When Should We Privatize?
An Incomplete-Contracts Approach

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May 1998
SFB-Discussion Paper A-547

Summary

The paper compares efficiency in public and private enterprises in an incomplete contracting framework. Under each organizational mode, the manager of the firm can invest in the development of an innovative production technology. While this new technology is always efficient, its implementation incurs costs on the manager who therefore prefers a prevailing basic technology. In case that the basic technology remains viable, a switch in technologies may thus require to renegotiate the manager's contract. We show that the firm should remain under public governance if it is ex ante unlikely that the basic technology remains viable. Conversely, privatization is optimal in reverse situations. Interestingly, privatization can turn out to be

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optimal although (a) the government is purely benevolent, (b) the economic environment in either regime is identical, and (c) the government cannot commit ex ante to an ex post inefficient behavior.

Keywords: Privatization, Incomplete Contracts, Innovative Technologies.

JEL-Classification: D23, H57, L51.

1 Introduction

The last decade has brought a widespread political agreement on the welfare-enhancing effects of private governance. Public officials now assess privatization as a proper instrument to reduce slack, implement more efficient production technologies, or promote a faster development of promising product innovations. This view has been supported by empirical studies that report positive effects of privatization on the firm's productive efficiency.[1]

Perhaps surprisingly, economic theory has more difficulties to identify the merits of privatization, in particular when the government is assumed to behave purely benevolent. The public-choice oriented branch of the literature stresses the private goals of government officials, and welcomes privatization as a means to constrain self-interested bureaucrats or politicians [Shapiro and Willig (1990), Boycko, Shleifer and Vishny (1996)]. In a similar spirit, some authors start from the empirical observation that inefficient contracting prevents efficient outcomes in public firms: for example, governments often refrain from signing incentive contracts with their managers and workers, which can be seen as an exogenous impediment to optimal performance [see, e.g., Vickers and Yarrow (1988) and Bös (1991))].

These approaches provide reasonable arguments in favor of privatization. Yet, not all governments behave badly, in particular, if they are effectively controlled by their citizens. Thus, this branch of the literature fails to answer the more fundamental question whether a *rationally acting and benevolent* government may be less suited to be an owner of a firm than a private, profit maximizing entrepeneur. In light of the work by Coase (1937) and Williamson (1985), an affirmative answer to this question seems difficult. These authors conjectured that the entire economy should optimally be organized as a single firm governed by a chairman (a welfare-maximizing government in our context) who selectively intervenes into the decisions of lower hierarchy levels whenever an intervention increases the 'profit' of the whole organization. Only the recent property rights approach,

[1]For a recent empirical assessment of the UK privatisation programmes, see e.g. Martin and Parker (1997).

which starts with the pioneering article by Grossman and Hart (1986), has resolved this so-called 'Williamson puzzle' and has succeeded in identifying the vices of centralized ownership. The main methodological corner stone of this theory is the idea that contracts are necessarily incomplete, which renders it possible to study the implications of different ownership structures.[2]

The present article follows this methodological paradigm.[3] We consider the privatization decision of a welfare-maximizing government under incomplete contracting. Specifically, we assume that an initial labor contract between the government (or a private owner) and the management of the firm cannot be conditional on the subsequent invention and implementation of an innovative and more efficient production technology.[4] This innovative technology can be developed by the firm's manager. At any given wage level, however, the manager opposes its installation after invention since the new technology forces him to work harder than before or requires specific training. Therefore, the challenge is not only to find ways to provide efficient investment incentives to the management, but also to persuade it to implement an efficient technology after it has become available. These intertwined problems bear empirical relevance: in situations where the management does not face substantial pressure to innovate (which may be thought of the owners' credibe threat to shut down the firm after a bad performance), innovative concepts can frequently be enforced only when management and workforce are conceded a share of additional profits. In the model, we assume that these renegotiations take place as Nash-bargaining between the management and the respective owner of the firm. We consider a game with complete information. Accordingly, the possibility to renegotiate

[2]When 'comprehensive' contracts are feasible, all agents can be tied by a so called 'grand contract' and property rights are not a meaningful concept. Contracts are comprehensive when they are contingent on any relevant contingency that is jointly observed by the parties. Therefore, even informational asymmetries between principal and agent, which are the focus of the standard contract-theoretical literature, do not preclude the optimality of grand contracts. See, for example, Hart and Holmström (1987) and Holmström and Tirole (1989).

[3]The application of incomplete contracting models to public policy issues is relatively new; for excellent treatments, see Tirole (1994) and Dixit (1996).

[4]For similar approaches in trade contexts, see Aghion and Tirole (1994), Hart (1995), Segal (1995), Bös and Lülfesmann (1996b) and Lülfesmann (1997).

always leads to an ex-post efficient result under either governance structure. In particular, the innovative technology is implemented in equilibrium whenever it is invented, and the initial regulation contract assures that firm produces the welfare-maximizing level of output even if it is privatized. The outcome of renegotiations, however, affects the manager's investment inventives, and thus has a feedback on productive efficiency.

As a key to our results, we find that the set of situations where renegotiations occurs depends on the governance structure. Under nationalization, the government has a softer budget constraint since it cannot credibly threat to close the firm as long as the sum of consumer surplus and profits is positive. We show that the welfare maximizing objective of the government assures efficient investments whenever the parties know that production cannot take place under the basic technology. In contrast, efficient investments cannot be induced under public governance in situations where the firm can continue its operation under the basic technology, that is, in a scenario without urgent requirement to innovate. In this case, the tighter budget constraint of a profit-maximizing private owner allows for efficient investments and hence, privatization should take place. Parameterizing the probability that the firm can successfully be operated under the basic technology, we are also able to derive clearcut conclusions on the parameter regions in which one of the governance structures dominates the other: loosely speaking, the stronger the pressure to innovate, the better is the relative performance under nationalization and vice-versa.

Our approach is related to other articles which analyze privatization in incomplete-contract frameworks with benevolent governments. Schmidt (1996) postulates an interdependency between ownership information structure by assuming that privatization reduces the government's knowledge on the firm's production costs. This informational wedge can induce the firm's private manager to work hard and decrease production costs.[5] Intuitively, since the government does not observe the realization of production costs after privatization, ex post regulation under asymmetric information generates an informational rent for the manager, thereby sacrificing allocative efficiency. The manager's informa-

[5] In Shapiro and Willig (1990), the creation of an informational barrier between regulator and firm via privatization prevents the malevolent regulator from pursuing his own idiosyncratic goals, which can explain the benefits of privatization.

tional rent, in turn, provides him with incentives to invest in cost reductions ex ante. Conversely, the government can easily enforce the efficient output level in a public firm, but at the same time the public manager does not engage in cost reductions since these investments do not affect his payoff. In a different setting, Hart, Shleifer and Vishny (1997) investigate the effects of privatization in a model where the firm's manager (or owner-manager after privatization) can invest into cost reducing and quality-improving technologies, respectively. Under nationalization, the implementation of either technology requires (Nash)bargaining between manager and government. This implies that the manager captures only half of the marginal surplus from both activities, and therefore strictly underinvests. After privatization, the owner-manager can unilaterally implement the cost-reducing technology and becomes the residual claimant for that activity. As a result, he invests efficiently in cost reductions which makes privatization the efficient organizational mode (at least if the effort cost functions are separable).[6]

The present paper may be seen as complementary to these approaches: in contrast to Schmidt, we do not assume a connection between governance and the information structure. In contrast to Hart et al., we do not impose the assumption that a public manager cannot be made residual claimant for his own cost savings (while a private manager-owner can).[7]

The remainder of this paper is organized as follows. Section 2 introduces a simple model. Sections 3 solve the model for either regime, public and private governance. Section 4 collects and discusses the main results, and Section 5 concludes.

2 The Model

There are three parties, the government (G), a private owner (P), and a manager (M). All parties are risk neutral and have complete information throughout the game. Initially,

[6] To implement quality improvements, the private owner still has to bargain with the government, and therefore underinvests in the same way as a public manager.

[7] In addition, in our setting the firm's operations are delegated to to an employed manager. Delegation would invalidate the benefits of privatization in Hart, Shleifer and Vishny, while the outcome in Schmidt remains qualitatively unaffected.

the government owns a monopolistic enterprise and offers a wage contract W to the firm's manager.[8] Thereafter, the government decides whether to privatize the firm, that is, whether to sell it to the private owner. In case of privatization, the private entrepreneur pays a lump-sum amount t to the government and becomes residual claimant for the firm's return streams. We assume that t extracts all expected profits.[9] In addition, we allow the government to regulate the privatized firm by specifying a level of output y (or, alternatively, a consumer price) in the privatization contract. As we will see, this quantity is optimally set at its welfare-maximizing level. If the enterprise is not privatized, it remains in public hands. Under either governance structure, the self-interested (and indispensable) manager M runs the enterprise.

To carry out production, the manager potentially has two technologies at his disposal: a *basic* technology T_B and a more efficient *innovative* technology T_I. For convenience, we will assume that the innovative technology lowers the fixed costs of production only, leaving the variable production costs unaffected. More specifically, the innovative technology reduces the firms' fixed production costs from $\delta_B > 0$ to $\delta_I = 0$. In addition, T_I imposes a personal cost $c_I \equiv c > 0$ on the manager (c_B is normalized to zero). Thus, the manager incurs a disutility c when switching from the basic technology T_B to the innovative technology T_I. The parameter c could be interpreted as an implementation (or switching) cost that the manager has to bear because the the innovative technology forces him to reduce slack or requires additional training in specific skills.[10] Throughout the paper, we will also assume $\delta_B > c$, i.e., it is always optimal to implement the innovative technology whenever it has been invented.

While the firm already controls the basic technology prior to the privatization decision, the innovative technology first has to be invented. This is done by the manager who can

[8]If the government can decide to privatize the firm before or after a wage contract has been written, it will endogenously choose the latter option [see Section 3].

[9]Thus, all bargaining power rests with the government. This will be the case if if the identity of P is determined through a competitive bidding process. Otherwise, privatization would cause a welfare loss when the government's objective function exhibits shadow costs of public funds; see below.

[10]In an alternative interpretation where the manager represents a labor union, the innovative technology may impose layoff costs on workers.

exert effort e, thereby increasing the probabiliy that T_I becomes available. Without loss of generality, let e be the probability that T_I is invented. The manager's associated investement costs $\psi(e)$ are increasing, strictly convex, and satisfy the Inada conditions. Both c and e are idiosyncratic variables and assumed to be non-contractible.

In what follows, the index $i \in \{B, I\}$ indicates the technology that is used. Furthermore, let $x_i \in \{0, 1\}$ be a binary variable with $x_i = 1$ if technology i is implemented and $\sum_i x_i \in \{0, 1\}$ (at most one technology is utilized). We can then write the manager's utility as

$$U^M = \sum_i x_i(w_i - c_i) + (1 - \sum_i x_i)w_0 - \psi(e) \quad i \in \{B, I\}, \tag{1}$$

where w_i is the actual equilibrum wage paid to the manager when production takes place under technology i, while w_0 represents his wage level when the firm is shut down. Since we suppose that neither managerial effort nor the technology-dependent wages are directly implementable, w_i may differ from the initially contracted wage level. In particular, we follow the incomplete-contracting literature in assuming that managerial effort and the firm's profits cannot be observed by third parties as the courts (i.e., they are non-contractible). Accordingly, the initial labor contract cannot be contingent on these variables. Managerial investments are often idiosyncratic and therefore non-contractible, while non-contractability of profits is a reasonable assumption if accounting data can easily be manipulated.[11] Hence, the initial labor contract can be conditioned only on the events that the firm either operates or not: it can specify a tuple of wages $W \equiv (w_0, w_1)$ to be paid when the firm is shut down or the manager quits his job (w_0) or remains in business (w_1).[12] For this reason, owner and manager may have to renegotiate the initial contract W. For example, either manager or owner may credibly threat not to produce

[11] Observe that the assumed contractability of output does not substantially enlargen the relevant contracting contingencies because the efficient output level does not depend on the employed technology [see Section 4 for more on this point].

[12] We introduce w_0 in order to leave the issue of limited liability aside. If the manager is subject to limited liability, he cannot be punished when the firm shuts down ($w_0 \geq 0$). This constraint ensures a positive expected rent for M whenever $e > 0$. This implied trade-off between rent extraction and efficient investments in moral hazard problems has been extensively explored in the literature and is not the focus of the present paper. We therefore allow for a negative w_0 which can be adjusted in a way to make the managerial reservation utility binding under the optimal contract.

when wages are either to high or too low, or the manager may reject to implement T_I after it has been invented. A detailed description of renegotiation will be provided in the next section. When renegotiations arise, we assume a bargaining process that leads to the Nash-bargaining solution. Thus, the surplus exceeding the parties' respective threat points is evenly shared.[13]

If owner and manager agree on production, the firm produces a homogeneous output in quantity y that is sold to consumers. We denote net consumer surplus by $S(y)$. Under privatization, only the firm's profits enter the owners' objective function. Denoting the firm's *operating profits* (revenues minus variable production costs) by $\Pi(y)$, the private owner's utility level or the net profits are

$$U^P = \sum_i x_i[\Pi(y) - \delta_i - w_i] - (1 - \sum_i x_i)w_0. \tag{2}$$

In contrast, a public owner maximizes welfare which is defined as a weighted sum of consumer surplus and the firm's net profits.[14] In particular, we allow for budgetary flows that exhibit shadow costs of public funds with a shadow price $\lambda \in [0, 1]$. Welfare can thus be represented by

$$W = \sum_i x_i[S(y) + (1 + \lambda)(\Pi(y) - \delta_i - w_i)] + (1 - \sum_i x_i)(1 + \lambda)w_0. \tag{3}$$

Recall that the technology choice does not affect variable production costs. The welfare maximizing quantity $y^*(\lambda)$ is therefore constant across technologies and can be supressed in the notation in what follows.[15] As stated above, y^* can be specified in an initial priva-

[13]The assumption of an equal split is made for expositional convenience only. The subsequent results would qualitatively remain unaffected if one instead postulated an arbitrary linear sharing rule.

[14]We assume here that the government does not value managerial utility, which may be small relative to consumer surplus and profits. This assumption simplifies the exposition without affecting the results.

[15]This quantity is implicitly determined by the first-order condition (primes denote derivatives)

$$S'(y^*) = (1 + \lambda)\Pi'(y^*)$$

and equates the marginal net consumer surplus with the weighted marginal operating profits of the firm. This condition implies an output price in excess of marginal production costs for any $\lambda > 0$. We can therefore interpret the corresponding prices as Ramsey-prices [see, e.g., Laffont-Tirole (1993)]. For vanishing shadow costs, $\lambda = 0$, welfare maximizing prices are equal to marginal costs.

tization contract in order to prevent the privatized firm to set monopoly prices.[16] Thus, privatization has no impact on the ex-post chosen output level. An efficient allocation is reached in either regime, which allows us to focus entirely on the implications of ownership structures on equilibrium investments.

As a final important ingredient of the model, we allow for situations where production under the basic technology is not *viable*. Production is said to be non-viable if there exists no level of output under which owner and manager can agree on production. To incorporate this issue in the simplest way, suppose that the fixed costs δ_B to be incurred under T_B are a binary random variable:

- With probabilty $q \in [0,1]$, $\delta_B = \delta > 0$ and the basic technology is viable under both governance structures (i.e., $\Pi > \delta \Rightarrow \frac{S}{1+\lambda} + \Pi > \delta$).
- With probability $(1-q)$, the basic technology is not viable under both governance structures (i.e., $\delta_B >> \frac{S}{1+\lambda} + \Pi$).

If the basic technology is viable ($\delta_B = \delta$), there always exist nonnegative wages where both principals prefer to operate the firm under T_B. This event occurs with probability q. Otherwise, T_B is not viable for any principal and, unless T_I is invented and implemented, a shutdown cannot be avoided as the fixed costs of production are too high. The parameter q has an interesting interpretation: it represents the probability that the firm can survive in the market given the technology it has used so far. Thus, it is an indicator of how advanced the firm's technology is when the privatization decision is made. Alternatively, it may be interpeted as a measure of the necessity to improve existing production technologies. Most of our results will crucially depend on this parameter.

Taken together, we consider the following stage game under complete information:

- *Stage 0:* The government offers a labor contract w to the manager. This remuneration is contingent on the firm's operation at stage 5.

[16]Regulating the output level after privatization is not optimal: unless t is made contingent on output, the firm's profits do not affect government's budget after privatization. It then becomes optimal for the government to instruct marginal-cost pricing in order to maximize gross consumer surplus. In contrast, ex ante regulation of prices or output generates a commitment not to exploit the firm's profits ex post, which is efficient from an ex ante point of view.

- *Stage 1:* The government decides whether to privatize the public enterprise. In case of privatization, the firm is sold to a profit-maximizing entrepeneur at a fixed sales price t, and the government regulates the subsequent output level y^* (or, equivalently, the consumer price).

- *Stage 2:* The manager exerts a nonmonetary investment (effort). A higher effort level increases the probability that an innovative production technology T_I becomes available to the firm.

- *Stage 3:* Nature decides whether T_I is invented, and determines whether the basic technology basic technology T_B remains viable (that is, whether δ_B is high or low).

- *Stage 4:* Either T_B, or the innovative technology T_I (if available) can now be implemented, possibly after the precontracted wage rate w has been renegotiated between owner and manager. Alternatively, the enterprise is shut down, in which case the game ends.

- *Stage 5:* Output y^* is produced and sold to consumers. All payoffs are realized.

3 Equilibrium Analysis

Before we proceed, let us calculate the first best level of managerial investments, $e^{FB}(q)$, as a benchmark. This level maximizes expected welfare under the constraint that the manager obtains in expectations his reservation utility (normalized to zero). Substituting this constraint into (**??**) and taking expectations, we have

$$\begin{aligned} E[W] &= eU_I^G + q(1-e)U_B^G \\ &= e[S + (1+\lambda)(\Pi - c)] + (1-e)q[S + (1+\lambda)(\Pi - \delta)] \\ &- \psi(e)(1+\lambda) \end{aligned} \quad (4)$$

Note that we have defined U_i^G as the welfare level when production takes place under technology i (for subsequent refernce, an equivalent definition concerns U_i^k, $k \in \{G, P, M\}$).

Maximizing this concave program with respect to e yields a unique maximizer determined by the first order condition

$$(1-q)(\frac{S}{1+\lambda}+\Pi-c)+q(\delta-c)=\psi'(e^{FB}) \tag{5}$$

For future reference, note that e^{FB} strictly decreases in q.

We can now go on to analyse the outcome of the renegotiation and investment stages. First, reconsider the objective functions (**??**), (**??**), and (**??**) and observe that they can be rewritten in term of a state-dependent wage differential $w_i - w_0$ and a state independent (base) wage of w_0. Clearly, the latter does not influence the manager's incentives and will never be renegotiated.[17] The manager chooses his effort e to maximize expected utility, taking into account the wage differentials that are determined by the outcome of renegotiation at date 4. As we will see below, these compensation levels depend on the initially contracted wage differential $w \equiv w_1 - w_0$ as well as on whether the basic technology is viable or not (both determine set of situations where the initial compensation is actually modified). In addition, they depend on which (if any) technology is implemented.

3.1 Renegotiation

Suppose that G and M have agreed on a wage contract stipulating w at stage 1. After the governance structure has been chosen and the manager has invested, the state of the world is realized and either G or P may have to renegotiate the initial wage contract with M. As stated above, we assume that the outcome of renegotiation corresponds to the Nash-bargaining solution. First, this implies that renegotiation always leads to an efficient outcome. Second, the parties split the additional surpus evenly over their respective disagreement (threat) points. Given the possible state of nature at date 3, the parties will renegotiate if and only if one of the following events has occured:[18]

(a) The innovation has been invented and therefore should be implemented. In addition:

[17] When it is efficient to shut down the firm ex post, renegotiation is useless since manager and owner will never jointly agree on a revised labor contract inducing production. In the corresponding state, the parties face a zero sum game and the initially contracted shut-down wage remains in force.

[18] For the outcome of the renegotiation stage for each state, the reader is referred to Appendix A.

(i) the basic technology is not viable, but the manager's remuneration does not cover his implementation costs c.

(ii) the basic technology is viable and both parties prefer to continue production under T_B to a shutdown. In this situation, the manager can credibly insist on T_B which renders renegotiation necessary to implement T_I.

(iii) The manager's remuneration is sufficiently large so that the principal prefers to shut down the firm.

(b) The innovative technology has not become available, the basic technology is viable, and

(i) the manager's wage differential w is less than zero, or

(ii) the firm's owner prefers to shut down the firm given w.

Clearly, renegotiation is always needed when it is optimal to continue production and wages are either so low that the manager credibly refuses to quit, or if they are so high that the firm's owner receives a negative payoff; renegotiation then starts from the no-production payoffs w_0 (manager) and $-w_0$ (owner), respectively. These situations cover all of the above contingencies except the possibility in (a_{ii}). If this latter scenario arises, both parties prefer to produce under T_B rather than to shut down the firm given the initial labor contract w. Since T_I has been invented, however, they have opposing interests with respect to their preferred technology. Recall that implementation of T_I causes switching costs c for the manager. Hence, he strictly prefers the basic technology at any given w, and vice versa for the firm's owner. Since bargaining leads to an efficent outcome, the parties will eventually agree on technology T_I. Yet, the owner cannot credibly threat to close down the firm when renegotiations fail. As a consequence, the manager's threat point in this situation is determined by w_1, his net payoff when T_B is implemented. This logic turns out to be the key to our subsequent results.

For what follows, it will be helpful to characterize the outcome of renegotiation directly in terms of the parties' utility levels. Thus, let $U_I^M(w, 0)$ and $U_I^M(w, B)$ be the manager's equilibrium utility when the innovative technology is available and the disagreement point is no production and production under T_B, respectively. Similarly, let $U_B^M(w)$ be his utility when T_I has not been invented and T_B is viable. We already know that his investment effort only depends on the difference $U_i(\cdot) \equiv U_i^M(\cdot) - w_0$. Rewriting (**??**) in terms of U_i and taking derivatives with respect to e yields

$$(1-q)U_I(w,0) + q[U_I(w,B) - U_B(w)] = \psi'(e^*). \tag{6}$$

as the manager's equilibrium effort, given that he correctly anticipates his equilibrium utility at stage 4.

3.2 Public Governance

Suppose the government abstained from privatization at date 2. Let $G_i \equiv \frac{S}{1+\lambda} + \Pi - \delta_i$ be the payoff of the government (in monetary units) gross of wages when technology i is implemented. Table 1 below summmarizes the manager's equilibrium payoffs depending upon the initially contracted wage level and the state of nature.[19]

w	$U_B(w)$	$U_I(w,B)$	$U_I(w,0)$
$w < c$	w	$w + \frac{1}{2}[\delta - c]$	$\frac{1}{2}[\frac{S}{1+\lambda} + \Pi - c]$
$c \leq w \leq G_B$	w	$w + \frac{1}{2}[\delta - c]$	$w - c$
$G_B < w \leq G_I$	$\frac{1}{2}[\frac{S}{1+\lambda} + \Pi - \delta]$	$w - c$	$w - c$
$w > G_I$	$\frac{1}{2}[\frac{S}{1+\lambda} + \Pi - \delta]$	$\frac{1}{2}[\frac{S}{1+\lambda} + \Pi - c]$	$\frac{1}{2}[\frac{S}{1+\lambda} + \Pi - c]$

Table 1

To understand the above outcomes, consider for instance a situation in which the innovative technology has been invented and the basic technology is viable. If w is below G_B, both G and M prefer to continue operation under T_B to a shut down. Since the manager

[19] Recall that we have defined $U_i(w,\cdot)$ as the manager's utility in renegotiations, net of w_0.

strictly prefers T_B to T_I and T_I is efficient, renegotiations take place. The manager's disagreement utility in this case is w and he receives an equal share of the additional surplus $\delta - c$ generated if T_I is implemented: his wage is raised to $w_I(w, B) = w + c + \frac{1}{2}(\delta - c)$. For $w \in]G_B, G_I]$, in contrast, the government credibly resists implementation of B since w is now too high. Since both parties already agree on implementing T_I under the initial renumeration, no renegation occurs and $U_I(w, B) = w - c$. All other possiblities can be found analogously.

One can translate these equilibrium utilities into investments e^*, by substituting them into (**??**). All calculations are straightforward and have been relegated to Appendix B. Not surprisingly, potential candidates for first-best investments are wages in the interval $w \in]G_B, G_I]$. Indeed, the appendix shows that investments for either very low ($w < c$) or very high initial wages ($w > G_I$) are strictly below the first best level. To see this, observe that in these wage intervals, the implementation of the innovative technology requires renegotiation. These renegotiations start from both parties' no-production payoffs which leads to surplus sharing between manager and government. Thus, the manager receives exactly half of the surplus plus a constant in those states which prompts him to underinvest.[20] We also find that efficient investments cannot be induced for wages $w \in [c, G_B]$ where the manager still underinvests: although incentives now strictly increase in w for any $q < 1$, there is underinvestment even at the upper bound of this interval $w = G_B$. Analyzing the remaining interval, $w \in]G_B, G_I]$ yields the following:

Proposition 1 *Efficient investments in the nationalization regime can be induced if and only if* $q \leq \min\{q^G, 1\}$ *where*

$$q^G \equiv \frac{2\delta}{S/(1+\lambda) + (\Pi - \delta)} > 0.$$

[20]More precisely, he obtains half of total surplus when B is non-viable. When B is viable (which emerges with probability q), the manager accrues half of the additional surplus from I for $w < c$, and half of total surplus from the efficient technology when $w > G_I$. Although these local payoffs differ in absolute terms, they give rise to identical marginal incentives $q(U_I(w, B) - U_B(w)) = \delta - c$.

In particular, a first best under nationalization is always feasible as $q \to 0$. For $q \to 1$, the first best effort is not implementable if

$$q^G < 1 \Leftrightarrow \frac{S}{1+\lambda} + \Pi > 3\delta. \tag{7}$$

To understand this result intuitively, consider first a situation where the basic technology is never viable, i.e., $q = 0$. In this case, the above implementation problem reduces to a standard moral hazard framework with a risk-neutral agent who is not subject to limited liability: as no renegotiation takes place for initial wages $w \in [c, G_I]$,[21] the first best effort can be induced with an initial compensation of $w = G_I$. The manager becomes residual claimant and he therefore invests efficiently.[22] At the same time, the government can extract all rents from M by an appropriate choice of w_0. Hence, for $q = 0$, efficient investments e^{FB} can be induced at no welfare loss for the government.

Next, consider the opposite limit case where the basic technology remains viable with probability one. In such a situation, the manager's incentives do *not* smoothly increase over the interval $w \in [c, G_I]$. To see this, observe that the parties' threat points for $w \leq G_B$ are now determined by $\bar{U}^M = w$ and $\bar{U}^G = G_B - w$. Thus, no renegotiation is required if T_I is not invented and T_B is viable: at the upper bound, M receives $w = G_B$. Increasing w slightly above G_B, however, triggers a radical shift in payoffs and incentives. Now, the government can credibly threat to cease production provided that the basic technology is implemented. The surplus from production under T_B is evenly shared and wages are renegotiated downwards to $w_B = \frac{1}{2}(\frac{S}{1+\lambda} + \Pi - \delta) = \frac{1}{2}G_B$. Thus, the managers payoff is sharply reduced whenever T_I has not been invented and his incentives to invest rise discontinuously at $w = G_B$.[23] The implied discontinuity may prevent the government from inducing first best investements. Under the conditions given in Proposition 1, efficiency

[21] The utility levels $U_B(w)$ and $U_I(w, B)$ in Table 1 never become relevant.

[22] Formally, the unique maximzer of $E[U^M] = eG_I - \psi(e) + w_0$ coincides with e^{FB}.

[23] As can be inferred from Table 1, there is a countervailing effect since the manager's payoff $U_I(w, B)$ decreases for w slightly above the boundary level G_B. As long as $G_B > \delta$ (which is implied by (7)), however, this counteracting force does not offset the investment enhancing effect of the sharp decrease in $U_B(w)$. In particular, his incremental wage $U_I(w, B) - U_B(w)$ after invention and implementation of I still discontinuously rises at $w = G_B$; see (6) and Table 1.

cannot be induced under public governance for $q = 1$. In this case, the government can only induce over- or underinvestments. Clearly, this line of reasoning continues to apply for intermediate values of q and the existence of a threshold probability q^G follows. Figure **??** below visualizes the manager's investment as a function of w and illustrates our arguments.

Figure 1: Investments

To be sure, the above inefficiency result applies only to certain parameter constellations. As will become clear shortly, however, the intuition for this finding may be more general: in the presence of a viable basic technology, the government's softness reduces the pressure on the manager to innovate. In the subsequent section, we will argue that this result is reversed in the privatization regime.

3.3 Privatization

Unlike the government, a profit-maximizing owner is neither interested in consumer surplus, nor is she subject to shadow costs of public funds. Therefore, she will not accept any wage payment that exceeds gross profits $P_i \equiv \Pi - \delta_i$. As in the nationalization regime, we have to consider four classes of initial wage contracts. Observe that since $P_i < G_i$, $i \in \{I; B\}$, the boundary values P_B and P_I are now smaller than their respective counterparts under public governance. Table 2 below summarizes the manager's equilibrium utilities in all states of the world and for all initial compensation schemes.

w	$U_B(w)$	$U_I(w,B)$	$U_I(w,0)$
$w < c$	w	$w + \frac{1}{2}[\delta - c]$	$\frac{1}{2}[\Pi - c]$
$c < w \leq P_B$	w	$w + \frac{1}{2}[\delta - c]$	$w - c$
$P_B < w \leq P_I$	$\frac{1}{2}[\Pi - \delta]$	$w - c$	$w - c$
$w > P_I$	$\frac{1}{2}[\Pi - \delta]$	$\frac{1}{2}[\Pi - c]$	$\frac{1}{2}[\Pi - c]$

Table 2

While all formal derivations have been relegated to Appendix B, it is again easy to see that the manager strictly underinvests for wage contracts $w < c$ and $w > P_I$. His effort decision for wages in these intervals is now strictly smaller than under nationalization because renegotiation leads to an equal share of profits (instead of welfare). Likewise, his equilibrium effort in the interval $w \in [c, P_B]$ is inefficiently low: a comparison of Table 1 and 2 for the respective interval reveals that investment incentives for any given w are identical to that of a public manager who was shown to underinvest. In addition, investments strictly increase in w throughout the interval and since the upper boundary P_B falls short of G_B, the result immediately follows.

Thus, efficient investments can potentially be induced only for initial labor contracts that lie in the interval $w \in]P_B, P_I]$. The proposition below shows that this may indeed be possible.

Proposition 2 *Efficient investments after privatization can be induced if and only if* $\underline{q}^P \leq q \leq \min\{\overline{q}^P, 1\}$, *where*

$$\underline{q}^P \equiv \frac{S/(1+\lambda)}{S/(1+\lambda) + \frac{1}{2}(\Pi - \delta)} \quad \text{and} \quad \bar{q}^P \equiv \frac{S/(1+\lambda) + \delta}{S/(1+\lambda) + \frac{1}{2}(\Pi - \delta)}.$$

In particular, efficient investments cannot be induced as $q \to 0$. *For* $q \to 1$, *the first best effort is implementable iff*

$$\bar{q}^P \geq 1 \Leftrightarrow \Pi \leq 3\delta. \tag{8}$$

Proposition 2 demonstrates that the efficiency ranges of public and private governance are complementary. Under privatization, efficiency is unattainable if q is small. This result is very intuitive: as has been explained in the last section, we have a standard moral hazard problem when the basic technology is never viable (the government's softness with respect to this technology plays no role). Then, efficient investments can be implemented by a principal whose objective function coincides with welfare, as is the case in the nationalization regime. Under privatization, in contrast, the owner cannot commit to a wage level that exceeds her gross-of-wages profit from the innovative technology. At the highest credible wage level that is not renegotiated, $w = P_I$, the manager's investment incentives are still suboptimal.

In the other limit case where $q = 1$, the presence of the basic technology always prevents a shutdown of the firm. Again, the manager's investments sharply discontinuously at a wage level $w = P_B$ for the same reason as under public governance: at this point, he looses half of the surplus from the basic technology. This boundary wage, however, is strictly smaller than the corresponding level G_B under public governance. As a consequence, the jump in investments is more moderate than in the nationalization regime. Therefore, it is likely that M still underinvests at the lower bound of $]P_B, P_I]$. To be precise, this condition is met whenever the firm's operating profits fall short of 3δ [see (**??**)]. Efficient investments can then be induced if the manager overinvests at the upper boundary $w = P_I$ which is shown to hold when q exceeds a threshold level $\underline{q}^P$. Intuitively, the private firm's commitment to a harder budget constraint helps to achieve efficiency in situations where the basic technology remains viable with a relatively high probability.

The mechanism at work, though, is somewhat different from that identified in the informal literature on soft budget constraints: there, it is often argued that the government's assumed soft budget constraint reduces investment incentives.[24] In line with these arguments, in the present context the government can credibly commit to higher wage payments than the private owner who is less soft.[25] As the optimal investment effort de-

[24]The basic argument of this literature can be seen in the present model as well: suppose that the government cannot use wages to set incentives correctly. In addition, assume that M obtains more than his reservation utility from a continuation of production (e.g., because he looses his reputation in case of a shutdown or the exogenous wage level is high). If the government is soft when T_I has not been invented and continues production, M has no incentives to invest. To the contrary, a private owner may well decide to shut down the firm in this case, thereby providing the manager with a reason to reduce costs. Observe, however, that this argument is based on rather strong assumptions. First, it does not allow for wage as an instrument to set incentives correctly (recall that for a sufficiently small q, the government can achieve a first best by an appropriate choice of the wage contract. Second and most importantly, it requires a strong commitment from G in the sense that G does not intervene into the ex post inefficient decision of a shutdown [see also Section 4].

[25]Despite this softness, investment incentives may even be higher than under privatization at a given precontracted wage level. This is not always be the case, however. To see this, consider a wage $w \in]P_B, P_I]$ and suppose in addition that $P_I < G_B \Rightarrow w < G_B$. Inserting the utility levels from respective

creases with q, the government's commitment to high equilibrium wage levels is beneficial when q is low while for a high q, wages cannot be adjusted to induce efficient investment and over- or undershooting cannot be prevented - a problem that is much less serious under privatization.

Before concluding this section, we should rationalize our assumption that the labor contract is already written at stage 0, that is, prior to privatization. Suppose there exists an initial compensation scheme w^* that guarantees optimal investments after privatization. If not forced to by the gvernment, the private owner has in general no interest to implement this wage differential due to her suboptimal objective function (she does not internalize the consumer surplus). Rather, she will choose a contract under which equilibrium wages and managerial incentives are strictly lower than e^{FB}.[26] Hence, it is strictly preferable for the government to set a wage rate *prior* to privatization to counterbalance the private owner's suboptimal objectives.[27] This timing should also be the leading case in practice since a change in the ownership structure in general does not invalidate previous wage arrangements.[28]

4 Summary and Discussion

Summarizing our results for the two governance structures and the subsequent discussion, we have

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intervals of Table 1 and 2 into (**??**), we see that the manager's incentives are strictly higher under private than under public governance for $P_I - c > 2\delta$, irrespective of q. The reason is that the government is too soft on the basic technology (the managers' wage is not renegotiated downward) which weakens M's incentives to invest into cost reduction.

[26] More precisely, the private owner wants to induce a profit-maximizing effort level

$$e^P = (1-q)(\Pi - c) + q(\delta - c), \tag{9}$$

which strictly falls short of e^{FB} unless $q = 1$.

[27] Alternatively, one could also specify w as a component in the privatization contract. This policy has, for example, frequently been pursued by the German *Treuhandanstalt* when it privatized the formerly state-owned East German enterprises.

[28] A case in point is German Telekom who had to take over the entire management (including the civil servants with their generous salaries) when privatized.