THE OPTIMAL ALLOCATION OF DECISION AND EXIT RIGHTS IN ORGANIZATIONS*

Helmut Bester† and Daniel Krähmer‡

June 2016

Abstract

We show that in a bilateral relation with conflicting preferences and transferable utility it is unambiguously optimal to assign the authority over project decisions to the party with private decision–relevant information rather than to the uninformed party. This holds irrespective of the degree of conflict and the distribution of private information. Under the optimal contract the uninformed party is protected by an exit option, which it will exert after observing that the decision maker has not chosen the promised decision. Exit prematurely terminates the relation and destroys (some part of) the surplus from the project. We show that the first–best efficient solution can be obtained by such a contract.

Keywords: Authority, decision rights, exit options, incomplete contracts, asymmetric information.
JEL Classification No.: D23, D82, D86.

*An earlier version of the paper circulated under the title "The Allocation of Authority and Exit Options." Support by the German Science Foundation (DFG) through SFB/TR 15 is gratefully acknowledged. We thank an associate editor and three referees for helpful comments. We also thank Eugen Kovac, Johannes Münster, Tymofiy Mylovanov, Klaus Schmidt, Roland Strausz, and Stefan Terstiege for useful discussions.

†Free University Berlin, Dept. of Economics, Boltzmannstr. 20, D-14195 Berlin (Germany); email: *hbester@wiwiss.fu-berlin.de*

‡University of Bonn, Institute for Microeconomics, Adenauer Allee 24-42, D-53113 Bonn (Germany); email: *kraehmer@hcm.uni-bonn.de*

1 Introduction

One of the central problems in relationships such as joint ventures, partnerships, or supply relationships is that important decisions can frequently not be contractually specified in advance and that decision relevant information is often held privately by some party. When contracts are incomplete and information is hidden, determining who should have authority over decisions is therefore among the most vital choices of contract design. The optimal assignment of authority faces the dual challenge of restraining the self–interest of the party in authority and of providing incentives for the informed parties to reveal their private information.

An application are research alliances where important strategic research decisions such as what research directions to pursue, how to respond to new results, which staff to hire, etc. are, due to transaction costs or unforseen contingencies, impossible to fully specify in advance. Moreover, there is often a considerable conflict of interest between the financing and the research firm ("commercial" versus "academic"), and the research firm typically has superior knowledge about the viability of a strategy (see Lerner and Malmendier (2010) for evidence from the biotech industry). Other examples arise in vertical supply relations where contracts often specify the authority over design choices that have to be implemented by the supplier who has private information about costs.

The novelty of this paper is to study the allocation of authority in relationships that can be prematurely terminated. When termination is possible, exit options can be used which, as a part of the contractual arrangement, assign the right to cease cooperation and specify provisions for this case. In particular, we consider situations in which the parties can exchange payments conditional on whether the relation is terminated or not.[1] For instance, as documented by Lerner and Malmendier (2010), exit options of this kind are pervasive in research agreements giving the financing firm the right to cease collaboration and obtain the property rights from the research upon termination.

Our analysis establishes two main results. First, we show that decision rights should unambiguously be given to the informed party, and exit rights should be given to the uninformed party. This always generates a higher surplus than when the uninformed party has authority. This finding is remarkably robust. It does neither depend on the probability distribution of the private information, nor on the size of the parties' conflict of interest. Second, we show that the optimal allocation of decision and exit rights has a surprising efficiency implication: it in fact allows implementing the first–best outcome! Thus, when the informed party has authority, the problem of jointly providing incentives for decision making and information revelation can be overcome as if there was no contractual incompleteness or asymmetric information.[2]

[1] The feasibility of monetary payments distinguishes our paper from much of the work on the allocation of decision rights. See the literature review below.

[2] We discuss general implications for implementation in Section 5.

Our analysis supports the view that authority should be delegated to those who possess decision-relevant information.[3] Reversely, we argue that the uninformed party should be protected by exit rights. These findings are in line with Lerner and Malmendier's (2010) analysis of research agreements which shows that the research firm enjoys considerable discretion over strategic research decisions despite important conflicts of interest. In fact, due to the large conflict of interest, Lerner and Malmendier (2010, p. 217) consider the "pervasiveness of research agreements in the biotechnology sector [...] puzzling". Moreover, Lerner and Malmendier (2010) document the widespread use of exit options for the financing firm and provide evidence that the use of termination clauses is more common when research decisions are non–contractible.[4]

To establish our results, we allow for payments which can be fine–tuned to information revealed by the informed party about, for instance, which decisions it plans or recommends to take. This approach is the conceptual and normative starting point from a contract design perspective so as to determine the efficiency frontier under a given allocation of authority. In the practical context of research agreements, contracts of this kind arise when the research firm files a research proposal and the payments depend on the content of the proposal. The logic behind our main results, however, extends also to settings where report–contingent payments are infeasible or appear empirically implausible. In Section 5, we discuss contracts when payments are constrained to be contingent only on whether the project is terminated or not, and not on communication. We argue that, under the condition that decision authority is assigned to the informed party (and not to the uninformed party), then in a large class of settings an exit option contract can implement the same outcome as if decisions were contractible. Thus exit options in combination with the appropriate allocation of authority can circumvent the problem of non–contractibility independently of whether communication–dependent payments are feasible or not.

In some cases, our results require that the parties can employ a budget breaker in the off–equilibrium event that the project is terminated. As we show, however, a budget breaker is not needed if, for example, the conflict of interest is small, or the surplus lost from termination is large. In Section 5, we discuss features of a second–best optimal contract under agent authority when a budget breaker is not available.

[3]There is a long tradition in economics going back to Hayek (1945) that argues in favor of delegating decisions to individuals with "local" knowledge. For a more modern account of this view in the context of organizations, see, e.g. Milgrom and Roberts (1992). The drawback of delegation, that decision makers act opportunistically in their self-interest, can be traced back to Simon (1951).

[4]Further examples of exit option contracts comprise contracts for house re–modeling, book publishing, advertising pilot campaigns, real estate agency services, or procurement contracts for specialized equipment (see Taylor (1993), Che and Chung (1999)). Also, performance contingent termination clauses in loan contracts or non–promotion clauses in labor contracts, or certain financial contracts such as convertible bond securities can be interpreted as forms of exit options (see Aghion et al. (2004), Kahn and Huberman (1988), Stiglitz and Weiss (1983)). An empirical analysis of control and exit rights is provided by Bienz and Waltz (2010) and Hellmann (1998) for venture capital markets and by Arrunada et al. (2001) for the auto industry.

To study optimal authority with exit options, we adopt the by now standard framework where a principal hires an agent to undertake a joint project whose payoffs depend on a non–contractible decision.[5] The agent receives decision–relevant private information, his 'type', but disagrees with the principal over the ideal course of action. Even though the decision is not contractible, the right over taking the decision can be contractually assigned to one of the parties. Because we allow the parties to exchange contractible monetary transfers the first–best efficient decision, which maximizes the parties' joint surplus, is a compromise between the principal's and the agent's favorite decision. We depart from existing work by analyzing the case where an initiated project can be prematurely terminated. An exit option gives the party who is not in authority the right to exit the relation after the decision has been taken, possibly contingent on the exchange of payments. Premature exit destroys some (though not necessarily all) project payoffs so that efficiency mandates completing the project.

Our two main results show that in this environment the first–best decision can be implemented under agent– but not under principal–authority. To see intuitively why this is the case, suppose for a moment that decisions are contractible (and thus the assignment of decision rights is irrelevant). In our setting, it follows from a standard screening argument that the first–best can be implemented by a payment schedule that induces the agent to reveal his information truthfully.[6] When we apply this payment schedule to the situation where decisions are observed only by the two parties but not publicly, it remains to ensure that truthful reporting by the agent will induce the party with authority to select the first–best.

Regardless of who has authority, to provide first–best decision making incentives for the party in authority, the party with the exit option has to be indifferent between exiting and continuing the relation at the first–best decision. The reason is that the party with the exit right should continue if the first–best decision was chosen. But, it cannot strictly prefer continuation, because then the party in authority could gain by deviating to a slightly more partisan decision which would still be accepted.

With this in mind, we can now see why the first–best can be implemented if the principal delegates the decision right to the agent and retains the right to exit. Note that under the payment schedule that implements truth–telling with contractible decisions, it is not profitable for the agent to lie about his type and choose the first–best decision consistent with this lie. Therefore, there remain two possible deviations that the agent has to be deterred from. First, he could announce some type and choose a smaller decision than the first–best that is accepted by the principal. But, this is not profitable because the first–best decision is the largest decision that the principal accepts under her exit option, and the agent prefers larger decisions. Second, the agent could announce a type and deviate to a decision larger

[5]More precisely, we assume that the decision is observable by both parties but not verifiable. That is, the decision cannot be legally enforced by a court. Similarly, Hermalin and Katz (1991) consider a model in which the principal and the agent are better informed about some action than the court.

[6]The technical reason for this is that the agent's utility satisfies a single crossing property and the first–best decision is monotone in his type.

than the first-best, which induces the principal to exit. He is then punished by the loss in payments and surplus that is associated with termination. Should this not be a sufficient deterrent, the agent's obedience can be easily achieved by using a third party as a budget breaker and imposing a heavy penalty on the agent should the principal exit. Yet, third party payments are not always needed to achieve efficiency under agent–authority: we show that they are redundant if the conflict of interest between the agent and the principal is not too large, or if the surplus is not too small.

In contrast, under principal–authority an exit option for the agent cannot implement the first–best. The reason is that an exit option gives the agent two possible deviations that involve lying: lying about his type to induce the principal to choose another decision, and lying and then exercising the exit option. It is impossible to prevent both deviations simultaneously. The intuition is easiest to illustrate for the case that the agent's benefit from the project in the event of termination is zero, independently of his type. Clearly, each type of the agent can ensure himself the payoff from exiting. Since the termination benefit is zero for all types, by incentive compatibility the payment that the agent receives after exerting the exit option must be type independent. Further, to deter the principal from deviating from the promised decision, at the first–best decision the agent must be kept indifferent between exiting and continuing. Therefore, also the agent's utility from continuing has to be independent of his type. This, however, makes it impossible to elicit the agent's information truthfully: his utility from staying in the relation cannot be constant in his type, because otherwise standard screening arguments imply that 'more efficient' agent types cannot be deterred from mimicking 'less efficient' types.[7] Hence, providing the appropriate decision incentives for the principal through the agent's exit option is incompatible with the agent's communication incentives for information revelation.

Related Literature

Our paper contributes to the literature on the allocation of decision making authority between a principal and a better informed agent when decisions are non–contractible.[8,9] At the heart of this work is the trade–off that delegating authority to the agent allows the principal

[7]When the termination value is a fraction of the completion value of the project, then the indifference condition implies that the slope of the agent's utility is smaller than what is needed to screen the agent and make him stay in the relation.

[8]When decisions are contractible, the principal allows the agent to select a decision in a pre-determined permissible "delegation set". This is impossible in our setting with non–contractible decisions. For work on delegation with contractible decisions, private information and non–transferable utility see Holmström (1984), Melumad and Shibano (1991), Alonso and Matouscheck (2008), Amador and Bagwell (2013), or Krähmer and Kovac (2016). For a comparison of mechanisms, depending on the principal's commitment power, see Goltsman et al. (2009). Mylovanov (2008) shows that contractible decisions can also be implemented by giving the principal a veto right in combination with a contractually specified default option.

[9]For work on delegation without private information, see also Aghion and Tirole (1997), Bester and Krähmer (2008), or Section 2 in Bester (2009).

to make better use of the agent's superior information but entails biased decision making due to the parties' conflict of interest.

Our paper is most closely related to Krishna and Morgan (2008) who enrich the 'cheap talk' model of Crawford and Sobel (1982) by allowing for the possibility of contractual monetary transfers that are contingent on the information reported by the agent. Our model extends their analysis by adding exit options, which specify contingent monetary transfers for the event of premature termination.[10] While in Krishna and Morgan (2008) delegation outperforms authority only if the conflict of interest is sufficiently small, we show that with exit options delegation is always optimal. Through exit options the agent's incentives can be fully aligned with maximizing the joint surplus so that he always reports truthfully and chooses the first–best decision.

Dessein (2002) compares the outcomes under delegation and cheap talk in model of Crawford and Sobel (1982) without allowing for monetary transfers. He finds that the principal prefers delegating control rather than relying on cheap talk when the conflict of interest is small. The conclusion that delegation is suboptimal for a large conflict of interest, is also obtained by Bester (2009) and Krähmer (2006), who study more specific contracting environments with monetary transfers but without exit options.

In all these contributions, the agent's decision making under delegation is biased which implies that for large conflict of interest, authority dominates delegation even though this means that information transmission is imperfect and full information revelation is not obtained. Against this background, our contribution is to show that the drawbacks of delegation can be overcome by employing exit options. In a setup that is almost as general as Crawford and Sobel (1982) and more general than Dessein (2002) and Krishna and Morgan (2008), we show that there is an exit option contract which induces the agent to take the efficient decision. In particular, the trade-off between authority and delegation disappears, and delegation is always optimal, irrespective of the conflict of interest.[11]

In this paper, efficiency is achieved by a simple scheme which assigns the decision right to the informed party and only requires the uninformed party to choose whether to exit or continue the relation. In related work, Bester and Krähmer (2012) consider exit options in an incomplete contract between a seller and a buyer who has private information about his valuation. But, decision rights cannot be re–allocated and it is the uninformed party who selects an unverifiable decision: the seller, who is uninformed about the buyer's valuation, chooses the quality of his service. In contrast with the simple scheme in the present paper, an efficient mechanism then requires that termination of the relation is determined by a complex

[10] A further difference to our paper is that they consider an agent protected by limited liability.

[11] Somewhat related to our exit option, Dessein (2002) allows the principal to delegate authority to the agent also considers the possibility that the principal delegates authority to the agent but retains the right to approve or veto proposals by the agent and, in case of veto, implements a default option. Yet, he finds that keeping veto power generally does not dominate full delegation.

message game involving both parties and randomization off the equilibrium path.[12]

Finally, our paper is related to the literature on options in incomplete contracts with symmetric information in the context of the hold–up problem. It is well–known that, when information is symmetric and the parties can commit not to renegotiate an initial contract, incentives for opportunistic behavior by the party in charge of the decision can be mitigated through giving the other party an exit option (cf. Che and Hausch (1999)). As we show, this efficiency property of option contracts extends to our environment where one of the parties has private information. When the parties cannot commit not to renegotiate an initial contract, then pre-specified trading options affect investment incentives, because they determine the disagreement point in renegotiations.[13] In this context, efficient breach remedies have been studied by Edlin and Reichelstein (1996) and Ohlendorf (2009) who show that it is possible to provide efficient incentives for ex ante investments. In our model, in contrast, rather than determining disagreement payoffs in renegotiations after breach, exit options prevent misbehavior to begin with.

Our paper is organized as follows. Section 2 describes the problem of allocating authority in a principal–agent environment in which the agent has private information. In Section 3 we show that the assignment of decision rights is irrelevant in the benchmark case with symmetric information. Section 4 contains the main results of our analysis: we show that a simple exit option contract can implement the first–best outcome if the principal delegates the decision right to the agent, but not if she maintains authority. We discuss implications and extensions of our analysis in Section 5. Section 6 concludes. Most of our formal results are rather straightforward and explained in the main text; only the more technical and lengthy proofs of Lemmas 6 and 8 and Propositions 4–6 are relegated to an appendix in Section 7.

2 The model

2.1 The environment

A principal (she) can hire an agent (he) to undertake a joint project. As mentioned in the Introduction, examples include research alliances to develop a new product or vertical supply relations to produce a relation-specific input. In the course of the project various decisions have to be taken that affect the payoff from the project whose details are impossible to specify in advance. For example, the uncertainty and long planning horizon involved in conducting research about a new product make it practically impossible to ex ante foresee the decisions required to resolve unexpected problems in the research process and thus to write complete

[12] It is not clear whether a similar mechanism can be constructed in the present setting for the technical reason that Bester and Krähmer (2012) consider a discrete type space, whereas here, a continuous type space is considered.

[13] See, e.g., Aghion et al. (1994), Che and Chung (1999), Chung (1991), Evans (2008), Nöldeke and Schmidt (1995, 1998).

contracts. To capture this, we assume that the payoff from the project depends on a (for simplicity, single) non–contractible decision $d \in D = \mathbb{R}$. We adopt an incomplete contract approach and assume that d is not verifiable (neither ex ante nor ex post), but observable by both parties. In particular, the decision is not legally enforceable by a court.

Moreover, the payoff from the project also depends on a state of the world $\theta \in \Theta = [0,1]$ which captures the fact that a decision may be more or less appropriate depending on exogenous circumstances. We will focus on the case that the state of the world is privately observed by the agent (e.g. in a research alliance, the research firm is typically better informed about the feasibility of a certain research strategy). Hence, we refer to the state of the world as the agent's type. The distribution of the agent's type is common knowledge. Our results hold for any distribution of the agent's type with support Θ. Finally, the principal and the agent disagree about the appropriate course of action (e.g. in research alliances, the financing firm has typically a more commercial, and the research firm a more academic interest).

As in Crawford and Sobel (1982), the principal's and the agent's (gross) payoffs are described by the utility functions $U_P(\theta,d)$ and $U_A(\theta,d)$, which are twice continuously differentiable and satisfy for $i = P,A$

$$\frac{\partial^2 U_i(\theta,d)}{\partial d^2} < 0, \quad \frac{\partial^2 U_i(\theta,d)}{\partial d \partial \theta} > 0, \quad \frac{\partial U_i(\theta,d_i(\theta))}{\partial d} = 0 \tag{1}$$

for some $d_i(\theta) \in D$. Hence each party $i \in \{P,A\}$ has a unique *ideal decision* $d_i(\theta)$ in each state θ. The second condition in (1) is a Spence–Mirrlees single crossing property and implies that ideal decisions are strictly increasing in the state: $\partial d_i(\theta)/\partial \theta > 0$ for $i = P,A$. In addition to the usual assumptions of the Crawford–Sobel model, we assume that the following *regularity* condition holds for $i \in \{P,A\}$:[14]

$$\frac{\partial U_i(\theta,d)}{\partial \theta} \neq 0 \quad \text{for all} \quad d \neq d_i(\theta). \tag{2}$$

This ensures that, at least for non–ideal decisions, the parties' preferences are sensitive to the state θ.

The conflict of interest between the principal and the agent is described by the difference between their ideal decisions

$$b(\theta) \equiv d_A(\theta) - d_P(\theta), \tag{3}$$

which in the following we refer to as the agent's *bias*. To avoid case distinctions, we assume that

$$\frac{\partial U_A(\theta,d)}{\partial d} > \frac{\partial U_P(\theta,d)}{\partial d} \tag{4}$$

for all θ and d. Therefore, the bias does not change sign and $b(\theta) > 0$ for all θ.[15]

[14]Note that (2) is not implied by (1).

[15]Our arguments also apply in a model where the bias changes sign once such as, for example, in Section V.A. of Kamenica and Gentzkow (2011).

After the decision is taken and observed by both parties, the project can be prematurely terminated. For example, the principal can dismiss the agent, or the agent can quit. In this case, the principal receives only a fraction $\alpha_P \in [0,1)$ of her completion payoff U_P, and the agent receives only a fraction $\alpha_A \in [0,1)$ of his completion payoff U_A.[16]

We consider the case with transferable utility and assume that the parties can commit to the exchange of monetary transfers without limited liability restrictions.[17] The *first–best decision* $d^*(\theta)$ therefore maximizes the joint surplus $U_P(\theta,d) + U_A(\theta,d)$. By our assumptions the surplus is strictly concave in d and so $d^*(\theta)$ is uniquely defined by the first–order condition

$$\frac{\partial U_P(\theta, d^*(\theta))}{\partial d} + \frac{\partial U_A(\theta, d^*(\theta))}{\partial d} = 0. \tag{5}$$

Therefore[18]

$$d_P(\theta) < d^*(\theta) < d_A(\theta), \quad \text{and} \quad \partial d^*(\theta)/\partial \theta > 0, \tag{6}$$

that is, the first–best decision is in between the parties' ideal decisions and strictly increasing in the state of the world. In what follows, we assume that for all values of θ

$$U_P(\theta, d^*(\theta)) + U_A(\theta, d^*(\theta)) > \alpha_P U_P(\theta, d^*(\theta)) + \alpha_A U_A(\theta, d^*(\theta)) \geq 0. \tag{7}$$

Combined with the assumption that both parties receive zero utility from not cooperating, this ensures that undertaking and completing the project is optimal whenever the first–best can be implemented.

2.2 Exit option contracts

We follow the literature on incomplete contracts in assuming that decisions and the gross payoffs from decisions are observable to the contracting parties but not to outsiders. Therefore, decisions are not contractible. The parties, however, can commit to the allocation of decision rights. That is, they can sign a binding agreement on whether the principal or the agent is entitled to select the decision d.[19] In addition to the allocation of authority, the parties can contractually assign to the party not in charge of the decision the right to prematurely terminate the relation after the decision d has been observed. While the type of

[16]Our analysis would remain valid if the exit payoffs are not proportional to continuation payoffs and more generally given by $\bar{U}_P(\theta,d) < U_P(\theta,d)$ and $\bar{U}_A(\theta,d) < U_A(\theta,d)$, respectively. This would affect only the proof of Lemma 4 which continues to hold under the assumption that $\partial \bar{U}_A(\theta,d)/\partial\theta \neq \partial U_A(\theta,d)/\partial\theta$ for some θ. Our simplification allows us to address the comparative statics of the optimal contract for changes in α in Section 5.

[17]While we impose no *exogenous* bounds on payments, the payment schedules we derive below in (20) and (21) are clearly bounded because they are continuous on a compact set.

[18] To see this, observe that (4) and (5) imply $\partial U_P(\theta, d^*(\theta))/\partial d < 0 < \partial U_A(\theta, d^*(\theta))/\partial d$. Since payoffs are strictly concave in d this yields the first statement in (6). Finally, by differentiating (5) with respect to θ one immediately obtains by (1) that $\partial d^*(\theta)/\partial\theta > 0$.

[19]The allocation of authority may be enforced by the legal access to the assets and resources that are necessary to implement a decision.

project is not verifiable, we assume that completion or termination of the project are. For example, in a vertical supply relation some characteristics of a good or service may not be contractible, but whether delivery occurs or not is observable by outsiders and therefore contractible.[20] For the research alliance application, Lerner and Malmendier (2010) document that contracts frequently include termination options in particular when research itself is non-contractible. We refer to the right to terminate the relation as *exit option*.

A contract specifies the allocation of authority $h \in \{P, A\}$ which assigns the right to choose d either to the principal ($h = P$) or the agent ($h = A$). Under an exit option contract, the principal's payments to the agent are contingent upon whether the party with the exit option does or does not exercise its exit option.[21] Moreover, we allow the principal's payments to depend on a verifiable report $\theta \in \Theta$ by the agent about his true type. Hence, the principal has to pay $P_Y(\theta)$ if the project is completed, and $P_N(\theta)$ if the project is terminated because the exit option has been exercised.

From a practical perspective, payments that depend on a report about the agent's abstract type, may seem unrealistically complex. But, an equivalent way of specifying payments is to make them contingent on a *verifiable, non–binding* project proposal $\hat{d} \in D$ by the agent.[22] Under P–authority, we may interpret the proposal as a public recommendation to the principal to choose a project, while under A–authority, the proposal can be seen as a public announcement to choose a project.[23]

By allowing for message–contingent payments, we adopt the standard approach in contract theory to investigate the efficiency properties of different authority regimes, without imposing restrictions on the usage of revealed information. But, our analysis of exit options is also applicable to situations in which, for some reason, payments are constrained not to depend on reports or announced decisions: as we argue in Section 5, our result that only under A–authority there is an exit option contract that attains the same outcome as if the decision was contractible, in many settings carries over to the case where payments can depend merely on whether a project is terminated or not. Therefore, also in environments where message-contingent payments are not feasible only A–authority is optimal.

[20] A closely related assumption is standard in the hold–up literature: relation-specific investments are not contractible, but the disagreement point can be contractually determined through pre-specified trading options.

[21] This differs from Compte and Jehiel (2007) who study a bargaining problem with *quitting rights*, where termination is *not* contractible. In their paper, the right to quit means that each party can get its *exogenous* outside option payoff in any event after the contract is signed. A contract has then to respect ex post participation constraints. They show that private information about outside options leads to inevitable inefficiencies.

[22] To see why this is equivalent to our "direct" contract, observe that in equilibrium, agent type θ will report some message $\hat{\theta}$, inducing an equilibrium action $d(\hat{\theta})$. Thus, in the spirit of the taxation principle, the principal, instead of requiring a report $\hat{\theta}$, may as well offer the agent to propose a project from a menu that covers all possible equilibrium actions $\{\hat{d} = d(\hat{\theta}) | \hat{\theta} \in \Theta\}$. It is then an equilibrium that the agent proposes the project that would have been induced under his original report.

[23] We think it is rather plausible that, in reality, actual payments differ depending on the project that the parties plan to implement. An example is research funding where the research budget awarded depends on the research proposal.

Finally, we allow the contracting parties to use penalty payments to a passive third party:[24] the party who has the decision right has to pay the penalty $\Pi \geq 0$ if the other party exercises the exit option.[25] Thus the third party payment $\Pi \geq 0$ serves as a disciplining device for the party who has authority. Note that for contracts under which the parties can share the first–best surplus in any state θ, the penalty Π only deters deviating behavior and is never paid in equilibrium. Observe that since $\Pi \geq 0$, no outside funds are available.[26] The third party payment may represent the cash equivalent of a (contractible) penalty that harms the decision making party but does not benefit the other party. For example, in an organization the decision making party may be degraded in rank or suffer a reputation loss as a result of exit.[27] As pointed out by MacLeod (2003), third party payments can also be interpreted as the monetary equivalent of the loss from breaking up a repeated relationship or organizational conflict in the form of strikes, sabotage, and costly litigation. Further, in an organization with more than two parties, an outside budget breaker is not needed because one can penalize one party by redistributing payments within the organization.[28]

In summary, an *exit option contract (with h–authority)* is a schedule

$$\gamma = (h, P_Y(\cdot), P_N(\cdot), \Pi). \tag{8}$$

The relation proceeds as follows. Before the agent privately observes his type, the principal and the agent sign a contract γ. Their outside payoffs at this stage are zero.[29] After the agreement the agent observes his type and submits a report about his type to the principal. Then the party in charge selects a decision and, after having observed the decision, the other party decides whether to exit or not. Finally, payments are made.

A contract induces a dynamic game of incomplete information. We assume that the parties play a Perfect Bayesian Equilibrium of that game. In a Perfect Bayesian Equilibrium,

[24] Allowing for third party payments is not uncontroversial since three party contracts of this sort may be difficult to implement, as they raise the problem of collusion between two of the agents against the third, cf. Hart and Moore (1988), especially their footnote 20. For an argument in support of three party agreements, see Baliga and Sjöström (2009) who show in a complete information setting that if all coalitions have access to the same contracting technology, introducing a third party allows implementation of the first–best, even if the third party is corruptible.

[25] In principle, Π could depend on θ, but this would not affect any of our results. In particular, the argument for our impossibility result in Section 4.1 does not involve Π at all.

[26] Note that it is not substantial that the decision making party pays the penalty in case of exit. For example, under P–authority, instead of having the principal pay Π in case of exit, one can simply reduce P_N by Π so that, in effect, the agent reimburses the principal for paying Π. This is payoff equivalent to our formulation. Moreover, we do not consider penalty payments when the project is completed. This is so because we will focus on the question whether the first–best can be implemented which requires that the project is not terminated and no money is left on the table.

[27] See Diamond (1984) for an elaboration of this idea in the context of a borrower lender relationship.

[28] See e.g. Rajan and Reichelstein (2006) for the use of 'bonus pools'.

[29] The division of surplus depends on the parties' bargaining power at the contracting stage. Indeed, our analysis shows that under an optimal contract the payments in (8) are determined only up to a constant.

each player acts optimally given his beliefs, and conditional on the opponent's strategy, beliefs are derived by Bayes' rule whenever possible. In particular, if the agent announces his type truthfully in equilibrium, the principal believes that the agent's type is equal to the observed report with probability 1.[30]

The payments in the exit option contract can also be interpreted as a contractual liability provision, which is frequently observed in practice. Under *A*–authority, for instance, the agent is liable for damages when the project is terminated. The principal pays P_Y to the agent immediately after the project proposal. When exit occurs, the agent has to pay back P_Y and, in addition, pay damages $-P_N$ to the principal.

We refer to a contract γ as *first–best efficient* if the induced game has a Perfect Bayesian Equilibrium in which the party in charge selects the first–best decision $d^*(\theta)$ for any agent type θ and the other party does not exit. Note that since the agent's private information arrives after contracting, both parties agree at the contracting stage to maximize their joint surplus. Hence, only first–best efficient contracts are optimal whenever they are feasible.

Exit option contracts are not the most general contracts for the contracting environment we consider and may look restrictive in several ways. First, they restrict communication between the agent and the principal to direct communication. In general, a contract could employ a mediator who coordinates communication between the parties. Second, exit option contracts assign the right to terminate the relation exclusively to one of the parties. This option can be viewed as a rather simple message game where one of the parties can select between two messages. One of these messages induces continuation of the project, whereas the other leads to termination. In general, a contract could make outcomes contingent on a more complicated message game between both parties.[31] Third, by restricting ourselves to deterministic contracts, we do not consider random allocations of authority or stochastic termination. In our setup, however, more complicated contracts cannot dominate the simple contracts that we study. Indeed, we show below that there is a first–best efficient exit option contract with *A*–authority. Thus, more general contracts cannot generate higher payoffs. This efficiency property and the simplicity of implementation make exit option contracts attractive to investigate and may explain why they are widely observed in practice.

3 Decision incentives with symmetric information

Because the decision is not contractible in our setting, and because the agent's information is private, a first–best efficient exit option contract has to provide incentives for the party in

[30] More precisely, under *A*–authority the principal's beliefs depend on both the agent's report and his decision. In an equilibrium in which the agent tells the truth, the principal's beliefs therefore need to be equal to the agent's report only if also the agent's actual decision coincides with the prescribed equilibrium decision of this agent type.

[31] See Bester and Krähmer (2012) for an elaboration of this point.

charge to choose the first–best decision and for the agent to reveal his information truthfully. In this section, we argue that, regardless of who has authority, to provide efficient decision incentives, the exit payments must take a specific form in the spirit of expectation damages. To isolate this point, we abstract in this section from communication incentives by focussing on the benchmark case in which the agent's type θ is observable by all parties and verifiable. Moreover, we show that with symmetric information the allocation of authority is irrelevant to the extent that a first–best exit option contract exists both under P– and A–authority.

When θ is publicly observable and verifiable, the payments can depend on it directly (rather than on a report about θ). The following insight is fundamental for our analysis.

Lemma 1 *Suppose θ is publicly observable and verifiable. Then under a first–best efficient exit option contract, the party with the exit right must be indifferent between exiting and continuing the relationship at the first–best decision. That is, for all $\theta \in \Theta$:*

$$U_A(\theta, d^*(\theta)) + P_Y(\theta) = \alpha_A U_A(\theta, d^*(\theta)) + P_N(\theta) \quad \text{if } h = P; \tag{9}$$

$$U_P(\theta, d^*(\theta)) - P_Y(\theta) = \alpha_P U_P(\theta, d^*(\theta)) - P_N(\theta) \quad \text{if } h = A. \tag{10}$$

To understand the conditions, consider the case that the principal has authority. (The case with agent authority is analogous.) Condition (9) says that in this case, the agent has to be indifferent between staying and exiting. This follows from the joint requirements that the principal chooses the first–best decision and that the agent stays in the relation. The left hand side is the agent's utility if the principal has chosen the first–best decision and the agent stays in the relation, while the right hand side is the agent's utility when he exits. For the agent to stay in the relation, the left hand side needs therefore to be weakly larger than the right hand side. On the other hand, if there was a strict inequality in (9), the agent would still stay in the relation even if the principal chose a decision slightly smaller than the first–best decision. Since the principal would be better off with such a decision, she would not choose the first–best decision in this case. Hence, under a first–best efficient contract, equality has to hold in (9).

In other words, condition (9) states that if the principal triggers exit, then she has to compensate the agent so that he is as well off as he would have been had exit not occurred. Thus, the exit payments of first–best exit option contracts are in the spirit of standard *expectation damages*. Under expectation damages, a party that violates the contract has to pay damages which leave the other party in the same material position as if a violation had not occurred. In our setting, the party in authority violates the contract if it triggers termination by selecting a decision that is closer to its ideal decision than the "promised" first–best decision $d^*(\theta)$. If exit destroys all surplus ($\alpha = 0$), the exit payments in Lemma 1 give the party without decision rights exactly the same payoff after termination as if the decision maker had chosen the promised first–best $d^*(\theta)$. Otherwise, if some surplus is left, the damages compensate only for the lost profits that would result if exit occurred at the first–best decision.[32]

In the remainder of this section, we show that under symmetric information both under P– and A–authority, the threat of exit can be used to induce the party in authority to select the first-best $d^*(\theta)$. First consider the case of P—authority. Since the agent's utility attains its maximum at $d_A(\theta) > d^*(\theta)$, the payments in (9) imply that $d^*(\theta)$ is the lowest decision that he will accept, whereas he will exit whenever the principal chooses $d < d^*(\theta)$. Since the principal prefers decisions smaller than the first–best, her optimal decision to prevent exit is therefore $d^*(\theta)$, while her optimal decision to trigger exit is her ideal decision $d_P(\theta) < d^*(\theta)$. Therefore, whenever

$$U_P(\theta, d^*(\theta)) - P_Y(\theta) \geq \alpha_P U_P(\theta, d_P(\theta)) - P_N(\theta) - \Pi \tag{11}$$

for all $\theta \in \Theta$, she optimally chooses $d^*(\theta)$. For the case of A—authority, an analogous argument shows that by (10) the agent will optimally select $d^*(\theta)$ rather than his ideal decision $d_A(\theta)$ if

$$U_A(\theta, d^*(\theta)) + P_Y(\theta) \geq \alpha_A U_A(\theta, d_A(\theta)) + P_N(\theta) - \Pi \tag{12}$$

for all $\theta \in \Theta$.

It is easily verified that there exist payments $(P_Y(\cdot), P_N(\cdot), \Pi)$ that satisfy (9) and (11) for P—authority, and (10) and (12) for A—authority, respectively. This establishes the following result:

Proposition 1 *The allocation of authority is irrelevant if the agent's type is publicly observable and verifiable: under both P– and A–authority there is a first–best efficient exit option contract.*

In the following section we show that Proposition 1 no longer holds if the agent is privately informed about the state θ. The reason is that the payments then, in addition to satisfying the indifference conditions of Lemma 1, also have to induce the agent to report his information truthfully.

4 Asymmetric information

In this section, we prove that in the case of asymmetric information there is a first–best efficient exit option contract with A–authority but none with P–authority. Therefore, assigning authority to the agent rather than to the principal is always the optimal contractual choice.

[32] Then the actual utility of the exiting party is smaller than what it would get had the decision maker not deviated. For example, under P–authority, if the principal misbehaves and chooses $d < d^*(\theta)$, the agent ends up with $\alpha_A U_A(\theta, d) + P_N(\theta) < U_A(\theta, d^*(\theta)) + P_Y(\theta)$.

4.1 P–authority

We begin by analyzing contracts with P–authority and show that in this case decision and communication incentives necessarily conflict with each other so that achieving the first–best is impossible:

Proposition 2 *There is no first–best efficient exit option contract with P–authority.*

We prove Proposition 2 by contradiction. We will derive a number of necessary conditions for first–best implementation under P–authority and show that they are incompatible with one another.

We start with the simple observation that our restriction to "direct" exit option contracts, which require the agent to report his type, is without loss of generality: if there is no direct first–best efficient exit option contract, then there is none which uses some other, more general message set. The reason is that under a first–best efficient contract, the principal has to choose the first–best decision $d^*(\theta)$ for all agent types θ. Since $d^*(\theta)$ is distinct for every agent type, it is thus necessary that the agent truthfully reveals his type to the principal. It follows by an argument in the spirit of the Revelation Principle that if the first–best can be implemented by some exit option contract, it can be implemented by a direct contract where the message space coincides with the type space. In addition, we can restrict attention to contracts which induce the agent to report his type truthfully.[33]

Because we can restrict attention to direct contracts where the agent tells the truth, a first–best efficient exit option contract with P–authority satisfies the following three incentive constraints:

(i) Agent type θ reports his type truthfully;

(ii) Upon receiving a report θ, the principal believes that the agent's type is θ and selects the first–best decision $d^*(\theta)$;

(iii) After observing the decision $d^*(\theta)$, the agent does not exit but continues the relation.

Under such a contract, agent type θ therefore receives utility

$$V_A(\theta) \equiv U_A(\theta, d^*(\theta)) + P_Y(\theta). \tag{13}$$

[33] A first–best efficient exit option contract employing some message space M can be replicated by the direct contract which requires the agent to report a type in Θ and that then implements the contract terms which are induced by the message of this type under the original contract. Note that this argument follows only because under a first–best exit option the type must be fully revealed. It does not follow from the standard Revelation Principle of Myerson (1979) because we consider communication without a mediator and imperfect commitment to decisions. In this case, the set of implementable outcomes could possibly be enlarged by allowing the agent to not communicate truthfully (cf. Bester and Strausz (2001)).

We now show that the incentive constraints (i)-(iii) cannot be jointly satisfied by deriving three necessary conditions which turn out to be incompatible. Constraints (ii) and (iii) capture the decision incentive constraints for the principal. Since the agent's type is revealed on the equilibrium path, these constraints are the same as in the benchmark case with symmetric information. Therefore, for the same reasons as in Lemma 1, the agent must be indifferent between exiting and continuing the relation given the first–best decision.

Lemma 2 *Under a first–best efficient contract with P–authority, for all $\theta \in \Theta$,*

$$V_A(\theta) = \alpha_A U_A(\theta, d^*(\theta)) + P_N(\theta). \tag{14}$$

Next, we derive two necessary conditions that follow from the requirement (i) that the agent reveals his type truthfully. First, truth–telling requires that type θ must not be better off by submitting a report $\hat{\theta} \neq \theta$ and then accepting the induced decision $d^*(\hat{\theta})$. That is, for all $\theta \in \Theta$:

$$V_A(\theta) = \max_{\hat{\theta}} \left[U_A(\theta, d^*(\hat{\theta})) + P_Y(\hat{\theta}) \right]. \tag{15}$$

By a standard envelope argument, this pins down the derivative of V_A:[34]

Lemma 3 *Under a first–best efficient contract with P–authority, for all $\theta \in \Theta$,*

$$V_A'(\theta) = \frac{\partial U_A(\theta, d^*(\theta))}{\partial \theta}. \tag{16}$$

The second implication of the truth–telling requirement is that type θ must not be better off by submitting a report $\hat{\theta} \neq \theta$ and then exiting after the principal chose $d^*(\hat{\theta})$. This means, it must be the case that for all $\theta, \hat{\theta} \in \Theta$

$$V_A(\theta) \geq \alpha_A U_A(\theta, d^*(\hat{\theta})) + P_N(\hat{\theta}). \tag{17}$$

Together with the indifference condition (14) in Lemma 2, it follows that

$$V_A(\theta) = \max_{\hat{\theta}} \left[\alpha_A U_A(\theta, d^*(\hat{\theta})) + P_N(\hat{\theta}) \right]. \tag{18}$$

Applying again an envelope argument, we get in analogy to Lemma 3 the following result:

Lemma 4 *Under a first–best efficient contract with P–authority, for all $\theta \in \Theta$,*

$$V_A'(\theta) = \alpha_A \frac{\partial U_A(\theta, d^*(\theta))}{\partial \theta}. \tag{19}$$

[34] Intuitively, because θ is a maximizer of $\tilde{U}_A(\theta, \hat{\theta}) \equiv U_A(\theta, d^*(\hat{\theta})) + P_Y(\hat{\theta})$, the first order condition for truth–telling to be optimal implies that $\partial \tilde{U}_A(\theta, \theta)/\partial \hat{\theta} = 0$. Thus, $V_A'(\theta) = \partial \tilde{U}_A(\theta, \theta)/\partial \theta + \partial \tilde{U}_A(\theta, \theta)/\partial \hat{\theta} = \partial \tilde{U}_A(\theta, \theta)/\partial \theta$.

Note that $\partial U_A(\theta, d^*(\theta))/\partial\theta \neq 0$ by assumption (2) because $d^*(\theta) \neq d_A(\theta)$ by (6). Since $\alpha_A < 1$, Lemma 4 therefore yields a contradiction to Lemma 3 and this proves Proposition 2.

The intuition for the impossibility result in Proposition 2 is straightforward for the case that $\alpha_A = 0$. In this case, the agent's value of exit is independent of his true type. In fact, if type θ announces some other type $\hat{\theta} \neq \theta$ and then exits, he cashes in the exit payment $P_N(\hat{\theta})$ corresponding to the announcement $\hat{\theta}$. But, if $\alpha_A = 0$, the indifference condition (14) implies that type $\hat{\theta}$'s utility exactly amounts to this exit payment $P_N(\hat{\theta})$. Therefore, by announcing $\hat{\theta}$ and exiting, type θ can secure the *same* utility as type $\hat{\theta}$. But the implication that all types get the same utility, is inconsistent with providing incentives for truthful communication and implementing the first–best decision, because incentive compatibility implies that different agent types obtain different payoffs. In summary, the exit option cannot be designed so that it prevents shirking by the principal and at the same time induces the agent to reveal his type and not to exit the relation.

If $\alpha_A > 0$, the agent's value of exit does depend on his true type because the termination value of the project is no longer zero. Thus, if type θ announces some $\hat{\theta} \neq \theta$ to exit later on, he has to take into account that the principal will choose $d^*(\hat{\theta})$ after the report. While this effect may work in favor of truth–telling, cheating and exiting still allows the agent to obtain a higher payoff than truthful reporting and accepting the principal's decision.

The deeper reason for why an efficient exit option contract fails to exist under P–authority, is that the decision right is not in the hands of the party that possesses private information. As we show next, if authority resides with the agent, an exit option contract exists that solves the incentive problems that arise from the combination of contractual incompleteness and asymmetric information.

4.2 *A*–authority

The problem under P–authority in the previous section is that providing incentives for the principal to choose the first–best decision necessarily creates incentives for some agent types to trigger exit. We now show that this tension can be resolved by giving the decision right to the agent:

Proposition 3 *There is a first–best efficient exit option contract with A–authority.*

We prove Proposition 3 constructively by designing a first–best efficient exit option contract explicitly. To do so, we will first construct candidate payments by exploiting conditions that a first–best efficient exit option contract with A–authority necessarily has to satisfy. In a second step, we will then verify that these payments indeed constitute a first–best exit option contract.

A first–best efficient exit option contract with A–authority has to satisfy the following three incentive constraints:

(i) Agent type θ reports his type truthfully;

(ii) Agent type θ chooses the first–best decision $d^*(\theta)$;

(iii) Upon receiving a report θ and observing decision $d^*(\theta)$, the principal believes that the agent's type is θ and continues the relation.

Before we derive implications of these incentive constraints, we discuss how the principal's beliefs are formed if the agent's report and his decision are inconsistent with one another. More precisely, under a first–best efficient exit option contract, agent type θ reports θ and selects $d^*(\theta)$. Therefore, observing a report θ and a decision $d \neq d^*(\theta)$ constitutes a zero probability event under a first–best efficient exit option contract. Accordingly, the principal's beliefs about the agent's type cannot be determined by Bayes' rule. Throughout, we assume that in this case the principal believes that the agent's type is equal to his report with probability 1.[35]

We now examine the implications of the incentive constraints stated above. Constraints (ii) and (iii) capture the decision incentive constraints for the agent. Since the agent's type is revealed on the equilibrium path, these constraints are the same as in the benchmark case with symmetric information. Therefore, for the same reasons as in Lemma 1, the principal must be indifferent between exiting and continuing the relation after having observed the agent's report θ and the first–best decision $d^*(\theta)$.

Lemma 5 *Under a first–best efficient contract with A–authority, for all $\theta \in \Theta$,*

$$U_P(\theta, d^*(\theta)) - P_Y(\theta) = \alpha_P U_P(\theta, d^*(\theta)) - P_N(\theta). \tag{20}$$

Next, we show that the requirement in (i) that the agent reveals his type truthfully, determines the payments $P_Y(\cdot)$, as stated in the next lemma.

Lemma 6 *Under a first–best efficient contract with A–authority, for all $\theta \in \Theta$,*

$$P_Y(\theta) \quad = \quad c - \int_\theta^1 \frac{\partial U_A(t, d^*(t))}{\partial \theta} dt - U_A(\theta, d^*(\theta)), \tag{21}$$

for some constant c. Moreover, $P_Y(\cdot)$ is strictly decreasing in θ.

To understand (21), denote agent type θ's utility under a first–best efficient contract again by

$$V_A(\theta) \equiv U_A(\theta, d^*(\theta)) + P_Y(\theta). \tag{22}$$

[35] Other specifications of the principal's out-of-equilibrium beliefs also work. For example, our arguments go through in an analogous manner if, after an off-the-path event, the principal believes that the agent is type $\theta = 0$ with probability 1.

Truth–telling requires that type θ must not be better off by submitting a report $\hat{\theta} \neq \theta$ and then choosing the decision $d^*(\hat{\theta})$, anticipating that the principal continues the relation in that case. That is, for all $\theta \in \Theta$:

$$V_A(\theta) = \max_{\hat{\theta}} \left[U_A(\theta, d^*(\hat{\theta})) + P_Y(\hat{\theta}) \right]. \tag{23}$$

This is the same condition as (15) and by employing the envelope theorem, we can again deduce that $V_A'(\theta) = \partial U_A(\theta, d^*(\theta))/\partial \theta$ as in (16). Therefore, the payments $P_Y(\cdot)$ can be recovered by integration, which yields the expression in Lemma 6.[36]

Hence, as is familiar in screening problems of this kind, we obtain that up to a constant, incentive compatibility uniquely pins downs the payments $P_Y(\cdot)$ as a function of the implemented decision. To complete the proof of Lemma 6, we show in the appendix that the derivative of $P_Y(\cdot)$ is negative.

The continuation payments $P_Y(\cdot)$ also determine the exit payments $P_N(\cdot)$ by condition (20). We take these payments as our candidate payments for a first–best efficient exit option contract. To complete the construction of the contract, we now define a penalty Π which is sufficient to deter the agent from a deviation that would induce the principal to exercise her exit option. Under a first–best efficient contract, agent type θ must prefer truth–telling and choosing the first–best decision to the deviation that consists in submitting some report $\hat{\theta} \in \Theta$ and then taking some decision d which the principal rejects. The agent's utility from such a deviation is $\alpha_A U_A(\theta, d) + P_N(\hat{\theta}) - \Pi$. Clearly, this cannot be higher than $\alpha_A U_A(\theta, d_A(\theta)) + \max_{\hat{\theta}} P_N(\hat{\theta}) - \Pi$. Thus, a sufficient condition to prevent such a deviation by the agent is that the penalty satisfies

$$V_A(\theta) \geq \alpha_A U_A(\theta, d_A(\theta)) + \max_{\hat{\theta}} P_N(\hat{\theta}) - \Pi. \tag{24}$$

for all $\theta \in \Theta$. Accordingly, if we set

$$\Pi \equiv \max\left[0, \max_{\theta}[\alpha_A U_A(\theta, d_A(\theta)) - V_A(\theta)] + \max_{\theta} P_N(\theta)\right], \tag{25}$$

then this suffices to guarantee that the agent will avoid triggering exit by the principal.

When constructing the candidate payments, we have only exploited conditions that a first–best efficient exit option contract with A–authority necessarily needs to satisfy. We now prove the reverse and show that these payments do in fact constitute a first–best efficient exit option contract with A–authority.

As the first step, we characterize the principal's optimal behavior, given the agent has announced some type $\hat{\theta}$ and chosen a decision d. To deduce the principal's optimal strategy, recall our assumption that the principal's belief always coincides with the agent's report.

[36] $P_Y(\theta) = V_A(\theta) - U_A(\theta, d^*(\theta)) = V_A(1) - \int_\theta^1 [\partial U_A(t, d^*(t))/\partial \theta] dt - U_A(\theta, d^*(\theta))$. The constant c is thus equal to the utility, $V_A(1)$, of the agent of type $\theta = 1$.

Accordingly, since the principal's utility declines in d for all $d \geq d_P(\theta)$, the indifference condition (20) implies that the principal optimally exits if the decision d is larger than the first best–decision $d^*(\hat{\theta})$. Likewise, the principal exits if the agent chooses a sufficiently small decision. More precisely, let $\underline{d}(\hat{\theta}) < d^*(\hat{\theta})$ be the smallest decision such that the principal is indifferent between exiting and not exiting, which is defined by the solution to

$$U_P(\hat{\theta}, \underline{d}(\hat{\theta})) - P_Y(\hat{\theta}) = \alpha_P U_P(\hat{\theta}, \underline{d}(\hat{\theta})) - P_N(\hat{\theta}). \tag{26}$$

Thus, upon receiving a report $\hat{\theta}$, the principal exits whenever the agent chooses a decision outside the interval

$$Y(\hat{\theta}) \equiv [\underline{d}(\hat{\theta}), d^*(\hat{\theta})], \tag{27}$$

and continues the relation otherwise. We summarize these considerations in the next lemma:

Lemma 7 *Let $P_Y(\cdot)$ and $P_N(\cdot)$ be given by (20) and (21). After having observed the report $\hat{\theta}$ and the decision d, the principal stays in the relation if and only if $d \in Y(\hat{\theta})$.*

We can now complete our argument that the payments $P_Y(\cdot), P_N(\cdot), \Pi$ constitute a first–best efficient exit option contract with A–authority. First, observe that Lemma 7, in particular implies that the principal continues the relation if the agent chooses the first–best decision, as is required for first–best implementation. Therefore, what remains to be shown is that the payments $P_Y(\cdot), P_N(\cdot)$, and Π induce the agent to tell the truth and choose the first–best decision. This is stated in the next lemma, which we prove in the appendix.

Lemma 8 *Let $P_Y(\cdot)$ and $P_N(\cdot)$ be given by (20) and (21), and let Π be given by (25). Then,*

(i) it is never optimal for the agent to misrepresent his type and choose the respective first–best decision. That is, for all $\theta, \hat{\theta} \in \Theta$:

$$V_A(\theta) \geq U_A(\theta, d^*(\hat{\theta})) + P_Y(\hat{\theta}); \tag{28}$$

(ii) it is never optimal for the agent to announce some type and choose a decision smaller than the first–best decision that leads the principal to stay in the relation. That is, for all $\theta, \hat{\theta} \in \Theta$, $d \in Y(\hat{\theta})$ with $d < d^*(\hat{\theta})$:

$$V_A(\theta) \geq U_A(\theta, d) + P_Y(\hat{\theta}); \tag{29}$$

(iii) it is never optimal for the agent to announce some type and choose a decision that triggers exit by the principal. That is, for all $\theta, \hat{\theta} \in \Theta$, $d \notin Y(\hat{\theta})$:

$$V_A(\theta) \geq \alpha_A U_A(\theta, d) + P_N(\hat{\theta}) - \Pi. \tag{30}$$

To implement the first–best, the agent has to be deterred from the following deviations. First, the agent could lie about his type and choose the first–best decision consistent with this lie. Part (i) of Lemma 8 shows that this deviation is not profitable because the payments $P_Y(\cdot)$ imply the "global" incentive compatibility constraints that the agent has no incentive to misrepresent his type and choose the corresponding first–best decision. Note that global incentive compatibility does not follow from construction directly since we have constructed the payments by employing only the "local" incentive compatibility constraints. That they indeed satisfy also the global constraints is because in our setup the Spence–Mirrlees condition $\partial^2 U_A/\partial\theta\partial d > 0$ holds and since $d^*(\cdot)$ is increasing. It is well–known that in this case, local incentive compatibility is sufficient for global incentive compatibility.

Second, the agent could choose a report $\hat{\theta}$ and a decision $d < d^*(\hat{\theta})$ such that the principal continues the relation. Part (ii) of Lemma 8 says that it is never optimal for the agent to adopt such a deviation. Intuitively, this is so because if such a deviation was optimal, then the agent would be even better off by announcing a slightly smaller report $\hat{\theta}-\epsilon$ and choose the same decision d. The principal would still continue the relation in this case (by Lemma 7), but the payment $P_Y(\hat{\theta}-\epsilon)$ for the agent would be higher as $P_Y(\cdot)$ is decreasing by Lemma 6.

Finally, the agent could choose a report and a decision that triggers exit by the principal. Part (iii) of Lemma 8 says that this not profitable for the agent. This is a direct consequence of how we set up the penalty payment Π. Lemma 8 together with Lemma 7 imply Proposition 3.

The above arguments show that there is an exit option contract with *A*–authority that implements the first–best. A simple but important part of the argument is the insight that it is always possible to specify payments such that the agent prefers choosing the first–best over triggering termination. By (25) this may require the agent to make a payment Π to a third party in the event of termination. Since such payments are controversially discussed in the literature[37], it may be worth indicating that in some situations this can also be achieved without third party payments. In fact, we show below that third party payments are redundant if the conflict of interest between the agent and the principal is not too large.

Finally, note that both parties can share the surplus by adjusting the payments through the parameter c in (21). If the principal has all the bargaining power at the contracting stage, she can appropriate the entire surplus from completing the project. Note also that the penalty payments defined in (25) are independent of the agent's message, and that no punishment occurs on the equilibrium path.

Example: The optimal contract under *A*–authority can easily be illustrated for a quadratic specification of payoffs, which is the leading example in applications of Crawford and Sobel

[37] Cf. footnote 24.

(1982). Further, for simplicity let termination of the project destroy the entire surplus:

$$U_P(\theta,d) = r_P - (\theta - d)^2, \quad U_A(\theta,d) = r_A - (\theta + \beta - d)^2, \quad \alpha_P = \alpha_A = 0, \tag{31}$$

where $\beta > 0$. The ideal decisions are then $d_P(\theta) = \theta$ for the principal and $d_A(\theta) = \theta + \beta$ for the agent. The agent's bias is thus equal to β and does not depend on θ. The solution of (5) yields the first–best decision $d^*(\theta) = \theta + \beta/2$, and assumption (7) requires that $r_P + r_A > \beta^2/2$.

Computing the payments in (20) and (21) yields

$$P_Y(\theta) \;=\; c - r_A + \beta(1-\theta) + \frac{\beta^2}{4}, \quad P_N(\theta) = c - r_A - r_P + \beta(1-\theta) + \frac{\beta^2}{2}, \tag{32}$$

for some constant c. The principal continues the relation if $d \in Y(\hat{\theta}) = [\hat{\theta} - \beta/2, \hat{\theta} + \beta/2]$. Since $V_A(\theta) = \beta(1-\theta) + c$ and $P_N(\theta)$ are decreasing in θ, we obtain from (25) the penalty payment

$$\Pi \;=\; \max\left[0, -V_A(1) + P_N(0)\right] = \max\left[0,\, \beta + \frac{\beta^2}{2} - r_P - r_A\right]. \tag{33}$$

Interestingly, $\Pi = 0$ as long as the agent's bias β is not too large, because $r_P + r_A > \beta^2/2$. ◇

5 Discussion

In this section we discuss some implications and extensions of our analysis.

Third party payments We now come back to our earlier claim that third party payments are redundant under *A*–authority, if the conflict of interest between the agent and the principal is not too large. To show that this is indeed the case, we measure the conflict of interest by a scalar $\beta \in [0,1]$, and consider the preference specification with "constant" bias:

$$U_A(\theta, d|\beta) = U_P(\theta, d - \beta) + k \quad \text{for all } \theta, d, \tag{34}$$

and for some constant k. This implies that the agent's favorite decision is given by $d_A(\theta|\beta) = d_P(\theta) + \beta$. Hence, the bias, as defined in (3), is equal to the constant β.

Moreover, we assume that the first inequality in (7) remains strict in the limit $\beta \to 0$. More precisely, we assume that for all $\theta \in [0,1]$

$$\lim_{\beta \to 0} \left[(\alpha_A - 1)U_A(\theta, d^*(\theta|\beta)|\beta) + (\alpha_P - 1)U_P(\theta, d^*(\theta|\beta))\right] \leq \lambda \tag{35}$$

for some constant $\lambda < 0$.

Proposition 4 *Let the agent's preferences satisfy (34) and (35). Then there is a critical $\hat{\beta} > 0$ so that whenever $\beta < \hat{\beta}$, there is a first–best efficient exit option contract under A–authority without third party payments, i.e.* $\Pi = 0$.

This means that even without third party payments the agent can be deterred from triggering project termination if the parties' conflict of interest is sufficiently small. Intuitively, if the agent's bias is small, he cannot gain much by deviating from the first–best decision. Therefore, the loss of surplus is sufficient to deter him from triggering project termination. In this context, it may be worth mentioning that the first–best decision $d^*(\cdot)$ can be implemented without third party payments if the joint surplus is increased by a sufficiently large constant. Indeed, equation (33) in our example shows that $\Pi = 0$ if $r_A + r_P$ is large enough. The proof of Proposition 5 below reveals that this insight holds in general for $\alpha_P = \alpha_A = 0$.[38]

An interesting question is how an exit option contract looks like if the first–best exit option contract under A–authority would require positive penalties ($\Pi > 0$), but a budget breaker is not available. To address this question, we investigate which decisions can be implemented under A–authority by an exit option contract with $\Pi = 0$. For simplicity let $\alpha_P = \alpha_A = 0$.

In what follows, consider some function $\tilde{d}(\theta)$ that the principal seeks to implement. For the agent to reveal his type, $\tilde{d}(\theta)$ needs to be increasing. Moreover implementability restricts $\tilde{d}(\theta)$ to be located between the principal's and the agent's favorite decision, i.e.

$$\tilde{d}(\theta) \in [d_P(\theta), d_A(\theta)] \quad \text{for all } \theta \in \Theta. \tag{36}$$

The reason is simply that only within this interval the principal and the agent have conflicting interests. If for instance $\tilde{d}(\theta) > d_A(\theta)$, then the principal would actually gain if the agent deviated to some decision slightly smaller than $\tilde{d}(\theta)$. Thus, she would not exercise her exit option after such a deviation. Note that (36) has not been required for our analysis so far because it always holds for the first–best $d^*(\cdot)$.

Because $\tilde{d}(\theta)$ is increasing, our single crossing assumption in (1) implies that we can find a payment schedule $P_Y(\cdot)$ that induces the agent to report truthfully, i.e.

$$U_A(\theta, \tilde{d}(\theta)) + P_Y(\theta) = \max_{\hat{\theta}} \left[U_A(\theta, \tilde{d}(\hat{\theta})) + P_Y(\hat{\theta}) \right], \tag{37}$$

for all $\theta \in \Theta$. For any $\tilde{d}(\cdot)$ satisfying (36) the principal's indifference condition

$$U_P(\theta, \tilde{d}(\theta)) - P_Y(\theta) = -P_N(\theta). \tag{38}$$

ensures that she exits whenever the agent deviates to a decision that is more favorable for him. Finally, even without third party payments the threat of exit deters the agent from deviating if

$$U_A(\theta, \tilde{d}(\theta)) + P_Y(\theta) \geq P_N(\hat{\theta}) \tag{39}$$

[38] This can be seen from constraint (73) in the appendix, which is equivalent to the "no third party payment" constraint (39). Constraint (73) is always satisfied for $d^*(\cdot)$ by adding a sufficiently large constant to the total surplus.

for all $\theta, \hat{\theta} \in \Theta$. Conditions (37)–(39) simply replicate the implementability conditions in Section 4.2, adjusted to $\Pi = 0$ (and $\alpha_P = \alpha_A = 0$). We refer to an increasing decision rule $\tilde{d}(\cdot)$ as *implementable under A–authority without third party payments* if (36)–(39) hold for some payments $P_Y(\cdot)$ and $P_N(\cdot)$.

As the following Proposition shows, if a first–best efficient exit option contract requires a budget breaker, then without third party payments only decisions can be implemented which, at least for some values of θ, are closer to the agent's favorite decision than the first–best decision.

Proposition 5 *Let $\partial U_A(\theta, d)/\partial \theta \leq 0$ for all $d \leq d_A(\theta)$, and $\alpha_P = \alpha_A = 0$. Consider A–authority and suppose that the first–best $d^*(\cdot)$ is not implementable without third party payments.*[39]

(i) If $\tilde{d}(\cdot)$ is implementable without third party payments, then $\tilde{d}(\theta) > d^*(\theta)$ for some $\theta \in \Theta$.

(ii) Let $\tilde{d}(\cdot)$ be a decision rule that maximizes expected joint surplus over all decision functions that are implementable without third party payments. Then for all $\theta \in \Theta$, $\tilde{d}(\theta) \geq d^*(\theta)$ with strict inequality for some $\theta \in \Theta$.

If third party payments cannot be used to punish a deviation by the agent severely enough, his utility loss from exit has to be increased by other means. As part (i) of Proposition 5 shows, this is achieved by moving the decision away from the first–best closer to the agent's ideal. But, thereby also his exit payoff P_N is affected, because by (38) it depends on the decision. The condition on the agent's marginal utility stated in the proposition avoids a possibly countervailing effect: it ensures that P_N decreases if the decision moves closer to the agent's favorite decision.[40] Part (ii) is a straightforward implication of part (i): if a decision rule is smaller than the first–best for some values of θ, it is also possible to implement the decision rule which, instead, selects the first–best decision for these values of θ. Clearly this increases expected surplus.

Non–contingent payments Our results in Section 4 have been derived under the assumption that payments are contingent on a message which the agent submits after observing the state θ. In some situations, however, the principal may not want to use message-contingent payments or is constrained not to do so. We now demonstrate that our analysis is applicable also to such settings. Suppose payments can only depend on whether a project is terminated or not. A "non–contingent" exit option contract with h-authority is then a schedule $\gamma = (h, P_Y, P_N, \Pi) \in \{A, P\} \times \mathbb{R}^3$. We focus on the quadratic example with constant bias:

$$U_P(\theta, d) = r_P - (\theta - d)^2, \quad U_A(\theta, d) = r_A - (\theta + \beta - d)^2, \quad 0 < \beta < 1, \quad r_P + r_A > \beta^2, \tag{40}$$

[39]Because $\tilde{d}(\cdot)$ is increasing and $d^*(\cdot)$ continuous, it is easy to see that $\tilde{d}(\theta) > d^*(\theta)$ in statements (i) and (ii) implies that $\tilde{d}(\theta') > d^*(\theta')$ for all $\theta' \in [\theta, \theta + \epsilon]$ for some $\epsilon > 0$.

[40]This condition is quite natural and satisfied, for example, in the quadratic example above.

where the restriction $\beta < 1$ avoids case distinctions, and the final inequality ensures that expected surplus from contracting is positive. The following proposition establishes the analog to our results in the previous section for the case of non-contingent payments:

Proposition 6 *Let $U_P(\theta, d)$ and $U_A(\theta, d)$ satisfy (40) and let θ be uniformly distributed on $\Theta = [0, 1]$. Then*

(i) there is a non–contingent exit option contract with A–authority which yields the same outcome as the optimal contract with contractible decisions and non–contingent payments; and

(ii) there is no non–contingent exit option contract with P–authority which yields the same outcome as the optimal contract with contractible decisions and non–contingent payments.

Therefore, also with non-contingent payments it remains optimal to assign the decision right to the informed party, and not to the uninformed party. Indeed, the optimal exit option contract under *A*–authority fully resolves the problem of non–contractible decisions. While Proposition 6 shows this for a quadratic specification of payoffs, under appropriate regularity conditions on preferences and the distribution of types, this result will carry over to more general environments.

To see the intuition behind Proposition 6, note first that for non–contingent payments and contractible decisions, Holmström (1984) has shown that an optimal contract corresponds to allowing the agent to choose a decision from a contractually specified "delegation set". Under appropriate conditions, in particular under (40), the optimal delegation set is an interval permitting the agent to choose freely any decision between his smallest favorite action $d_A(0)$ and a "cap" $\bar{d} < d_A(1)$. The basic idea to implement the same outcome under agent authority when decisions are not contractible, is to choose the non–contingent payments P_Y and P_N so that the principal is indifferent between continuation and termination if the agent type with ideal decision $\bar{d}$ actually chooses $\bar{d}$. Intuitively, the optimal delegation set is therefore implemented, because the principal will then terminate the relation whenever the agent chooses a decision $d > \bar{d}$ outside the delegation set, and he will continue the relationship whenever the agent chooses a decision $d \leq \bar{d}$ inside the delegation set.[41]

Renegotiation Implementation of the first-best outcome in Section 4.2 is based on the commitment that the principal's exit decision cannot be renegotiated. If the parties cannot credibly commit not to renegotiate, they will bargain to reverse exit in order to avoid the losses from

[41] Part (ii) of Proposition 6 can be shown similarly as in the case with contingent payments by deriving a contradiction between the requirements that the agent be indifferent between continuation and termination for any decision that the principal chooses on the equilibrium path and the requirement that he announces his type truthfully.

termination. The question then arises whether this undermines condition (24), which deters the agent from deviating from the first–best project.

For simplicity, let $\alpha_P = \alpha_A = 0$. Then in the renegotiation game the status quo payoffs of the principal and the agent are their exit payoffs $-P_N(\hat{\theta})$ and $P_N(\hat{\theta})-\Pi$, respectively. If renegotiation is successful, the agent may capture a fraction of the gains from renegotiation in addition to his status quo $P_N(\hat{\theta})-\Pi$. Nonetheless, as long as this fraction is sufficiently small, condition (24) can still be satisfied if the right hand side is replaced by the expected payoff from renegotiation. Therefore implementability of the first–best may depend on how the bargaining solution of the renegotiation game splits the surplus between the two parties.[42]

Relation specificity The parameters α_P and α_A capture the extent to which the project is relation–specific, and one can ask how the first–best efficient contract under *A*–authority changes with the degree of relation–specificity. Interestingly, as is evident from (20) and (21), the payments P_Y are independent of α_A and α_P. Therefore, by observing the payment the agent receives after completing the project, an outsider cannot infer the degree of relation–specificity. On the other hand, the exit payment P_N depends on α_P but not on α_A. The reason is that the exit option payments compensate the principal for her loss in case of exit. Accordingly, the more relation–specific the project, the higher the compensation in case of exit.

General implementation While we have focussed on the implementation of the first–best efficient outcome, our analysis of *A*–authority implies a more fundamental implementability result: if the informed party has the decision right, a large class of outcomes that can be implemented when decisions are contractible, can also be implemented with an exit option contract when decisions are not contractible. This follows because the property which drives our efficiency result under *A*–authority is that the first–best efficient decision is increasing in the agent's type and lies in between the parties' ideal decisions. Therefore, any such decision rule that is increasing in the agent's type and, for each type, specifies a decision in between the parties' ideal decisions can be implemented with an exit option contract under *A*–authority. In our setting with a single–crossing condition, this property is satisfied in particular for the optimal contract if the agent receives information *ex ante* before the contract is signed, rather than ex post as in our analysis. Therefore, our results are robust with respect to the timing of information arrival.

On the other hand, it is much more difficult to say which decision rules can, in general, be implemented under *P*–authority and to determine the optimal contract if the decision right cannot be transferred to the agent. The reason is that in our framework, where the decision is not contractible, the Revelation Principle requires to consider mediated communication

[42]A formal analysis of renegotiation is beyond the scope of this paper, because it is complicated by the fact that the agent is privately informed about his type. As is well–known from bargaining under asymmetric information, the outcome is sensitive to the specification of the bargaining game and assumptions about how the behavior of the informed party affects the uninformed party's beliefs.

(Myerson (1982)). To our knowledge, it is still an open question how an optimal mediation mechanism looks like in the general framework of Crawford and Sobel (1982).[43] Moreover, for the case with unmediated face–to–face communication, there is, for our setting with a continuum of states, no general Revelation Principle that would make the search for an optimal contract tractable.[44]

6 Conclusion

We have shown that introducing exit options in environments with contractual incompleteness and asymmetric information has a significant impact on both the allocation of authority and on efficiency. Our result that delegating decision rights to the informed party always outperforms decision making by the uninformed party provides a novel justification for the view that authority should reside with the informed party. Reversely, our analysis predicts that exit rights should reside with the uninformed party. This conclusion holds under surprisingly weak assumptions. It is independent of the distribution of the agent's type and the size of the conflict of interest, as measured by the bias.

Our paper studies the problem of allocating authority in bilateral relations between an uninformed principal and a single informed agent. An interesting extension of our analysis would be to consider organizations in which decision relevant knowledge is distributed among several agents.[45] In a corporation, for example, optimal decision making may depend on the combined information held by its experts in engineering, marketing, and finance. We conjecture that exit option contracts are also useful in such environments. Under such a multi-party contract, the principal delegates decision authority to one of the informed agents but keeps the right to terminate operations. All agents report their private information to the principal and to the agent who has obtained authority. The latter agent thus decides on the basis of all available information. As long as the optimal decision is monotone in the agents' types, appropriate payment schemes can provide communication incentives for truthful information revelation. Further, the principal's exit option allows creating decision incentives for the agent in authority to deter him from misusing the decision right.

[43] For the case with quadratic preferences, constant bias, uniform distribution, and non-transferable utility, Goltsman et al. (2009) derive the optimal mediation mechanism.

[44] For the case with discrete states, Bester and Strausz (2001) do provide such a generalized Revelation Principle.

[45] See Alonso, Dessein and Matouschek (2008) for a related setup.

7 Appendix

This appendix contains the proofs of Lemmas 6 and 8 and Propositions 4–6. Propositions 1–3 and Lemmas 1–5, and 7 are substantiated in the main text.

Proof of Lemma 6 As (21) has been shown in the main text, it remains to show that $P_Y(\theta)$ is strictly decreasing. Since the first-best decision $d^*(\theta) \in (d_P(\theta), d_A(\theta))$ lies between the ideal decision of the principal and the agent, our assumptions imply:

$$\frac{\partial U_A(\theta, d^*(\theta))}{\partial d} > 0. \tag{41}$$

Since $\partial d^*(\theta)/\partial \theta > 0$, taking the derivative of (21) yields

$$P_Y'(\theta) = \frac{\partial U_A(\theta, d^*(\theta))}{\partial \theta} - \frac{\partial U_A(\theta, d^*(\theta))}{\partial \theta} - \frac{\partial U_A(\theta, d^*(\theta))}{\partial d}\frac{\partial d^*(\theta)}{\partial \theta} < 0, \tag{42}$$

and this shows that $P_Y(\cdot)$ is strictly decreasing. Q.E.D.

Proof of Lemma 8 (i) Observe that in our setup, for all (θ, d) the Spence–Mirrlees condition $\partial^2 U_A(\theta, d)/\partial \theta \partial d > 0$ holds. By an argument due to Mirrlees (1971), it is well–known that condition (21) and the fact that $d^*(\cdot)$ is increasing then imply (28).

(ii) Let $\theta, \hat{\theta} \in \Theta$ and $d \in Y(\hat{\theta})$ with $d < d^*(\hat{\theta})$. We distinguish two cases. First, suppose that there is a $\theta' \in \Theta$ so that $d = d^*(\theta')$. Since $d < d^*(\hat{\theta})$ and $d^*(\cdot)$ is increasing, we have that $\theta' < \hat{\theta}$. Moreover, by Lemma 6, $P_Y(\cdot)$ is decreasing. Hence,

$$U_A(\theta, d) + P_Y(\hat{\theta}) = U_A(\theta, d^*(\theta')) + P_Y(\hat{\theta}) \le U_A(\theta, d^*(\theta')) + P_Y(\theta') \le V_A(\theta), \tag{43}$$

where the final inequality follows from (28). Hence, (29) is met, as desired.

Next, suppose that for all θ', it holds that $d \neq d^*(\theta')$. Since $d < d^*(\hat{\theta})$ and since $d^*(\cdot)$ is increasing, d can be smaller than $d^*(\theta')$ for all θ' only if $d < d^*(0)$. Now observe that $d^*(0)$ is smaller than any agent type θ's ideal decision $d_A(\theta)$ and that the agent's utility is increasing in d for $d \le d_A(\theta)$. Thus, $U_A(\theta, d) \le U_A(\theta, d^*(0))$, and we can deduce:

$$U_A(\theta, d) + P_Y(\hat{\theta}) \le U_A(\theta, d^*(0)) + P_Y(\hat{\theta}) \le U_A(\theta, d^*(0)) + P_Y(0) \le V_A(\theta). \tag{44}$$

The second inequality follows because $P_Y(\cdot)$ is decreasing by Lemma 6, and the final inequality follows from (28). This establishes (29).

(iii) Let $\theta, \hat{\theta} \in \Theta$, $d \notin Y(\hat{\theta})$. Since $U_A(\theta, d) \le U_A(\theta, d_A(\theta))$ for all θ, d, we have

$$\alpha_A U_A(\theta, d) + P_N(\hat{\theta}) - \Pi \le \alpha_A U_A(\theta, d_A(\theta)) + P_N(\hat{\theta}) - \Pi \tag{45}$$

$$\le \alpha_A U_A(\theta, d_A(\theta)) - \max_{\theta'}[\alpha_A U_A(\theta', d_A(\theta')) - V_A(\theta')] + P_N(\hat{\theta}) - \max_{\theta'} P_N(\theta') \tag{46}$$

$$\le V_A(\theta). \tag{47}$$

The inequality in the second line follows from the definition of Π in (25), and the final inequality is obvious. This completes the proof. Q.E.D.

Proof of Proposition 4 It follows from (25) that we can set $\Pi = 0$ if

$$\max_{\theta}[\alpha_A U_A(\theta, d_A(\theta|\beta)|\beta) - V_A(\theta|\beta)] + \max_{\theta} P_N(\theta|\beta) \leq 0. \tag{48}$$

Using the definition of $V_A(\theta)$ in (22) and solving the principal's indifference condition (20) for $P_N(\theta)$ yields the equivalent condition

$$\begin{aligned}&\max_{\theta}[\alpha_A U_A(\theta, d_A(\theta|\beta)|\beta) - U_A(\theta, d^*(\theta|\beta)|\beta) - P_Y(\theta|\beta)] \qquad (49)\\ &+ \max_{\theta}[(\alpha_P - 1)U_P(\theta, d^*(\theta|\beta)) + P_Y(\theta|\beta)] \leq 0.\end{aligned}$$

Now subtract and add $\alpha_A U_A(\theta, d^*(\theta|\beta)|\beta)$ in the first "max"-term, and recall that by Lemma 6 the payment $P_Y(\cdot)$ is decreasing. Therefore, condition (49) certainly holds if

$$\begin{aligned}\varphi_1(\beta) \quad &\equiv \quad \max_{\theta}[\alpha_A\{U_A(\theta, d_A(\theta|\beta)|\beta) - U_A(\theta, d^*(\theta|\beta)|\beta)\}] && (50)\\ &\quad + \max_{\theta}(\alpha_A - 1)U_A(\theta, d^*(\theta|\beta)|\beta) + \max_{\theta}(\alpha_P - 1)U_P(\theta, d^*(\theta|\beta)) && (51)\\ &\leq \quad \varphi_2(\beta) \equiv P_Y(1|\beta) - P_Y(0|\beta). && (52)\end{aligned}$$

To prove the claim, we now show that

$$\lim_{\beta\to 0}\varphi_1(\beta) \leq \lambda < 0, \quad \text{and} \quad \lim_{\beta\to 0}\varphi_2(\beta) = 0. \tag{53}$$

As a preliminary step, observe that since $d_P(\theta)$ is a continuous function on the compact set $\theta \in [0,1]$, and since $d_A(\theta|\beta) = d_P(\theta) + \beta$ and $d^*(\theta|\beta) \in [d_A(\theta|\beta), d_P(\theta)]$, there is a compact set $\hat{D}$ so that for all $(\theta, \beta) \in [0,1]^2$, we have that $d_A(\theta|\beta), d^*(\theta|\beta), d_P(\theta) \in \hat{D}$.

We next show that $\lim_{\beta\to 0}\varphi_1(\beta) \leq \lambda$. To see this, we first show that the term on the right hand side of (50) converges to zero for $\beta \to 0$. Indeed,

$$\begin{aligned}&\max_{\theta\in[0,1]}|\{U_A(\theta, d_A(\theta|\beta)|\beta) - U_A(\theta, d^*(\theta|\beta)|\beta)\}| && (54)\\ &\leq \max_{(\theta,\beta,d)\in[0,1]^2\times\hat{D}}\left|\frac{\partial U_A(\theta, d|\beta)}{\partial d}\right| \cdot \max_{(\theta,\beta)\in[0,1]^2}|d_A(\theta|\beta) - d^*(\theta|\beta)| \leq L\cdot\beta, && (55)\end{aligned}$$

where the first inequality in the second line follows because $\partial U_A/\partial d$ is continuous and thus bounded by a constant $L > 0$ on the compact set $[0,1]^2 \times \hat{D}$, and the second inequality follows since $d_A(\theta|\beta) - d^*(\theta|\beta) \leq d_A(\theta|\beta) - d_P(\theta) = \beta$. This shows the claim.

Second, we show that the term in (51) attains a limit smaller than λ as $\beta \to 0$. Indeed, observe first that by (34),

$$\begin{aligned}&\max_{\theta\in[0,1]}|U_A(\theta, d^*(\theta|\beta)|\beta) - \{U_P(\theta, d^*(\theta|\beta) + k\})| && (56)\\ = \quad &\max_{\theta\in[0,1]}|U_P(\theta, d^*(\theta|\beta) - \beta) + k - \{U_P(\theta, d^*(\theta|\beta) + k\})| && (57)\\ \leq \quad &\max_{\theta\in[0,1]}\left|\frac{\partial U_P(\theta, d^*(\theta|\beta))}{\partial d}\right| \cdot \beta \leq M\beta, && (58)\end{aligned}$$

where the second inequality follows because the derivative of U_P is continuous on the compact set $[0,1]\times\hat{D}$ and thus bounded by some $M>0$. To simplify notation, let

$$F(\theta|\beta)=U_A(\theta,d^*(\theta|\beta)|\beta),\ G(\theta|\beta)=U_P(\theta,d^*(\theta|\beta)),\ \mu=\alpha_A-1,\ \eta=\alpha_P-1. \tag{59}$$

Then, we obtain that

$$\lim_{\beta\to0}\left[\max_\theta \mu F(\theta|\beta)+\max_\theta \eta G(\theta|\beta)\right]=\lim_{\beta\to0}\max_\theta[\mu F(\theta|\beta)+\eta G(\theta|\beta)], \tag{60}$$

because

$$\begin{aligned}
0 &\le \max_\theta \mu F(\theta|\beta)+\max_\theta \eta G(\theta|\beta)-\max_\theta[\mu F(\theta|\beta)+\eta G(\theta|\beta)] && (61)\\
&\le \max_\theta[\mu F(\theta|\beta)-\mu\{G(\theta|\beta)+k\}]+\max_\theta[\mu\{G(\theta|\beta)+k\}+\eta G(\theta|\beta)] && (62)\\
&\quad -\max_\theta[\mu F(\theta|\beta)+\eta G(\theta|\beta)]\\
&= \max_\theta[\mu F(\theta|\beta)-\mu\{G(\theta|\beta)+k\}]+\max_\theta[\mu\{G(\theta|\beta)+k\}-\mu F(\theta|\beta)] && (63)\\
&\quad +\max_\theta[\mu F(\theta|\beta)+\eta G(\theta|\beta)]-\max_\theta[\mu F(\theta|\beta)+\eta G(\theta|\beta)]\\
&\le -\mu 2\max_\theta|F(\theta|\beta)-\{G(\theta|\beta)+k\}|\le-\mu 2\beta M, && (64)
\end{aligned}$$

where the second to last inequality follows because $\mu<0$, and the final inequality follows from (58). Together with assumption (35), equation (60) implies

$$\lim_{\beta\to0}\left[\max_\theta \mu F(\theta|\beta)+\max_\theta \eta G(\theta|\beta)\right]\le\lambda. \tag{65}$$

The previous two steps imply that $\lim_{\beta\to0}\varphi_1(\beta)\le\lambda$ which establishes the first part of (53).

To conclude the proof of (53), we show that $\lim_{\beta\to0}\varphi_2(\beta)=0$. Indeed, (21) implies that

$$\begin{aligned}
\varphi_2(\beta) &= P_Y(1)-P_Y(0) && (66)\\
&= \int_0^1 \frac{\partial U_A(t,d^*(t|\beta)|\beta)}{\partial d}\frac{\partial d^*(t|\beta)}{\partial\theta}\,dt && (67)\\
&= \int_0^1 \frac{1}{2}\left[\frac{\partial U_A(t,d^*(t|\beta)|\beta)}{\partial d}-\frac{\partial U_P(t,d^*(t|\beta))}{\partial d}\right]\frac{\partial d^*(t|\beta)}{\partial\theta}\,dt && (68)\\
&\quad+\int_0^1 \frac{1}{2}\left[\frac{\partial U_A(t,d^*(t|\beta)|\beta)}{\partial d}+\frac{\partial U_P(t,d^*(t|\beta))}{\partial d}\right]\frac{\partial d^*(t|\beta)}{\partial\theta}\,dt\\
&= \int_0^1 \frac{1}{2}\left[\frac{\partial U_P(t,d^*(t|\beta)-\beta)}{\partial d}-\frac{\partial U_P(t,d^*(t|\beta))}{\partial d}\right]\frac{\partial d^*(t|\beta)}{\partial\theta}\,dt+0 && (69)\\
&\le \max_{(\theta,d)\in[0,1]\times\hat{D}}\left|\frac{\partial^2 U_P(\theta,d)}{\partial d^2}\right|\beta|d^*(1|\beta)-d^*(0|\beta)|. && (70)
\end{aligned}$$

The fourth equality follows from the definition of U_A in (34) and because the second integral after the third equality sign is zero by the definition of the first-best decision. Because the second derivative of U_P is continuous and thus bounded on the compact set $[0,1]\times\hat{D}$, and since $d^*(\theta|\beta)$ is bounded, we can conclude that $\lim_{\beta\to 0}\varphi_2(\beta)=0$ as desired. Q.E.D.

Proof of Proposition 5 (i) Analogously to Lemma 6, the truth–telling constraint (37) is equivalent to the payment schedule

$$P_Y(\theta)=c-\int_\theta^1 \frac{\partial U_A(t,\tilde{d}(t))}{\partial\theta}dt-U_A(\theta,\tilde{d}(\theta)) \quad \text{for some constant } c. \tag{71}$$

Inserting $P_Y(\cdot)$ and $P_N(\cdot)$ from (38) yields that (39) is equivalent to

$$S(\hat{\theta},\tilde{d}(\hat{\theta}))+\int_{\hat{\theta}}^1 \frac{\partial U_A(t,\tilde{d}(t))}{\partial\theta}\,dt \geq \int_\theta^1 \frac{\partial U_A(t,\tilde{d}(t))}{\partial\theta}\,dt \quad \text{for all } \theta,\hat{\theta}\in\Theta, \tag{72}$$

where $S(\theta,d)\equiv U_P(\theta,d)+U_A(\theta,d)$ denotes the joint surplus generated by decision d in state θ. Because $\partial U_A(\theta,d)/\partial\theta\leq 0$ for all $d\leq d_A(\theta)$ by assumption, (36) implies that (72) is satisfied for all θ if it is satisfied only for $\theta=1$, and hence it can be replaced by

$$S(\hat{\theta},\tilde{d}(\hat{\theta}))+\int_{\hat{\theta}}^1 \frac{\partial U_A(t,\tilde{d}(t))}{\partial\theta}\,dt\geq 0 \quad \text{for all } \hat{\theta}\in\Theta. \tag{73}$$

Now, suppose to the contrary that $\tilde{d}(\cdot)$ is implementable with $\tilde{d}(\theta)\leq d^*(\theta)$ for all θ. Since $d^*(\cdot)$ is not implementable without third party payments by assumption, there is $\hat{\theta}_0$ where $d^*(\cdot)$ violates (73):

$$S(\hat{\theta}_0,d^*(\hat{\theta}_0))+\int_{\hat{\theta}_0}^1 \frac{\partial U_A(t,d^*(t))}{\partial\theta}\,dt<0. \tag{74}$$

The fact that $\tilde{d}(\theta)\leq d^*(\theta)$ for all θ now first implies that

$$S(\hat{\theta}_0,\tilde{d}(\hat{\theta}_0))\leq S(\hat{\theta}_0,d^*(\hat{\theta}_0)), \tag{75}$$

and, second, since $\partial^2U_A/\partial d\partial\theta\geq 0$, it also implies that

$$\int_{\hat{\theta}_0}^1 \frac{\partial U_A(t,\tilde{d}(t))}{\partial\theta}\,dt\leq\int_{\hat{\theta}_0}^1 \frac{\partial U_A(t,d^*(t))}{\partial\theta}\,dt. \tag{76}$$

But together with (75), the two previous inequalities establish that $\tilde{d}(\cdot)$ violates (73) for $\hat{\theta}=\hat{\theta}_0$, contradicting the assumption that $\tilde{d}(\cdot)$ is implementable.

(ii) Suppose contrary to statement (ii) of the proposition that $\tilde{d}(\theta)<d^*(\theta)$ for some θ. Now consider the alternative decision rule $d^+(\theta)=\max[\tilde{d}(\theta),d^*(\theta)]$. Clearly, under our assumption that the agent's type is distributed with support Θ, $d^+(\cdot)$ yields a higher expected surplus. Thus $d^+(\cdot)$ is increasing and satisfies (36) because $d_P(\theta)<d^*(\theta)<d_A(\theta)$. Thus, to obtain a contradiction, it remains to show that it also satisfies the implementability conditions (37)–(39).

As part (i) of the proof shows, conditions (37)–(39) are equivalent to condition (73). To complete the proof, it thus remains to show that not only $\tilde{d}(\cdot)$ but also $d^+(\cdot)$ satisfies (73). This can easily be established with the same arguments as in the last step of the proof of part (i). Q.E.D.

Proof of Proposition 6 We prove the proposition by first characterizing the optimal contract with contractible decisions and then showing that the outcome can be replicated for non–contractible decisions by a non–contingent exit option contract under A–authority, but not under P–authority.

Contractible decisions Suppose that d is contractible, but the parties can only use non–contingent payments. Clearly, the allocation of authority is then irrelevant and exit payments P_N and penalties Π are redundant. At the contracting stage, before the agent observes θ, both parties can split the expected joint surplus through the payment P_Y. Therefore, they agree to maximize their expected joint surplus

$$\int_0^1 U_P(\theta, d(\theta)) + U_A(\theta, d(\theta))\, \mathrm{d}\theta \tag{77}$$

subject to the agent's incentive-compatibility constraints: $U_A(\theta, d(\theta)) \geq U_A(\theta, d(\hat{\theta}))$ for all $\theta, \hat{\theta} \in \Theta$.[46] As shown by Holmström (1984), these constraints are equivalent to allowing the agent to choose the project d freely from some *delegation set* $\mathscr{D} \subseteq D$ of permissible decisions:

$$d(\theta) \in \operatorname*{argmax}_{d \in \mathscr{D}} U_A(\theta, d), \tag{78}$$

for all $\theta \in \Theta$. By (40),

$$U_P(\theta, d) + U_A(\theta, d) = r_A + r_P - 2(\theta + \beta/2 - d)^2 - 2\beta^2/4. \tag{79}$$

Therefore, the contracting problem can be stated as

$$\max_{\mathscr{D}} \int_0^1 -[\theta + \beta/2 - d(\theta)]^2 \ \mathrm{d}\theta \quad \text{s.t.} \quad d(\theta) \in \operatorname*{argmax}_{d \in \mathscr{D}} [-(\theta + \beta - d)^2]. \tag{80}$$

It is well known that the optimal delegation set that solves this problem is an interval $\mathscr{D} = [\beta, \bar{d}]$.[47] Thus the constraint in (80) becomes $d(\theta) = \min[\theta + \beta, \bar{d}]$ and so the optimal $\bar{d}^*$ is given by the first–order condition

$$\frac{\partial}{\partial \bar{d}} \left[\int_0^{\bar{d}-\beta} -(\theta + \beta/2 - (\theta + \beta))^2 \, d\theta + \int_{\bar{d}-\beta}^1 -(\theta + \beta/2 - \bar{d})^2 \, d\theta \right] = 0. \tag{81}$$

[46]Note that the payment P_Y is irrelevant for these constraints because it is constrained to be non–contingent.
[47]See, e.g., Amador and Bagwell (2013) and Melumad and Shibano (1991).

A straightforward calculation yields that $\bar{d}^* = 1$. Let

$$\bar{\theta} \equiv \bar{d}^* - \beta = 1 - \beta \tag{82}$$

be the largest type who still receives his favorite decision under the optimal delegation set $\mathscr{D}^* = [\beta, 1]$.

Non–contractible decisions: A–authority When the decision is non–contractible, and the agent has authority, then after having signed the contract, the agent selects a decision which the principal accepts (in which case she pays P_Y to the agent) or rejects (in which case she pays P_N to the agent, and the agent pays Π to a third party). Define P_Y and P_N so that the principal is indifferent at $\bar{\theta}$ and $\bar{d}^*$:

$$\begin{aligned} U_P(\bar{\theta}, \bar{d}^*) - P_Y &= \alpha_P U_P(\bar{\theta}, \bar{d}^*) - P_N \\ \Leftrightarrow \quad r_P - \beta^2 - P_Y &= \alpha_P (r_P - \beta^2) - P_N, \end{aligned} \tag{83}$$

and moreover, let Π be sufficiently large. We now prove Proposition 6 (i) by verifying that the following strategies and beliefs form a Perfect Bayesian Equilibrium:

(a) The agent chooses d to maximize $U_A(\theta, d)$ subject to $d \in \mathscr{D}^*$: all types $\theta < \bar{\theta}$ choose $d(\theta) = \theta + \beta$, and all types $\theta \geq \bar{\theta}$ choose $d(\theta) = \bar{d}^*$.

(b) The principal accepts all decisions $d \in \mathscr{D}^*$, and rejects all decisions $d > \bar{d}^*$, and rejects or accepts decisions $d < \beta$.

(c) Moreover, when the principal observes the off path decision $d > \bar{d}^*$, she believes that the agent is of type $\bar{\theta}$. (For $d < \beta$, beliefs can be specified arbitrarily.)[48]

Indeed, (a) describes clearly an optimal strategy for the agent given (b) and if Π is sufficiently large. To see that (b) describes an optimal strategy for the principal, suppose first that she observes a decision $d \in [\beta, \bar{d}^*)$. Given (a), she then infers that the agent's type is $\theta = d - \beta$, and hence accepting the decision is optimal if

$$\begin{aligned} U_P(d - \beta, d) - P_Y &\geq \alpha_P U_P(d - \beta, d) - P_N \\ \Leftrightarrow \quad r_P - \beta^2 - P_Y &\geq \alpha_P (r_P - \beta^2) - P_N, \end{aligned} \tag{84}$$

which is satisfied by (83). Next, suppose the principal observes the decision $d = \bar{d}^* = 1$. Given (a), she then infers that the agent's type is uniformly distributed on $[\bar{\theta}, 1]$, and hence accepting the decision is optimal if

$$\begin{aligned} \int_{\bar{\theta}}^{1} U_P(\theta, \bar{d}^*)\, d\theta \cdot \frac{1}{1 - \bar{\theta}} - P_Y &\geq \alpha_P \int_{\bar{\theta}}^{1} U_P(\theta, \bar{d}^*)\, d\theta \cdot \frac{1}{1 - \bar{\theta}} - P_N \\ \Leftrightarrow \quad r_P - 1/3 \cdot \beta^2 - P_Y &\geq \alpha_P (r_P - 1/3 \cdot \beta^2) - P_N, \end{aligned} \tag{85}$$

[48] It is easy to see that there are other belief specifications for $d > \bar{d}^*$ which also work.

which is implied by (83). Finally, suppose the principal observes a decision $d > \bar{d}^* = 1$. Given (a), this constitutes a zero probability event, and by (c), the principal then believes that the agent's type is $\bar{\theta}$. Hence, rejecting the decision is optimal if

$$\begin{aligned} U_P(\bar{\theta}, d) - P_Y &\leq \alpha_P U_P(\bar{\theta}, d) - P_N \qquad (86) \\ \Leftrightarrow \qquad r_P - (1-\beta-d)^2 - P_Y &\leq \alpha_P (r_P - (1-\beta-d)^2) - P_N, \end{aligned}$$

which, since $d > 1$ is implied by (83). This establishes part (i) of Proposition 6.

Non–contractible decisions: P–authority We now show part (ii) of Proposition 6 that with P–authority there is no non–contingent exit option contract that implements the benchmark outcome with contractible decisions. Towards a contradiction, suppose such a contract exists. Then for any agent type $\theta \leq \bar{\theta}$, the principal (after having received an appropriate message by the agent that reveals the agent's type), chooses $d(\theta) = \theta + \beta$ in equilibrium, and the agent is indifferent between accepting and rejecting:

$$\begin{aligned} U_A(\theta, \theta+\beta) + P_Y &= \alpha_A U_A(\theta, \theta+\beta) + P_N \qquad (87) \\ \Leftrightarrow \qquad r_A + P_Y &= \alpha_A r_A + P_N. \qquad (88) \end{aligned}$$

Otherwise, if the agent strictly preferred to accept the decision, the principal could benefit from choosing a slightly smaller, and hence still accepted, decision.

Moreover, for any agent type $\theta > \bar{\theta}$, the principal selects $\bar{d}^* = 1$ in equilibrium, and the agent accepts this decision:

$$\begin{aligned} U_A(\theta, \bar{d}^*) + P_Y &\geq \alpha_A U_A(\theta, \bar{d}^*) + P_N \qquad (89) \\ \Leftrightarrow \qquad r_A - (\theta+\beta-1)^2 + P_Y &\geq \alpha_A (r_A - (\theta+\beta-1)^2) + P_N. \end{aligned}$$

But since $\theta > \bar{\theta} = 1 - \beta$, this is a contradiction to (88). This establishes part (ii) of Proposition 6. Q.E.D.

8 References

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