The Lure of Authority: Motivation and Incentive Effects of Power

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Online Appendix

Appendix A: Regret Theory

This appendix examines the extent to which regret theory can rationalize our data. It is divided into three parts. In part one, we consider the effort stage of the experiment and concentrate on the decision problem of an agent. We consider two different sources of regret: loser regret and overrule regret. An agent experiences *loser regret* if he remains uninformed but could have achieved a higher payoff had he chosen a higher effort and been informed. An agent experiences *overrule regret* if he is in the role of the subordinate, the controlling party is informed, and the agent's recommendation is disregarded or his effort is wasted. We show that loser regret and overrule regret can rationalize important aspects of the agents' behavior. In particular, loser regret induces agents in the position of the controlling party to overexert effort relative to the best reply of those without loser regret. Overrule regret, by contrast, induces agents in the subordinate position to reduce effort relative to agents who have no overrule regret.

In part two, we show that these two regret forces also suffice to explain effort choices as well as under-delegation of authority by the principals. In part three, we extend the analysis of the principal and include a third form of regret that only principals can experience: *delegation regret*. In contrast to the agents, regret experienced by principals can also stem from their delegation decision, i.e., having delegated or not having delegated the decision right. We show that including regret that stems from delegation can further decrease a principal's utility from delegating and has effects on effort similar to the regret forces studied in the first two parts.

Part 1: Regret and Effort Decisions of the Agent: In the auction literature, it has recently been proposed by Filiz-Ozbay and Ozbay (2007) that a reason for overbidding in the first price sealed bid auction is that individuals experience "loser regret." Loser regret occurs when an individual bids below their valuation and is beaten by a higher bid that is below their true valuation. In these cases, individuals experience regret because they would have preferred to bid higher *ex post* than is optimal to bid *ex ante*. An individual who anticipates such regret optimally increases their bid relative to the risk neutral Nash equilibrium in order to reduce the potential states for which regret occurs.

In our experiment, individuals may similarly experience loser regret in cases where they remain uninformed and thus cannot implement their preferred project. These will be cases in which an individual's effort is below the number drawn by the random number generator that guides success and failure of an individual's effort.

As the likelihood of being informed, and therefore the likelihood of regret, is based on an agent's effort relative to a number drawn by nature, we require a formal way of expressing these draws. Let x_A be the realization of the random number generator (uniform between 0 and 1) for the agent, where the agent is informed if his effort is above or equal to the realization of x_A and uninformed if it is below x_A. Likewise, let x_P be the realization of the number generator for the principal, with the principal being informed when his effort is above or equal to x_P and uninformed if his effort is below x_P.[1]

In developing a formal model, we follow Loomes and Sugden (1982) and assume that loser regret enters utility linearly. Individuals experience loser regret when they remain uninformed and a project with a lower payoff is implemented compared to the payoff that would have resulted from the *ex-post* optimal effort decision of the individual. The magnitude of regret is related to the difference between the actual payoff and the payoff from this optimal effort decision.

We begin by considering an agent who has received decision rights and is now the controlling party. Given an implemented project k, an exerted cost of effort e^d, and a draw from the number generator x_A, the agent experiences loser regret equal to

$$\lambda_{LR} \max\{[A_2 - g(x_A)] - [A_k - g(e^d)], 0\} \tag{1}$$

any time his preferred project is not implemented, where the parameter $\lambda_{LR} \geq 0$ is the agent's degree of loser regret. Note that the max function explicitly rules out rejoicing and that the utility from the improved project choice, $A_2 - A_k$ must exceed the additional cost of effort $g(x_A) - g(e^d)$ in order for loser regret to be positive.

[1]Individuals in the experiment were informed of their own draw from the number generator in each period. They were uninformed about the other party's draw. For loser regret and overrule regret considered in the first part of the appendix, only the information state of the other party matters for regret, not their actual draw.

Let $\hat{E}^d$ be the agent's belief about the principal's effort in the role of the subordinate. Based on these beliefs and the realizations of x_P and x_A, the outcome space can be partitioned into four distinct "cells" which differ in the extent to which regret influences utility. These cells are shown in figure (1).

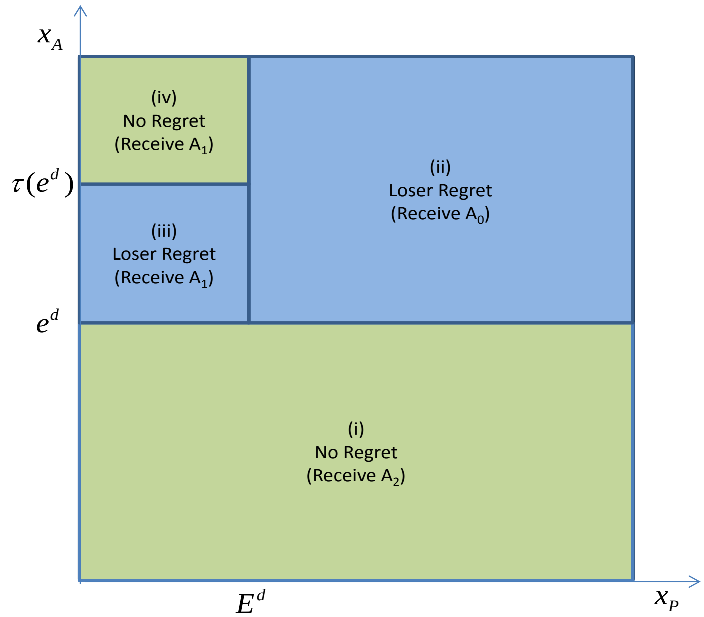

Figure 1: **Agent as Controlling Party:** As a controlling party, the outcome space can be partitioned into four cells that differ with regard to the regret experienced by the agent: In cell (i), the agent does not experience regret because he is informed and can implement his preferred project. In cells (ii) and (iii), however, a regret averse agent will experience loser regret since he could have achieved a higher payoff had he increased his effort. In cell (ii), the principal is also uninformed and the agent always experiences loser regret, since it would have been profitable to increase effort. In cells (iii) and (iv), the principal is informed and the principal's preferred project is implemented. In cell (iii), the return from having the agent's preferred project implemented, $\hat{A}_2 - \hat{A}_1$, exceeds the additional cost of acquiring the necessary information, given by $g_A(x_A) - g_A(e^d)$. Therefore, the agent experiences loser regret. In cell (iv), the additional effort cost exceeds the increased project return, and the principal does not experience regret. The cutoff between cells (iii) and (iv) is given by $\tau(e^d) \equiv \min\{g_A^{-1}(\hat{A}_2 - \hat{A}_1 + g_A(e^d)), 1\}$, where the min function is included to bound $\tau(e^d)$ in cases in which $\hat{A}_2 - \hat{A}_1$ exceeds the potential increase in effort costs.

In cell (i), we assume that an agent does not experience regret since he is informed and therefore is able to implement his preferred project. In the remaining three cells, however, the agent's effort is below the threshold for success ($e^d < x_A$) and the agent is uninformed. In these cases, the agent may regret his insufficient level of effort if the gain from being informed through improved project selection exceeds the incremental cost of attaining this information.

In cell (ii), the principal is uninformed and project 0 is recommended. If such a state is realized, the agent always prefers to be informed and regrets his insufficient effort level. In cells (iii) and (iv), the principal is informed and recommends project 1. Cell (iii) contains states in which the increased returns due to improved project choice exceed the cost of raising effort from e^d to x_A, i.e., states where $\hat{A}_2 - \hat{A}_1 \geq g_A(x_A) - g_A(e^d)$, and therefore the agent experiences loser regret. Cell (iv) contains states in which the additional cost of being informed exceeds its value, and therefore the agent does not experience loser regret. The threshold between cells (iii) and (iv) is given by $\tau(e^d)$, where $\tau(e^d) \equiv min\{g_A^{-1}(\hat{A}_2 - \hat{A}_1 + g_A(e^d)), 1\}$.[2]

Considering all four cells for the computation of utility, an agent in the role of the controlling party has utility $u_A^d(e^d|x_A, x_P, \hat{E}^d) =$

$$= \begin{cases} A_2 - g_A(e^d) & \textit{if } x_A \leq e^d, \\ A_0 - g_A(e^d) - \lambda_{LR}[\hat{A}_2 - g_A(x_A) + g_A(e^d)] & \textit{if } x_A > e^d \ \& \ x_P > \hat{E}^d, \\ A_1 - g_A(e^d) - \lambda_{LR}[\hat{A}_2 - \hat{A}_1 - g_A(x_A) + g_A(e^d)] & \textit{if } \tau(e^d) \geq x_A > e^d \ \& \ x_P \leq \hat{E}^d, \\ A_1 - g_A(e^d) & \textit{if } x_A > \tau(e^d) > e^d \ \& \ x_P \leq \hat{E}^d. \end{cases} \quad (2)$$

Intuitively, individuals who are in the role of the controlling party experience loser regret only in cases where they exert less effort than the amount needed to be informed. Thus, individuals who anticipate loser regret are likely to increase their effort relative to that of the best response of a standard expected value maximizer. The following proposition formalizes this intuition:

Proposition 1 *In the effort stage of the authority-delegation game, an agent who anticipates loser regret and who has received control from a delegating principal will over exert effort relative to the best response of an individual who maximizes expected value.*

Proof. An agent who has anticipatory regret maximizes the expected value of $u_A^d(e^d|x_A, x_P, \hat{E}^d)$ over all realizations of x_A and x_P. Taking into consideration the cases in which regret will

[2]Since x_A is bounded above at 1, $\tau(e^d)$ is also bounded above at 1. If $\tau(e^d) = 1$ the agent always experiences loser regret. Note that $\hat{A}_2 - g_A(1) + g_A(0) > 0$ for the parameters chosen so that the agent always regrets not implementing his best project when the outside option is implemented.

occur, this is equivalent to maximizing:

$$\begin{aligned}\max_{e^d} \quad & e^d\hat{A}_2 + (1-e^d)\hat{E}^d\hat{A}_1 - g_A(e^d) \\ & -\lambda_{LR}(1-\hat{E}^d)(1-e^d)[\hat{A}_2 - \mathbb{E}_{x_A}(g_A(x_A)|x_A > e^d) + g_A(e^d)] \\ & -\lambda_{LR}\hat{E}^d(\tau(e^d)-e^d)[\hat{A}_2 - \hat{A}_1 - \mathbb{E}_{x_A}(g_A(x_A)|x_A \in (e^d, \tau(e^d))) + g_A(e^d)]\end{aligned}$$

As the derivative of $\tau(e^d)$ is discontinuous at 1, the first order condition is solved separately for $\tau(e^d) < 1$ and $\tau(e^d) = 1$. In the case of $\tau(e^d) < 1$, two intermediate results are useful for constructing the first order condition. First note that:

$$-\frac{d}{de^d}(1-e^d)\mathbb{E}_{x_A}(g_A(x_A)|x_A > e^d) = -\int_{e^d}^1 g_A(z)dz = g_A(e^d) \tag{3}$$

by Leipniz's rule. Further,

$$-\frac{d}{de^d}(\tau(e^d)-e^d)\mathbb{E}_{x_A}(g_A(x_A)|x_A \in (e^d, \tau(e^d)) = -\tau^{'}(e^d)[\hat{A}_2 - \hat{A}_1 + g_A(e^d)] + g_A(e^d) \tag{4}$$

by Leipniz's rule and the fact that $g_A(\tau(e^d)) = \hat{A}_2 - \hat{A}_1 + g_A(e^d)$. Using these intermediate calculations, the first order condition of this equation can be expressed as the following implicit function:

$$\begin{aligned}\hat{A}_2 - \hat{E}^d\hat{A}_1 - g_A^{'}(e^d) + \lambda_{LR}(1-\hat{E}^d)[\hat{A}_2 - (1-e^d)g_A^{'}(e^d)] + \\ +\lambda_{LR}\hat{E}^d[\hat{A}_2 - \hat{A}_1 - (\tau(e^d)-e^d)g_A^{'}(e^d)] = 0.\end{aligned} \tag{5}$$

Effort is strictly above the best response of a standard expected value maximizer without regret if for a positive λ_{LR} the last two terms are positive when evaluated at or below the standard best response. Note that at the standard best response correspondence, $g_A^{'}(e^d) = \hat{A}_2 - \hat{E}^d\hat{A}_1$, we can substitute in for $g_A^{'}(e^d)$ to test this restriction. Looking at the last two terms with $g_A^{'}(e^d)$ replaced with $\hat{A}_2 - \hat{E}^d\hat{A}_1$ yields

$$\lambda_{LR}(1-\hat{E}^d)[e^d\hat{A}_2 + (1-e^d)\hat{E}^d\hat{A}_1] \tag{6}$$

for the second to last term and

$$\lambda_{LR}\hat{E}^d[\hat{A}_2 - \hat{A}_1 - (\tau(e^d)-e^d)[\hat{A}_2 - \hat{E}^d\hat{A}_1]] \tag{7}$$

for the last term. Subtracting $\hat{E}^d(1-\hat{E}^d)\hat{A}_1$ from expression (6) and adding it to expression

(7), these two sub-equations can be further rewritten as

$$\lambda_{LR}(1-\hat{E}^d)e^d[\hat{A}_2-\hat{E}^d\hat{A}_1] \tag{8}$$

and

$$\lambda_{LR}\hat{E}^d[\hat{A}_2-\hat{A}_1+(1-\hat{E}^d)\hat{A}_1-(\tau(e^d)-e^d)[\hat{A}_2-\hat{E}^d\hat{A}_1]]. \tag{9}$$

Expression (8) is clearly positive since e^d and E^d take intermediate values between zero and one along the best response function and $\hat{A}_2>\hat{A}_1$. Expression (9) is decreasing in $\tau(e^d)$ and thus is (weakly) larger than

$$\lambda_{LR}\hat{E}^d[\hat{A}_2-\hat{A}_1+(1-\hat{E}^d)\hat{A}_1-(1-e^d)[\hat{A}_2-\hat{E}^d\hat{A}_1]]=\lambda_{LR}\hat{E}^d e^d[\hat{A}_2-\hat{E}^d\hat{A}_1], \tag{10}$$

which is also strictly positive. Thus, expression (9) is positive. As both terms are positive, it follows that an individual who experiences loser regret will exert more effort than an individual who maximizes expected value for any given belief about the other parties effort.
■

Proposition 1 shows that controlling agents who experience loser regret tend to overprovide effort relative to an expected value maximizer which rationalizes an important aspect of our data.[3]

Turning to the subordinate role, the agent's optimization problem and the potential sources of regret change considerably. In particular, as a subordinate the agent can experience regret whenever the controlling party is informed since subordinate effort is wasted in these cases and it would have been optimal *ex post* to free ride on the informed principal. We refer to this form of regret as *overrule regret.* Regretting wasted effort is likely to be particularly salient when the agent is successful and the information generated from his effort is wasted. To account for the particular salience of this event, we assume that the agents who are overruled not only experience regret due to their wasted effort, but also in proportion to the foregone payoffs lost due to their information being ignored.[4]

[3] Note that in principle, individuals may also experience "winner regret" in which an individual regrets over exertion relative to the level of effort needed to be informed. This force could be added to our model and would not change the main propositions as long as anticipated loser regret is not outweighed by anticipated winner regret. Note that if winner regret would be stronger than loser regret one cannot explain the overprovision of effort by the controlling parties. This suggests that winner regret is weaker than loser regret in our setting. This is precisely the result reported in Filiz-Ozbay and Ozbay (2007), who find strong evidence of loser regret but conclude that "winner regret" is either a weaker force or unanticipated by subjects. Therefore, to keep our model simple and parsimonious, we have excluded winner regret from the analysis.

[4] Formally, the agent experiences overrule regret equal to $\lambda_{OR}g_A(e)$ if the principal is informed and the agent is uninformed, and overrule regret equal to $\lambda_{OR}[\hat{A}_2-\hat{A}_1+g_A(e)]$ if both parties are informed and the

In figure (2) we again partition the state space into cells that differ with regard to the regret experienced by the agent. We continue to assume that no regret is experienced if the agent receives the payoff from his own preferred project. This is the case in cell (i), since the agent is informed and the controlling party is not. In cell (ii), the agent experiences loser regret since both parties remain uninformed and project 0 is implemented. In such states, the agent regrets his insufficient effort level since he could have improved project selection had he chosen $e = x_A$.

Cells (iii) and (iv) are cases in which the controlling party is informed. As the agent in the subordinate role is not in control of final project selection, subordinate effort in these cases is effectively wasted, and the agent experiences overrule regret. In cell (iii), the agent remained uninformed and therefore regrets having wasted his effort. In cell (iv), the agent was informed himself and experiences overrule regret not only from wasted effort, but also from having his recommendation ignored by the principal.

As with loser regret, we model "overrule regret" in a linear fashion. Let e be the effort of the agent in the role of the subordinate and let $\hat{E}$ be the agent's belief about the principal's effort in the role of the controlling party. The utility of an agent in the role of the subordinate is then given by:

$$u_A(e|x_A, x_P, \hat{E}) = \begin{cases} A_2 - g_A(e) & \textit{if } x_A \leq e \ \textit{\&} \ x_P > \hat{E} \\ A_0 - g_A(e) - \lambda_{LR}[\hat{A}_2 - g_A(x_A) + g_A(e)] & \textit{if } x_A > e \ \textit{\&} \ x_P > \hat{E} \\ A_1 - g_A(e) - \lambda_{OR} g_A(e) & \textit{if } x_A > e \ \textit{\&} \ x_P \leq \hat{E} \\ A_1 - g_A(e) - \lambda_{OR}[\hat{A}_2 - \hat{A}_1 + g_A(e)] & \textit{if } x_A \leq e \ \textit{\&} \ x_P \leq \hat{E} \end{cases} \tag{11}$$

where $\lambda_{OR} \geq 0$ is the agent's degree of overrule regret.

Just as loser regret can increase effort relative to the best response, individuals who anticipate overrule regret will decrease effort in order to reduce the possibility of being overruled. Depending on whether an individual is more sensitive to loser regret or overrule regret, effort in the subordinate role can be either higher or lower than the standard best response. Effort may also be zero if individuals experience a significant amount of overrule regret and the degree of loser regret isn't too strong.

agent is overruled. We also considered specifications in which (i) wasted effort and the disutility of being overruled had different coefficients and (ii) where one of the two forces was excluded. As both forces move in the same direction, both forms of regret lead to a reduction in effort relative to the standard best response, and therefore there is no qualitative differences across these models. However, regret proportional to the foregone payoff $(\hat{A}_2 - \hat{A}_1)$ due to the overruled recommendation is necessary to predict zero effort choices by subordinates. If wasted effort is the only source of overrule regret, the marginal increase in anticipatory regret at an effort level of zero is zero, implying that positive effort is always predicted. This is not the case when the foregone payoff $(\hat{A}_2 - \hat{A}_1)$ matters for overrule regret.

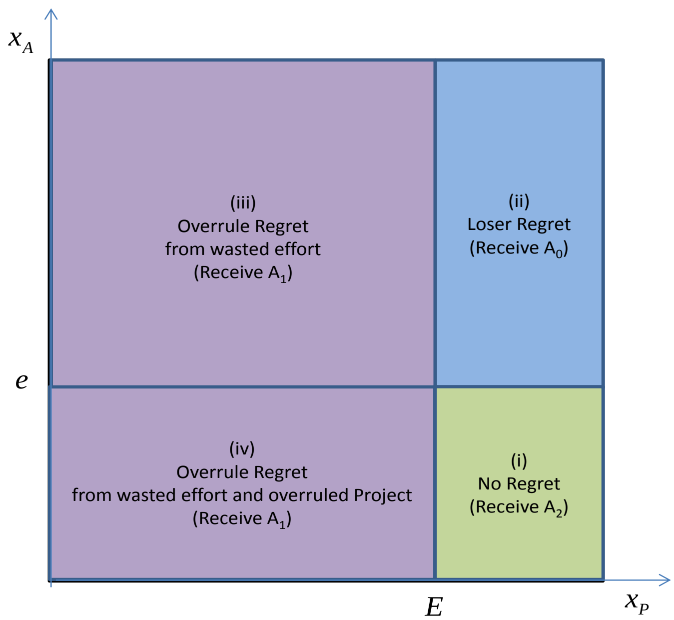

Figure 2: **Agent as Subordinate:** For agents as subordinates, the state space can be partitioned into four cells, which differ in the extent to which the agent experiences regret: In cell (i), the agent experiences no regret because his preferred project is implemented. In cell (ii), the agent experiences loser regret. Here both parties remain uninformed, implying that the agent could have improved the outcome by raising his own effort to $e = x_A$. The agent experiences overrule regret from wasted effort whenever the controlling party is informed, which is the case in cells (iii) and (iv). In cell (iv), overrule regret is particularly strong because the agent is also informed, but the agent's recommendation is ignored.

Proposition 2 *In the effort stage of the authority-delegation game, an agent who is in the role of the subordinate may experience either loser regret or overrule regret depending on the realized state. Individuals who anticipate a disutility of being overruled will decrease effort relative to those who do not. Individuals who anticipate loser regret will increase effort relative to those who do not. As these forces move in different directions, heterogeneity in anticipatory regret may lead to observed effort choices both above and below the best response.*

Proof. As before, an agent who has anticipatory regret maximizes the expected value of $u_A(e^d|x_A, x_P, \hat{E})$ over all realizations of x_A and x_P. After some simplifications, the agent maximizes:

$$\begin{aligned} \max_e \quad & \hat{E}[\hat{A}_1 - e\lambda_{OR}(\hat{A}_2 - \hat{A}_1)] - g_A(e) + [1-\hat{E}]\hat{A}_2[e - \lambda_{LR}(1-e)] + \\ & +[1-\hat{E}](1-e)\lambda_{LR}\mathbb{E}_{x_A}(g_A(x_A)|x_A > e) - [1-\hat{E}](1-e)\lambda_{LR}g_A(e) - \hat{E}\lambda_{OR}g_A(e) \end{aligned} \tag{12}$$

Taking the first order condition yields the following implicit function:

$$(1+\lambda_{LR})[1-\hat{E}]\hat{A}_2 - \hat{E}\lambda_{OR}(\hat{A}_2 - \hat{A}_1) = g_A^{'}(e)[1 + (1-\hat{E})(1-e)\lambda_{LR} + \hat{E}\lambda_{OR}] \tag{13}$$

As $[1-\hat{E}][1-e] < 1-\hat{E}$, effort is again higher when λ_{LR} is positive. However, since the left hand side is decreasing in λ_{OR} while the right hand side is increasing, overrule regret leads to a decrease in effort relative to an expected value maximizer. As overrule regret and loser regret go in opposite directions, effort choices as a subordinate should be heterogeneous depending on the magnitude of these forces in individuals' utility functions. ■

Part 2: Overrule Regret and the Delegation Decision of the Principal: Having considered how regret affects the effort decision of an agent in the controlling party and the subordinate role, we next turn to the effort and delegation decisions of the principal. Just as with the agent, a principal can experience loser regret in cases where her best project is not implemented and overrule regret in cases where she is in the subordinate role and the agent is informed. Analogous to the agent, these forces increase the principal's effort as a controlling party and can lead her to under or over-exert effort after delegation, i.e. when she is the subordinate.

Propositions (1) and (2) and analogous results for the principal thus show that loser regret and overrule regret can rationalize the effort patterns observed in our experimental data. Controlling parties with loser regret will over provide effort relative to the risk neutral best reply of an individual without loser regret. Rational subordinates who anticipate the increased effort of the controlling party will update their beliefs upward (as observed in the data) and have an incentive to reduce their effort relative to the risk neutral Nash equilibrium. In addition, regret averse subordinates with strong enough overrule regret will have an incentive to further decrease their effort below the risk neutral best reply because this reduces overrule regret. If anticipated, this decrease in subordinate effort will further increase effort of the controlling party. Taken together, equilibrium effort provision is expected to be larger for controlling parties and smaller for subordinates if regret aversion exists compared to the risk neutral Nash equilibrium without regret.

It turns out that these same forces can also result in under delegation by the principal. As overrule regret has a negative utility that arises only in the case of delegation, overrule regret decreases the utility of delegation relative to the utility of keeping control. Thus overrule regret can lead to under delegation relative to a standard expected utility maximizer.[5]

Proposition 3 *Overrule regret decreases the utility of delegation and has no effect on the utility of keeping control. Thus individuals who experience overrule regret may keep control rights even in cases in which expected value comparisons predict delegation.*

Proof. This proposition follows from a direct comparison of the utility for a principal holding control and delegating. ■

Part 3: Regret Due to the Delegation Choice: While we can capture all the main deviations observed in our data with loser regret and overrule regret, a formulation using only these two forces ignores the fact that the principal's decision problem and the agent's decision problem differ in the delegation stage. In order to understand how regret over the delegation decision might affect the principal's decisions, this section extends the model to include regret that might occur due to the principal's delegation choice.

In modeling regret over the delegation choice, we take a direct extension of the baseline model where a principal compares the outcome of his selected delegation and effort decision pair with the decision pair which would maximize his payoff *ex post* given information about the state of nature and beliefs about agent behavior. To ensure consistency, we hold the beliefs about the effort of the agent in the subgame which was not entered constant.[6] We also rule out the analogue of winner regret by assuming that the minimum effort that an individual believes she will exert in the counterfactual where she kept control rights is equal to the amount of effort actually exerted after delegation (i.e., we restrict the counterfactual E to be greater or equal to E^d).

[5]The effects of loser regret on delegation are more subtle and may go in either direction depending on the efforts chosen by the principal and agent.

[6]For example, if the principal keeps control, she does not update her beliefs about the effort the agent would have put in she had delegated regardless of the effort observed from the agent in the subordinate role.

We begin by studying the effort decision of a principal who keeps control. In cases where the principal's preferred project is not implemented, a principal has two possible ways in which she might alter her actions to improve her final payoff. First, if she continues to maintain control, the principal can increase effort to $E = x_P$, thus ensuring her preferred project is implemented. Second, if in case of delegation the agent is informed, the principal could instead delegate control to the agent. In this alternative case, the principal's optimal subordinate effort is zero since the informed agent will anyway implement his preferred project, regardless of the principal's recommendation. As a naming convention, we define *delegation regret* as regret which occurs in states where the principal would prefer to change her delegation decision.

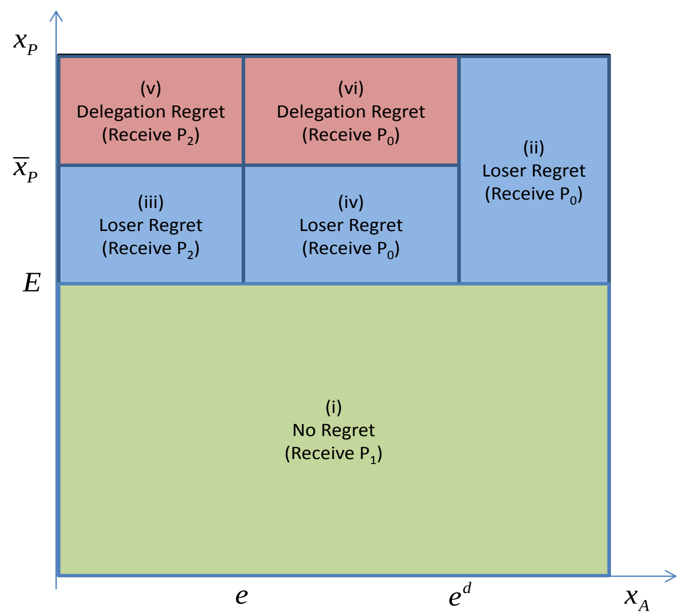

Figure 3: **Principal as Controlling Party:** For principals in the role of the controlling party, the state space can be partitioned into six cells, which differ with regard to the regret experienced by the principal. In cell (i), the principal experiences no regret because her preferred project is implemented. In cell (ii), both the principal and the agent remain uninformed in both subgames. In the remaining cells, the principal is uninformed but the agent is either informed, as in cells (iii) and (v), or would have been informed if delegation had taken place, as in cells (iv) and (vi). In these cells, the principal either regrets his effort choice and experiences loser regret or regrets his delegation choice and experiences delegation regret. This depends on whether it is *ex-post* optimal to keep the decision right and increase effort to $E = x_P$, as in cells (iii) and (iv), or whether it is *ex-post* optimal to delegate the decision right to the agent and choose $E^d = 0$, as in cells (v) and (vi). The cutoff between cells with loser regret and delegation regret if the agent would be informed after delegation depend on whether $P_1 - g_P(x_P)$ is greater or less than $P_2 - g_P(0)$ and is defined by $\overline{x}_P \equiv g_p^{-1}(P_1 - P_2)$.

In figure (3) we again partition the state space into cells that differ with regard to the regret experienced by the principal. In cell (i), we continue to assume that no regret is experienced if the principal is informed and can choose her preferred project. If the principal remains uninformed, however, she experiences either loser regret or delegation regret. In cell (ii), the agent remains uninformed even if the principal delegates decision rights. In this case, the principal can improve her payoff by increasing her own effort, and therefore she experiences loser regret. In cells (iii) and (v), the principal remains uninformed and the agent is informed, such that project 2 is chosen. In these cases, the principal could have improved her payoff by either keeping the decision right and increasing her own effort to x_P, or by delegating the decision right to the informed agent and choosing zero effort herself. This will depend on the profitability of these alternative strategies, i.e., on whether $P_1 - g_P(x_P)$ is greater or less than $P_2 - g_P(0)$. The threshold between these strategies is defined by $\overline{x}_P$, where $\overline{x}_P \equiv g_p^{-1}(P_1 - P_2)$. In cell (iii), $P_1 - g_P(x_P) \geq P_2 - g_P(0)$, such that the principal prefers to keep the decision right and to increase effort. Therefore, she experiences loser regret. In cell (v), $P_1 - g_P(x_P) < P_2 - g_P(0)$, such that the principal prefers to delegate the decision right and to choose zero effort. Therefore, she experiences delegation regret.

Cells (iv) and (vi) differ from cells (iii) and (v) in that the agent is uninformed as a subordinate and therefore project 0 is implemented. However, if the principal delegates the decision right the agent is informed, and therefore project 2 is implemented. Whether the principal prefers to increase her own effort or to delegate the decision right to the agent and to choose zero effort herself will therefore again depend on which of these two strategies is more profitable, i.e., whether $P_1 - g_P(x_P)$ is greater or less than $P_2 - g_P(0)$. In cell (iv), the principal prefers to raise her effort and hence she experiences loser regret. In cell (vi), the principal prefers to delegate the decision right and to choose zero effort, and hence she experiences delegation regret.[7]

Combining all cells, the utility of a principal in the role of the controlling party is given

[7] Note that $g_p^{-1}(P_1 - P_2) \leq g_P^{-1}(P_1 - P_2 + g_P(E))$, i. e., $\overline{x}_P \leq \tau(E)$. Hence, unlike the agent, the principal will always experience either delegation regret or loser regret in case she remains uninformed. If $\overline{x}_P > 1$, the principal never experiences delegation regret and always regrets not having invested more effort.

by $u_P(E|x_A, x_P, \hat{e}, E^d) =$

$$\begin{cases} P_1 - g_P(E) & \text{\textit{if} } x_P \leq E \\ P_0 - g_P(E) - \lambda_{LR}[\hat{P}_1 - g_P(x_P) + g_P(E)] & \text{\textit{if} } x_P > E \;\&\; x_A > \hat{e}^d \\ P_0 - g_P(E) - \lambda_{LR}[\hat{P}_1 - g_P(x_P) + g_P(E)] & \text{\textit{if} } \overline{x}_P \geq x_P > E \;\&\; \hat{e} < x_A \leq \hat{e}^d \\ P_2 - g_P(E) - \lambda_{LR}[\hat{P}_1 - \hat{P}_2 - g_P(x_P) + g_P(E)] & \text{\textit{if} } \overline{x}_P \geq x_P > E \;\&\; x_A \leq \hat{e} \\ P_0 - g_P(E) - \lambda_D[\hat{P}_2 + g_P(E)] & \text{\textit{if} } x_P > \overline{x}_P \;\&\; x_P > E \;\&\; \hat{e} < x_A \leq \hat{e}^d \\ P_2 - g_P(E) - \lambda_D[g_P(E)] & \text{\textit{if} } x_P > \overline{x}_P \;\&\; x_P > E \;\&\; x_A \leq \hat{e} \end{cases} \tag{14}$$

where λ_D is the principal's degree of delegation regret.

As can be seen by comparing equations (2) and (14) as well as figures (1) and (3), the principal's utility is similar to that of the agent except that for those realizations of x_P and x_A for which the principal would have preferred to delegate rather than to have increased effort, loser regret is substituted by delegation regret. Note that both forms of regret can be reduced by increasing E and therefore affect the controlling party's effort decision in similar ways. The following remark summarizes the effects of delegation regret on effort:[8]

Remark 1 *In the effort stage of the authority-delegation game, a principal who anticipates delegation regret and has held decision rights will over exert effort relative to the best response of an individual who maximizes expected value.*

Remark (1) shows that delegation regret has a positive effect on the principal's effort as a controlling party. As with loser regret, the principal attempts to avoid states where he is uninformed in order to reduce the likelihood of regretting his delegation decision.

Finally, we can turn attention to the case of a principal who delegated control. In this subgame, a principal can potentially experience all three forms of regret: loser regret, overrule regret and delegation regret. In figure (4) we again partition the state space into cells that differ with regard to the regret experienced by the principal.

In cell (i), the principal can implement her preferred project and therefore she does not experience regret. In cell (ii), both the principal and the agent are uninformed. As the principal could have been informed by increasing effort, she experiences loser regret. In cells (iii) and (iv) the agent is informed and thus the agent implements his preferred project. As the principal receives the agent's preferred project, she experiences either delegation regret or overrule regret depending on her *ex-post* optimal strategy. If $x_P \leq \overline{x}_P = g_p^{-1}(P_1 - P_2)$, the

[8]The proof for this remark follows directly from the first order condition of the principal's decision problem and is omitted.

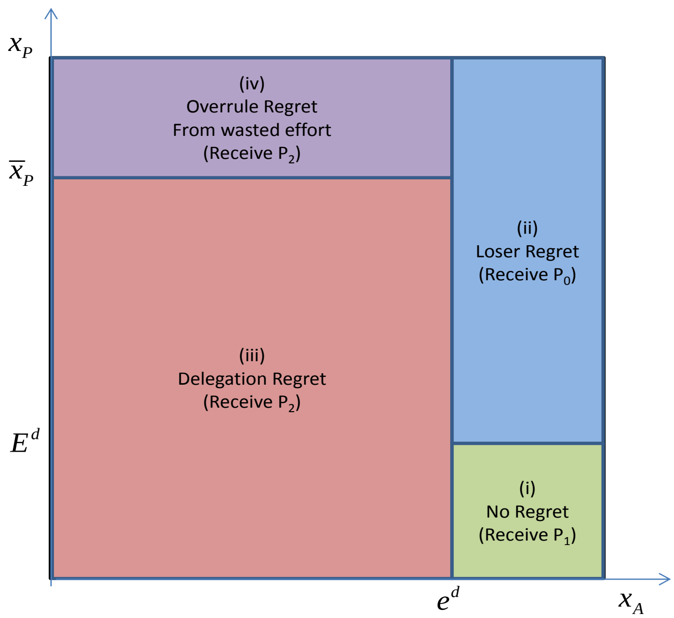

Figure 4: **Principal as Subordinate:** For principals in the role of the subordinate party, the state space can be partitioned into four cells, which differ with regard to the regret experienced by the principal. In cell (i), a principal experiences no regret because only she is informed and therefore her preferred project is implemented. In cell (ii), both parties remain uninformed and therefore the principal experiences loser regret from not having chosen $E^d = x_P$. In cells (iii) and (iv), the agent is informed and implements his preferred project. In these cells, the principal either regrets delegating or regrets his effort choice. Which regret force is felt depends on whether it is *ex-post* optimal to have kept the decision right and exerted $E = \max\{E^d, x_P\}$, as in cell (iii), or to have delegated the decision right and exerted $E^d = 0$, as in cell (iv). The cutoff between cells with delegation regret and overrule regret depend on whether $P_1 - g_P(x_P)$ is greater or less than $P_2 - g_P(0)$ and is defined by $\overline{x}_P \equiv g_p^{-1}(P_1 - P_2)$.

principal's *ex-post* optimal action is to keep the decision right and choose $E = \max\{E^d, x_P\}$, where the "max" comes from the assumption that the principal never expects to exert less effort with held control rights than after delegation. If $x_P > \overline{x}_P$, however, the principal's *ex-post* optimal action is to continue to delegate and choose zero effort. Therefore, in cell (iii), the principal experiences delegation regret and in cell (iv) the principal experiences overrule regret.

Combing the cells into a single utility function, the utility of a principal in the role of the subordinate is given by $U_P^d(E^d|x_A, x_P, \hat{e}^d, E) =$

$$= \begin{cases} P_1 - g_P(E^d) & \textit{if } x_P \le E^d \;\&\; x_A > \hat{e}^d \\ P_0 - g_P(E^d) - \lambda_{LR}[\hat{P}_1 - g_P(x_P) + g_P(E^d)] & \textit{if } x_P > E^d \;\&\; x_A > \hat{e}^d \\ P_2 - g_P(E^d) - \lambda_D[\hat{P}_1 - \hat{P}_2 - g_P(\max\{E^d, x_P\}) + g_P(E^d)] & \textit{if } x_P \le \overline{x}_P \;\&\; x_A \le \hat{e}^d \\ P_2 - g_P(E^d) - \lambda_{OR} g_P(E^d) & \textit{if } x_P > \overline{x}_P \;\&\; x_A \le \hat{e}^d \end{cases}, \tag{15}$$

Comparing equations (15) and (11) as well as figures (2) and (4), it can again be seen that overrule regret is substituted by delegation regret whenever delegation regret is of larger magnitude than overrule regret. This implies that the effort choice of the principal as a subordinate is increasing or decreasing relative to the standard best response, depending on the strength of loser regret and the combined strength of overrule and delegation regret.

Remark 2 *Principals in the subordinate role either experience delegation regret or overrule regret when the controlling party is informed. Anticipation of both forms of regret will decrease effort relative to those who do not. Individuals who anticipate loser regret will increase effort relative to those who do not. As these forces move in different directions, heterogeneity in anticipatory regret may lead to observed effort choices both above and below the best response.*

We now turn attention to the effects of delegation regret on the delegation decision. Delegation regret further reduces the utility of delegation since the principal will ex-post experience delegation regret in a multitude of states. Delegation regret may also reduce the utility in case of kept control, since the principal may also regret not having delegated ex-post. However, as we explain below, it seems plausible that in our experiment regret after delegation played a more important role.

A principal who delegates observes x_P ex-post and thus knows with certainty whether she would have had a better outcome had she kept decision rights. She also directly experiences her recommendation being overruled, which may be particularly salient. By contrast, the principal is never informed of x_A. If a principal keeps control and experiences the agent recommending the outside option (which indicates that the agent is not informed) she does not know whether the agent would have been informed if she had delegated. It therefore seems reasonable to assume that the experience of delegation regret after the principal kept control is much less salient than the delegation regret experienced after the principal delegated and was informed. If this was the case, delegation regret is likely to have reduced the incentive to delegate.[9]

[9] One way to account for these saliency differences in the model might be to allow for different degrees of delegation regret λ_D in the delegation and in the no-delegation subgames. To avoid further notation, however, we abstracted from this differentiation in this appendix.

Appendix B: Session Overview

Table B.1: Session Overview

Date	**Treatment**	**Subjects**	**Matching Groups**	**Periods**
Main Treatments				
May 2008	PLOW	30	3	10
May 2008	PLOW	30	3	10
May 2007[1]	LOW	12	1	10
May 2007	LOW	30	3	10
May 2008	LOW	30	3	10
May 2007[1]	HIGH	10	1	10
May 2007	HIGH	30	3	10
June 2007	HIGH	28	3	10
Oct 2008[2]	HIGH	30	3	10
June 2007	PHIGH	30	3	10
May 2008	PHIGH	30	3	10
Control Treatments				
Oct 2008	HIGH RAND	30	3	10
May 2009	HIGH RAND	30	3	10
May 2009	HIGH RAND	30	3	10
April 2011	PHIGH50	32	2	50
April 2011	PHIGH50	32	2	50
April 2011	HIGH NOREC	28	2	25
April 2011	PHIGH25	32	2	25

[1] This session was split into two matching groups with different treatments.

[2] This session did not use the strategy method for eliciting agent effort.

Appendix C: Additional Tables

Table C.1: Average effort levels vs. Nash predictions across treatments

	Controlling Party						Subordinate					
	Principal			Agent			Agent			Principal		
	E		E^{NE}	e^d		$e^{d^{NE}}$	e		e^{NE}	E^d		$E^{d^{NE}}$
PLOW	55.7		55	68.1	***	45	22.8		25	16.5	***	35
LOW	66.1	***	55	68.3	***	55	14.3	***	25	16.2	**	25
HIGH	48.2	*	45	58.7	***	45	26.5	***	35	19.6	***	35
PHIGH	58.2	***	45	65.1	**	55	17.3	***	35	20.7		25

Significance Levels for Wilcoxon Signed-Rank Tests against Nash predictions with data averaged by individual prior to estimation. Significance Levels: *** $p < .01$, ** $p < .05$, * $p < .1$.

Table C.2: Overall profit of principals and agents by treatment

	Principals		Agents	
	Actual[a]	**Predicted**[b]	**Actual**[a]	**Predicted**[b]
PLOW	18.23	*20.1*	22.35	*25.6*
LOW	18.40	*20.1*	16.32	*17.3*
HIGH	21.13	*24.0*	20.69	*23.3*
PHIGH	21.89	*25.6*	16.83	*20.1*

[a]Actual earnings in treatment.

[b]Predicted earnings with Nash equilibrium effort and delegation.

Table C.3: Delegation decisions by principals

	(1)	(2)	(3[a])	(4[b])
PLOW	0.035	0.061	0.106	
	(0.068)	(0.073)	(0.080)	
HIGH	0.245***	0.310***	0.462***	
	(0.061)	(0.097)	(0.153)	
PHIGH	0.326***	0.356***	0.503***	0.003
	(0.085)	(0.118)	(0.160)	(0.144)
Belief if subordinate		–0.003**	–0.002	–0.005
		(0.001)	(0.001)	(0.003)
Belief if controlling party		0.003***	0.006***	0.012***
		(0.001)	(0.002)	(0.004)
# of Lotteries Declined			–0.062**	–0.120**
			(0.026)	(0.052)
Period Dummies?	Yes	Yes	Yes	Yes
Pseudo. R^2	.062	.112	.179	.176
Observations	1450	1450	750	300

Marginal effects of a probit regression. Significance levels: * p<0.1, ** p<0.05, *** p<0.01. Robust standard error in parentheses, clustered by individual. [a] Regret aversion measures are available only for sessions conducted in 2008-2011. [b] Column (4) includes data only from the HIGH and PHIGH treatments for which we have regret aversion measures, and HIGH is the omitted category.

Table C.4: Average effort levels vs. average beliefs across treatments

	Controlling Party Effort						**Subordinate Effort**					
	Principal has control			**Agent has control**			**Agent has control**			**Principal has control**		
	E		$\hat{E}$	e^d		$\hat{e}^d$	e		$\hat{e}$	E^d		$\hat{E}^d$
PLOW	55.7	**	64.8	68.1	**	59.6	22.8		30.4	16.5		21.8
LOW	66.1		66.9	68.3		68.4	14.3	***	27.5	16.2	*	20.9
HIGH	48.2	***	59.0	58.7		56.2	26.5	**	35.8	19.6	*	29.4
PHIGH	58.2	**	69.3	65.1		62.3	17.3	**	28.2	20.7		19.0

Significance levels calculated using a Wilcoxon Rank-Sum test with beliefs and effort averaged by individual prior to estimation. Significance levels: *** $p < .01$, ** $p < .05$, * $p < .1$. E is the principals' average effort with control. $\hat{E}$ is the agents' average belief about principals' effort with control. e^d is the agents' average effort with control. $\hat{e}^d$ is the principals' average belief about agents' effort with control. e is the agents' average effort in the subordinate role. $\hat{e}$ is the principals' average belief about agents' effort in the subordinate role. E^d is the principals' average effort in the subordinate role. $\hat{E}^d$ is the agents' average belief about principals' effort in the subordinate role.

Appendix D: Loss Aversion and Effort

In discussing the effort provision of a loss averse individual, we made the intuitive argument that loss aversion cannot explain the observed effort choices of the controlling party. This appendix shows that a controlling party who is loss averse will never choose effort which is above 60 but below 100. To simplify the equations, we follow the theory section and express all effort choices in decimal form (i.e., an effort of 60 is expressed as .6).

Following Koszegi and Rabin (2006), we assume that subjects have a utility function of the following form:

$$v(x) = \begin{cases} x - R & \text{if } x \geq R \\ (1+\lambda)(x-R) & \text{if } x < R \end{cases}, \tag{16}$$

where $\lambda \geq 0$ denotes the degree of loss aversion and R denotes the reference point. A natural reference point is $R = 10$, the value of project P_0 in each experiment. Recall that if subjects provide zero effort, they can always ensure a payoff of $P_0 = 10$ by choosing the known outside option. Also recall that $\hat{e}$ is the belief of the principal about the effort of the agent when she is the controlling party. We begin by proving the following:

Lemma 1 *Let $E^*(\lambda, \hat{e})$ be a local maximum of the principal's utility maximization problem when she is the controlling party with loss aversion λ and beliefs $\hat{e}$. Then $E^*(\lambda, \hat{e})$ is decreasing in loss aversion if $E^*(0, \hat{e}) < .65$.*

Proof. If $E < 0.65$, the cost of effort is below 10. Given the parameters in the authority game, this implies that losses relative to the reference point can only occur in the case that both the controlling party and the subordinate remain uninformed. We use this fact to circumvent non-differentiability around the reference point by restricting analysis to this region. The optimization problem of the principal when she is the controlling party is

$$\begin{aligned} \max_E U(E) = E(P_1 - R - g_P(E)) + (1-E)\hat{e}(P_2 - R - g_P(E)) \\ -(1+\lambda)(1-E)(1-\hat{e})(P_0 - R - g_P(E)). \end{aligned} \tag{17}$$

By assumption $R = P_0$, which implies that the corresponding first order condition is:

$$\begin{aligned} U'(E) = (\hat{P}_1 - g_P(E)) - Eg_P^{'}(E) - \hat{e}(\hat{P}_2 - g_P(E)) - g_P^{'}(E)\hat{e}(1-E) - \\ (1+\lambda)(1-\hat{e})[(g_P(E)) - g_P^{'}(E)(1-E)] = 0. \end{aligned} \tag{18}$$

Rearranging this equation and replacing $g_P^{'}(E)$ and $g_P(E)$ and $\hat{P}_1$ with their values which were constant across treatments yields:

$$U'(E) = -50E + 30 - \hat{e}\hat{P}_2 + 50\lambda(1-\hat{e})E\left[\frac{3}{2}E - 1\right] = 0. \tag{19}$$

Writing 19 as an implicit function, the FOC is satisfied when:

$$E = \frac{30 - \hat{e}\hat{P}_2}{50} + \lambda(1-\hat{e})E\left[\frac{3}{2}E - 1\right]. \tag{20}$$

The last term is negative for $E \in \left[0, \frac{2}{3}\right]$ and $\lambda > 0$. Thus, effort is decreasing in λ for all $E^*(0, \hat{e}) < .65$ (our initial condition for the considered case). ■

We now prove our main result:

Proposition 4 *Effort of a loss averse individual will never be above 60 but below 100.*

Proof. Equation 19 can be rewritten as follows:

$$U'(E) = 75\lambda(1-\hat{e})E^2 - 50[1 + \lambda(1-\hat{e})]E + 30 - \hat{e}\hat{P}_2 = 0. \tag{21}$$

Note that this equation is quadratic and thus has two roots. Taking the second derivative of U with respect to E we have:

$$U''(E) = 150\lambda(1-\hat{e})E - 50[1 + \lambda(1-\hat{e})]. \tag{22}$$

Thus, there is a unique inflection point at $E = \frac{1}{3}\frac{1+\lambda(1-\hat{e})}{\lambda(1-\hat{e})}$. The second derivative is negative to the left of this reflection point and positive to the right of this inflection point.

Solving the quadratic equation, E is a local maxima/minima at:

$$\frac{50[1 + \lambda(1-\hat{e})] \pm \sqrt{Z(\lambda)}}{150\lambda(1-\hat{e})}, \tag{23}$$

where $Z(\lambda) = 2500[1 + \lambda(1-\hat{e})]^2 - 300\lambda(1-\hat{e})[30 - \hat{e}\hat{P}_2]$. Also note that $Z(\lambda)$ is always greater than 0 so both roots exist. Comparing this to the inflection point, the left root is the local maximum. Next, using L'Hôpital's rule,

$$E^*(0, \hat{e}) = \lim_{\lambda \to 0} \frac{50[1 + \lambda(1-\hat{e})] - \sqrt{Z(\lambda)}}{150\lambda(1-\hat{e})} = \frac{[30 - \hat{e}\hat{P}_2]}{50} \leq .6 \tag{24}$$

By lemma 1, it follows that this unique local maximum is decreasing in loss aversion. As the unique local maximum is always below 60 and $E \in [0, 100]$, it follows that the global maxima are either below 60 or at the boundaries of $E = 0$ and $E = 100$. ■

Appendix E: Risk Aversion and Effort

In discussing the effort provision of a risk averse individual, we made an informal argument as to why risk aversion and risk lovingness cannot account for the effort provisions of the controlling party. This appendix provides numeric support for this argument for the case of CRRA utility. To simplify the equations, we follow the theory section and express all effort choices in decimal form (i.e., an effort of 60 is expressed as .6).

Recall that a controlling principal with belief $\hat{e}$ about the effort of the subordinate and a concave utility function has an expected utility of

$$\begin{aligned} U(E) = Eu(P_1 + w - g_P(E)) + \hat{e}(1-E)u(P_2 + w - g_P(E)) \\ +(1-\hat{e})(1-E)u(P_0 + w - g_P(E)) \end{aligned} \tag{25}$$

where w is wealth, $P_1 = 40$, $P_2 \in \{35, 20\}$, $P_0 = 10$, $g_P(E) = 25E^2$, and $\hat{e} \in \{0, .05, \ldots, 1\}$. As can be seen by studying the arguments on the right hand side of this equation, increasing effort has two effects. First, an increase in effort increases the probability of winning the highest valued gamble which strictly increases utility. Second, increasing effort decreases the utility earned for each of the three possible outcomes. As this second effect necessarily depends on the marginal utility of three separate points, it is easy to construct cases in which locally, effort is increasing in risk aversion. Such local non-monotonicity makes analytic analysis both tedious and unenlightening, particularly for extremely concave utility or those which do not satisfy decreasing relative risk aversion.

As the decision problem of the controlling party is inherently discrete, we take a more direct approach to determining the potential effect of risk aversion on effort. Starting with common parameterized risk aversion utility functions such as CRRA and CARA, we find the risk aversion parameters which maximize effort and then compare these effort levels to the risk neutral baseline.

As with loss aversion, there is potential that an extremely risk averse controlling party will choose an effort of 100 and ensure themselves P_1. As a first step of the analysis, we start by finding the lowest σ for which an individual with a CRRA utility will choose an effort of

1. Let

$$E(\sigma, \hat{e}) = arg\max_{E} Eu(P_1+w-g_P(E))+\hat{e}(1-E)u(P_2+w-g_P(E))+(1-\hat{e})(1-E)u(P_0+w-g_P(E)) \tag{26}$$

be the optimal effort of an individual with CRRA utility of the form $u(x) = \frac{x^{1-\sigma}}{1-\sigma}$ where $w \geq 16$ so that utility is always well defined. Next, define σ_1 to be the smallest risk aversion parameter such that $E(\sigma_1, \hat{e}) = 1$. It can be shown analytically that $E(\sigma, \hat{e}) = 1$ for all $\sigma > \sigma_1$ and thus that σ_1 is a sufficient statistic for the parameter space where full effort is predicted.

Our interest in risk aversion lies in being able to predict effort levels above the risk neutral prediction but below an effort of 1. The next step of our analysis is to look at the maximum possible effort which can be predicted for all $\sigma \in [-\infty, \sigma_1)$. Let

$$\sigma^*(\hat{e}) = arg \max_{\sigma \in [-\infty, \sigma_1)} E(\sigma, \hat{e}) \tag{27}$$

and define $E(\sigma^*(\hat{e}), \hat{e})$ as the effort level which corresponds to $\sigma^*(\hat{e})$. For all initial beliefs, we find $E(\sigma^*(\hat{e}), \hat{e})$ and compare this to $E(0, \hat{e})$, the effort predicted when an individual is risk neutral.

Table E.1: Maximum effort predicted by risk aversion

	Low Treatment					*High Treatment*			
$\hat{e}$	$\sigma^*(\hat{e})$	σ_1	$E(\sigma^*, \hat{e})$	$E(0, \hat{e})$	$\hat{e}$	$\sigma^*(\hat{e})$	σ_1	$E(\sigma^*, \hat{e})$	$E(0, \hat{e})$
0	$-0.7 - 0.6$	1.2	60	60	0	$-0.7 - 0.6$	1.2	60	60
10	$-0.3 - 0.3$	1.4	60	60	10	$-.9 - 0.7$	1.6	55	55
20	$-1.3 - 0.7$	1.6	55	55	20	$-1.1 - 0.7$	2.2	50	50
30	$-0.9 - 0.5$	2.0	55	55	30	$-1.2 - 0.8$	2.9	45	45
40	$-2 - 0.9$	2.5	50	50	40	$-1.4 - 0.9$	3.8	40	40
50	$-1.8 - 0.6$	3.2	50	50	50	$-1.5 - 1.3$	5.0	35	35

Table E.1 reports $\sigma^*(\hat{e})$, σ_1, as well as $E(\sigma^*(\hat{e}), \hat{e})$ and $E(0, \hat{e})$ for initial beliefs $\hat{e}$ in intervals of 10. As can be seen, $\sigma^*(\hat{e}) < 0$ for all initial beliefs revealing that an individual who is slightly risk loving will provide the highest effort. As can be seen in the last two columns of the table, however, the increase in effort for these individuals is not large enough to alter the effort predictions.

As we typically are most interested in small amounts of risk aversion, it is useful to also look at σ in the domain of $[0, \sigma_1)$. For all wealth and beliefs, it is the case that effort is maximal in this domain when $\sigma = 0$.

Just as with loss aversion, effort provision under risk aversion has a difficult time explaining effort levels above the risk neutral prediction. For all $w \geq 16$, all beliefs $\hat{e}$, and using both CRRA and CARA utility, it is never the case that $E(\sigma^*(\hat{e}), \hat{e}) - E(0, \hat{e}) > 5$. As 50 percent of our data lies 15 points above the risk neutral prediction, we cannot rationalize the over-provision of effort by the controlling party with risk preferences.

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