role. The government's payoff is only affected by its own litigation expenses, which explains why T_{GW} and T_{GL} do affect $\tilde{P}^*$.

We now turn to the *separating equilibrium of Proposition 3.* This equilibrium will occur when there is a high prior probability of the costs being low. For this reason the government is suspicious about price proposals. The separating equilibrium involves a mixed strategy applied by the government. This mixed strategy seems to be very realistic. It is as if the government is taking a random sample of the "high" proposals to be investigated by the court. An important constraint here is that the government should not give the low cost firm an incentive to mimic the high cost firm. The mixed strategy by the government is also welfare improving. In Proposition 2 all high cost firms are investigated by the court, while in Proposition 3 this is only the case for a fraction of these firms. This reduces the deadweight legal costs, and it also makes a mixed strategy separating equilibrium more attractive to the high cost firm. For this reason allowance of mixed strategies makes occurrence of a separating equilibrium more likely, as reflected by the fact that $\hat{\theta} \langle \theta^*$.

We have already observed that in Proposition 3 it holds that $\tilde{P}^*(C^H) > \tilde{P}^*(C^L)$. In both signals, only T_{GL} and T_{GW} appear, and not T_{FL} or T_{FW} . The same was true in the pooling equilibrium of Proposition 1. Inequality (26) and equality (27) again illustrate the strategic importance of T_{GL}.

5.2 The allocation of litigation expenses

In the literature on pre-trial settlements the issue of fee shifting is important: how are the litigation expenses shared by the two parties involved, and what are the strategic and welfare consequences of different allocation schemes? Two possible sharing rules are the American and the English rule. Spier (1994) states that

"In Europe and England, the loser is typically forced to bear the winner's legal expenses (the English Rule), while in the United States, each litigant traditionally bears his own costs (the American Rule)."

The notation we introduced in our model is consistent with the American rule. Even if a party wins, its expenses (T_{FW} and T_{GW}) will in general be positive. Under the English rule we have: $T^E_{GW} = T^E_{FW} = 0$, and $T^E_{GL} = T_{GL} + T_{FW}$, and $T^E_{FL} = T_{FL} + T_{GW}$. A move from the American rule to the English rule decreases the expenses of the winning party, and increases the expenses of the losing party. Since under the English rule a winning government bears no legal cost, it follows that under the English rule there is no room for nuisance suits.

In the context of the pooling equilibrium of Proposition 1 it is easy to see that the value of $\tilde{P}^*$ under the American rule exceeds the value of $\tilde{P}^*$ under the English rule if and only if $\theta > \frac{T_{FW}}{T_{GW}+T_{FW}}$. Hence, if the probability that the firm's cost is C^L is sufficiently high (but lower than $\hat{\theta}$, see (31)), the firm prefers the American rule, while the government prefers the English rule.

Under the English rule the low cost firm will never make a new price proposal in the case of a separating equilibrium, as $\tilde{P}^*(C^L) = P + T^E_{GW} = P$. This increases the payoff of the government. In the separating equilibrium it is clear that the value of λ (see (28)) is smaller under the English rule. Therefore, there are less lawsuits under the American rule than under the English rule, so that welfare is higher under the American rule. The intuition of this result is that under the English rule the government's litigation costs are zero if it wins the trial. This implies that there is no room for nuisance suits. Hence, it is more tempting for the low cost firm to offer a proposal based on high costs. For this reason, λ must not be too high to prevent the low cost firm from mimicking the high cost firm. The result that there are less law suits under the American rule is similar to results obtained by Shavell (1982), who shows this within a non-strategic framework, and by Bebchuk (1984).

5.3 Commitment value

In the game described in Section 2 a proposal $\tilde{P}$ made by the firm is brought to the court if it is rejected by the government. We now analyze a game in which the firm can withdraw a proposal if it observes that it is rejected by the government. We first analyze this alternative game, and then compare its equilibria with the equilibria of the previous game.

5.3.1 The game where the firm can withdraw its proposal

The resulting game tree is depicted in Figure 6. It is easily seen that the firm always withdraws its proposal when C^L prevails, while it does not withdraw under C^H. The game tree can be simplified by dropping the actions that will never be chosen as a result of these arguments. In the figure these payoffs are put between brackets.

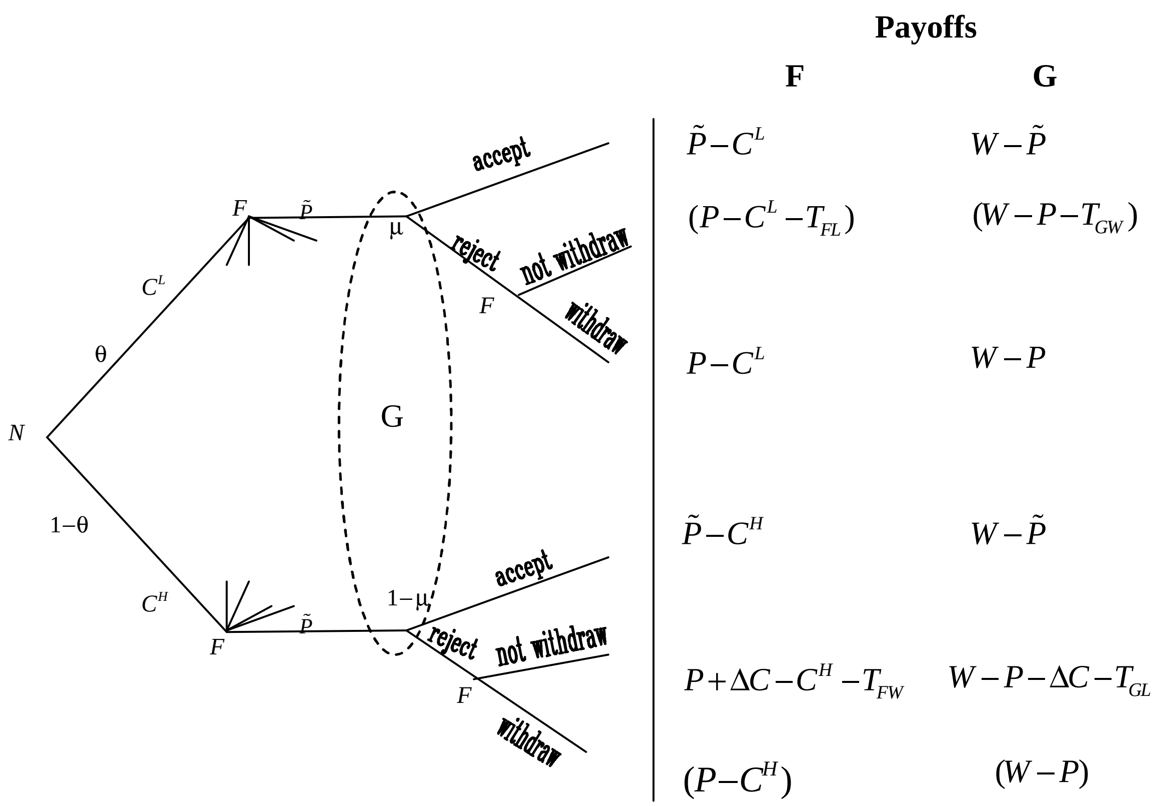

Figure 6: The game tree in case the firm can withdraw its proposal

The analysis of the resulting game then proceeds as follows. The government accepts a proposal when

$$W-\tilde{P}\geq\mu\left(\tilde{P}\right)[W-P]+\left[1-\mu\left(\tilde{P}\right)\right][W-P-\Delta C-T_{GL}],$$

which is equivalent to

$$\tilde{P} \leq P + \left[1 - \mu\left(\tilde{P}\right)\right]\left[\Delta C + T_{GL}\right]. \tag{33}$$

This implies that all proposals $\tilde{P}$ for which

$$\tilde{P} > P + \Delta C + T_{GL},$$

will certainly be rejected.

Optimal choice of low cost firm If the firm wants the government to accept its proposal, inequality (33) implies that the proposal $\tilde{P}$ will be the highest value for which

$$\tilde{P} = P + \left[1 - \mu\left(\tilde{P}\right)\right]\left[\Delta C + T_{GL}\right] \tag{34}$$

holds. If the government rejects, the firm withdraws its proposal, and the price remains P. Therefore, the firm will always propose the highest value of $\tilde{P}$ satisfying (34). We denote this value by $\tilde{P}^*$.

Optimal choice of high cost firm If the firm wants the government to accept its proposal, the best choice is $\tilde{P}^*$. If the government rejects, the court will fix the price at $P+\Delta C$, so that the revenue, after subtracting legal expenses, equals $P + \Delta C - T_{FW}$. Hence the firm will make a proposal such that the government accepts if and only if

$$P + \left[1 - \mu\left(\tilde{P}^*\right)\right]\left[\Delta C + T_{GL}\right] - C_H \geq P + \Delta C - T_{FW} - C^H.$$

This is equivalent to

$$\mu\left(\tilde{P}^*\right) \leq \frac{T_{FW} + T_{GL}}{\Delta C + T_{GL}}. \tag{35}$$

Pooling equilibrium If (35) holds, a pooling equilibrium arises: the firm will always propose $\tilde{P}^*$ and the government accepts. The pooling equilibrium requires that

$$\mu\left(\tilde{P}^*\right) = \theta,$$

so that

$$\tilde{P}^* = P + [1 - \theta]\left[\Delta C + T_{GL}\right]. \tag{36}$$

Separating equilibrium In the opposite case, when

$$\mu\left(\tilde{P}^*\right) > \frac{T_{FW} + T_{GL}}{\Delta C + T_{GL}},$$

a separating equilibrium arises. In case of C^L the firm proposes $\tilde{P}^*$ and the government accepts. Since in a separating equilibrium we have that $\mu\left(\tilde{P}^*\left(C^L\right)\right) = 1$, this implies via (34) that

$$\tilde{P}^*\left(C^L\right) = P. \tag{37}$$

When C^H prevails the firm proposes a price

$$\tilde{P}^*\left(C^H\right) > P + \Delta C + T_{GL}, \tag{38}$$

which is rejected by the government.

Mixed strategy for the government in the separating equilibrium As in Section 4.2, the government may consider playing a mixed strategy to reduce legal costs. Accepting the firm's offer with probability λ, the constraint

$$P \geq \lambda \left[P + \Delta C + T_{GL}\right] + \left[1 - \lambda\right] P$$

should be satisfied in order to prevent the low cost firm from mimicking the high cost firm. It is easy to see that, since $\lambda \in [0, 1]$, only $\lambda = 0$ satisfies this constraint, which implies that the government's strategy remains a pure strategy. The reason is that a low cost firm proposing $\tilde{P}^*\left(C^H\right)$, simply withdraws this proposal in case the government rejects. In other words, while announcing $\tilde{P}^*\left(C^H\right)$ the low cost firm still runs no risk losing a legal battle. For this reason it is only possible for the government to prevent the low cost firm from mimicking the high cost firm, when it rejects the proposal $\tilde{P}^*\left(C^H\right)$ with probability one.

5.3.2 Comparing the two games

If we first compare the pooling equilibrium (36) with the pooling equilibrium of Proposition 1, we see that the firm is better off in the latter equilibrium provided that $T_{GW} > 0$. This is a consequence of the firm's stronger commitment in Proposition 1. In this game, once a proposal has been made, the firm commits itself to go to court if its proposal is rejected. For the firm this strong commitment pays off, since commitment generates room for a nuisance suit preventing the government to start a law suit as long as the proposal stays below $P + T_{GW}$. Under the English rule the two equilibria are the same, because then $T_{GW} = 0$.

It is clear that the separating equilibrium (37) and (38) is very comparable to that of Proposition 2. The low cost firm is better off in the original game with commitment, provided again that $T_{GW} > 0$. Proposal (37) reflects that in the new game there is no room for nuisance suits, even under the American rule. For the high cost firm, there is no difference between the two games. As already explained, there is no equivalent of Proposition 3 in the new game.

6 Concluding remarks

This paper considers a government wanting to carry out a major public project. At the end of the bidding stage the project is assigned to the firm that submitted the lowest bid. This firm then signs a fixed price contract with the government. When starting the project the firm learns its true cost, while the government is not informed about this cost realization. Given this asymmetric information, and given the legal possibilities to renegotiate the contract, the firm may propose a price increase. In case the government rejects the proposed price increase, a law suit starts. If the court discovers that actual costs are not sufficiently higher than expected, the government wins, and the original price applies. In case costs are much higher than expected, the firm is allowed to increase its price.

We model this situation as a signaling game, where costs can have two realizations: low and high. In case the prior probability of a high cost is high, the government is willing to accept a substantial price revision. It knows that there is a high probability that it will lose its case once it is brought to court. Under these circumstances a pooling equilibrium can emerge in which the firm proposes the same price increase under each cost realization, which is always accepted by the government. If the prior probability of a high cost is low, the government is not willing to accept the proposal of the high cost firm. The result is that a separating equilibrium occurs. With respect to the proposal made by the high cost firm, the government can use a mixed strategy with a simple straightforward interpretation: accept a fraction of these proposals, and leave the remaining fraction for further investigation by the court. A strategy like this makes it more attractive for the firm to go for the separating equilibrium.

Let us compare our main findings with the Belgian experience as stated in the Introduction. First, disputes between the government and the contractor are rarely brought to court. This is consistent with our results. No court cases occur in the pooling equilibrium and in the separating equilibrium when costs are low. They can only arise in the separating equilibrium when costs are high. However, in the latter case the government may apply a mixed strategy, where only a fraction of these cases will be brought to court.

Second, price revisions are often very significant. This is confirmed by our results, especially when the government faces substantial governmental expenses in case it loses. In such a case the firm can afford to submit a price in the bidding process that is below the lowest possible cost realization.

Finally, there is a common belief that renegotiations occur much more often than can be justified by unforeseen events, as stated in the law. Our analysis provides two explanations for this observation. First, asymmetric information implies that the government does not know whether a price revision is justified or not, which the firm will exploit. Second, when the government has to bear legal expenses even when it wins the case, the firm will always start renegotiating price increases up to the level of these expenses.

We conclude by stating an interesting topic for further research. In our model the bidding and the renegotiation game is played only once. In the real world, however, the same firms may realize several projects for the government. This leads to a repeated game. It would then be interesting to explore the consequences of this repeated interaction. It can be expected that in this case firms and the government will reveal more cooperative behavior.

Acknowledgement

The authors like to thank Joseph Plasmans, Fred Schroyen, Jan Bouckaert and seminar participants at the University of Antwerp, Tilburg University

(TILEC), and at the Mini Workshop on Dynamic Games in Vienna for their constructive comments.

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