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How Blackwater Takes Uncle Sam for a Ride - and Why He Likes It*

A Model of Moral Hazard and Limited Commitment

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Abstract

Private Military and Security Companies (PMSCs) have been gaining increasing media and scholarly attention particularly due to their indispensable role in the wars in Afghanistan 2001 and Iraq 2003. Nevertheless, theoretical insights into the agency problems inherent when hiring PMSCs and how to optimally incentivize them are scarce. We study the complex relationship between intervening state, host state, and PMSC, taking into account the diverging interests of all involved parties as well as potential agency problems. We develop a theoretical model to characterize a state's optimal choice whether to perform a task associated with an intervening mission itself, hire a PMSC and optimally design the contract, or completely abstain from it.

We find that it might be optimal to hire PMSCs even if they are expected to do a worse job than the intervening state would do itself. This outcome is especially problematic for the host state, which prefers associated tasks to be done as good and carefully as possible. Furthermore, the often-heard call for transparency regarding agreements with PMSCs can lead to a situation where the latter's performance gets even worse - namely because the ability to implicit reward PMSCs for a good performance in the past is reduced.

Keywords: International Conflicts, Private Military and Security Companies, Moral Hazard, Relational Contracts

JEL-Classification: C72, C73, F51, F53

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"We are simply not going to go to war without contractors." (Carter, 2011)

1 Introduction

The current international security architecture has been undergoing tremendous changes within the last decades. The end of the Cold War in 1990 has disclosed a number of internal armed conflicts in regions of weak or failed statehood which up to that time were hidden under the covert of the rivalry of the two superpowers USA and USSR (Gleditsch et al., 2002). Since 1990, though, most leading industrial countries have not been willing to intervene in armed conflicts anymore, unless their direct strategic interests were in danger (Mandel, 2002; Singer, 2003).

These two contrary developments - the increasing number of armed conflicts around the world as well as the subliminal disinterest of those countries that would be able to intervene - have triggered a rising demand for private military and security services. Today, private military and security companies (henceforth PMSCs) offer a wide range of services, including combat operations, military assistance, intelligence, operational and logistics support, static security of individuals and property, advice and training of security forces, de-mining and weapons destruction, humanitarian aid, research and analysis, and even facility and infrastructure building (Perlo-Freeman and Sköns, 2008:6; Branovic, 2011:26). The clients of PMSCs are as diverse as the services they offer, ranging from states and international organizations, to transnational companies, humanitarian nongovernmental organizations, and even rebel groups (Singer, 2003:183; Holmqvist, 2005:7; Mathieu and Dearden, 2007). Particularly the wars in Afghanistan 2001 and Iraq 2003 remarkably increased the use of these companies and showed plainly that present implementation of international security policy is heavily reliant on the support of the private military and security industry. According to the report "Transforming Wartime Contracting" of the U.S. Congress' Commission on Wartime Contracting[1], the US Department of Defense, the US Department of State and the US Agency for International Development employed more than 260,000 contractor employees in Afghanistan and in Iraq in 2010. This number exceeds the number of US military and civilian personnel in these countries at that time. Furthermore, from 2002 through 2011 an estimated $206 billion were spent for these contracts (CWC, 2011).

However, various incidents have manifested that the collaboration between states and PMSCs presents new challenges which - due to the distinct nature of the tasks involved - substantially differ from previously made experiences with subcontracting and privatization. Several occurrences made clear that states that hire PMSCs rely on agents which have their own dynamics and engage in moral hazard. According to the Project on Government Oversight's

[1] The Commission on Wartime Contracting was created by the 110th US Congress. The first commissioners were appointed in July 2008.

Federal Contractor Misconduct Database (FCMD), this misconduct ranges from human rights violations, poor contract performance, government contract fraud, to cost/labor mischarge. For instance, in 1999 DynCorp International personnel engaged in human trafficking and forced prostitution in Bosnia Herzegowina. In 2007 personnel of the company Blackwater Worldwide shot and killed 17 Iraqi civilians. Due to this incidence, they lost their contracts with the US government in Iraq but secured new deals with the US government in Afghanistan. In the same year ArmorGroup International personnel, hired to provide security for the US embassy in Kabul, organized humiliating sex games and were unable to guarantee the security of the embassy due to internal inefficiencies (FCMD 2012). In addition, the process of how PMSCs are selected and how contracts with them are negotiated often seems to be very intransparent and cannot avoid a sense of corruption (Dickinson, 2007, or Stöber, 2007).

All these issues show quite plainly the implicit risks and imponderabilities of contracting with PMSCs in contingency operations. Despite these malpractices, PMSCs are constantly hired by states, though. Hence, the questions arise (1) why states, while being aware of the complicated agency dilemma inherent when hiring PMSCs, still rely on the services of these companies and (2) how to set the right incentives for and design contracts with these companies to act to the best advantage of their principals.

However, the scholarly debate concerning PMSCs has largely focused on normative questions. Besides, parts of the discussion suffer from polarization - by either condemning or praising the private military and security industry: Advocates of using PMSCs emphasize the strong demand for privatized military and security provision and the industry's role in filling the security gap (Shearer, 1998; Brooks, 2000). Critics, on the other hand, consider the strong reliance on PMSCs a threat for state authority and the legitimate use of force and fear the blurring of responsibilities, the weakening of democratic mechanisms and the legal grey area that surrounds PMSCs' activities (Cilliers and Mason, 1999; Musah and Fayemi, 2000). Both sides, though, are clear about the irreversibility of PMSCs' presence in the current international security structure. Hence, a third, more pragmatically oriented, strand of the literature has focused on how to establish effective regulatory, monitoring, accountability, and prosecution mechanisms in order to minimize the risks associated with the use of PMSCs (Chesterman and Lehnardt, 2007; Cockayne et al., 2009; Francioni and Ronzitti, 2011). However, studies investigating contextual factors that are conducive to the performance of PMSCs are rare. This is particularly astonishing regarding the increased reliance and use of PMSCs not only by states (whether strong or weak) but also by trans-national corporations or non-governmental organizations (Singer, 2001). To a large extent, this is driven by the difficulty of finding sufficient empirical evidence. Nevertheless, understanding the mechanisms that drive PMSCs' behaviour and identifying parameters which states can influence in order to induce a desired performance of PMSCs helps us to minimize the risks and benefit from the advantages associated with the use of PMSCs.

The goal of this paper is to shed light on one particular scenario of PMSC-client interaction: The complex relationship between an intervening state, a host state and a PMSC. We take into account the diverging interests of all involved parties as well as potential agency problems and develop a theoretical moral hazard model to analyze a states's optimal choice whether to perform a task associated with an international mission itself, engage a PMSC and optimally design the hiring contract, or completely abstain from doing it.

2 Overview

We develop a theoretical moral hazard model to analyze the optimal behavior of a state ("principal", "she") which has the option to delegate a military or security task to an agent ("he"), in this case a PMSC. The delegation can take place against the background of various scenarios; for example it might be that the state is dealing with oppositional groups inside its territory as it was the case with the missions of Executive Outcomes and Sandline International in Angola and Sierra Leone in the early 1990s; or it might be that the state aims at improving its military and security structure like it was the case with the support of the Croatian Army by MPRI during the Yugoslavian wars in the late 1990s; or it might be that the state plans to or has already intervened in another country like it has happened during the recent wars in Iraq and Afghanistan, in which the intervening countries hired various PMSCs to fulfil certain military and security tasks (see Singer, 2003). However, in the light of any potential scenario the state has three options: It can carry out the task itself, delegate it to a PMSC, or abstain from performing it at all.

If the task is supposed to be carried out, the state or the PMSC - depending on whether the task is delegated or not - decides on the resources they plan to spend, for example how many people to deploy for the task, their quality, the amount of training they receive, and the intended time period. All aspects that can determine the success of the mission are subsumed in a one-dimensional variable, denoted effort. Generally, a higher effort level is associated with higher costs, but also increases the chances for a good outcome.

The core question is: Why and how would the state choose to delegate the task? We identify three crucial advantages for states when delegating military and security tasks to PMSCs:

1. Reducing financial costs: States can reduce financial costs such as retirement, medical and training costs because PMSCs are paid only when needed. Furthermore, in cases where countries are involved in interventions or operations that are too extensive for their available force structure, additional costs, such as recruiting of new military and civilian personnel, accrue. States can circumvent these costs by hiring specialized PMSCs.

2. Enhancing military effectiveness: States can enhance their military effectiveness because

PMSCs are often specialized and possess modern military equipment and skills. In addition, hiring PMSCs enables the armed forces to free own resources and to concentrate on core functions.

3. Reducing political costs: States can reduce political costs which arise in the course of a military operation. There, it seems that states are particularly concerned with reducing political risks which might arise from high fatalities (Schreier and Caparini, 2005). Shaw (2002) argues that one important aspect of wars these days is to keep risks away from one's own military. As an example, he refers to recent military interventions (the Yugoslav War in the 1990s and the Afghanistan War in 2001) where local allies on the ground took a great share of battle casualties. He argues that states are more willing to accept indirect and less visible casualties, i.e. such casualties for which their own, direct responsibility can be dwarfed. Apparently, civilian casualties and deaths of regular soldiers count more - in terms of political costs - than casualties of PMSCs.

Within the context of our model, we subsume the first two aspects (reducing financial costs and enhancing military effectiveness) under the assumption that the variable effort costs the PMSC faces are lower than those of the state. The last aspect (reducing political costs) is captured by the assumption that negative outcomes are more harmful to the state if the latter has been active itself.

However, delegating the task is also associated with an agency problem: Contrary to the state, the PMSC has no intrinsic interest in achieving the outcome preferred by the principal. Furthermore, it is not possible or too costly to fully monitor the PMSC's effort. Instead, the state can only observe whether it was completed successfully or not. Whereas success is positively affected by the PMSC's effort, some uncertainty always prevails, and failure can even occur if the task has been carried out with all possible care.

In addition, giving the PMSC appropriate incentives is restricted by the extent to which compensation can be based on the realized outcome. Past experience has shown that contracts between states and PMSCs are left vague, leaving out potential contingencies and related consequences (Stöber, 2007). Even though it seems desirable to relate PMSCs' compensation to a realized performance measure, it appears very difficult to do so because verification and enforcement is always limited in the context of contingency operations (Dickinson, 2007). However, rewarding the PMSC based on performance is certainly not impossible because a state is likely to have more tasks and missions in the future, for which it potentially needs PMSCs. Hence, performance-based compensation can indirectly and implicitly be part of the agreement between state and PMSCs, namely as the expectation of being re-hired for future tasks and forwarded a rent. Indeed, there is evidence that these considerations play a role because PMSCs are often not chosen based on a competitive bidding process (Berrios, 2006; Dickinson, 2007; Ortiz, 2010). Therefore, we assume in the model that discretionary payments based on whether the task was completed successfully are possible but bounded. On the one hand, they cannot be negative, implying limited liability on the PMSCs' side. Hence, the only way to punish the PMSC for doing a bad job is not hiring it for future tasks. On the other hand, these payments cannot be arbitrarily large but are restricted by the value future collaborations have for the state (this aspect is achieved by an extension of the basic model, where we explicitly take the possibility of repeated interaction and the resulting consequences on the enforceability of rewards into account). If this value is too low, the state only has limited incentives to honor promises and maintain mutual trust.

We derive three main results that help to better understand the complicated relationship between states and PMSCs.

1. Even if the agent is expected to do a worse job than the principal would do herself, delegation can be optimal. Lower (induced) effort of the agent is possible although the latter faces lower variable costs. This is driven by two aspects: Limited liability on the agent's side might make it necessary to give him a rent. This rent increases with implemented effort, and the principal faces a trade-off between inducing more effort and rent extraction. Furthermore, the fact that negative outcomes are more harmful to the state if it has been active itself reduces the optimal power of incentives from the state's perspective. This outcome is especially problematic for a potential host state, which - upon entry - will prefer associated tasks to be done as well and carefully as possible. Thus, from a host state's perspective, either less PMSCs should be hired, or the involved states should set higher incentives. This will be difficult to impose, though, since the government of the intervening country acts in a way to maximize its own utility.

2. Countries not very active in international missions are less likely to hire PMSCs. The reason is that a lower frequency of future missions - which are used to "compensate" PMSCs for good outcomes in the past - restricts the states' ability to give appropriate incentives. However, commitment can also be increased by a decline in a country's ability to perform certain tasks itself (for example by a reduction of investments into its own troops). The reason is that promises to compensate the PMSC are more credible if the alternative options - compared to hiring a PMSC - are worse, and one alternative obviously is to carry out a mission oneself. Hence, reducing the attractiveness of this option increases the importance of good relationships with PMSCs and hence a government's commitment to maintain them.

3. The government's reputation in keeping promises after a good outcome is crucial in incentivizing PMSCs. If rents are forwarded to PMSCs as a reward for a good outcome in the past, this might appear to be missing a service in return, and is frequently criticized as inefficient or even containing elements of corruption. We argue that attempts to make

the hiring process for PMSCs more transparent - like using competitive bidding processes - can actually have a negative impact on the performance of PMSCs, because it reduces a government's commitment.[2]

The remainder of the paper proceeds as follows: The next section provides a brief overview of the economic and political science principal-agent literature on which this paper is based on and discusses the existent theoretical literature on PMSCs, in particular those which apply principal-agent theory. Section four presents the model setup, while section five analyzes the players' optimal actions in a static setting. Section six extends the model by incorporating the dynamic nature of the relationship between principal and agent. Section seven examines the impact of the use of PMSCs on a potential host state. Section eight concludes.

3 Related Literature

Our paper contributes to the theoretical literature on the implications of PMSCs' rise, influence, and deployment in crisis and war regions. So far this literature on PMSCs has focused on diverse topics: One branch of this literature deals with PMSCs' role in the creation, global perception, and maintenance of the concepts of security and risk (Krahmann 2011, Carmola 2010, Leander 2005). A second branch focuses on the influence of neo-liberal governmentality on the private security sector and the use of this concept by private security actors (Abrahamsen and Williams 2010, Leander and van Munster 2007). A third - and to this paper most related - branch of the literature examines principal-agent interactions between states and PMSCs, however only informally. Cockayne (2007), for instance, applies the ideas of principal-agent theory to the regulation of PMSCs and offers insights for potential risks and opportunities when contracting with private actors for security services, especially against the background of legitimacy, authority and rule of law. He reasons that security, particularly with regard to weak states, risks becoming a product of power and cash rather than a legal right. Dickinson (2007) discusses possible accountability mechanisms and focuses on the question how to design and improve contracts in such a way that they ensure efficient monitoring, oversight and enforcement mechanisms. She particularly calls on non-governmental organizations to strive towards alternative accountability instruments such as international accreditation regimes and to mobilize political pressure. Stöber (2007) analyzes the delegation of security to private actors by conducting a case study of the Iraq War of 2003. He uses a principal-agent approach in order to examine potential contractual hazards and the possibilities of the principal to enforce the agent's compliance to the negotiated contract.

However, even though all these studies use a principal-agent approach, none of them ex-

[2] See Calzolari and Spagnolo (2009), who develop a similar argument for public procurement.

amines the questions why it is optimal for the principal to delegate the provision of security to an agent and how to incentivize the agent optimally (for example by using a formal model), as does this paper. Hence, compared to the preceding literature the present paper goes one step further and, thus, makes a noteworthy contribution to the knowledge as well as theory building in this field of research. To use Feaver's (2003, p.113) words: "The monopoly on the legitimate use of force is what distinguishes governments from other institutions. Understanding how this monopoly is delegated and controlled is therefore central to the enterprise of political science."

Furthemore, this paper is based on the principal-agent moral hazard literature building on Holmström (1979) and Grossman and Hart (1983), which was initially developed to better understand employment relationships when an employee's effort is unobservable. Furthermore, we relate to different extensions of the original approach, which analyze enforcement problems that restrict payments to optimally base pay on performance. Innes (1990), for example, assumes that an agent might be protected by limited liability, implying that his compensation must not fall below a certain level. In this case, it is necessary to give the agent a rent, making it optimal for the principal to reduce incentives and consequently implemented effort. While all these models focus on explicit contracts that reward the agent based on verifiable performance measures, there has been an increased interest in implicit contracts as a way to mitigate the moral hazard problem if output or effort can be observed but not verified to an outside party (see, e.g. Bull 1987, MacLeod and Malcomson 1989, or Levin 2003). In this case, cooperation can only be sustained within a dynamic game. We think this aspect is also relevant for the relationship between a government and a PMSC, since compensation based on the outcome of past performance can only be implicit and for example manifest in future projects.

4 Model Setup - Static Game

Structure

A country, subsequently denoted as "principal" (or "she"), faces the choice to (1) exercise a military or security task herself, (2) completely abstain from performing it, or (3) hire a PMSC, subsequently denoted as "agent" (or "he"), to carry out the task. Military and security task in this context refer to any kind of such services potentially offered by PMSCs. Each of the three options causes the realization of different outcomes. This model focues on one specific task; however, the process will be identical among all of them, as long as there are no interdependencies. We assume that only one agent is available, but discuss the potential selection process below. In section 6, we further take into account the possibility that the agent can be hired repeatedly.

If the principal conducts the task herself, she faces fixed costs $F_P \geq 0$. After starting, she decides about her effort level e_P, which can take any value between zero and one, i.e., $e_P \in [0,1]$ and is directly chosen by the principal. However, effort is costly, and a higher level is associated with higher costs. Formally, effort costs are $c_P(e_P)$, with $c_P(e_P) = k_P \frac{e_P^2}{2}$, $k_P > 0$. Total costs for the principal, if she conducts the task herself and plans to choose effort e_P, thus amount to $C_P(e_P) = F_P + c_P(e_P)$.

The task can either be a success for the principal or not. This manifests in whether the initial purpose is met, but also in what happened during the period, for example the number of own soldiers that have died or other incidents that can have an impact on the domestic public opinion or the principal's international reputation. Formally, this is captured by the resulting outcome $Y_P \in \{L_P, H\}$, with $L_P \leq 0 < H$. The subscript in L_P captures the fact that a failure can be assessed differently by the principal, depending on whether she herself or the agent has been active. Conditional on performing the task, the probability of a success, i.e., of $Y = H$, is determined by the principal's effort, with $\text{Prob}(Y = H \mid e_P) = e_P$.

If the agent is hired instead, he also faces fixed starting costs, F_A and can choose effort $e_A \in [0,1]$, which is associated with variable effort costs $c_A(e_A) = k_A \frac{e_A^2}{2}$. Thus, total costs - borne by the hired agent - are $C_A(e_A) = F_A + k_A \frac{e_A^2}{2}$. The outcome Y_A can either be L_A or H, with $L_A \leq 0 < H$. The offer made by the principal consists of an ex ante payment w, as well as some discretionary compensation b, in the following referred to as bonus. In this setting, though, it does not refer to direct monetary payments but should rather be interpreted as the possibility of being rehired by the principal in the future. In the static benchmark model we assume that the principal can credibly commit to any value of b. However, in section 6 we endogenize the maximum enforceable value of b if the agent can be hired repeatedly. Then, the term b is equivalent to the maximum future rent the principal can credibly promise to forward to the agent.

Furthermore, the agent's effort is not observable to the principal, but output - as well as the decision to perform the task triggering the fixed starting costs - is. Thus, the bonus can only depend on the outcome, i.e., we have $b(Y_A)$. This implies that the principal can directly choose effort if she decides to enter herself but is not able to do so when the agent is hired, and then faces a moral hazard problem. In this case, incentives are given by an appropriate choice of $b(Y_A)$.

Players' Preferences

The principal would like to maximize her utility from the accomplishment of a military or security task, whereas the agent would like to excercise as little effort as possible. In particular, the players' preferences are defined as follows: If the principal conducts the task herself, her utility is $u_P^P = Y_P - C_P(e)$.[3] If the agent is hired, the principal's payoff is $u_P^A = Y_A - w - b(Y_A)$. If the principal neither conducts the task herself nor hires the agent, her utility equals $\overline{u}_P$. We impose no assumption on the size of $\overline{u}_P$. For some tasks, however, it might seem sensible to set $\overline{u}_P \geq L_P$. For example, combat operations with high civilian fatalities might make the principal worse off ex post compared to having abstained from the beginning. For other tasks, like the training of the host country's security forces in the context of a military intervention, any action is better than abstaining. In this case, we would have $\overline{u}_P < L_P$.

The agent's preferences are not affected by the outcome Y, but only depend on the payments he receives from the principal, as well as the costs he has to bear. Thus, we have $u_A = w + b(Y_A) - C_A(e_A)$ if the agent is hired. If not, his payoff is $\overline{u}_A$, where we make the normalization $\overline{u}_A = 0$.

Assumptions

Based on the overview in section 2, we establish some assumptions on the parameters that have a direct impact on the principal's preferred choice of action, and then describe and analyze the interaction between state and PMSC as reflected in our model.

First of all, the agent's variable costs are lower than the principal's , i.e., we make

Assumption 1: $k_P \geq k_A$.

We subsume under variable costs expenses such as hiring costs, training costs, pension, health care, and widow obligations.[4] It seems sensible that PMSCs can avoid various costs the state would have to bear. Moreover, past experiences with PMSCs show that they hire mostly locals or third-country nationals, who are even less costly (CWC, 2011, p.226).

We impose no assumption on the relationship between F_A and F_P. Of course, similar arguments as with variable costs could be used to claim that $F_P \geq F_A$. However, it should be noted that states already possess an infrastructure, for example for the training of employees, that can be used for another task at small additional costs.

Next, we impose

Assumption 2: $L_P \leq L_A$

This assumption implies that negative outcomes are more harmful if the principal has been active herself. As we have already discussed in section 2, we argue that the reputational loss

[3] Note that the principal's preferences are generally described by the preferences of the state's government.

[4] According to the Commission on Wartime Contracting, the incremental operating cost to deploy a military member is estimated to be about \$10,000 per year (CWC, 2011:225).

for the principal - when she does not succeed in a military operation, or when civilians or soldiers are killed or involved in criminal activities, or simply the fact that the principal is involved in controversial military operations which are not supported by the public - should be larger than when PMSCs had been responsible. Hence, when hiring PMSCs, states can avoid various political costs which they would have to bear otherwise.

The next assumption is purely technical, and serves to avoid corner solutions (i.e., to make sure that $e < 1$)

Assumption 3: $(H - L_A) < k_A$

Note that Assumption 3 - together with Assumption 1 - also implies $(H - L_P) < k_P$.

We could not find evidence that PMSCs offficially receive contingent compensation based on some (verfiable) measure of success. However, we believe that the component of a contingent compensation is not absent at all but implicitly enters the contract between principal and agent. Countries hiring contractors might also envisage other missions, and a good experience with one agent can increase the latter's prospect of being hired again. Therefore, we add the contingent payment b, which reflects this possibility, into our model. Our benchmark setup is a short-cut of this potential repeated interaction. However, the principal will not be able to credibly promise an arbitrarily high payment because future missions are limited. Hence, commitment to base payments on Y_A is possible, but this commitment is limited. We analyze this aspect in detail in section 6. For now, we impose no upper bound on b.

Moreover, payments are supposed to be non-negative. This reflects the implicit assumption that the agent is rewarded for a good outcome by being hired in future missions. In case of a bad outcome, however, the punishment that can be imposed on him cannot be more severe than not being hired for future tasks or receiving a lower rent in future task.

Hence, we impose

Assumption 4: $w, b \geq 0$

Consequently , we have a game of moral hozard with limited liability if the agent is hired, see Innes (1990) for a general characterization. Our model differs in a sense that the principal can also be active herself, but that this is associated with different costs and outcome parameters.

5 Results - Static Game

In the following sections, we analyze the optimal actions when the principal decides to perform the task herself, then derive the optimal contract if the agent is hired, and finally compare both options.

Optimal Effort Choice of the Principal

If the principal does not hire the agent but has to decide whether to carry out the task herself or not to do it at all, her optimal behavior is described by

Proposition 1: *If the principal decides not to hire the agent, effort conditional on performing the task is* $e_P^* = \frac{(H-L_P)}{k_P}$. *However, performing the task herself is optimal for the principal if and only if*

$$L_P + \frac{(H-L_P)^2}{2k_P} - F_P \geq \overline{u}_P. \tag{1}$$

Proof: In the present case, the principal can directly set the effort level. Thus, the problem to be solved equals

$$\max_{e_P} u_P = e_P H + (1 - e_P)\, L_P - C_P(e_P), \tag{2}$$

s.t. $u_P \geq \overline{u}_P$. The first-order condition characterizes equilibrium effort given performing the task (note that this condition is also sufficient, provided our assumptions concerning effort costs):

$$(H - L_P) - k_P e_P = 0. \tag{3}$$

Plugging this into the right hand side of (2) gives (1). Q.E.D.

Thus, more effort is chosen if variable costs k_P are lower and if the difference between good and bad outcome, $H - L_P$, is larger. The same is true for the probability of performing the task at all, which is also affected by fixed costs, as well as the principal's utility in the bad outcome. A lower L_P indicates that a failure is very detrimental to the principal's interest. For example, the political costs a state has to face in case of a bad outcome can outweigh any potential gains a military victory provides. In this case, it will be better for the principal to completely abstain from the task. We briefly illustrate this aspect with the US involvement in the Vietnam War between 1965 and 1975. Against the background of the Cold War, the US intervened in the war between the communist North Vietnam and anti-communist South Vietnam in order to halt the communist expansion. Even though the US was never defeated on the battlefield, the military involvement in the Vietnam War proved to be a political disaster for the US administration. The domestic public opinion turned against the US involvement and eventually caused the withdrawal of US troops from Vietnam particularly because of the brutal acts of war and the high civilian and troop causalities which became known to the US public during the war (Hess, 2009). In retrospective, one could therefore argue that it would have been better for the US not to intervene in the Vietnam War in the first place.

Optimal Contract if a Specific Agent is Hired

Now, assume that the principal decides to hire the agent. Here, we assume that all bargaining power is on the principal's side, who can therefore determine the terms of the contract. This could be justified by assuming competition on the PMSCs side. However, due to the exogenous bounds on compensation (which cannot be negative), the agent might still receive a rent.

Before exploring the agent's actual effort choice and associated incentives, we look at first-best effort (from the principal's perspective) given the agent is hired and take it as a benchmark. This level would be $e_A^{FB} = \frac{(H-L_A)}{k_A}$ and might or might not be higher than e_P^*.[5] More precisely, $e_A^{FB} \geq e_P^*$ if and only if $\frac{(H-L_A)}{(H-L_P)} \geq \frac{k_A}{k_P}$. On the one hand, a lower marginal effort costs k_A in relation to k_P makes it more likely to have $e_A^{FB} \geq e_P^*$. On the other hand, the fact that a bad outcome is worse for the principal if she had performed the task herself ($L_A \geq L_P$) works into the opposite direction.

If the agent's effort was verifiable, it would be optimal to induce e_A^{FB}. In this case, offering a bonus $b(e) = c_A(e_A^{FB})$ would provide sufficient incentives, and the fixed wage would be set to cover the agent's fixed costs and outside option, i.e. $w_A = F_A + \overline{u}_A = F_A$. However, the agent's effort is not contractible, and the contingent payment b can only be based on the realized outcome. Hence, it might be optimal to actually induce an effort level lower than e_A^{FB}. The reason is that due to the agent's limited liability constraint, the agent must receive a rent absent fixed costs. If F_A is sufficiently small, the agent receives a net rent, and the principal faces a trade-off between effort maximization and rent extraction. This induces her to implement an effort level that is below the first-best, even if the latter were enforceable.

Deriving these results, note that due to b being restricted to non-negative values, it will obviously be optimal to set $b(L_A) = 0$. If high output is realized, the agent receives the payment $b(H) \equiv b$. Given an arbitrary payment b, the agent chooses an effort level to maximize his expected utility. This is captured by the incentive compatibility (IC) constraint

$$e_A^* = \text{argmax} u_A = w + e_A b + (1 - e_A) \cdot 0 - C_A(e_A). \tag{IC}$$

Equilibrium effort is independent of the fixed payment w, which is set at the beginning of the relationship and thus cannot be used to give incentives. Since the conditions to use the

[5] e_A^{FB} would be the agent's effort if the principal were able to directly choose it herself. In this case, the principal solves $\max_{e_A} e_A H + (1 - e_A) L_A - C_A(e_A)$, where the first order condition gives e_A^{FB}.

first order approach are satisfied[6], we have equilibrium effort

$$e_A^* = \frac{b}{k_A}.$$

It follows that, conditional on hiring the agent, the principal sets b and w to

$$\max u_P = e_A(H-b) + (1-e_A)\,L_A - w,$$

subject to

$$e_A^* = \frac{b}{k_A} \tag{IC}$$

$$u_A = e_A b - k_A \frac{e_A^2}{2} - F_A + w \geq 0 \tag{IR}$$

$$w, b \geq 0 \tag{LL}$$

Proposition 2: *Assume the agent is hired. Then, equilibrium effort depends on F_A which determines whether the agent has to get a rent. More precisely, there exist values $\underline{F_A}$ and $\overline{F}_A$, with $\underline{F_A} < \overline{F}_A$, such that*

- *Effort is at its efficient level, $e_A^* = e_A^{FB} = \frac{(H-L_A)}{k_A}$, if $F_A \geq \overline{F}_A$. However, in this case it can only be optimal to hire the agent if doing nothing is worth than a failure, i.e., if $\overline{u}_P < L_A$*
- *Effort is at half its efficient level, $e_A^* = \frac{(H-L_A)}{2k_A}$* , if $F_A < \underline{F_A}$
- *Effort lies between e_A^{FB} and $\frac{e_A^{FB}}{2}$ if $\underline{F_A} \leq F_A < \overline{F}_A$*

The proof to Proposition 2 can be found in Appendix A.

For relatively high fixed costs, the principal does not have to give the agent an extra rent and thus implements first-best effort. However, this case can only be optimal if doing nothing is worth than a failure, i.e., if $\overline{u}_P < L_A$. This aspect is further explored in Proposition 5 below. For low fixed costs, the binding limited liability constraint allows the agent to extract some rent. Then, the principal faces a trade-off between surplus maximization and rent extraction, making it optimal to only implement half of first-best effort and paying the agent a rent. For intermediate levels of fixed costs, this tradeoff is also present. Then, however, it is optimal to only reduce effort and keep the agent at his outside utility. Thus, effort falls with lower fixed costs, until it reaches half the efficient level, where it becomes optimal to grant the agent a

[6] For example, see Rogerson (1985).

rent. Furthermore, the principal's payoff decreases with F_A as long as $F_A \geq \underline{F_A}$. For $F_A < \underline{F_A}$, u_P^A is independent of F_A.

Comparison

In the following, we compare the principal's decision to either perform the task herself with her decision to hire the agent. Generally, we can make the following statement.

Lemma 2: *Performing the task herself rather than hiring the agent becomes relatively better for the principal for higher levels of L_P, F_A and k_A, and for lower levels of L_A, F_B and k_B. The impact of a higher H is ambigous and depends on the size of k_A, k_P, L_A and L_P.*

The proof to Lemma 2 can be found in Appendix A. Not surprisingly, it becomes less attractive to hire the agent if the latter ceteris paribus faces higher operating costs, and if a bad outcome after performing the task itself, L_P, is less problematic. The next proposition - which is also proven in Appendix A - captures the importance of the difference between L_A and L_P, i.e., the principal's payoff after a failure, dependent on whether the agent was hired or not. In this case, a larger difference always makes it relatively better to hire the agent.

Proposition 3: *A larger difference between L_A and L_P reduces $u_P^P - u_P^A$.*

The fact that the domestic public opinion might be rather indifferent towards the death of PMSCs personnel compared to the death of regular soldiers leads to a problematic outcome: It not only reduces the implemented effort if the agent is hired, but also makes it more likely that the agent is actually chosen. In case of international military interventions, this result connotes a problem for the country in which the intervention takes place (the host state). Even though the host state mainly cares about how well the job is done - i.e., about the level of implemented effort - it is possible that the wrong player (from the host state's perspective), namely the PMSC instead of the principal's own forces, carries out the task. We further explore this issue in section 7.

Now, we present a further proposition that describes another case of when hiring the agent is always better than performing the task herself, namely when we assume $F_P \geq F_A$ and the agent's fixed costs are sufficiently high.

Proposition 4: *Assume $F_P \geq F_A$ and $F_A \geq \frac{(H-L_A)^2}{2k_A}$. Then, it is always better for the principal to hire the agent compared to performing the task herself.*

Proof: Note that $\frac{\partial\left(u_P^P - u_P^A\right)}{\partial k_P} = -\frac{(H-L_P)^2}{2k_P^2} < 0$. Since $k_P \geq k_A$, it is thus sufficient to show that $u_P^P - u_P^A < 0$ for $k_P = k_A$.

If $k_P = k_A = k$, then $u_P^P - u_P^A = L_P - L_A + \frac{2H(L_A - L_P) - \left(L_A^2 - L_P^2\right)}{2k} + F_A - F_P = L_P - L_A - (L_P - L_A)\frac{H - L_A + H - L_P}{2k} + F_A - F_P$.

Since $L_A \geq L_P$, $(H - L_A) < k_A$ and thus $\frac{H - L_A + H - L_P}{2k} < 1$, $u_P^P - u_P^A$ is negative for $F_P \geq F_A$.

Q.E.D.

Two aspects drive this result. First of all, high fixed costs alleviate the necessity to give the agent a rent, also making it optimal to induce first-best effort if the agent is hired. Since the principal's fixed costs are even higher, the need to compensate the agent for his fixed costs drives the principal to perform the task herself. Furthermore, $L_A \geq L_P$ reduces the principal's loss if the task fulfillment is not successful.

However, if the conditions of Proposition 4 are satisfied, the task might not be performed at all. Above, we described that often it seems sensible to assume $L_A \leq \overline{u}_P$, i.e., that a failure of the task gives the principal a lower payoff than if it had abstained from performing it from the beginning. Then, we have

Proposition 5: *Assume $F_P \geq F_A$, $F_A \geq \frac{(H-L_A)^2}{2k_A}$ and $\overline{u}_P \geq L_A$. Then, it is optimal for the principal to abstain from performing the task.*

Proof: From Proposition 2 above we know that for $F_A \geq \frac{(H-L_A)^2}{2k_A}$, we have $u_P^A = L_A - \left(F_A - \frac{(H-L_A)^2}{2k_A}\right)$. Since the term in brackets is positive, and since we assume $\overline{u}_P \geq L_A$, the condition $u_P^A \geq \overline{u}_P$ can never be satisfied. Finally, we can use Proposition 3, stating that the option of the principal performing the task herself is always dominated by the option of hiring the agent instead.

Q.E.D.

In all other cases, namely if $F_P < F_A$ or $F_A < \frac{(H-L_A)^2}{2k_A}$, each option can be optimal, and the agent even might be hired if this is with lower effort levels. For example, assume that $k_P = k_A = k$ and $F_A < \frac{(H-L_A)^2}{8k_A}$. Then, hiring the agent is always associated with substantially less effort than if the principal performs the task itself. However, the latter can be optimal, namely if $u_P^P - u_P^A = L_P - L_A + \frac{(H-L_P)^2}{2k} - \frac{(H-L_A)^2}{4k} - F_P < 0$. This is always true for F_P sufficiently large. Moreover, even if $F_P = 0$, this condition can be satisfied, depending on the difference between L_P and L_A (see Proposition 3).

6 Repeated Interaction and Potential Bounds on b

We already discussed that contingent compensation as an official part of agreements between governments and PMSCs is basically not observed. Instead, it seems that these components rather enter implicitly, namely via future collaborations where the agent will receive a rent. In this section, we incorporate the dynamic nature of the relationship between principal and agent into our model and analyze the consequences when all contingent compensation must be self-enforcing, i.e., it must be optimal for the principal to actually forward it to the agent.

We extend the model in the following way: The principal repeatedly faces the same choice as before, where all aspects of the task - costs, identity of agents and payoffs in case of success or failure - do not vary over time.[7] Furthermore, we abstract from all aspects and tasks of a mission for which the specific agent is not considered, either because others are better suited or because the principal is performing it herself. Formally, we analyze an infinitely repeated game in discrete time, where periods are denoted $t = 1, 2, ...$, and future period are discounted with the factor $\delta < 1$ (a complete formal characterization can be found in Appendix B). δ not only reflects time preferences, but also issues like the frequency with which this kind of task is carried out or the existence of other, competing agents.

In order to stay as close as possible to the static case, we still use bonus payments made at the end of a period to reward agents - although we argued that agents are rather compensated within future projects. However, if we replaced the bonus with a fixed wage w^h (with $w^h = \frac{b}{\delta} + w$), paid to the agent at the beginning of each period following a successful one, the following analysis would yield identical outcomes.

The crucial aspect in this section is that it has to be optimal for the principal to actually forward the bonus to the agent after a success. Hence, the principal must fear a punishment after failing to do so. This punishment takes the form of a complete loss of trust in the principal by the agent. In other words, the agent only trusts the principal to make future bonus payments as long as the latter has not broken any given promise in the past. After reneging, the principal knows that the agent will not exert effort anymore, and it will generally not be optimal to hire the agent for any future mission. Furthermore, we restrict our focus on so-called stationary contracts, i.e. the contract offered by the principal is identical in every period.[8]

The present analysis is only interesting if the agent is actually hired in equilibrium. A necessary condition for this is that hiring the agent is optimal given no upper bound on b exists. Due to stationarity, this is the case whenever hiring the agent is optimal in the static

[7] This assumption is solely made for concreteness. Letting parameters change stochastically would have no qualitative impact on our results.

[8] Note that under some circumstances, the principal could benefit from offering a non-stationary contract (see Fong and Li, 2010, for a theoretical analysis of relational contracts with limited liability). However, the simplifying assumption of stationary contracts is sufficient to make our point.

case, as analyzed above. From now on, we will hence impose

Assumption 5: In the static case analyzed above, it is optimal to hire the agent, i.e., $u_P^A > \max\left\{u_P^P, \overline{u}_P\right\}$.

Note that Assumption 5 does not automatically imply that the agent is also hired in this section. As will be shown below, if the maximum enforceable value of the bonus is too low, performing the task herself (or abstaining) will be the principal's optimal choice.

Furthermore, two aspects are worth mentioning. First of all, stationarity implies that if hiring the agent is optimal in one period, this will also be optimal in all periods. Furthermore, even if the agent is hired in equilibrium, the alternative of performing the task herself is still important as an off-equilibrium outside option for the principal.

Concerning payoffs, stationarity implies that all periods are identical. Hence, we can omit time subscripts and - in case the agent is hired - have discounted payoff streams

$$U_P^A = \frac{-w + e_A(H-b) + (1-e_A)L_A}{1-\delta}$$

and

$$U_A = \frac{w + e_A b - \left(F_A + k_A \frac{e_A^2}{2}\right)}{1-\delta}.$$

If the agent is not hired, he receives a payoff of zero, whereas the principals has an outside utility payoff stream $\overline{U}_P = \max\left\{\frac{L_P + \frac{(H-L_P)^2}{2k_P} - F_P}{1-\delta}, \frac{\overline{u}_P}{1-\delta}\right\}$, where the first component is the utility level when the principal is active and the second when the principal abstains from the task. We further assume that $\overline{U}_P > L_A - F_A$. Hence, it is not optimal to hire the agent without giving incentives, i.e., for $e_A = 0$.

Now, assume that the agent is hired and supposed to exert an effort level e_A^*. A number of constraints have to be satisfied for e_A^* being part of an equilibrium. As before, the agent's incentive compatibility (IC) constraint must hold,

$$e_A^* = \operatorname{argmax} U_A \tag{IC}$$

Due to stationarity, this condition is basically identical to the static game analyzed above.[9] Hence, equilibrium effort can be obtained using the first-order approach, and equals

$$e_A^* = \frac{b}{k_A}.$$

[9] If we allowed for non-stationary equilibria, the bonus would generally not to be constant over time, since future rents could be used to provide current incentives.

Furthermore, the agent's individual rationality (IR) constraint and the limited liability (LL) constraint are

$$U_A \geq 0 \tag{IR}$$

$$w \geq 0. \tag{LL}$$

In addition, it must be optimal for the principal to actually make the bonus payment b. As the outcome is not verifiable, the principal will only pay out b if it is optimal to do so. This is the case whenever the future value of cooperation is higher than the future value of non-cooperation, i.e. $\overline{U}_P$. Therefore, the principal's dynamic enforcement (DE) constraint equals

$$-b + \delta U_P^A \geq \delta \overline{U}. \tag{DE}$$

Note that whenever a strictly positive bonus and hence effort level can be enforced, then $U_P^A \geq \overline{U}$, and hiring the agent is optimal. In this case, the objective is to maximize U_P^A, subject to the constraints derived above.

In Appendix B, we fully characterize possible outcomes and show that if the principal's (DE) constraint does not bind, the results are identical to the static case derived above. Of particular interest, though, is

Proposition 6: There exist values $\hat{\delta}$ and $\overline{\delta}$, with $0 < \hat{\delta} < \overline{\delta} < 1$, such that

- The agent is not hired if $\delta < \hat{\delta}$
- The agent is hired, however equilibrium effort $e_A^*$is lower than in the static case if $\hat{\delta} \leq \delta < \overline{\delta}$
- The agent is hired, and equilibrium effort e_A^* is at the same level as in the static case if $\delta \geq \overline{\delta}$

These results are driven by two aspects. First of all, the maximum enforceable bonus - and hence maximum implementable effort - is determined by the principal's (DE) constraint, and increases in δ. If δ is rather large, the maximum enforceable effort is larger or equal than the effort level induced in the static case, which then is implemented by the principal. If δ gets smaller, enforceable effort goes down. At some point, it is so low and the likelihood of a failure so large that it becomes optimal for the principal to either perform the task herself or completely abstain from it.

Proposition 6 indicates that the main novelty of this section is the case when δ is between $\hat{\delta}$ and $\overline{\delta}$. Then, the agent is hired, however the principal would like to enforce a higher effort level but cannot commit to compensate the agent accordingly. Proposition 6 also implies that a higher δ increases the chances that hiring the PMSCs is actually optimal. The discount factor δ reflects time preferences, but also the frequency of potential tasks for which the principal considers hiring the agent. Hence, we should observe that countries that are hardly active in (international) military operations should be less likely to hire contractors than those who are repeatedly involved in large-scale projects.

In the remainder of this section, the parameters δ and $\overline{U}_P$ are of particular interest to us, and we want to explore their effect on the maximum enforceable value of b. In addition, we examine what the respective values might actually imply for countries that consider hiring a PMSC. All of the following results are proven in Appendix B.

In Proposition 7, we show that the higher the level of δ, the larger is the effort level that can be enforced in an equilibrium maximizing the principal's payoff stream.

Proposition 7: *Assume $\hat{\delta} \leq \delta < \overline{\delta}$. Then, equilibrium effort is strictly increasing in δ.*

Whenever the (DE) constraint does not bind and hence not restrict equilibrium effort, a higher δ has no impact on e_A^*. However, if (DE) binds and the principal cannot commit to pay a higher b to increase e_A^*, a higher δ would directly increase effort and hence U_P^A. Therefore, δ reflects the principal's (expected) level of commitment in her relationship with the PMSC.

Furthermore, a binding (DE) constraint implies that not only total payoff streams increase in δ, but also average, i.e., per-period payoffs. This is further captured by

Lemma 3: *Assume $\hat{\delta} \leq \delta < \overline{\delta}$. Then, per-period payoffs $(1-\delta)U_P^A$ are strictly increasing in δ.*

Furthermore, a higher outside option decreases the principal's payoff in the case when hiring the agent is optimal. This might seem counterintuitive, since generally a player should always benefit from a better alternative option (for example, this is the case in bargaining situations). However, a higher outside option also reduces the ability of the principal to credibly commit to reward the agent for successfully performing a task.

Proposition 8: *Assume $\hat{\delta} \leq \delta < \overline{\delta}$. Then, equilibrium effort is strictly decreasing in $\overline{U}_P$. Furthermore, per-period payoffs $(1-\delta)U_P^A$ are strictly decreasing in $\overline{U}_P$.*

Assuming that the value of not performing the task, $\overline{u}_P$, remains constant, the principal might be able to affect $\overline{U}_P$ if she is able to change parameters determing the value of being active herself. For example, the size of the defense budget could generally affect operating costs for a given mission or task. k_P and F_P might be lower if forces are better trained, or could reflect opportunity costs if forces are not multifunctionally deployable. Hence, lower investments into a country's military might on the one hand have a direct impact on the use of PMSCs - if the defense budget is reduced and the amount of activities remains constant, it will naturally be optimal to let more of these activitivies be performed by PMSCs - and might on the other hand have an indirect impact on the agent's effort level: A lower outside option increases the principal's commitment, and hiring the agent becomes relatively better compared to performing a given task herself. Hence, a reduction of the defense budget could counteract a reduction of δ that is implied by a lower frequency of international activities.

In this section we endogenized the maximum enforceable value of b and showed under which circumstances the principal can credibly commit to reward the agent. The most fundamental aspect here is the ability of the principal to implicitly forward an actual rent to the agent after a task has been performed, i.e. for which a service in return is not directly observable. Indeed, there is evidence that PMSCs receive rents (see Dickinson, 2007), however this practise is generally regarded as a problem - especially in terms of transparency and corruption - that has to be tackled. Hence, competitive bidding processes are demanded as a tool to fight corruption and enhance transparency. However, our results show that making it impossible or generally harder to (at first sight unnecessarily) forward rents to PMSCs can trigger unintended consequences: The principal's inability to forward rents may reduce the performance of PMSCs, and countries might either abstain or carry out task themselves where hiring a PMSC would otherwise be optimal.

7 Impact on a Host State

In this section, we analyze one particular scenario, namely the setting in which an international alliance untertakes a military intervention in another country (the host state), and individual states hire PMSCs for specific military or security tasks to be carried ou in the host state. When analyzing the impact of the use of PMSCs on the host state, it is less straightforward to define whose preferences are relevant - whether it is the government or just some weighted average of its inhabitants - especially if the purpose of the intervention is to replace the host state's government. Therefore, we confine on some general points on how the choice of the principal affects the host state. Assume that if the mission does not take place, the host state's payoff is $\overline{u}_H$. If either the principal herself or the agent performs the task, a success triggers a payoff H_H, while a failure is associated with L_H. Furthermore, a mission is always associated with (expected) costs $K_H \geq 0$ for the host state, for example caused by the destruction of infrastructure, loss of human lives, or disruption and polarization of the society. We do not impose any assumptions on the size of H_H and L_H and K_H. However, it seems sensible to assume $L_H \leq L_P$, i.e., the consequences of a failure of the task are more detrimental to the host country than to any other player. H_H could be larger or smaller than H. On the one hand, a success of the task can have additional benefits to the host state that the principal does not enjoy. On the other hand, the principal might enjoy reputational benefits that have no impact on welfare in the host state. Generally, it makes most sense to assume that given a task is being performed, the host state wants the job to be done as well as possible and thus always prefers higher effort levels. As already pointed out, though, it might very well be that the principal chooses the option with less effort (see Proposition 3). Generally, it is possible that the principal's and the host state's preferences are sufficiently aligned. However, the following cases can occur as well.

First of all, the principal might carry out a task even though the host state would have preferred her to abstain. To have this outcome, $\overline{u}_H$ and/or K_H just have to be set sufficiently high and $\overline{u}_P$ sufficiently low. Concerning the latter, just consider domestic conditions making an expansion of a mission very tempting for the principal. Furthermore, we might have $H_P > H_H$. In this case, a potential victory would give the principal way more benefits than the host state and thus make it optimal to carry out the task. The military interventions in Afghanistan (2001) and Iraq (2003), for instance, illustrate this case.

Another potentially suboptimal outcome for the host state refers to the already mentioned possibility that it might prefer the principal to carry out the task herself (especially if this was associated with higher effort), but the latter would rather hire the agent. This would more likely to happen for a larger difference between L_A and L_P (see Proposition 3). This outcome is particularly critical when the PMSC exercises low effort in fulfilling the task. Host states are normally war-ridden countries with very limited monitoring and oversight capacities. In case of misconduct of PMSCs, for example, they most likely will not be able to prosecute them appropriately as has for instance happened in Iraq, where employees of the PMSC Blackwater International killed many Iraqi citizens in 2007. As Ross (2007, p. 95) puts it: "[...] the Iraqi government attempted to prosecute those involved. It was unable to do so because of Coalition Provisional Authority (CPA) Order 17, which granted PMSCs and their personnel immunity from Iraqi prosecution. Order 17 was repealed in one of the first acts of the Iraqi Parliament in 2009, and the Ministry of Interior used its expanded authority to refuse Blackwater an operating license. Despite decisive action by the Iraqi authorities, the company (now called Xe Services) continues to operate in Iraq and is still the main provider of persnoal security services for the U.S. State Department."

8 Conclusion

We started our analysis from the basic questions (1) why states, while being aware of the complicated agency dilemma inherent when hiring PMSCs, still rely on the services of these companies and (2) how to set the right incentives for these companies to act according to the best advantage of their principals. We developed a formal principal-agent moral hazard model

- with bounds on how well performance can be rewarded and bad performance be punished - to explain some of the observed patterns in the relationship between PMSCs and states potentially hiring them. The formal model yields three main results which advert to crucial policy implications:

First, we showed that even if the agent is expected to do a worse job than the principal, delegation can be optimal. Hence, an outcome that is not in the interest of the host state, namely that the party expected to doing a worse job is selected for a given task, might occur.

The second major finding is that states which are not very active in international missions should be less likely to hire PMSCs because of their inability to give PMSCs appropiate incentives for exercising high effort. Even though in our analysis we considered the particular relationship between a so-called strong state that hires a PMSC for services in a host state, this result can also be applied to weak states that hire PMSCs in order to fill the gap left by the inefficiency of their own security forces. Weak states often face the problem of not being able to pay for these services. Then, the endowment with natural ressources might serve as a subsitute to incentivize PMSCs - because they might expect to participate in the extraction of natural ressources once the conflict is resolved. Early operations of PMSCs in ressource-rich African countries seem to empirically support such a prediction.[10] This result, however, unfolds crucial implications regarding the commodification of security and the distribution of security as a function of financial conditions, especially in weak states (see Krahmann 2008 and Leander 2005).

Thirdly, our analysis revealed that it is not only the PMSC's reputation that is of practical relevance, but more importantly the state's credibility to keep the promise of a bonus (i.e., rehire the PMSC in future task and then grant it a rent) after a good outcome. Our model suggests that this implicit promise is necessary in order to succesfully incentivize the agent to exercise high effort. From a transparency-oriented point of view, this implicit promise may be regarded as a form of corruption. This is reflected in the repeated requests for the enforcement of competitive bidding processes when contracting PMSCs. Our results, however, indicate that a high degree of transparency in the contracting process may have a negative impact on the performance of PMSCs.

The results of this analysis contribute to the theoretical understanding of the implications connected with the use of PMSCs by states and thus can serve as a base for further studies. Extending the setup along different dimensions, for example, should provide more insights. The process of how a specific agent is chosen could be analyzed, or several tasks might be regarded, either being substitutes or complements with respect to benefits and costs. The latter aspect seems especially worth pursuing, since it could help to capture the impact of a change in the stability of the host state. If instability increases, it will often be optimal to extend a mission, increasing the number of tasks to carry out and thus the possibility for PMSCs to

[10] See Musah (2000) for a detailed description of the involvement of PMSCs in African conflicts.

be hired. The latter should - at least initially - benefit from a less stable environment, which might even create perverse incentives on their side to engage in destabilizing activities (as long as this engagement is not too obvious). However, at some point more instability will also harm PMSCs. The reason is that more instability should increase the costs of effort (for both parties) via two channels. On the one hand, costs are directly increased by a higher demand for necessary resources. On the other hand, costs are indirectly affected because more instability will decrease the success probability for a given effort level. To maintain a certain success probability, more effort and thus more costly resources are necessary. Especially the last point can consequently lead to a situation where totally abstaining from some task or even an intervention as a whole will become optimal.

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Appendix A - Omitted Proofs for the Static Case

Proposition 2: *Assume the agent is hired. Then, equilibrium effort depends on F_A which determines whether the agent has to get a rent. More precisely, there exist values $\underline{F_A}$ and $\overline{F}_A$, with $\underline{F_A} < \overline{F}_A$, such that*

- *Effort is at its efficient level, $e_A^* = e_A^{FB} = \frac{(H-L_A)}{k_A}$, if $F_A \geq \overline{F}_A$. However, in this case it can only be optimal to hire the agent if doing nothing is worth than a failure, i.e., if $\overline{u}_P < L_A$*

- *Effort is at half its efficient level,* $e_A^* = \frac{(H-L_A)}{2k_A}$, if $F_A < \underline{F_A}$

- *Effort lies between* e_A^{FB} *and* $\frac{e_A^{FB}}{2}$ *if* $\underline{F_A} \leq F_A < \overline{F}_A$

Note that Proposition 2 is equivalent to

Proposition 2': *Assume the agent is hired. Then, equilibrium effort depends on* F_A *which determines whether the agent has to get a rent. More precisely,*

- *If* $F_A \geq \frac{(H-L_A)^2}{2k_A}$*, effort is at its efficient level,* $e_A^* = e_A^{FB} = \frac{(H-L_A)}{k_A}$*. A necessary condition for hiring the agent being optimal is* $u_P^A = e_A^*(H-b) + (1-e_A^*)L_A - w = L_A - \left(F_A - \frac{(H-L_A)^2}{2k_A}\right) \geq \overline{u}_P$*, which can only be satisfied when* $L_A > \overline{u}_P$*.*

- If $\frac{(H-L_A)^2}{8k_A} < F_A < \frac{(H-L_A)^2}{2k_A}$*, effort is inefficiently low and characterized by* $k_A\frac{(e_A^*)^2}{2} - F_A = 0$*, where we further have* $\frac{(H-L_A)}{2k_A} < e_A^* < \frac{(H-L_A)}{k_A}$*. A necessary condition for hiring the agent being optimal is* $L_A + \sqrt{2\frac{F_A}{k_A}}(H-L_A) - 2F_A \geq \overline{u}_P$*, where* $\sqrt{2\frac{F_A}{k_A}}(H-L_A) - 2F_A > 0$ *and decreasing with* F_A*.*

- *If* $F_A \leq \frac{(H-L_A)^2}{8k_A}$*, effort is half the efficient level, i.e.,* $e_A^* = \frac{(H-L_A)}{2k_A}$*. A necessary condition for hiring the agent being optimal is* $\frac{(H-L_A)^2}{4k_A} + L_A \geq \overline{u}_P$*.*

Proof: Given (IC), it is not necessary to impose the constraint $b \geq 0$, as long as the optimal effort choice is strictly positive (which will always be the case). Furthermore, we can use (IC) to plug in $b = e_A^* k_A$ into the principal's problem, who is thus effectively able to choose effort.

Then, the Lagrange function equals
$\max_{e_A,w} L = e_A H - e_A^2 k_A + (1-e_A)L_A - w + \lambda_{IR}\left[k_A\frac{e_A^2}{2} - F_A + w\right] + \lambda_{LL} w.$
First order conditions are

$$\frac{\partial L}{\partial e_A} = (H-L_A) - 2e_A k_A + \lambda_{IR} k_A e_A - \lambda_B k_A = 0 \tag{4}$$

$$\frac{\partial L}{\partial w} = -1 + \lambda_{IR} + \lambda_{LL} = 0 \tag{5}$$

Complementary slackness conditions are
$\lambda_{IR}\left[k_A\frac{e_A^2}{2} - F_A + w\right] = 0$
$\lambda_{LL} w = 0$
$\lambda_{IR}, \lambda_{LL} \geq 0$

Condition (5) implies that at least one of (IR) or (LL) has to bind. Analyzing all three possible cases gives the results stated in the proposition.

(A) (IR) binds, $\lambda_{LL} = 0$.

Then, we can use $\lambda_{IR} = 1$ from (5) and plug it into (4), which becomes $(H - L_A) - e_A k_A - \lambda_B k_A = 0$. Then, it will be optimal for the principal to implement first-best effort. Thus, we have e_{FB} if $\lambda_B = 0$. Furthermore, hiring the agent will not be dominated by staying out of the targent country as long as $u_P^A = e_A^*(H - b) + (1 - e_A^*)L_A - w \geq \overline{u}_P$. We already know that $e_A^* = \frac{H-L_A}{k_A}$ and $b = e_A^* k_A$. To obtain w, we use the fact that (IR) binds and thus $u_A = e_A^* b + w - k_A \frac{(e_A^*)^2}{2} - F_A = 0 \Rightarrow w = F_A - \frac{(H-L_A)^2}{2k_A}$. Plugging these values into the entry condition gives $L_A - \left(F_A - \frac{(H-L_A)^2}{2k_A}\right) \geq \overline{u}_P$. Finally, this case is only feasible as long as $w = F_A - \frac{(H-L_A)^2}{2k_A} \geq 0$.

(B) (LL) binds, $\lambda_{IR} = 0$, i.e., the agent gets a rent. Equation (4) now gives

$$e_A^* = \frac{(H - L_A)}{2k_A}$$

Now, equilibrium effort is only half its first-best level. Thus, the need to give a rent to the agent substantially reduces the implemented effort. The necessary condition to make entry optimal (note that $w = 0$) becomes $u_P^A = e_A^*(H - b) + (1 - e_A^*)L_A = \frac{(H-L_A)^2}{4k_A} + L_A \geq \overline{u}_P$. Finally, this case is only feasible as long as $u_A = k_A \frac{e_A^2}{2} - F_A = \frac{(H-L_A)^2}{8k_A} - F_A \geq 0$.

(C) (IR) and (LL) bind. From **(A)** and **(B)** it follows that the present case is relevant for $\frac{(H-L_A)^2}{8k_A} < F_A < \frac{(H-L_A)^2}{2k_A}$. Here, effort is thus characterized by binding (IR) and (LL) constraints, i.e., $k_A \frac{e_A^2}{2} - F_A = 0$. Plugging in the boundaries of F_A gives $\frac{(H-L_A)}{2k_A} < e_A^* < \frac{(H-L_A)}{k_A}$. Plugging this value into u_P^A further gives us the necessary condition for an entry being optimal. There, $\sqrt{2\frac{F_A}{k_A}}(H - L_A) - 2F_A$ has to be non-negative because otherwise, the principal could just enforce the same effort as in case (A), furthermore paying $w = 0$ and receiving L_A in expectation. More precisely, $\frac{\partial \sqrt{2\frac{F_A}{k_A}}(H-L_A)-2F_A}{\partial F_A} = \sqrt{\frac{(H-L_A)^2}{2k_A F_A}} - 2 \leq 2 - 2 = 0$. Thus, $\sqrt{2\frac{F_A}{k_A}}(H - L_A) - 2F_A \geq \sqrt{2\frac{\frac{(H-L_A)^2}{2k_A}}{k_A}}(H - L_A) - 2\frac{(H-L_A)^2}{2k_A} = \frac{(H-L_A)^2}{k_A} - \frac{(H-L_A)^2}{k_A} = 0$. Q.E.D.

Lemma 2: *Performing the task herself rather than hiring the agent becomes relatively better for the principal for higher levels of L_P, F_A and k_A, and for lower levels of L_A, F_B and k_B. The impact of a higher H is ambigous and depends on the size of k_A, k_P, L_A and L_P.*

Proof to Lemma 2: Immediately follows from differentiating $u_P^P - u_P^A = L_P - L_A + \frac{(H-L_P)^2}{2k_P} - \frac{(H-L_A)^2}{2k_A} + F_A - F_P$ (in the case of $F_A \geq \frac{(H-L_A)^2}{2k_A}$), $u_P^P - u_P^A = L_P - L_A + \frac{(H-L_P)^2}{2k_P} - \sqrt{2\frac{F_A}{k_A}}(H - L_A) - F_P + 2F_A$ (for $\frac{(H-L_A)^2}{8k_A} < F_A < \frac{(H-L_A)^2}{2k_A}$), or $u_P^P - u_P^A = L_P - L_A + \frac{(H-L_P)^2}{2k_P} - \frac{(H-L_A)^2}{4k_A} - F_P$ (for $F_A < \frac{(H-L_A)^2}{8k_A}$), taking into account that $L_A \geq L_P$, $k_A \leq k_P$ and $(H - L_A) < k_A$. Q.E.D.

Proposition 3: *A larger difference between L_A and L_P reduces $u_P^P - u_P^A$.*

Proof to Proposition 3: Define $\Delta L \equiv L_A - L_P \geq 0$ and plug it into $u_P^P - u_P^A$, further keeping L_P constant. Then,

- For $F_A \geq \frac{(H-L_A)^2}{2k_A}$, $\frac{\partial\left(U_P^P - U_P^A\right)}{\partial \Delta L} = -2 + \frac{(H-\Delta L - L_P)}{k_A}$, which is negative due to Assumption 3 ($(H - L_A) < k_A$)
- For $\frac{(H-L_A)^2}{8k_A} < F_A < \frac{(H-L_A)^2}{2k_A}$, $\frac{\partial\left(U_P^P - U_P^A\right)}{\partial \Delta L} = -1 + \sqrt{2\frac{F_A}{k_A}}$. Since $F_A < \frac{(H-L_A)^2}{2k_A}$ and $(H - L_A) < k_A$, $-1 + \sqrt{2\frac{F_A}{k_A}} \leq -1 + \frac{(H-L_A)}{k_A} < 0$
- For $F_A < \frac{(H-L_A)^2}{8k_A}$, $\frac{\partial\left(U_P^P - U_P^A\right)}{\partial \Delta L} = -1 + \frac{(H-(\Delta L + L_P))}{2k_A} < 0$

Q.E.D.

Appendix B - Endogenous b

Formal description

Time is discrete, future periods are discounted with the factor $\delta < 1$. At the beginning of each period $t = 1, 2, ...$, the principal either makes an offer to the agent (described by $d_t^P = 1$) or not ($d_t^P = 0$). This offer consists of a verifiable component $w_t \geq 0$ and the promise to pay a bonus $b_t \geq 0$ whenever $y_t = H$. If $d_t^P = 1$, the agent decides whether to accept the offer or not, i.e. chooses $d_t^A \in \{0, 1\}$. If the agent is actually hired in period t, i.e., if $d_t \equiv d_t^P d_t^A = 1$, the fixed component w_t is forwarded to the agent, who subsequently chooses effort $e_t \in [0, 1]$. Then, output $Y_t \in \{H, L_A\}$ is realized, and the principal has the choice to pay the discretionary bonus $b_t \geq 0$. Discounted payoff streams - given the agent is hired - are

$$U_{P,t}^A = \sum_{\tau=t}^{\infty} \delta^{t-\tau} \left[d_\tau \left(-w_\tau + e_{A,\tau}(H - b_\tau) + (1 - e_{A,\tau})L_A\right) + (1 - d_\tau)(1 - \delta)\overline{U}_P\right]$$

$$U_{A,t} = \sum_{\tau=t}^{\infty} \delta^{t-\tau} d_\tau \left(w_\tau + e_{A,\tau} b_\tau - \left(F_A + k_A \frac{e_{A,\tau}^2}{2} \right) \right),$$

where $(1 - \delta)\overline{U}_P = \max\left\{L_P + \frac{(H-L_P)^2}{2k_P} - F_P, \overline{u}_P\right\}$ describes the principal's optimal choice - either perform the task herself or abstaining from it - in case the agent is not hired. There, note that variable and fixed costs are constant over time and accrue in every period where the agent is hired.

After reneging, i.e., the principal's failure to make a promised payment b after a success was observed, we assume that the principal is punished as harshly as possible. This implies that the agent is not willing to exert positive effort in the future anymore and hence constitutes a reversion to the static Nash equilibrium where the principal receives $\overline{U}_P$ (see Abreu, Pearce, Stacchetti (1990) for why this maximum punishment - which never occurs in equilibrium - is optimal in a game like the one presented here).

The solution concept used is Public Perfect Equilibrium (see Fudenberg, Levine, and Maskin, 1994). This describes a Nash equilibrium for each date t and history, together with the assumption that players only use public strategies. The latter implies that any player's strategies only depend on publicly observable information. In particular, the agent's strategies are independent of his past effort choice. We are interested in the equilibrium that maximizes the principal's payoff, however impose a restriction to stationary contracts.

This gives constraints

$$\frac{w + k_A \frac{e_A^2}{2} - F_A}{1-\delta} \geq 0 \tag{IR}$$

$$-e_A k_A + \delta \left(\frac{e_A H + (1-e_A) L_A - w - e_A^2 k_A - \max\left\{ L_P + \frac{(H-L_P)^2}{2k_P} - F_P, \overline{u}_P \right\}}{1-\delta} \right) \geq 0, \tag{DE}$$

where we already used $b = e_A k_A$ from the agent's (IC) constraint.

Then, we have the Lagrange function

$L = \frac{e_A H + (1-e_A) L_A - e_A^2 k_A - w}{(1-\delta)} + \lambda_{IR} \left[\frac{w - F_A + k_A \frac{e_A^2}{2}}{(1-\delta)} \right] + \lambda_{DE} \left[\delta \frac{e_A H + (1-e_A) L_A - e_A^2 k_A - w - \max\left\{ L_P + \frac{(H-L_P)^2}{2k_P} - F_P, \overline{u}_P \right\}}{(1-\delta)} - \right.$

$\lambda_{LL} w^L$

and necessary conditions

$\frac{\partial L}{\partial w} = -\frac{1}{(1-\delta)} + \lambda_{IR} \frac{1}{(1-\delta)} - \lambda_{DE} \frac{\delta}{(1-\delta)} + \lambda_{LL} = 0$

$\frac{\partial L}{\partial e_A} = \frac{H - L_A - 2e_A k_A}{(1-\delta)} + \lambda_{IR} \frac{k_A e_A}{(1-\delta)} - \lambda_{DE} k_A \left[2e_A \frac{\delta}{(1-\delta)} + 1 \right] = 0$

$\lambda_{IR} \left[\frac{w - F_A + k_A \frac{e_A^2}{2}}{(1-\delta)} \right] = 0$

$\lambda_{DE} \left[\delta \frac{e_A H + (1-e_A) L_A - e_A^2 k_A - w^L}{(1-\delta)} - \delta \overline{U}_P - e_A k_A \right] = 0$

$\lambda_{LL} w = 0$

$\lambda_{IR}, \lambda_{DE}, \lambda_{LL} \geq 0$

These considerations already allows us to prove

Proposition 6: There exist values $\hat{\delta}$ and $\overline{\delta}$, with $0 < \hat{\delta} < \overline{\delta} < 1$, such that

- The agent is not hired if $\delta < \hat{\delta}$
- The agent is hired, however equilibrium effort $e_A^*$is lower than in the static case if $\hat{\delta} \leq \delta < \overline{\delta}$
- The agent is hired, and equilibrium effort e_A^* is at the same level as in the static case if $\delta \geq \overline{\delta}$

Proof: Note that if $\lambda_{DE} = 0$, this problem is identical to the static case. By Assumption 5, the term $\frac{e_A H + (1-e_A)L_A - e_A^2 k_A - w - \max\left\{L_P + \frac{(H-L_P)^2}{2k_P} - F_P, \overline{u}_P\right\}}{(1-\delta)}$ is positive when effort e_A is the same as in the static case. This (together with $e_A \leq 1$ and hence bounded) implies that for $\delta \to 1$, the constraint is satisfied for the static effort. Furthermore, note that the left hand side of (DE) increases in δ. Combining both arguments proves the existence of $\overline{\delta}$. As a next step, note that for $\delta = 0$, this term is equal to $-e_A k_A$ and hence negative for $e_A > 0$, which - together with the assumption that hiring the agent is not optimal for $e_A = 0$ - establishes the existence of $\hat{\delta}$. Finally, note that the left hand side is increasing in δ, completing the proof. Q.E.D.

Generally, the following cases are possible:

$\delta \geq \overline{\delta}$, i.e., (DE) does not bind

If the principal's (DE) constraint does not bind, the situation is basically identical to the static case:

(A) (IR) binds, $\lambda_{LL} = 0$.

Then, we have $\lambda_{IR} = 1$ and hence $e_A = \frac{H-L_A}{k_A}$, i.e. effort is at its efficient level. Since (IR) binds, it can be used to obtain w, which equals $w = F_A - \frac{(H-L_A)^2}{2k_A}$. Hence, the conditions for this case to hold are $F_A - \frac{(H-L_A)^2}{2k_A} \geq 0$ and - via (DE) -
$\frac{\delta}{1-\delta}\left(\frac{(H-L_A)^2}{2k_A} + L_A - F_A\right) - (H - L_A) \geq \delta\overline{U}_P$. Note this is only feasible if $\overline{U}_P < 0$, since the left hand side of this condition is negative.

(B) (LL) binds, $\lambda_{IR} = 0$, i.e., the agent gets a rent. Then, we have $e_A = \frac{H-L_A}{2k_A}$. Conditions for this case to hold are $F_A - \frac{(H-L_A)^2}{8k_A} \leq 0$ and $\frac{\delta}{(1-\delta)}\left[\frac{(H-L_A)^2}{4k_A} + L_A\right] - \frac{H-L_A}{2} \geq \delta\overline{U}_P$

(C) (IR) and (LL) bind. From **(A)** and **(B)** it follows that the present case is relevant for $\frac{(H-L_A)^2}{8k_A} < F_A < \frac{(H-L_A)^2}{2k_A}$. Effort is characterized by binding (IR) and (LL) constraints, i.e., $e_A = \sqrt{\frac{2F_A}{k_A}}$. Plugging in the boundaries of F_A gives $\frac{(H-L_A)}{2k_A} < e_A < \frac{(H-L_A)}{k_A}$.

Furthermore, now (DE) is satisfied as long as $\delta\frac{\sqrt{\frac{2F_A}{k_A}}H + (1-\sqrt{\frac{2F_A}{k_A}})L_A - 2F_A}{(1-\delta)} - \delta\overline{U}_P - \sqrt{\frac{2F_A}{k_A}}k_A \geq 0$

(D) $\lambda_{LL} = \lambda_{IR} = 0$

This case is not feasible, since it would imply $-\frac{1}{(1-\delta)} = 0$

$\hat{\delta} \leq \delta < \overline{\delta}$, i.e., (DE) binds but the task is delegated to the agent

(A) (IR) binds, $\lambda_{LL} = 0$.

Then, $w = F_A - k_A \frac{e_A^2}{2}$, and effort is characterized by $\delta \frac{e_A H + (1-e_A) L_A - F_A - k_A \frac{e_A^2}{2}}{(1-\delta)} - \delta \overline{U}_P - e_A k_A = 0$, at least as long as this is solved by a strictly positive effort level. Note that effort is inefficiently small in this case:

$\lambda_{IRA} = 1 + \delta \lambda_{DE}$

$\frac{H - L_A - e_A k_A}{(1-\delta)} - \lambda_{DE} k_A \left[e_A \frac{\delta}{(1-\delta)} + 1 \right] = 0$

(B) (LL) binds, $\lambda_{IR} = 0$.

Then, $w = 0$, and effort is characterized by $\delta \frac{e_A H + (1-e_A) L_A - e_A^2 k_A}{(1-\delta)} - \delta \overline{U}_P - e_A k_A = 0$, at least as long as this is solved by a strictly positive effort level. Furthermore, $e_A < \frac{H - L_A}{2k_A}$, since

$\frac{H - L_A - 2e_A k_A}{(1-\delta)} - \lambda_{DE} k_A \left[2e_A \frac{\delta}{(1-\delta)} + 1 \right] = 0$

(C) (IR) and (LL) bind.

Since $w = 0$, this case only reflects one point, namely where the conditions $\delta \frac{e_A H + (1-e_A) L_A - e_A^2 k_A}{(1-\delta)} - \delta \overline{U}_P - e_A k_A = 0$ and $-F_A + k_A \frac{e_A^2}{2} = 0$ give the same effort level.

To see that effort is continuous around that point we the binding (DE) constraints in cases (A) and (B), i.e., $\delta \frac{e_A H + (1-e_A) L_A - F_A - k_A \frac{e_A^2}{2}}{(1-\delta)} - \delta \overline{U}_P - e_A k_A = \delta \frac{e_A H + (1-e_A) L_A - e_A^2 k_A}{(1-\delta)} - \delta \overline{U}_P - e_A k_A$, which is satisfied for $-F_A + k_A \frac{e_A^2}{2} = 0$, namely where (IR) binds. Hence, $e_A < \frac{H - L_A}{2k_A}$ here as well.

(D) $\lambda_{LL} = \lambda_{IR} = 0$

This case is not feasible, since it would imply $-\frac{1}{(1-\delta)} - \lambda_{DE} \frac{\delta}{(1-\delta)} = 0$.

This analysis further allows us to prove

Proposition 7: *Assume $\hat{\delta} \leq \delta < \overline{\delta}$. Then, equilibrium effort is strictly increasing in δ.*

Proof: If the (DE) constraint binds, equilibrium effort is characterized by $\delta \frac{e_A H + (1-e_A) L_A - F_A - k_A \frac{e_A^2}{2}}{(1-\delta)} - \delta \overline{U}_P - e_A k_A = 0$ ($w > 0$) or $\delta \frac{e_A H + (1-e_A) L_A - e_A^2 k_A}{(1-\delta)} - \delta \overline{U}_P - e_A k_A = 0$ ($w = 0$). Thus, the implicit function theorem gives $\frac{de_A}{d\delta} = \begin{cases} -\frac{\frac{1}{(1-\delta)^2}\left(e_A H + (1-e_A) L_A - F_A - k_A \frac{e_A^2}{2}\right) - \overline{U}_P}{\delta \frac{H - L_A - k_A e_A}{(1-\delta)} - k_A} & \text{if } w > 0 \\ -\frac{\frac{1}{(1-\delta)^2}\left(e_A H + (1-e_A) L_A - e_A^2 k_A\right) - \overline{U}_P}{\delta \frac{H - L_A - 2e_A k_A}{(1-\delta)} - k_A} & \text{if } w = 0 \end{cases}$. To see that both expression must be positive, first note that the denominators, the partial derivatives of

(DE) with respect to e_A, must be negative. If any of them were positive, a higher effort level would relax the constraint, contradicting that (DE) binds and e_A is inefficiently small at the same time (what we established above). Furthermore, nominators have to be positive. In the first case a binding (DE) constraint implies $\frac{e_A H+(1-e_A)L_A-F_A-k_A\frac{e_A^2}{2}}{(1-\delta)}-\overline{U}_P=\frac{e_A k_A}{\delta}$. Hence, we have $\frac{1}{(1-\delta)^2}\left(e_A H+(1-e_A)L_A-F_A-k_A\frac{e_A^2}{2}\right)-\overline{U}_P\geq\frac{1}{(1-\delta)}\left(e_A H+(1-e_A)L_A-F_A-k_A\frac{e_A^2}{2}\right)-\overline{U}_P=\frac{e_A k_A}{\delta}>0$. Equivalent considerations help to establish that the nominator of the second expression - i.e. when (LL) binds - is positive as well. Q.E.D.

Furthermore, we can prove

Lemma 3: *Assume $\hat{\delta}\leq\delta<\overline{\delta}$. Then, per-period payoffs $(1-\delta)U_P^A$ are strictly increasing in δ.*

Proof: The principal's per-period payoffs are $(1-\delta)U_P^A=\begin{cases}e_A H+(1-e_A)L_A-k_A\frac{e_A^2}{2}-F_A & \textit{if } w>0\\ e_A H+(1-e_A)L_A-e_A^2 k_A & \textit{if } w=0\end{cases}$, with $\frac{d\left((1-\delta)U_P^A\right)}{d\delta}=\begin{cases}\frac{de_A}{d\delta}\left(H-L_A-e_A k_A\right) & \textit{if } w>0\\ \frac{de_A}{d\delta}\left(H-L_A-2e_A k_A\right) & \textit{if } w=0\end{cases}$. Above, we established that $H-L_A-e_A k_A>0$ $(w>0)$ and $H-L_A-2e_A k_A>0$ $(w=0)$, which together with Proposition 7 ($\frac{de_A}{d\delta}>0$ if the (DE) constraint binds) proves the Lemma. Q.E.D.

Finally we prove

Proposition 8: *Assume $\hat{\delta}\leq\delta<\overline{\delta}$. Then, equilibrium effort is strictly decreasing in $\overline{U}_P$. Furthermore, per-period payoffs $(1-\delta)U_P^A$ are strictly decreasing in $\overline{U}_P$.*

Proof: Now, we have
$\frac{de_A}{d\overline{U}_P}=\begin{cases}\frac{\delta}{\delta\frac{H-L_A-k_A e_A}{(1-\delta)}-k_A} & \text{if } w>0\\ \frac{\delta}{\delta\frac{H-L_A-2e_A k_A}{(1-\delta)}-k_A} & \text{if } w=0\end{cases}>0$, since the denominators must be negative (see the proof to Proposition). Again, the principal's per-period payoffs are $(1-\delta)U_P^A=\begin{cases}e_A H+(1-e_A)L_A-k_A\frac{e_A^2}{2}-F\\ e_A H+(1-e_A)L_A-e_A^2 k_A\end{cases}$ with $\frac{d\left((1-\delta)U_P^A\right)}{d\overline{U}_P}=\begin{cases}\frac{de_A}{d\overline{U}_P}\left(H-L_A-e_A k_A\right) & \textit{if } w>0\\ \frac{de_A}{d\overline{U}_P}\left(H-L_A-2e_A k_A\right) & \textit{if } w=0\end{cases}$, which is strictly negative if the (DE) constraint binds. Q.E.D.