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Resolving Contractual Disputes: Arbitration vs Mediation*

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Abstract

In this paper we analyze contracts written on potentially non-verifiable states. We first show that the contract always enters a dispute phase. We analyze two possible legal rules which can be used to resolve the disputes. Under both rules the paper derives the optimal contract. An interesting feature of the optimal contract is that for low verifiability likelihood the agent is always rewarded unless there is failure. The other result is that under both legal rules used first-best effort and more than first-best-effort level can be implemented, depending on how small the likelihood of verifiability is.

Keywords: Contracts and Dispute resolution

JEL Classification: J3 and K4

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1 Introduction

Theory of contracts over the last few decades has mainly dealt with contracts written on verifiable information, and on contracts which can be enforced by a third party like courts. An implication of this is that disputes never arise, which is in contrast to evidence on employment contracts (see next Section for more details on this). This paper aims to investigate the implications of relaxing this assumption and to the growing theoretical literature in subjective contracts (Levin (2004), Macleod (2003)). We are motivated by the mere observations that disputes often arise, and that contracts are written and incentives are provided in number of transactions based on subjective evaluation (Prendergast (1999)). Incentives such as bonus payments, promotions or rewards in organizations are often made using subjective criteria. For example doctors under National Health Service[1] in United Kingdom proceed in the NHS hierarchy based on courses taken, years of experience, administration, errors made and publications. But the contracts and the rules which are provided to the doctors do not specify objectively how much weight is assigned to each of these factors and only gives a broad indication of the job requirement. Exactly specifying the job requirements in this case may not only distort behavior (Holmstrom and Milgrom (1991)) of the doctors but may also be difficult to specify since medicine is a complex good.

The use of such measures can lead to disputes. Employees may find their year end bonus lower than their expectations. Recently there has been significant controversy over the bonus scheme designed in the advertisement firm WPP

[1] http://www.modern.nhs.uk

(Wire and Plastic Products)[2]. The bonus scheme stated that bonuses would be paid out if the company remained amongst the top two in the industry. No other details regarding the ranking of the firms in the industry were given. Share holders of the company have complained that the scheme is too vague and that this was a way for the management to award themselves bonuses.

Subjective assessments or potential non-verifiability of outcomes can lead to disputes and conflicts. The possibility of disputes not only creates transaction cost due to cost of disputes but may also make it more difficult to write a contract which provides correct incentives to the agent.

Transaction costs regarding the execution of contracts arise primarily due to gaps in contracts (Ayres and Gertner (1991)) or the inability of the contracting parties to write a contract based on verifiable performance. Gaps in contracts result in incomplete contracts which are dealt with renegotiation by the contracting parties (Hart and Moore, 1988). Bernheim and Whinston (1998) and Hart and Moore (2004) have discussed the issue of strategic ambiguity where the principal might gain by writing a contract which is vague and incomplete. This allows the principal more flexibility by fixing a payment but allowing the possibility of changing this later. The inefficiencies involved due to gaps in contracts is tackled by the hold-up literature. A key feature of these models is the assumption that only contracts which are based on verifiable information can be enforced, and that the renegotiation takes place under the threat of the original contract.

[2] http://news.bbc.co.uk/1/hi/business/3631069.stm

The main distinction from the incomplete contract literature is that we show that a contract can be written under potential non-verifiability, and that this contract can improve the trade surplus, as long as there is some arbitrator or a mediator present to address the dispute which may arise due to potential non-verifiability. In fact, we postulate that in this case contracts can be used even if the mediator or the arbitrator does not learn the true state of nature after the contract has been performed, and we show that this may lead, depending on the environment, to either a higher than first-best effort by the agent or to the efficient level of effort.

The inability of contracting parties to write a contract based on verifiable performance results from the contracting parties being unable to write contracts on objective measures. Previous literature has pointed out the presence of inefficiency in contracting under subjective assessment (Prendergast (1999) and Macleod (2003)). Macleod (2003) shows that in case of subjective evaluation, the principal is more likely to provide a favorable assessment for the agent's performance than is optimal, and this leads to inefficiency in contracts. Prendergast and Topel (1996) and Prendergast (1999) point out that subjective evaluation can lead to favoritism by the principal/supervisor and this may lead to inefficiency in the relationship. There is a compression of the evaluation of the agent towards a norm. However, in this strand of research the assumption that only contracts which are based on verifiable information can be enforced is maintained.[3]

[3] A related work here is the investigation of long-run contractual relationships when states are not verfiable to the enforcement agency (Levin (2003)). Here contracts are implicit.

In this paper we evaluate instead contracts which are written on potentially non-verifiable states. This will give rise to enforcement problems. The model consists of a contractual relationship between the principal and the agent where the principal cannot observe effort made by the agent. The outcome is observed by both the principal and the agent but may not be possible to be verified to a third party. Both the agent and principal report their assessment of the outcome to a third party, which can either be the court, arbitrator, mediator or any alternative dispute resolution body[4]. This gives both, the principal and the agent, an incentive to mis-report about the evaluation since any salary or reward for the outcome is a transfer from the principal to the agent[5]. Here we explicitly model the court's or the tribunal's role in evaluating the performance.

We view the court as an active player who attempts to find information about the potentially non-verifiable state, and uses any such information to resolve disputes over the states. We discuss two possible method or rules the tribunal may use in order to determine performance. The first method, which we call arbitration, is used when the court or tribunal itself observes an added signal about the performance, but this signal is an imperfect one. This is similar to instances when the dispute goes to an arbitrator or the court and they spend considerable amount of time and effort to find the truth. In this case when the arbitrator gets an extra signal, the rule or the mechanism used to determine the

[4] In UK labour disputes regarding performance pay generally go the Employment Appeals Tribunal.

[5] The principal-agent play a constant sum game. This has been discussed in Macleod and Malcomson (1989), Baker et.al. (1994). Pendergast (1999) discusses this issue as an issue of theft.

final payment to the agent is a truth-telling one.

The second rule depends only on the reports of the principal and the agent. This we call mediation or conciliation. In this case there is no added restriction of a truth telling. The only extra restriction which is used on this rule is that the rule strikes a compromise between the claims made by the principal and the agent. This we believe is similar to the case when the employer and the employee may take their dispute to an outside tribunal.

We postpone a discussion of the assumptions behind these two dispute-resolution mechanisms for the next Section. Under both the legal rules or mechanism we find that one of the contracting parties or both always go to the tribunal or the court. Both expect if the appeal is successful to get the contract changed in their favour. The agent will go to court if the outcome is a failure and claim success and in case of success the principal will go to court and claim failure. So the principal not only wants to avoid failure since she does not get any benefit but also since she cannot prove it and may still have to pay the agent something. And in case of successful outcome she not only gets the benefit of success but may also be able to reduce the payment to the agent due to non-verifiability. So, if there is non-verifiability the principal pays the agent more compared to objective contracts. The resulting contract depends on the degree of non-verifiability.

For lower degrees of non-verifiability the contract form is similar to that of contract written in case of full verifiability, regardless of the rule. For sufficiently low verifiability, under arbitration we interestingly get an optimal contract which is flat. Under mediation, however, the contract form is that the agent is given a bonus unless there is absolute failure. This is consistent with the findings in Macleod (2003) and Prendergast and Topel (1996), that if assessment is subjective then the principal is more likely to make a favorable ruling about the agent's performance.

The second main result in this paper is that, under both legal rules, agent may be induced to put in the efficient effort level or more than the first-best level of effort, i.e. the level which can be induced in case incentive contracts can be written on objectively assessed effort. The primary reason for this result is that agent can always expect some transfer more than the promised bonus even if the outcome is failure, and this in turn relaxes the agent's participation and incentive compatibility constraints.

2 Contracts and Enforcement

Under the Employments Right Act 1996[6] in U.K., it is necessary for the employer or principal to provide a written statement of terms and conditions of employment. The document may state that a contractual relationship exists and what its primary content is. This may not include full details of the relationship like terms and conditions for rewards and promotions[7]. Other details may be missing; for example, an office assistant's contract may not state that the job

[6] http://www.hmso.gov.uk/acts/acts1996/1996018.htm

[7] The Higher Education Roles Analysis (2004) provides a detailed list of tasks for academics in UK but does not provide any indication regarding the conditions for salary increases or promotions.

requires answering phones. Task of answering phones for an office assistant may be considered routine and therefore may be left out of the written document. But this may become an issue if the employer finds that the task is not being done to her liking and this may result in a dispute. For example Nationwide Building Society lays emphasis on level of performance, training, resources and guidance provided, time scales set and, finally, the possible reasons for performance standards not being met. The last issue is in fact an important one. Even if performance standards are well set, disputes occur due to the reasons for non-performance or sub par performance[8]. In case of a dispute, the problem legally becomes a contractual one. It is well documented in the industrial relation literature that one of the main reasons for employee grievances is that the employees are not satisfied with the way they have been graded or their performance evaluated[9]. These disputes create significant transaction costs. First it may be difficult for the employer to provide the employee proper incentives and the secondly there is the cost of the dispute itself. In UK, 383 working days were lost due to pay disputes in year 2000 and this accounted for 77% of the total working day lost[10]. In Northern Ireland, Labour Relation Agency, an alternative dispute resolution board released the following data: out of the total of 5073 labour disputes they dealt with 767 were regarding wage order disputes

[8] In Davison v. Kent (1975), the court ruled in favour of Ms Davison after she had incorrectly assembled 500 components, since the company failed to provide proper guidance regarding assembling the parts.

[9] A detailed study of grivance mechanism and procedures in 72 UK public and private sector work places can be found in Industrial Relations Services report *Handling Employee Grievances: Part 1,* Employment Trends No. 636 July (1997)

[10] Davies, J. (2001) 'Labour Disputes in 2000', Labour Market Trends, June 301-13.

and 682 were breach of contract disputes[11]. This suggests that a significant number of disputes arise due to wage order and contract breaches.

Performance disputes generally go to a tribunal (in UK it goes to the Industrial Tribunal), or the court. Given, common law and the civil code[12], the legal system promotes a dispute resolution process which is consistent with application of the dispute resolution procedures between individuals and across organizations, a dispute resolution scheme which is impartial, use of relevant information accurately by the mechanism, scope to change the outcome if required, allowing for representation of interests of both the employer and the employee and others involved and to adopt an efficient and fair standard. The tribunal mechanism is formal and the court or the tribunal spends a considerable amount of time and effort to learn the truth. Since in the tribunal system the adjudicator of the case is the arbitrator for the rest of the paper, note that we will use the courts and tribunals synonymously and judges and arbitrators synonymously.

The second method for resolving disputes is much more informal. This is something called either mediation or conciliation. The second mechanism basically consist of an outside conciliator or a mediator who helps bring the parties come to an agreement[13]. Unlike arbitration, conciliation or mediation is not legally binding. The ruling of the mediator holds only if both parties agree to the ruling. In England and Wales the alternative dispute resolution

[11] Labour Relation Agency Annual Review of Performance 2002-2003. www.lra.org.uk
[12] Check Employment Rights Act 1996
1996 Chapter 18 Section 23. United Kingdom.
[13] http://www.acas.org.uk/services/dispute_mediation.html

scheme is provided by ACAS, a government funded body[14]. The ACAS website lists the following as the main difference between the alternative dispute resolution scheme and tribunal, "the arbitration hearing is informal and non-confrontational". The main method the alternative scheme works is that the mediator or conciliator talks with disputing parties together and individually and helps them reach a resolution.

3 Model

Consider a risk neutral principal and a risk neutral agent contract to produce a product, y, in the future. The agent exerts effort e. Effort can take three possible values: 0, ε and 1 such that $\varepsilon \in (0,1)$. The disutility of effort is given by the function $\psi(e)$, which is continuos and $\psi(0) = 0$. $\psi(e)$ is strictly increasing and convex. The outcome of a project y is stochastic and effort-dependent with $y \in \{0, B_L, B\}$, $B > B_L > 0$, $\Pr(y = B_L \mid e) = \hat{\pi}(e)$ and $\Pr(y = B \mid e) = \pi(e), \pi \in (0,1)$, $\hat{\pi} \in (0,1)$, $\pi + \hat{\pi} \in (0,1)$. Let us denote $\Delta\pi_2 = \pi(1) - \pi(\varepsilon)$, $\Delta\pi_1 = \pi(\varepsilon) - \pi(0)$, $\Delta\hat{\pi}_2 = \hat{\pi}(1) - \hat{\pi}(\varepsilon)$, $\Delta\hat{\pi}_1 = \hat{\pi}(\varepsilon) - \hat{\pi}(0)$. We assume also that the monotone likelihood ratio property (MLRP) holds, i.e. $\frac{\Delta\pi_2}{\pi(\varepsilon)} > \frac{\Delta\hat{\pi}_2}{\hat{\pi}(\varepsilon)}$ and $\frac{\Delta\pi_1}{\pi(0)} > \frac{\Delta\hat{\pi}_1}{\hat{\pi}(0)}$. In addition we assume that $\pi(e)$ and $\hat{\pi}(e)$ are strictly increasing and concave. Assume also that the agent can, instead, supply her labour endowment for other projects. The expected payoff of the alternative employment is normalized to zero.

[14] http://www.acas.org.uk

Consider also a principal who owns the produced 'object' and has a utility function $S(y)$. Let for simplicity $S(y) = y$. Assume that

$$\arg\max_{e}\{\pi(e)B + \hat{\pi}(e)B_L - \psi(e)\} \equiv e^o > 0$$

and so there are gains from ex ante trade between the principal and the agent. In particular, let $e^o = \varepsilon$: the ex-ante efficient level of effort is the intermediate one.

The agent receives $w + t(y)$. w is the up-front payment and $t(y)$ is the amount the agent gets after completion depending on the outcome. The up-front payment w to the agent establishes an employment relationship and transfers the ownership of the project to the principal before the effort is exerted.

The principal does not observe the effort exerted by the agent but observes the outcome. The outcome of the project is common knowledge between the principal and the agent but potentially non-verifiable by a third party. The principal provides a payment scheme $t(y)$ which is a function of the outcome of the project. Suppose that the agent is protected with limited-liability[15], and denote $w + t(0) = w$, $w + t(B_L) = w + b_L$ and $w + t(B) = w + b$, with $w \geq 0$, $b_L \geq 0$ and $b \geq 0$. With such transfers, the agent is rewarded for good performance (measured by the quality of the completed project), while w is the state-independent component of the transfer.

The problem of providing correct incentives is aggravated by the fact that

[15] In the absence of risk, limited liability makes it difficult to provide incentives. Sappington(1983)

the outcome is potentially non-verifiable. In this case, a state-dependent contract could emerge as an implicit contract or due to 'trust' (Levin (2003)). If y is not verifiable, a performance-dependent contract could in principle also be one which is based on 'subjective valuations'. This is investigated in, for instance, Prendergast and Topel (1996), Prendergast (1993) and Macleod (2003). There, the terms of the contract can be verified, and the court simply enforces the written contract. Crucially, this contract may include compulsory payments from the principal to a third party (like the court itself). Here, we investigate instead the emergence, in one-off relationships with no transfers to third parties being feasible, of performance-dependent contracts due to the presence of an arbitrator or mediator who can resolve any dispute that may arise over the terms of a contract. In particular, we assume that the arbitrator or the mediator can enforce a transfer rule which depends on the information I it gets. This information I the court or the tribunal may get itself or may be from the other sources including the contracting parties. In particular, we allow for the court to settle any dispute over the state by, implementing its ruling $w + h(I)$, which specifies explicitly a transfer h from the principal to the agent given the information I available to the court. Note that the information I may consist of the reports the court receives from the contracting parties or may be what it has collected itself. One can think of I as being determined, among others, by the 'cases' presented by the disputing parties, by who has initiated the judicial process, by any external/independent information on the state of the world. Notice, that we allow for $h(I)$ to be a stochastic transfer, to capture any randomness in the ability of the court to infer the true state of the world. Importantly, we also show that, at least in the environment we consider here, such an institutional arrangement is welfare-improving relative to contracts based on 'subjective valuations'.

3.1 Timing

The timing of the game is the following:

- First, the principal offers the contract $\{w, t(y)\}$.
- The agent either rejects the contract and takes up the alternative employment attaining a payoff of 0, or accepts the contract, receives w and exerts effort e.
- The state of the world y is realized according to the probability distribution $\{\pi(e), \hat{\pi}(e)\}$.
- The principal and the agent decide simultaneously and independently whether they will challenge the state of the world, and thereby the transfer/bonus $t(y)$ which is specified by the contract.
- If either challenges the quality of the project, they make their reports and the third party collects independent evidence. Given available information, the court then makes a ruling $h(I)$.
- If none challenges the contract, the contract $t(y)$ is fulfilled.

3.2 Information Structure and Principles of Dispute Resolution

The information content of the collected evidence is as follows. Assume that, with probability $\xi < 1$, the third party possesses compelling evidence about the true quality of the project completed. With probability $1 - \xi$, on the other hand, the collected evidence amounts to the tribunal receiving an imperfect cost less signal of the quality of the project $\sigma \in \Sigma$, with $\Sigma \subseteq \mathbf{R}$, according to the joint p.d.f. $f(\sigma, q)$, where $q \in Q \subseteq \mathbf{R}$. This joint p.d.f. depends on the exerted level of effort - we drop for expositional simplicity this dependence whenever there is no risk of confusion. The joint p.d.f. has full support with respect to σ when $q \in \{0, B_L, B\}$, and is also such that $f(\sigma, q) = 0$ for any $\sigma \in \Sigma$ when $q \notin \{0, B_L, B\}$. In addition, $\int_\Sigma f(\sigma, B) d\sigma = \pi(e)$, $\int_\Sigma f(\sigma, B_L) d\sigma = \hat{\pi}(e)$. The parties do not observe this signal σ prior to challenging the contract.We can think of this signal as something the third body may learn itself about the relationship at the time it is asked to make the ruling on the dispute. Let us also assume that signals and outcomes are affiliated, $f(\sigma, y')f(\sigma, y) \leq f(\sigma'.y')f(\sigma, y)$ for any $\sigma' \leq \sigma$, $y' \leq y$; the higher the signal, the more likely it is that output is high.

Assume that if the court is convinced that the outcome is y then it enforces the original contract. If on the other hand the court is not certain about the true state of the world, then it enforces a transfer which depends on the information itself gathers and the 'claims' (or 'cases') of the parties[16]. In particular, if the

[16] Damages awarded are just transfers between the parties. Damages are not dependent on

agent claims that the state of the world is such that, based on the contract $t(y)$, she should receive a bonus $m_a \in \{0, b_L, b\}$ and the principal claims that the state of the world is such that, based on the contract $t(y)$, she should only pay a bonus $m_p \in \{0, b_L, b\}$ then the ruling of the court is that the bonus to the agent should be $h(\sigma, m_a, m_p)$. Note that players making claims about the bonus is equivalent to players making claims about the state of the world. Due to limited liability, let $h \geq 0$, and note that h can be thought of as the bonus to the worker the court is willing to rule for, in the absence of compelling evidence on the state of the world.

It follows that the expected bonus the court will enforce is $\xi t(y) + (1 - \xi)\eta(e, m_a, m_p)$, where

$$\eta(e, m_a, m_p) \equiv \int_{\Sigma} \int_{Q} f(\sigma, q) h(\sigma, m_a, m_p) d\sigma dq$$

is the expected, prior to the realization of outcome, bonus received by the worker if it is anticipated that the state is challenged in court. Thus, the agent's expected payoff if the contract goes to court is

$$w + \xi t(y) + (1 - \xi)\eta(e, m_a, m_p) - \psi(e)$$

while her expected payoff if the original contract is fulfilled is $t(y) - \psi(e)$. The

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the party who initiates the dispute. This implicit assumption is without loss of generality, as the identity of who initiates the dispute bears no informational content.

principal's expected payoff if it is anticipated that the contract goes to court is

$$y - \{w + \xi t(y) + (1 - \xi)\eta(e, m_a, m_p)\}$$

while his payoff if the original contract is anticipated to be fulfilled is $y - t(y)$.

Define $\delta(0)$, $\delta(B_L)$ and $\delta(B)$ by the following three equations respectively.

$$w + \delta(0) = w + (1 - \xi) \int_\Sigma f(\sigma \mid 0) h(\sigma, m_a, m_p) d\sigma$$

$$w + b_L + \delta(B_L) = w + \xi b_L + (1 - \xi) \int_\Sigma f(\sigma \mid B_L) h(\sigma, m_a, m_p) d\sigma$$

$$w + b + \delta(B) = w + \xi b + (1 - \xi) \int_\Sigma f(\sigma \mid B) h(\sigma, m_a, m_p) d\sigma.$$

$\delta(y)$ is the agent's anticipated gain if he goes to court. Note that $\delta' s$ depend on the bonuses in the contract, the 'claims' $\{m_a, m_p\}$ and the quality of the verification technology ξ; for expositional simplicity we drop, whenever there is no risk of confusion.

In the next Sections, we turn to the determination of the optimal contract.[17] We believe that the model can be extended to the case when w is given after the completion of the contract, with the object being 'owned' by the agent [18]

[17] Allowing non-verifiable effort, which can nevertheless be observed by the principal and the agent would complicate matters. The reason is that then, and in the presence of a dispute resolution mechanism, the issue of what weights should effort and perfomance bear in the contract arises. To isolate the implications of arbitration and mediation we refrain from investigating this, nevertheless, very interesting question. We tackle this important issue in a companion paper.

[18] If y is observable but non-verifiable, there is no court of law to enforce some state-dependent contract and the ownership right of the 'object' falls with the agent, then we have trade only if the project is not a failure, i.e. only if $S(y) \geq p(y)$, where $p(y)$ is the price the agent can ensure from another party. That is, after setting $w = 0$ for expositional simplicity, $t(y) = \max\{p(y),\, p(y) + \theta(B_L - p(B_L)\}$, and if $y \geq p(y)$ then $e = e^\theta \equiv$

and in the case when it is costly to go to a court.[19]

4 Benchmark Cases

We now consider three extreme cases. First, when the outcome is completely verifiable. Second, when the outcome is completely non-verifiable. Finally, when the outcome is imperfectly verifiable and there is a third party which administers a flat (i.e. performance-independent) bonus to the agent whenever a dispute arises and there is not compelling evidence for the quality of the project, while it simply enforces the contract if there is sufficient evidence concerning performance.

4.1 Outcome is Verifiable

If effort is the agent's private information, but y is verifiable (i.e. $\xi = 1$), and $\psi(e) \geq Z(e)\pi(e)$, where $Z(0) \equiv 0$, $Z(\varepsilon) \equiv \Delta\psi_1/\Delta\pi_1$, $\Delta\psi_1 \equiv \psi(\varepsilon) - \psi(0) = \psi(\varepsilon)$, $Z(1) \equiv \Delta\psi_2/\Delta\pi_2$ and $\Delta\psi_2 \equiv \psi(1) - \psi(\varepsilon)$, then the principal can induce the effort level in question by means of a contract $b_L = 0$, $b = Z(e)$ and $w = \psi(e) -$

$\arg\max\{\pi(e)[p(B)(1-\theta) + \theta B] + \hat{\pi}(e)[p(B_L)(1-\theta) + \theta B_L] - \psi(e)\}$, where θ is the bargaining power of the agent. This is the hold-up scenario, which, if $\theta < 1$, features ineffcient investment/effort, i.e. $e^{\theta} < e^{o}$.

Suppose now that y is observable but non-verifiable, there is a court of law to enforce some state-dependent contract (possibly different than the original) - i.e. $\xi < 1$- but the ownership right of the 'object' falls with the agent. Then, and in contrast to our model above, there may be scope for re-negotiation - that is, there may be ex post trade on voluntarily agreed new terms. Such scope will exist if the agent can sell the object ex post to a third party at a price $p(y)$ with $p(y) \geq \max\{t^*(y), S(y) - t^*(y)\}$, where $t^*(y) \in \{t(y), t(y) + \delta(y)\}$ depending on whether, in the absence of re-negotiation, the original contract is fulfilled or not.

[19] In this case the incentive to go to court is determined by $\delta(y) - k$ where k is the cost of challenging the contract, possibly the cost of the tribunal collecting the evdience which is passed onto the disputing parties. In this case, out of court settlements can emerge. This scenario differs from the 'subjective valuation' contract investigated by, for instance, MacLeod (2003) in that k is fixed and cannot be chosen optimally.

$\pi(e)Z(e)$. This follows directly from observing that under such contract the participation constraint $\pi(e)b + \hat{\pi}(e)b_L \geq \psi(e)$ is just satisfied and the agent finds it to her benefit to exert effort e, i.e. $e = \arg\max_{x\in\{0,\varepsilon,1\}}\{\pi(x)b + \hat{\pi}(x)b_L - \psi(x)\}$. Thus, in this case, the existence of complete contracts leads to production at minimum cost $\psi(e)$, as in the first-best outcome, despite asymmetric information regarding effort.

If, however, $\psi(e) < Z(e)\pi(e)$ then asymmetric information regarding effort has a bite when it comes to inducing effort level e. In particular, now, if the principal wants to induce a positive level of effort e, he would need to incur a total cost of $\pi(e)Z(e)$. The formal derivation of this is standard and can be found in Appendix 1. Here we only present the intuition. Note that the problem of the agent is well-behaved, and, in particular, that the marginal benefit of exerting effort is strictly increasing with either of the bonuses, and that the benefit and cost functions of effort are concave and convex, respectively. Then, the minimum monetary cost, for any given down-payment w, at which the principal can induce effort level $e > 0$ is attained when the 'downward local incentive compatibility constraint' is binding, i.e.

$$\Delta\hat{\pi}_j b_L + \Delta\pi_j b = \Delta\psi_j,\ \ j = 1, 2.$$

Here, if $e = \varepsilon$ then $j = 1$, while if $e = 1$ then $j = 2$. The above equation for $j = 1$ comes from the indifference of the agent between exerting effort level ε and no effort; similarly for $j = 2$.[20] It follows that $b_L = \frac{\Delta\psi_j - \Delta\pi_j b}{\Delta\hat{\pi}_j} \equiv \frac{\Delta\pi_j[Z(e)-b]}{\Delta\hat{\pi}_j}$. So, the bonuses, when the quality is of an intermediate and high level, are substitutes. Recall that for any given down-payment w, that the expected cost to the principal is $\pi b + \hat{\pi} b_L$.Therefore increasing the bonus when the outcome is a success leads to a higher cost by $\pi(\varepsilon)$ while it saves on the bonus given when the state is B_L by an amount of $\hat{\pi}(e)\frac{\Delta\pi_j}{\Delta\hat{\pi}_j}$. Due to MLRP the latter is larger than the former and, so, increasing b as much as possible is optimal for the principal. The principal is constrained by the requirement that $b_L \geq 0$ and the agent's participation constraint that $\pi(e)b + \hat{\pi}(e)b_L + w \geq \psi(e)$. Since $\psi(e) < Z(e)\pi(e)$ and $w \geq 0$, we clearly, then, have that the participation constraint is slack. Therefore, $b = Z(e)$ and thereby $b_L = 0$. As down-payments are costly we also have that $w = 0$. So the total cost of inducing e is indeed $\pi(e)Z(e)$. Note that due to convexity of the utility cost ψ and the concavity of probability of success π we have that $Z(1) > Z(\varepsilon)$. So, the bonus for success is increasing with implemented effort.

Accordingly, for any given effort level the principal wants to induce, the complete contract has $b_L = 0, b = Z(e)$ and $w = \max\{0, \psi(e) - Z(e)\pi(e)\}$, and total production costs are given by $\max\{\psi(e), Z(e)\pi(e)\}$. Observe also that the benefit from exerting effort levels ε and 1, instead of zero effort, are $\Delta\hat{\pi}_1 B_L + \Delta\pi_1 B$ and $[\Delta\hat{\pi}_1 + \Delta\hat{\pi}_2]B_L + [\Delta\pi_1 + \Delta\pi_2]B$ respectively.

[20] If the agent's problem is well behaved then an agent who is indifferent between effort $e > 0$ and the immediately lower effort level, prefers also (strictly) effort e over any other effort level.

Assume hereafter that $\psi(\varepsilon) < Z(\varepsilon)\pi(\varepsilon)$. It follows then directly that if

$$\max\{\pi(1)Z(1), \psi(1)\} \geq [\Delta\hat{\pi}_1 + \Delta\hat{\pi}_2]B_L + [\Delta\pi_1 + \Delta\pi_2]B$$

and

$$\pi(\varepsilon)Z(\varepsilon) \geq \Delta\hat{\pi}_1 B_L + \Delta\pi_1 B,$$

then the principal finds it optimal to induce no effort.This is the standard complete contract scenario with inefficient investment/effort due to limited liability. Assume hereafter that this is indeed the case. Then, we have:

Proposition 1 *The optimal complete contract will be $b_L = b = 0$ in order to induce effort $e = 0$.Also, it will be $b_L = 0$ and $b = Z(e) > 0$ to induce $e = \varepsilon$ or $e = 1$. The Principal will choose to induce $e = 0$.*

4.2 Outcome is Non-Verifiable

If y is observable but non-verifiable, and there is no enforcement mechanism, then ex post, i.e. once the agent has exerted effort, the principal has no incentive to pay a bonus. Thus, again, $t(y) \equiv 0$ and $e = 0$. This is one of the incomplete contract scenarios, with zero investment/effort (Grossman and Hart(1986)).

If however courts exist to simply enforce contracts which are based on verifiable information, we have that the principal can offer a contract which is based on 'subjective valuations'. This contract is offered by the principal, prior to the agent exerting effort, and induces truth-telling by both parties once the state is realized. In more detail, such contract specifies a transfer to the agent as a function of the parties' reports to courts about the state, $k(r_a, r_p)$, with $r_a, r_p \in \{0, B_L, B\}$ being the reports of the agent and principal respectively and $k(.) \geq 0$ satisfying:

$$e^* = \arg\max_e \pi(e)k(B,B) + \hat{\pi}(e)k(B_L,B_L) + [1 - \pi(e) - \hat{\pi}(e)]k(0,0) - \psi(e) \tag{1}$$

$$\pi(e^*)k(B,B) + \hat{\pi}(e^*)k(B_L,B_L) + [1 - \pi(e^*) - \hat{\pi}(e^*)]k(0,0) \geq \psi(e^*) \tag{2}$$

$$k(y,y) \geq k(r_a, y) \text{ for any } y, r_a \neq y \tag{3}$$

$$k(y,y) \leq k(y, r_p) \text{ for any } y, r_a \neq y. \tag{4}$$

The first constraint is the incentive-compatibility constraint of the agent when she chooses her effort given that she anticipates truth-telling, while the second is her participation constraint. The third constraint requires truth-telling by the agent given the state y and given that the principal reports truthfully. Similarly, the last constraint is the truth-telling constraint for the principal himself given the state y. The principal, then, maximizes his expected payoff

$$\pi(e^*)[B - k(B,B)] + \hat{\pi}(e^*)[B_L - k(B_L,B_L)] - [1 - \pi(e^*) - \hat{\pi}(e^*)]k(0,0)$$

with respect to $k(r_a, r_p)$ for any r_a, r_p subject to the above constraints. It turns out that the only flat transfers, $k(r_a, r_p) = \bar{k}$ for any r_a, r_p, induce truth-telling.[21] Thus, for any given flat transfer, the agent finds it optimal to exert no

[21] For truth-telling in the court of law to be a Nash equilibrium, given any state y, it must be that $k(y,y) \geq k(r_a, y)$ and $k(y,y) \leq k(y, r_p)$ for any $r_a \neq y$ and any $r_p \neq y$. It follows that

effort, and thereby the principal finds it optimal to offer no transfers.

Consider now the case when y is unobservable. Now, no state-dependent contract can emerge. So, the agent has an incentive to exert no effort, and thereby the principal has no incentive to pay any bonus; that is, $t(y) \equiv 0$ and $e = 0$.

The discussion above emphasizes that as long as the court, if there is any, aims either at simply enforcing contracts which are based on verifiable information or at inducing truth-telling by disputing parties, without using any extra information for the performance, then the outcome is the one of zero effort and zero payments from the employer to the agent.

4.3 The Flat Dispute-resolution Rule

Consider, now the intermediate case of imperfect verification ($0 < \xi < 1$) by a dispute resolution mechanism, with $t(y)$ being the bonus only if there is compelling evidence about performance and $\bar{k} \geq 0$ being the bonus otherwise. Note that this rule could be one of all possible rules available to either an arbitrator or a mediator.

Note first that under such a rule both the principal and the agent are indifferent over their reports to the tribunal, after a dispute has been arisen: if compelling evidence for y is found then the transfer $t(y)$ is administered, while $\bar{k}$ is the enforced bonus otherwise. That is, such a rule is truth-telling. It

$k(B_L, B_L) \leq k(B_L, 0) \leq k(0,0) \leq k(0, B_L) \leq k(B_L, B_L)$, that $k(B, B) \leq k(B, 0) \leq k(0,0) \leq k(0, B) \leq k(B, B)$ and that $k(B, B) \leq k(B, B_L) \leq k(B_L, B_L) \leq k(B_L, B) \leq k(B, B)$. This can only hold if $k(r_a, r_p) = k$ for any r_a, r_p.

turns out that the agent's anticipated gain if he goes to court, given state y, is $\delta(y) = (1-\xi)[\bar{k} - t(y)]$.

Given these anticipated payoffs we can find if a dispute will arise. In particular, given the state y, the parties are involved in the following zero-sum game (the following matrix contains only the payoff of the agent)

$$\begin{array}{ccc} P\backslash A & challenge & not \\ challenge & t(y)+\delta(y) & t(y)+\delta(y) \\ not & t(y)+\delta(y) & t(y) \end{array} \cdot \tag{5}$$

Notice that if $\bar{k} > t(y)$ then challenging the contract is a weakly dominant strategy for the agent, while if $\bar{k} < t(y)$ then challenging the contract is a weakly dominant strategy for the principal. Thus, at any state y, if $\bar{k} \neq t(y)$ a dispute will arise, while if $\bar{k} = t(y)$ parties are indifferent between fulfilling or not the contract. Let us assume therefore, hereafter, to simplify exposition, that a dispute will always arise. The principal will go to the court when $\delta(y) \leq 0$ and the agent will do so when $\delta(y) \geq 0$.

We turn to the derivation of the optimal contract. Given such a dispute-resolution rule, we have that the principal offers the contract $\{w, b_L, b\}$ that solves the following problem:

$$\max_{w\geq 0, b_L\geq 0, b\geq 0} \pi(e^*)[B-\xi b]+\hat{\pi}(e^*)[B_L-\xi b_L]-w \tag{6}$$

$$\text{subject to } e^* = \arg\max_{e} \xi[\pi(e)b+\hat{\pi}(e)b_L]-\psi(e) \tag{7}$$

$$w+\xi[\pi(e^*)b+\hat{\pi}(e^*)b_L]+(1-\xi)\bar{k}\geq\psi(e^*). \tag{8}$$

To facilitate a simple comparison between the solution of this problem and the complete contract discussed in Section 4.1 above, note that the non-verifiability of information and the presence of a court that administers a flat bonus whenever there is no compelling evidence about performance implies that given any contract $\{w, b_L, b\}$ the *actual* expected cost to the principal is $(1-\xi)\bar{k}+w+\xi[\pi(e)b+\hat{\pi}(e)b_L]$. The reason is that the court can verify the information - and, so, the original contract can be implemented - only with probability ξ, while whenever the court does not find compelling evidence it implements the bonus $\bar{k}$. In other words, the non-verifiability of states under such a dipute resolution rule leads to an additional transfer to the agent of $(1-\xi)[\bar{k}-C(e)]$, where $C(e)\equiv\pi(e)b+\hat{\pi}(e)b_L$ is the expected bonus under verifiability. Notice that this transfer could be negative, i.e. non-verifiability could in principle benefit either of the contracting parties, but crucially not both.

Note that if $\xi=0$ then the agent exerts zero effort, as he expects to receive $w+(1-\xi)\bar{k}$ regardless of his effort. As $\psi(0)=0$, we have that the principal can attain minimum possible costs subject to participation and limited lability by setting $b=b_L=w=0$. This is the same outcome with that in the incomplete contract scenario.

Let now $\xi > 0$. The above problem then is in fact equivalent to the one under complete verifiability after defining bonuses now as $b' \equiv \xi b$ and $b'_L \equiv \xi b_L$ and the utility cost of effort as $\psi(e) - (1-\xi)\bar{k}$. Thus, such a rule does not affect the incentive-compatibility constraints of the agent regarding effort, up to a proportional decrease of the contract's bonuses. Note, however, that this rule relaxes the participation constraint. Also, the agent's problem is well-defined. Following the discussion of the optimal complete contract in the previous subsection we then have that the contract under non-verifiability is $b_L = 0$, $b = \frac{Z(e^*)}{\xi}$, $w = \max\{0, \psi(e^*) - (1-\xi)\bar{k} - Z(e^*)\pi(e^*)\}$. In addition, total monetary costs are $\max\{\psi(e^*), (1-\xi)\bar{k} + Z(e^*)\pi(e^*)\}$.

Clearly then total monetary costs under imperfect verifiability and a flat dispute-resolution rule are weakly higher than monetary costs under complete verifiability, for any given level of effort. In fact, after recalling that $Z(\varepsilon)\pi(\varepsilon) > \psi(\varepsilon)$ and $Z(0) = \psi(0) = 0$ we have that the monetary cost of inducing zero effort is $(1-\xi)\bar{k} \geq 0$, while that of inducing effort ε is $Z(\varepsilon)\pi(\varepsilon) + (1-\xi)\bar{k}$. Clearly, then the extra monetary cost of inducing effort ε instead of 0 is still $Z(\varepsilon)\pi(\varepsilon)$ and thereby zero effort still dominates the intermediate level of effort ε. However, zero effort may no longer dominate full effort. To see this, note first that if $\pi(1)Z(1) > \psi(1)$, i.e. if full effort cannot be implemented at minimum cost while ensuring individual-rationality, then the extra monetary cost of inducing effort 1 instead of 0 is equal to the extra cost under complete verifiability, $Z(1)\pi(1)$. Therefore, zero effort still dominates the full effort. That is, in this case, zero effort is again the outcome. If, however, $\pi(1)Z(1) \leq \psi(1)$ then the extra monetary cost of inducing effort 1 instead of 0 when $0 < \xi < 1$, $\max\{\pi(1)Z(1) + (1-\xi)\bar{k}, \psi(1)\} - (1-\xi)\bar{k}$, is (weakly) lower than the extra cost when $\xi = 1$, $\psi(1)$. This, in turn, implies that full effort can now dominate zero effort, and thereby be optimal.[22] That is, if asymmetric information regarding effort does not have a bite when it comes to implementing full effort, then incomplete verifiability of performance in conjunction with a flat dispute-resolution rule can lead to over-provision of effort. Specifically, we have

Proposition 2 Suppose that under verifiability of performance the exerted effort is zero. Then, under incomplete verifiability and a dispute-resolution rule $\bar{k}$, zero effort is as well the outcome unless $\pi(1)Z(1) \leq \psi(1)$ and $\max\{\pi(1)Z(1)+ (1-\xi)\bar{k}, \psi(1)\} - (1-\xi)\bar{k} < [\Delta\hat{\pi}_1 + \Delta\hat{\pi}_2]B_L + [\Delta\pi_1 + \Delta\pi_2]B$. If the latter is true then full effort is exerted.

That is, in principle, there can be a sufficiently worker-friendly flat dispute-resolution rule $\bar{k}$ and sufficiently low degree of verifiability that lead to over-investment. Laffont and Martimort (2002) and DeMeza and Lockwood (2004) discuss also the possibility of over investment. Laffont and Martimort (2002) discuss the possibility of over-investment arising due to more than two effort levels in an environment of complete verifiability. In DeMeza and Lockwood

[22] Note that if $\max\{\pi(1)Z(1) + (1-\xi)\bar{k}, \psi(1)\} - (1-\xi)\bar{k} < [\Delta\hat{\pi}_1+\Delta\hat{\pi}_2]B_L + [\Delta\pi_1+\Delta\pi_2]B$ then full effort dominates zero effort. This condition implies that $-[\Delta\hat{\pi}_1 B_L + \Delta\pi_1 B] \leq \Delta\hat{\pi}_2 B_L + \Delta\pi_2 B - \max\{\pi(1)Z(1) + (1-\xi)\bar{k}, \psi(1)\} + (1-\xi)\bar{k}$. Also, the fact that zero effort dominates the intermediate effort implies that $\Delta\hat{\pi}_1 B_L + \Delta\pi_1 B < \pi(\varepsilon)Z(\varepsilon)$. Combining the last two conditions we have $-\pi(\varepsilon)Z(\varepsilon) < \Delta\hat{\pi}_2 B_L + \Delta\pi_2 B - \max\{\pi(1)Z(1) + (1-\xi)\bar{k}, \psi(1)\} + (1-\xi)\bar{k}$ which in turn implies that full effort also dominates the intermediate effort.

(2004) the argument is based on a coordination problem between many principals and many agents who are randomly matched in pairs under complete non-verifiability. Here, we see, instead, that the possibility of over-investment is due to the interaction of imperfect verifiability and a flat dispute-resolution rule $\bar{k}$.

This sub-section emphasizes that as long as a third party aims at inducing truth-telling by disputing parties, without using any extra information, *whenever there is no compelling evidence,* for the performance, then the outcome is either the one of zero effort and zero payments from the employer to the agent, or the one of full effort induced by means of a positive bonus only when there is success and total monetary costs lower than utility costs.

We move to the intermediate case of imperfect verifiability by a third party which can resolve a dispute by means of a non-flat bonus schedule. That is, we view the court/tribunal/arbitrator/mediator as an active player who attempts to find information about the non-verifiable state, and uses any such information to resolve disputes over the states. Since such a third party cannot use a generalized mechanism that includes both the ex post judicial rule (which settles contractual disputes) and the terms of the original contract, the Revelation Principle does not necessarily hold. Interestingly, the third party may do better by not using a rule that induces truth-telling. To investigate how the dispute-resolution rule affects the contract offered by the principal, and whether any contractual dispute arises, we examine two cases in turn. First, in the next Section, we visit the case when the court uses a signal-contingent rule which is truth-telling and Nash-implementable. We identify this rule with arbitration for the reasons we discussed in Section 2. In Section 6, then, we turn our attention to a rule which does not induce truth-telling and, given again our discussion in Section 2, we call this rule mediation. Specifically, in the absence of compelling evidence about the state, mediation strikes a compromise between the 'claims' made by the two parties whenever a dispute arises.

5 Arbitration

Suppose, here, that the arbitrator commits to some rule $h(\sigma, m_a, m_p)$ which dictates the bonus to the agent if a dispute arises and the court receives a signal σ when there is no compelling evidence about performance. To induce truth-telling by the disputing parties as a Nash equilibrium, at any state of the world, it must be that

$$\int_{\Sigma} f(\sigma \mid y) h(\sigma, y, y) d\sigma \geq \int_{\Sigma} f(\sigma \mid y) h(\sigma, m_a, y) d\sigma \text{ for any } y, m_a \neq y \tag{9}$$

$$\int_{\Sigma} f(\sigma \mid y) h(\sigma, y, y) d\sigma \leq \int_{\Sigma} f(\sigma \mid y) h(\sigma, y, m_p) d\sigma \text{ for any } y, m_p \neq y. \tag{10}$$

As we have emphasized in Section 2, such rules are akin to an arbitration mechanism in an organization. The arbitrator gathers information, and since the gathering the information is quite detailed and careful we assume here that the arbitration procedure leads to truth telling. The implications of a mechanism which uses signals σ, but nevertheless does not lead to revelation of performance is investigated in Section 6.2

These incentive-compatibility constraints regarding revelation of performance can be satisfied by a host of arbitration rules. For instance, an arbitration rule which disregards completely the disputing parties' claims, i.e. $h(\sigma, m_a, m_p) = \bar{h}(\sigma)$ for any m_a, m_p, σ, is obviously individually rational. The same is true for a rule with $\int_\Sigma f(\sigma \mid y)h(\sigma, m_a, m_p)d\sigma = \int_\Sigma f(\sigma \mid y')h(\sigma, m_a, m_p)d\sigma$ for any $m_a \neq m_b$, and $y', y \in \{m_a, m_p\}$, i.e. when the expected bonus, after effort has been exerted, is performance-independent when a non-trivial dispute arises.[23]

Focusing on non-flat rules, i.e. on nontrivial signal-dependent transfers $h(\sigma, y, y)$, it follows that the expected benefits of the parties, given the state of the world, $\delta' s$, are outcome-dependent. That is, after letting $\bar{h}(\sigma, y) \equiv h(\sigma, y, y)$ we have

$$\delta(0) = (1 - \xi) \int_\Sigma f(\sigma \mid 0)\bar{h}(\sigma, 0)d\sigma,$$

$$\delta(B_L) = (1 - \xi)[\int_\Sigma f(\sigma \mid B_L)\bar{h}(\sigma, B_L)d\sigma - b_L]$$

and

$$\delta(B) = (1 - \xi)[\int_\Sigma f(\sigma \mid B)\bar{h}(\sigma, B)d\sigma - b].$$

Note also that the non-trivial dependence of the arbitration rule on signals σ imply that $\bar{h}(\sigma, y) > 0$ for some signal σ and some outcome y.

Given these anticipated payoffs, we can find, by following the steps in Section 4.3, that a dispute will always arise. The principal will go to the court when $\delta(y) \leq 0$ and the agent will do so when $\delta(y) \geq 0$.

[23] To see this let $k(m_a, m_p, y) \equiv \int_\Sigma f(\sigma \mid y')h(\sigma, m_a, m_p)d\sigma$ and use the steps in footnote 20 where we analyse the proprties of individually-rational 'subjective valuation' contracts.

We turn to the derivation of the optimal contract. The principal offers the contract $\{w, b_L, b\}$ that solves the following problem:

$$\max_{w\geq 0, b_L\geq 0, b\geq 0} \pi(e^*)[B-\xi b]+\hat{\pi}(e^*)[B_L-\xi b_L]-(1-\xi)Q(e^*)-w \tag{11}$$

$$\text{subject to } e^* = \arg\max_{e} \xi[\pi(e)b+\hat{\pi}(e)b_L]+(1-\xi)Q(e)-\psi(e) \tag{12}$$

$$w+\xi[\pi(e^*)b+\hat{\pi}(e^*)b_L]+(1-\xi)Q(e^*)\geq \psi(e^*), \tag{13}$$

where

$$Q(e) \equiv \pi(e)\int_{\Sigma} f(\sigma \mid B)\bar{h}(\sigma, B)d\sigma+\hat{\pi}(e)\int_{\Sigma} f(\sigma \mid B_L)\bar{h}(\sigma, B_L)d\sigma$$
$$+[1-\pi(e)-\hat{\pi}(e)]\int_{\Sigma} f(\sigma \mid 0)\bar{h}(\sigma, 0)d\sigma.$$

Comparing, the present rule with the flat-rule in Section 4.2, notice that now the expected bonus conditional on no compelling evidence about quality Q is no longer fixed, but it depends on exerted effort. Also, the arbitration rule does affect the incentive-compatibility constraints of the agent regarding effort, even after defining bonuses as $\xi t(y)$. In fact, if $Q' > 0$ (respectively $Q' < 0$), then the arbitration (non-flat) rule relaxes (respectively restricts) the incentive-compatibility constraints of inducing higher effort levels. Note that the monotonicity and concavity of Q depends on the arbitration rule and the information technology $f(\sigma, y)$. Specifically, define

$$\begin{aligned}\Delta Q_i &\equiv \Delta\pi_i \int_\Sigma [f(\sigma \mid B)\bar{h}(\sigma, B) - f(\sigma \mid 0)\bar{h}(\sigma, 0)]d\sigma \\ +\Delta\hat{\pi}_i \int_\Sigma [f(\sigma &\mid B_L)\bar{h}(\sigma, B_L) - f(\sigma \mid 0)\bar{h}(\sigma, 0)]d\sigma\end{aligned}$$

for $i = 1, 2$. Then the implementation of increases in effort becomes easier if $\Delta Q_i > 0$ for $i = 1, 2$. Also, the agent's problem is well-behaved, in the sense that the effective cost of exerting effort $\psi(e) - (1 - \xi)Q(e)$ is convex, if $\Delta\psi_2 - (1 - \xi)\Delta Q_2 \geq \Delta\psi_1 - (1 - \xi)\Delta Q_1$. Given the affiliation of signals and outcomes, we have that if the arbitration rule is output independent and the bonus is increasing with signals[24] - that is, if $\bar{h}_2(\sigma, y) \equiv 0$ and $\bar{h}_1(\sigma, .) \geq 0$ - then Q is increasing and concave function of the effort. Thus, $\Delta Q_1 \geq \Delta Q_2 \geq 0$ and the incentive-compatibility constraints for increases in effort are relaxed, and the agent's problem is well behaved. Note that a state indepedent ruling emerges if and only if $h(\sigma, y, y) = h(\sigma, y', y')$ for any $y, y' \in \{0, B_L, B\}$; that is if and only if when disputing parties make the same claims then the bonus is only responsive to the received signal σ. As we have seen above, this can emerge when the expected bonus, after effort has been exerted, is performance-independent when a non-trivial dispute arises. In the case of 'fair' arbitration rules which are increasing in truthful reports we have,[25] given affiliation, that $\int_\Sigma f(\sigma \mid y)\bar{h}(\sigma, y)d\sigma$ is increasing with y, and thereby Q is increasing and concave if

[24] Note that due to affiliation, higher signal imply higher likelihood that performance is high, and so it does make sense to focus on 'fair' arbitration rules $\bar{h}_1(\sigma, y) \geq 0$.

[25] Note that due to affiliation, higher signal imply higher likelihood that performance is high, and so it does make sense to focus on 'fair' arbitration rules $\bar{h}_1(\sigma, y) \geq 0$.

signals and truthful reports are not sufficiently high complements.[26] Assume hereafter that $\Delta Q_1 \geq \Delta Q_2 \geq 0$.

Interestingly, depending on technologies, the first-best can be implemented by means of an appropriate arbitration rule.

Proposition 3 If there is a function $\bar{h}(.)$ such that $\Delta Q_1 \geq \Delta\psi_1/(1-\xi)$ and $\Delta Q_2 \leq \Delta\psi_2/(1-\xi)$, then the principal offers no bonuses and the agent exerts the first-best effort level ε.

Proof: Given zero bonuses the agent chooses the effort that maximizes his expected benefit from the contract being through arbitration net of cost of effort $(1-\xi)Q(e) - \psi(e)$. So, ε is the effort exerted by the agent if $\Delta Q_1 \geq \Delta\psi_1/(1-\xi)$ and $\Delta Q_2 \leq \Delta\psi_2/(1-\xi)$. As ε is the first-best level of effort and it can be implemented at minimum possible cost to ensure participation and limited liability, i.e. by means of zero bonuses and $w = \max\{0, \psi(\varepsilon) - (1-\xi)Q(\varepsilon)\}$, the principal finds it optimal, given the arbitration rule $\bar{h}(.)$, to do so.■

Note that there is nothing in the model to presume a certain ordering between $\Delta Q_1/\Delta\psi_1$ and $\Delta Q_2/\Delta\psi_2$. So a necessary condition for the first-best level of effort being implementable with zero bonuses is that $\Delta Q_2/\Delta\psi_2 \geq \Delta Q_1/\Delta\psi_1$.

It turns out, that there can also be arbitration rules $\bar{h}()$ that lead to over-investment regardless of the contract offered by the principal.

[26] Note that integration be parts gives that $\int_\Sigma f(\sigma \mid y)\bar{h}(\sigma, y)d\sigma - \int_\Sigma f(\sigma \mid y)\bar{h}(\sigma, y')d\sigma$, where $y > y'$, equals $\bar{h}(\bar{\sigma}, y) - \bar{h}(\bar{\sigma}, y') - \{\int_\Sigma [F(\sigma \mid y)\bar{h}_\sigma(\sigma, y) - F(\sigma \mid y')\bar{h}_\sigma(\sigma, y')]d\sigma\}$, where $\bar{\sigma}$ is the supremum of Σ. Thus $\int_\Sigma f(\sigma \mid y)\bar{h}(\sigma, y)d\sigma$ is increasing if $\int_\Sigma [F(\sigma \mid y)\bar{h}_\sigma(\sigma, y) - F(\sigma \mid y')\bar{h}_\sigma(\sigma, y')]d\sigma \leq \bar{h}(\bar{\sigma}, y) - \bar{h}(\bar{\sigma}, y')$, where the right hand side is non-negative. This in turn implies, given that $F(\sigma \mid y)\bar{h}_\sigma(\sigma, y) \leq F(\sigma \mid y')$ due to affiliation, that the expected bonus administered by the arbitrator is increasing with the state if $F(\sigma \mid y)\bar{h}_\sigma(\sigma, y)/\bar{h}_\sigma(\sigma, y')$ is not very much higher than $F(\sigma \mid y')/F(\sigma \mid y)$ (which is at least equal to 1).

Proposition 4 If the arbitration rule $\bar{h}()$ is such that $\Delta Q_1 + \Delta Q_2 \geq (\Delta\psi_1 + \Delta\psi_2)/(1-\xi)$ and $\Delta Q_2 > \Delta\psi_2/(1-\xi)$ then the principal offers no bonuses and the agent exerts maximum effort level 1.

Proof: Suppose that the principal offers zero bonus. If verifiability is sufficiently low so that the above conditions hold, the agent exerts maximizes $(1-\xi)Q(e) - \psi(e)$ by exerting effort $e = 1$. Notice, however, that bonus will reinforce the incentive to exert effort. So, regardless of the contract, maximum effort level is optimal for the agent. As this effort level can be implemented at minimum possible cost to ensure participation and limited liability, i.e. by means of zero bonuses and $w = \max\{0, \psi(1) - (1-\xi)Q(1)\}$, the principal finds it optimal to offer zero bonuses.■

Note that despite the fact that the ordering between $\Delta Q_2/\Delta\psi_2$ and $\Delta Q_1/\Delta\psi_1$ depends on the fundamentals of the model, we have that $(\Delta Q_1+\Delta Q_2)/(\Delta\psi_1 + \Delta\psi_2)$ always lies between $\Delta Q_2/\Delta\psi_2$ and $\Delta Q_1/\Delta\psi_1$.

The above analysis highlights the fact that optimal effort level ε and the maximum effort level 1 can both be implemented (with zero bonuses) under certain circumstances. This is, primarily, due to the fact that the agent is able to recover some of the costs of exerting effort by going to court. In the above, the costs the agent can recover are sufficient to induce her to exert effort, and, so, the principal offers low-powered incentive contracts.

If, however, the recovered costs are sufficiently low and/or verifiability is sufficiently high - in particular, in the remaining case of $1-\xi < \min\{\Delta\psi_1/\Delta Q_1, (\Delta\psi_1+\Delta\psi_2)/(\Delta Q_1+\Delta Q_2)\}$ - zero effort is the outcome. To see this, note that when the agent is faced with zero bonuses she exerts no effort. In this case, as in the case of complete verifiability inducing positive effort will come at a cost to the principal. It turns out that the relevant monetary costs are lower than the benefits, and hence the principal will find it optimal to induce no effort. To see the latter, note that now the problem the principal faces is analogous to the one under compete verifiability, with the difference that now effective bonuses are $b' = \xi b$ and $b'_L = \xi b_L$, and the effective cost to the agent from effort e is $\psi(e) - (1 - \xi)Q(e)$.

Following the discussion of the optimal complete contract in the previous Section we then have that the contract under non-verifiability is $b_L = 0$, $b = \frac{Z(e^*)}{\xi}$, $w = \max\{0, \psi(e^*) - (1 - \xi)Q(e^*) - Z(e^*)\pi(e^*)\}$. In addition, total monetary costs are $\max\{\psi(e^*), (1 - \xi)Q(e^*) + Z(e^*)\pi(e^*)\}$.

Clearly then total monetary costs under arbitration are weakly higher than monetary costs under complete verifiability, for any given level of effort. In fact, after recalling that $Z(\varepsilon)\pi(\varepsilon) > \psi(\varepsilon)$ and $Z(0) = \psi(0) = 0$ we have that the monetary cost of inducing zero effort is $(1 - \xi)Q(0) \geq 0$, while that of inducing effort ε is $Z(\varepsilon)\pi(\varepsilon) + (1 - \xi)Q(\varepsilon)$. Clearly, then the extra monetary cost of inducing effort ε instead of 0 is $Z(\varepsilon)\pi(\varepsilon) + (1 - \xi)\Delta Q_1 \geq Z(\varepsilon)\pi(\varepsilon)$ and thereby zero effort still dominates the intermediate level of effort ε. However, zero effort may no longer dominate full effort. To see this, note first that if $\pi(1)Z(1) > \psi(1)$, i.e. if full effort cannot be implemented under verifiability at minimum cost while ensuring individual-rationality, then the extra monetary cost of inducing effort 1 instead of 0, under non-verifiability and arbitration, is equal to $Z(1)\pi(1)+(1-\xi)(\Delta Q_1+\Delta Q_2) \geq Z(1)\pi(1)$. Therefore, zero effort still dominates the full effort. That is, in this case, zero effort is again the outcome. Similarly, if $\pi(1)Z(1) \leq \psi(1) \leq \pi(1)Z(1) + (1-\xi)Q(1)$ and $Z(1)\pi(1) + (1-\xi)(\Delta Q_1+\Delta Q_2) \geq \psi(1)$ then the extra monetary cost of inducing effort 1 instead of 0 under non-verifiability and arbitration $\max\{\pi(1)Z(1)+(1-\xi)Q(1), \psi(1)\} - (1-\xi)Q(0)$, is (weakly) higher than the extra cost when $\xi = 1$, $\psi(1)$. Again zero effort is the outcome. In the remaining cases, however, the extra monetary cost of inducing effort 1 instead of 0 under non-verifiability and arbitration is (weakly) lower than the extra cost when $\xi = 1$, $\psi(1)$. This, in turn, implies that full effort can now dominate zero effort, and thereby be optimal.[27] Specifically, we have

Proposition 5 Suppose that under verifiability of performance the exerted effort is zero. Then, under incomplete verifiability and arbitration, zero effort is as well the outcome unless $\pi(1)Z(1) \leq \psi(1)$ and $\max\{\pi(1)Z(1) + (1-\xi)Q(1), \psi(1)\} - (1-\xi)Q(\varepsilon) < [\Delta\hat{\pi}_1 + \Delta\hat{\pi}_2]B_L + [\Delta\pi_1 + \Delta\pi_2]B$. If the latter is true then full effort is exerted.

In the next Section, we investigate a dispute-resolution rule which does not induce truth-telling, and yet can be welfare improving under certain conditions. An interesting implication of this rule is that the use of additional information about the non-verifiable state may not be crucial

[27] Note that if full effort dominates zero effort, and zero effort dominates the intermediate effort, then full effort also dominates the intermediate effort.

6 Mediation

Now we consider a dispute resolution mechanism that relies on a mediator. Recall from Section 2 that here we have in mind the arbitration process protocol described by the American Arbitrator Association[28] and ACAS. A mediator listens to the reports about the state of nature from the two conflicting parties and then makes a ruling based on the reports. The protocol described by both ACAS and the American Arbitrator Association emphasizes minimizing cost of the information gathering process. We will assume that this means that the mediator is unable to induce truth-revelation.

In more detail, we consider the following rule. The mediation rule aims at enforcing the original contract whenever the parties agree on the bonus the agent is to receive or whenever there is compelling evidence about the state. In all other cases, the rule is compromising, i.e. it decides on a bonus which is between the parties' claims. The rule in mind is also anonymous, in the sense that the ruling is based only on the original contract, the claims and any additional information, and not on the identity of the claimants. Finally, the rule is monotonic, in the sense that the bonus to the agent - if parties disagree and the court has found no compelling evidence about the state - is non-decreasing in the parties' claims.

Specifically, suppose that the agent's bonus - when a party goes to court and there is no compelling evidence about the state - is determined by the rule $h(\sigma, m_a, m_p)$, $m_a, m_p \in \{0, b_L, b\}$, where m_a and m_p are the reports provided

[28] http://www.adr.org

by the agent and the principal respectively about the state of the world to the court,

$$h(\sigma, m_a, m_p) = \left\{ \begin{array}{c} m \text{ if } m_a = m_p = m \\ \beta(\sigma, m_a, m_p) = \beta(\sigma, m_p, m_a) \in (m_a, m_p) \text{ if } m_a \neq m_p \end{array} \right\} \quad (14)$$

$$\textit{and } \beta_2 \geq 0, \beta_3 \geq 0. \quad (15)$$

Given this rule, and after reintroducing the dependence of $\delta's$ on the claims, we have that the state-dependent expected benefits of the agent from going to court are $\delta(0, m_a, m_p) = (1 - \xi) \int_\Sigma f(\sigma \mid 0) h(\sigma, m_a, m_p) d\sigma$, $\delta(B_L, m_a, m_p) = (1 - \xi)[\int_\Sigma f(\sigma \mid B_L) h(\sigma, m_a, m_p) d\sigma - b_L]$ and $\delta(B, m_a, m_p) = (1 - \xi)[\int_\Sigma f(\sigma \mid B) h(\sigma, m_a, m_p) d\sigma - b]$. Given the implied anticipated state-dependent payoffs, we can find if a dispute will arise. In particular, we have that, given the state y, the parties have to decide whether they will go to court or not, and, if they do challenge the state, what claim will they make.

Using backward-induction, we have that parties are involved in the following state-dependent zero-sum 'lawsuit' game (the following matrix contains only the payoff of the agent)

$$\begin{array}{cccc} m_a \backslash m_p & 0 & b_L & b \\ 0 & t(y) + \delta(y, 0, 0) & t(y) + \delta(y, 0, b_L) & t(y) + \delta(y, 0, b) \\ b_L & t(y) + \delta(y, 0, b_L) & t(y) + \delta(y, b_L, b_L) & t(y) + \delta(y, b_L, b) \\ b & t(y) + \delta(y, 0, b) & t(y) + \delta(y, b_L, b) & t(y) + \delta(y, b, b) \end{array} . \quad (16)$$

Let hereafter that $b \geq b_L$. This comes without loss of generality, as it is shown in Appendix 2. Given that $m_a = b$ and $m_p = 0$ are weakly dominant strategies for the agent and the principal, respectively, we have that state-dependent equilibrium bonus to the agent - conditional on the state being challenged - is $\delta(y, b, 0)$, and thereby, in deciding whether to go to court or not, the parties are involved in the following zero-sum game

$$\begin{array}{ccc} A \backslash P & \textit{challenge} & \textit{not} \\ \textit{challenge} & t(y) + \delta(y, b, 0) & t(y) + \delta(y, b, 0) \\ \textit{not} & t(y) + \delta(y, b, 0) & t(y) \end{array} \cdot \tag{17}$$

Clearly, as long as $\delta(y, b, 0)$ is non-zero, a dispute will always arise. If $\delta(y, b, 0) > 0$ the agent challenges the state y, while if $\delta(y, b, 0) < 0$ it is the principal who goes to court. The only environment in which a dispute never arises is when $\delta(y, b, 0) = 0$ for any y, which, in turn, amounts to having a contract with $b_L = b = 0$ and thereby $h(\sigma, b, 0) = 0$ for any σ. It follows that, unless $b = b_L = 0$, a dispute will always occur regardless of the state of the world.[29]

Therefore, the ex ante (i.e. prior to the effort being exerted) expected bonus

[29] Suppose that $b > 0$, $b \geq b_L \geq 0$. The mediation rule then implies that $h(\sigma, b, 0) > 0$ for any σ. Thus, under state $y = 0$ the agent goes to court. The compromising nature of the judicial rule and $f > 0$ implies also that $\int_\Sigma f(\sigma \mid B)h(\sigma, b, 0)d\sigma < b$, and so under state $y = B$ the principal goes to court. In state $y = B_L$ we have that if $\int_\Sigma f(\sigma \mid B_L)h(\sigma, b, 0)d\sigma < b_L$ the agent goes to court, while if $\int_\Sigma f(\sigma \mid B_L)h(\sigma, b, 0)d\sigma > b_L$ the principal challenges the state. In the final case of $y = B_L$ and $\int_\Sigma f(\sigma \mid B_L)h(\sigma, b, 0)d\sigma = b_L$ the parties are indifferent; to simplify exposition, though, we implicitly assume that some party will go to court.

is $\xi t(y) + (1-\xi)\eta(e,b,0)$, where

$$\eta(e,b,0) \equiv$$
$$\pi(e)\int_{\Sigma} f(\sigma \mid B)h(\sigma,b,0)d\sigma + \hat{\pi}(e)\int_{\Sigma} f(\sigma \mid B_L)h(\sigma,b,0)d\sigma$$
$$+[1-\pi(e)-\hat{\pi}(e)]\int_{\Sigma} f(\sigma \mid 0)h(\sigma,b,0)d\sigma.$$

and the principal offers the contract $\{w, b_L, b\}$ that solves the following problem:

$$\max_{w\geq 0, b_L\geq 0, b\geq b_L} \pi(e^*)[B-\xi b] + \hat{\pi}(e^*)[B_L - \xi b_L] - (1-\xi)\eta(e^*,b,0) - w \quad (18)$$

$$\text{subject to } e^* = \arg\max_e \xi[\pi(e)b + \hat{\pi}(e)b_L] + (1-\xi)\eta(e,b,0) - \psi(e) \quad (19)$$

$$w + \xi[\pi(e^*)b + \hat{\pi}(e^*)b_L] + (1-\xi)\eta(e^*,b,0) \geq \psi(e^*). \quad (20)$$

As in the case of the arbitration rule, the non-verifiability of information and the presence of a mediator that uses the rule $h(\sigma, m_a, m_b)$ described above implies that given any contract $\{w, b_L, b\}$ the *actual* expected cost to the principal is $(1-\xi)\eta(e,b,0) + w + \xi[\pi(e)b + \hat{\pi}(e)b_L]$. Thus, the cost Q is replaced by the cost η which now also depends on the claims made by both parties, and, in particular, on the bonus b. Note that $\eta(.,0,0) = 0$, and hence zero effort can be induced by offering the flat-contract with $w = b = b_L = 0$.

Notice that a direct implication of the cost being $\eta(e,b,0)$, with $\eta_2(e,b,0) \geq 0$, instead of Q is that increasing the bonus b increases the extend at which the participation constraint is relaxed. Also, as long as effort affects positively η and the agent's report and effort are complements in the mediation rule, we have that increasing the bonus b increases the extend at which the incentive compatibility constraints of increasing effort is relaxed. In what follows, we derive the contract offered by the principal and the implemented effort.

6.1 Signal-Unresponsive Rule

We discuss two cases, first where the mediator does not use or possesses additional information on non-verifiable states and second where the mediator possesses and uses all additional information regarding performance. In this subsection, we assume that the rule uses only the claims to decide on the bonus to the worker when no compelling evidence exists about the state, with the remaining case discussed in the following sub-section.

So here the mediator does not get any additional signal σ. The mediator cannot gather any new information on her own, therefore she has to base the ruling on the information provided by the contracting parties. This assumption is justified, as we have discussed in Section 2, by the fact that mediators often, in order to reduce the cost of dispute resolution, do not gather information themselves. Therefore, here, the mediator's ruling is, $h(\sigma, b, 0) \equiv \tilde{h}(b, 0)$ for any $\sigma \in \Sigma$, and as a result η is not effected by effort. Thus, mediation here does not, in contrast to arbitration, relax the incentive-compatibility constraints of increasing effort.

Here, also, the marginal benefit for the agent, decreases with effort and increases with the bonuses offered by the principal. Recall that if the principal offers no bonuses then the agent exerts no effort (and no dispute arises). Thus, the agent's problem is well-defined. In addition, if the mediation rule is a convex function of bonus b then the principal's cost minimization, for any given positive effort, problem is also well-behaved. Assume hereafter that this is indeed the case.

Note that if $\xi = 0$ then the agent exerts zero effort, as he expects to receive $w + (1-\xi)\eta(.,b,0)$ regardless of his effort. As $\psi(0) = \eta(.,0,0) = 0$, we have that the principal can ensure minimum costs, by setting $b = b_L = w = 0$. Recall that this is also the outcome under a flat rule when $\xi = 0$.

Let now $\xi > 1$. Define also

$$
\begin{aligned}
b_L^*(e) &= \frac{\Delta\pi_j[Z(e) - \xi b^*(e)]}{\xi\Delta\hat{\pi}_j}, && (21)\\
b^*(e) &= \arg\max_{b\in[\frac{\gamma(e)Z(e)}{\xi},\frac{Z(e)}{\xi}]} \{\xi\Gamma(e)b - (1-\xi)\eta(.,b,0)\}, && (22)\\
\gamma(e) &\equiv \frac{\Delta\pi_j}{\Delta\hat{\pi}_j + \Delta\pi_j}, && (23)\\
\Gamma(e) &\equiv \frac{\hat{\pi}(e)\Delta\pi_j}{\Delta\hat{\pi}_j} - \pi(e), \text{ with } e > 0 \text{ and } j = 1 \text{ if } e = \varepsilon, \text{ and } j = 2 \text{ if } e \ne (24)
\end{aligned}
$$

Note that due to MLRP we have $\Gamma(e) > 0$. It follows then, after following the steps in the complete contract scenario, that if $\psi(e) \geq \xi[\pi(e)b^*(e) + \hat{\pi}(e)b_L^*(e)] + (1-\xi)\eta(.,b^*(e),0) \equiv C^*(\xi,e)$, then the principal can induce the effort level $e > 0$ by means of a contract $b_L = b_L^*(e)$, $b = b^*(e)$ and $w = \psi(e) - \xi[\pi(e)b^*(e) + \hat{\pi}(e)b_L^*(e)] + (1-\xi)\eta(.,b^*(e),0) \geq 0$. This follows directly from observing that under such contract the participation constraint is just satisfied and the agent finds it to her benefit to exert effort e. Thus, in this case, the existence of mediation leads to production at minimum cost $\psi(e)$, as in the first-best outcome, despite asymmetric information regarding effort.

If, however, $\psi(e) < C^*(\xi, e)$ then asymmetric information regarding effort has a bite when it comes to inducing effort level e. In particular, now, if the principal wants to induce a positive level of effort e, he would need to incur a total cost of $C^*(\xi, e)$. The formal derivation of this is can be found in Appendix 3. Here we only present the intuition. As the problem of the agent is well-behaved, the minimum monetary cost, for any given down-payment w, at which the principal can induce effort level $e > 0$ is attained when the 'downward local incentive compatibility constraint' is binding, i.e.

$$\xi[\Delta\hat{\pi}_j b_L + \Delta\pi_j b] = \Delta\psi_j,\ j = 1, 2.$$

As in the complete contract scenario, the above equation for $j = 1$ comes from the indifference of the agent between exerting effort level ε and no effort; similarly for $j = 2$. It follows that $b_L = \frac{\Delta\pi_j[Z(e)-\xi b]}{\xi\Delta\hat{\pi}_j}$. So, the bonuses, when the quality is of an intermediate and high level, are substitutes. Recall that for any given down-payment w, that the expected cost to the principal is $\xi[\pi b + \hat{\pi} b_L] + (1 - \xi)\eta(., b, 0)$.Therefore increasing the bonus when the outcome is a success leads to a gain $\xi\Gamma(e)$ from the bonuses paid when there is compelling evidence about the state, an at a cost $(1 - \xi)\eta(., b, 0)$ from the bonuses paid when the state is not verified. The principal is constrained by the requirement that $b \geq b_L \geq 0$ and the agent's participation constraint that $\xi[\pi(e)b + \hat{\pi}(e)b_L] + (1-\xi)\eta(., b, 0) + w \geq \psi(e)$. Notice that $b \geq b_L \geq 0$ translates into $b \in [\frac{\gamma(e)Z(e)}{\xi}, \frac{Z(e)}{\xi}]$. Since $\psi(e) < C^*(\xi, e)$ and $w \geq 0$, we clearly, then, have that the participation constraint is slack. Therefore, $b = b^*(e)$ and $b^*_L(e)$. As down-payments are costly we also have that $w = 0$. So the total cost of inducing e is indeed $C^*(\xi, e)$.

Accordingly, for any given effort level the principal wants to induce, the contract has $b = b^*(e)$ and $b^*_L(e)$ and $w = \max\{0, \psi(e) - C^*(\xi, e)\}$, and total production costs are given by $\max\{\psi(e), C^*(\xi, e)\}$. It follows that if $\xi\Gamma(e) \leq (1-\xi)\eta_b(., \frac{\gamma Z}{\xi}, 0)$ then the principal finds it optimal to offer the same bonus whenever the project is not a failure, i.e. $b = b_L = \frac{\gamma(e)Z(e)}{\xi}$. Furthermore, if $(1-\xi)\eta_b(., \frac{\gamma(e)Z(e)}{\xi}, 0) < \xi\Gamma(e) < (1-\xi)\eta_b(., \frac{Z(e)}{\xi}, 0)$ then the principal finds it optimal to offers some bonus, though lower than b, at the intermediate state of performance. Specifically, the principal offers, at the state of success, bonus $\hat{b}(e)$, which is the solution of $\xi\Gamma(e) = (1-\xi)\eta_b(., b, 0)$. That is, the bonus when the project is a success balances the trade-off between higher incentives and higher cost due to non-verifiability. Also, we have that $b_L = \frac{\Delta\pi_j}{\Delta\hat{\pi}_j}[\frac{Z(e)}{\xi} - \hat{b}(e)] \equiv \hat{b}_L(e)$. Finally, if $\xi\Gamma(e) \geq (1-\xi)\eta_b(., \frac{Z(e)}{\xi}, 0)$ then, despite the fact that non-verifiability does increase the principal's costs at the margin, increasing bonus b as much as possible is still optimal. Thus, $b = \frac{Z(e)}{\xi}$, $b_L = 0$. Note, that this contractual form is the one under complete contracts, adjusted for the possibility of non-verifiability ($\xi < 1$) and that non-verifiability increases the monetary costs by $(1-\xi)\eta(., b, 0)$.

The above discussion highlights that under non-verifiability and the mediation rule in question, the contractual form of the principal inducing a certain level of effort may be different than that under verifiability. Summarizing, we have:

Proposition 6 For sufficiently high values of ξ then a given positive effort level e is induced by offering a bonus only when the project is a success, $b = \frac{Z(e)}{\xi}$, $b_L = 0$. If value of ξ is sufficiently low then the bonuses are the same when the project is not a failure $b = b_L = \frac{\gamma e) Z(e)}{\xi}$. Otherwise for intermediate levels of ξ a bonus is also offered at the intermediate performance level $\frac{Z(e)}{\xi} > b = \hat{b}(e) > \frac{\gamma e) Z(e)}{\xi} > b_L = \hat{b}_L(e)$.

Proof: The proof follows directly from above discussion, after defining two threshold levels of degree of verifiability ξ_l and ξ_h, with $\xi_l < \xi_h$, by the solutions of $\xi\Gamma = (1-\xi)\eta_b(., \frac{\gamma Z}{\xi}, 0)$ and $\xi\Gamma = (1-\xi)\eta_b(., \frac{Z}{\xi}, 0)$, respectively.■

It is interesting to note that this Proposition emphasizes that even under non-verifiability incentives are not flat. This will be true as long as there is an effective mechanism to resolve any disputes arising from the non-verifiability. In particular, the agent is provided incentives, with the power of incentives being increasing with the degree of verifiability. We see that high powered incentives can be provided even under non verifiability, i.e., if $\xi \geq \xi_h$ and hence $b_L = 0$. Interestingly, verifiability increases the amount paid at the intermediate performance decreases; if $\xi \geq \xi_h$ then $b = Z/\xi$. This something which we would expect, since higher verifiability would facilitate the provision of incentives.

Next, we turn to the determination of the optimal effort induced for varying degrees of non-verifiability given by the variable ξ. We have

Proposition 7 The first-best level of effort is optimal if $\xi < \xi_h(\varepsilon)$, and $\Delta\hat{\pi}_1 B_L + \Delta\pi_1 B \geq \max\{\xi[\pi(\varepsilon)b(\xi,\varepsilon) + \hat{\pi}(\varepsilon)b_L(\xi,\varepsilon)] + (1-\xi)\eta(.,b(\xi,\varepsilon),0),\ \psi(\varepsilon)\}$ and $\Delta\hat{\pi}_2 B_L + \Delta\pi_2 B \leq \max\{\xi[\pi(1)b(\xi,1) + \hat{\pi}(1)b_L(\xi,1)]\xi + (1-\xi)\eta(.,b(\xi,1),0),$ $\psi(1)\} - \max\{\xi[\pi(\varepsilon)b(\xi,\varepsilon) + \hat{\pi}(\varepsilon)b_L(\xi,\varepsilon)]\xi + (1-\xi)\eta(.,b(\xi,\varepsilon),0),\ \psi(\varepsilon)\}$, where $b_L(\xi,e) = \frac{\Delta\pi_1}{\Delta\hat{\pi}_1}[\frac{Z(e)}{\xi} - b(\xi,e)]$ and $b(\xi,e) = \hat{b}(e)$ if $\xi > \xi_l(e)$, $b(\xi) = \frac{\gamma(e)Z(e)}{\xi}$ if $\xi \leq \xi_l(e)$.

Proof. *See Appendix 4* ■

Proposition 8 Full effort is optimal if $\xi < \xi_h(1)$, and $(\Delta\hat{\pi}_1 + \Delta\hat{\pi}_2)B_L + (\Delta\pi_1 + \Delta\pi_2)B \geq \max\{\xi[\pi(1)b(\xi,1) + \hat{\pi}(1)b_L(\xi,1)] + (1-\xi)\eta(.,b(\xi,1),0),\ \psi(1)\}$ and $\Delta\hat{\pi}_2 B_L + \Delta\pi_2 B > \max\{\xi[\pi(1)b(\xi,1) + \hat{\pi}(1)b_L(\xi,1)]\xi + (1-\xi)\eta(.,b(\xi,1),0),$ $\psi(1)\} - \max\{\xi[\pi(\varepsilon)b(\xi,\varepsilon) + \hat{\pi}(\varepsilon)b_L(\xi,\varepsilon)]\xi + (1-\xi)\eta(.,b(\xi,\varepsilon),0),\ \psi(\varepsilon)\}$, where $b_L(\xi,e) = \frac{\Delta\pi_1}{\Delta\hat{\pi}_1}[\frac{Z(e)}{\xi} - b(\xi,e)]$ and $b(\xi,e) = \hat{b}(e)$ if $\xi > \xi_l(e)$, $b(\xi) = \frac{\gamma(e)Z(e)}{\xi}$ if $\xi \leq \xi_l(e)$.

Proof. *See Appendix 4* ■

Corollary 9 A necessary condition for some positive effort level to be optimal is that this effort level must be induced by offering some bonuses at the intermediate performance state.

The intuition should be clear by now: if bonuses are given only if the project is a success the total monetary costs are (weakly) higher that those under complete verifiability, with the latter being sufficiently high to ensure zero effort if $\xi = 1$.

6.2 Signal-responsive Rule

We now return to the general case of $\eta(e, b, 0)$. As the rule $h(\sigma, b, 0)$ is independent of the state, affiliation implies that if the rule is 'fair', i.e. $h_1 \geq 0$, then $\eta(e, b, 0)$ is an increasing and concave function of effort. Assume also that $\eta(e, b, 0)$ is convex with respect to the agent's report, to ensure that the principal's problem is well-behaved.

This rule combines elements from the arbitration and the signal-unresponsive mediation rule. In particular, by letting, with some abuse of notation, $\Delta Q_2 = \eta(1, 0, 0) - \eta(\varepsilon, 0, 0)$ and $\Delta Q_1 = \eta(\varepsilon, 0, 0) - \eta(0, 0, 0)$ one can see that Propositions 3 and 4 are hold here as well: first-best or full effort are implemented due the participation constraint and the incentive compatibility constraint for increases in effort be relaxed.

When, on the other hand, $1 - \xi < \Delta\psi_1 / \Delta Q_1$ and $1 - \xi \leq (\Delta\psi_1 + \Delta\psi_2)/(\Delta Q_1 + \Delta Q_2)$ we have that zero bonuses induce zero effort. Note also that due to convexity of ψ and concavity of $\pi, \hat{\pi}$ and $\eta(e, ., .)$ we have that ensuring the 'local downward' incentive compatibility constraint for some positive effort level e implies that e is also preferred to the other effort levels. Then, we have in a similar manner to that in Section 6.1 that $w = \max\{0, \psi(e) - \bar{C}(\xi, e)\}$, $\bar{b}(e) = \arg\max_{b \in []} \{\xi \Gamma(e) b - (1 - \xi)[\eta(e, b, 0) - \frac{\hat{\pi}_j \Delta\eta_j(b)}{\Delta\hat{\pi}_j}]\}$, $\bar{b}_L(e) = \frac{\Delta\pi_j [Z(e) - \xi \bar{b}(e)]}{\xi \Delta\hat{\pi}_j} - \frac{(1-\xi)\Delta\eta_j(b)}{\xi \Delta\hat{\pi}_j}$ and total monetary costs are $\max\{\psi(e), \bar{C}(\xi, e)\}$, where $\bar{C}(\xi, e) \equiv \xi[\pi(e)\bar{b}(e) + \hat{\pi}(e)\bar{b}_L(e)] + (1 - \xi)\eta(e, \bar{b}(e), 0)$, $\Delta\eta_2(b) \equiv \eta(1, b, 0) - \eta(\varepsilon, b, 0)$ and $\Delta\eta_1(b) \equiv \eta(\varepsilon, b, 0) - \eta(0, b, 0)$, with $j = 1$ if $e = \varepsilon$, and $j = 2$ if $e = 1$. That is, as the extend to which incentive-compatibility is relaxed depends on the bonus

b, the cost of increasing b has the additional cost $\frac{\hat{\pi}_j d\Delta\eta_j(b)}{\Delta\hat{\pi}_j db}$, and the power of incentives is affected accordingly. If the latter decreases, i.e. if $\frac{\hat{\pi}_j d\Delta\eta_j(b)}{\Delta\hat{\pi}_j db} < 0$, then monetary costs are lower, relative to the case with $\xi = 1$, thereby increasing the cases of positive effort levels being implemented.

7 Choosing either Mediation or Arbitration

In the previous sections we have not considered the choice of the disputing parties regarding the mechanism used for dispute resolution. We have assumed that the disputing parties are aware that either mediation is available to them or arbitration is available to them. But in reality the disputing parties generally make a choice where to get their disputes resolved. Disputing parties when they register their dispute often have an option to get it resolved through a mediator or take it to an arbitrator at the tribunal. The dispute can be taken to the mediator only if both parties agree. If the dispute is taken to the mediator and one party is not satisfied with the solution then the case ends up with arbitrator at the tribunal. The ruling of the mediator is not legally binding while that of the arbitrator generally is. This form can easily be incorporated into our model. With a choice the players will always use the arbitration at the tribunal. The reason being that the players play a zero sum game if they go to a mediator. Since it is necessary that in order for mediation to occur both parties have to agree, mediation will never take place due to this and they will end up going to an arbitrator. So the outcome will be that the case will always be resolved at the tribunal by an arbitrator.

In certain industries it is compulsory to take a dispute to the mediator and then take it to the arbitrator at the tribunal. In this case again the result of the arbitration will be the equilibrium result. Again the reason being that the players play a zero sum game at the mediation stage and mediation has to be agreed by both parties and is not legally binding. Therefore at least one party will always take the case further to arbitration. In our model, given either simulataneous choice or sequential choice between the two mechanisms the arbitration ruling will always hold. In case the game structure is such that players can go to a mediator first and then to an arbitrator or make a simultaneous choice between the two, mediation ruling may be accepted by both players if there is an added cost to going to arbitration. This cost may be greater time required or more resources since arbitration generally takes more time and resources. In such a case mediation rule would dominate.

8 Conclusion

It is often not possible to write contracts where performance is measured precisely and within firms and organizations this may lead to disputes and grievances. Firms and organizations realize this and often they have well defined and extensive mechanism in their job code to deal with such cases. If there are no such provisions within the organization, the disputes either go to arbitrators out of the organizations or to the courts. In the analysis above we look into two possible dispute resolution mechanism or rules and the effect it would have on the ex ante contract written and the effort level of the agent which can be induced. In case of a dispute resolution mechanism which induces truthful reporting the result will be low-powered incentives or a flat contract while if the mechanism is such that it just follows the reporting of the participants without forcing to report honestly about what they observe a high powered incentive contract can be written. This provides another rationale why firms may write a contract providing low powered incentives as opposed to high powered incentives. Over the last few decades there has been increasing use of alternative dispute resolutions. In certain industrial sectors use of ADRs have become compulsory. The main advantage of ADRs over tribunals or courts is that it is less costly.

We believe that this framework can be applied to various other incentive problems. In public sector for instance, where most organizations are complex, it may be extremely difficult to write a fully verifiable contracts. This makes it difficult to write incentive contracts. But we see that given a mechanis to deal with the non verfiability of contracts, incentive contracts can be written. Other areas include providing incentives in teams, where contributions from different agents may be difficult to measure. We believe that addressing this issue of non verifiablity fills an important gap in the theory of contracts between the incomplete literature and the complete contract literature.

9 References

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10 Appendices 1-3

These Appendices are available upon request.

11 Appendix 4

- Case 1: $\xi\Gamma(\varepsilon) \geq (1-\xi)\eta_b(., \frac{Z(\varepsilon)}{\xi}, 0)$ and $\xi\Gamma(1) \geq (1-\xi)\eta_b(., \frac{Z(1)}{\xi}, 0)$, or equivalently $\xi \geq \max\{\xi_h(\varepsilon), \xi_h(1)\}$. In this case, any positive level of effort is induced by offering no bonuses at the intermediate level of performance. That is, $b_L = 0$ and $b(e) = Z(e)/\xi$. Hence, the induced effort maximizes $\pi(e)B + \hat{\pi}(e)B_L - \max\{\psi(e), \pi(e)Z(e) + (1-\xi)\eta(., \frac{Z(e)}{\xi}, 0)\}$, with $Z(0) \equiv 0$. Clearly, then, due to $\eta(., 0, 0) = 0$ and that zero effort is induced under verifiability, and that monetary costs are (weakly) higher than those under full verifiability we have that zero effort is still optimal for the principal under non-verifiability.

- Case 2: $\xi \geq \xi_h(\varepsilon)$ and $\xi < \xi_h(1)$. In this case, effort level ε is induced by means of bonuses $\{b_L = 0, b = Z(\varepsilon)/\xi\}$, while effort level 1 is induced with bonuses $\{b_L^*(1), b^*(1)\}$ where $b^*(1) < \frac{Z(1)}{\xi}$. Here, optimal effort may be positive, depending on the parameters. Nevertheless, it will not be the first-best one, as the cost of inducing it, here, is even higher than under verifiability. In particular, note that $\Delta\hat{\pi}_1 B_L + \Delta\pi_1 B \leq \max\{\pi(\varepsilon)Z(\varepsilon), \psi(\varepsilon)\}$ $\leq \max\{\pi(\varepsilon)Z(\varepsilon) + (1-\xi)\eta(., \frac{Z(\varepsilon)}{\xi}, 0), \psi(\varepsilon)\}$, where the first inequality follows from the fact that zero effort is the outcome under verifiability and the second inequality follows from the additional cost $(1-\xi)\eta(., \frac{Z(\varepsilon)}{\xi}, 0)$ the principal faces under non-verifiability. Thus, here, if positive effort is optimal it must be the maximum one. In fact, $e = 1$ is preferred to $e = 0$ if

$$(\Delta\hat{\pi}_1+\Delta\hat{\pi}_2)B_L+(\Delta\pi_1+\Delta\pi_2)B > \max\{\xi[\pi(1)b^*(1)+\hat{\pi}(1)b^*_L(1)]+(1-\xi)\eta(., \hat{b}(1), 0), \psi(1)\}$$

Note that the latter inequality can, in principle be true, despite the fact that zero effort is optimal under verifiability and the cost of inducing effort 1 instead of 0 is weakly higher by $(1-\xi)\eta(., \frac{Z(\varepsilon)}{\xi}, 0)$ under non-verifiability. The reason is that $\xi b^*(1)$ (which is strictly lower than $Z(1)$) may be sufficiently lower than $Z(1)$ to compensate for the higher bonus under the intermediate state of performance and for the higher actual cost due to non-verifiability.

- Case 3: $\xi < \xi_h(\varepsilon)$ and $\xi \geq \xi_h(1)$. In this case, effort level ε is induced by means of bonuses $\{b^*_L(\varepsilon), b^*(\varepsilon)\}$, where $b^*(\varepsilon) < \frac{Z(\varepsilon)}{\xi}$, while effort level 1 is induced with bonuses $\{b_L = 0, b = Z(1)/\xi\}$. Repeating the steps above, we have that effort level 1 is dominated by zero effort level, given that the latter is optimal under verifiability and under non-verifiability the principal's actual cost (weakly) increases by $(1-\xi)\eta(., \frac{Z(1)}{\xi}, 0)$. However, the first-best level may now be optimal. This will be the case if

$$\max\{\pi(\varepsilon)b^*(\varepsilon)+\hat{\pi}(\varepsilon)b_L^*(\varepsilon)+(1-\xi)\eta(.,b^*(\varepsilon),0),\psi(\varepsilon)\} \leq \Delta\hat{\pi}_1 B_L + \Delta\pi_1 B.$$

Similarly[30] to Case 2, note that the latter inequality can, in principle may be true, despite the fact that zero effort is optimal under verifiability and the cost of inducing effort ε instead of 0 is (weakly) higher by $(1-\xi)\eta(.,b^*(\varepsilon),0)$ under non-verifiability. The reason is that $\xi b^*(\varepsilon)$ (which is strictly lower than $Z(\varepsilon)$) may be sufficiently lower than $Z(\varepsilon)$ to compensate for the higher bonus under the intermediate state of performance and for the higher actual cost due to non-verifiability.

- Case 4: $\xi < \xi_h(\varepsilon)$ and $\xi < \xi_h(1)$. In this case, effort level ε is induced by means of bonuses $\{\hat{b}_L(\varepsilon), \hat{b}(\varepsilon)\}$, where recall that $\hat{b}(\varepsilon) < \frac{Z(\varepsilon)}{\xi}$, and effort level 1 is induced with bonuses $\{b_L^*(1), b^*(1)\}$ where $b^*(1) < \frac{Z(1)}{\xi}$. Therefore, combining the arguments in Cases 2 and 3 we have that, depending on the parameters, either effort level could be optimal. Incentive compatibility provides us with the obvious conditions.

[30]Note that ε dominating full effort follows from full effort being dominated by zero effort, and zero effort be dominated by ε.