Two Styles of Communication*

Preliminary Version - Not to be Cited

Olivier Body †
Université Libre de Bruxelles - ECARES

September 2011

Abstract

Dewatripont and Tirole built an economic model about costly interpersonal communication (2005). In this model, a sender tries to persuade a receiver to accept a project. I extend it in 4 separate ways:
1) agents have social preferences;
2) the sender is uncertain about the receiver's social preferences;
3) the sender may choose the kind of arguments he communicates;
4) both agents are uncertain about their revenue attached to the project.

I show that for such a general setup, there are two types of communication differing in their objective.

On the one hand, the receiver may communicate *to get a high quality project*: he accepts the project if and only if he learns that it is of high quality. The receiver's communication objective is to increase his probability of earning the revenue of a high quality project.

On the other hand, the receiver may communicate *in order to avoid getting a low quality project*: he accepts the project unless he learns that it is of low quality. The receiver's communication objective is to decrease his probability of earning the revenue of a low quality project.

1 Introduction

In the *modes of communication* model (Dewatripont and Tirole 2005), a sender proposes a project to a receiver. If the receiver accepts the project, the sender gets a positive payoff. However the receiver is uncertain about the quality of

*This research has received funding from the FNRS. I am especially grateful to Georg Kirchsteiger and Mathias Dewatripont for their very helpful comments and discussions. I thank also all the participants of the ECARES seminar, of the ECORE Summer School, and of the 4th Maastricht Behavioral and Experimental Economics Symposium for their interesting questions and comments.

†Address: ECARES (Université Libre de Bruxelles), Avenue F.D. Roosevelt 50, CP139, 1050 Brussels, Belgium, e-mail: olivier.body@ulb.ac.be

the project prior to communication. The agents may therefore exert a costly communication effort to resolve this uncertainty. There are 3 possible communication outcomes :

1) communication succeeds and the agents learn that the project is of high quality;

2) communication succeeds and the agents learn that the project is of low quality;

3) communication fails and the agents do not know whether the project is of high or of low quality.

Consider for example that I am the sender and that I am presenting my paper to you, the receiver. You might be a referee deciding whether or not to recommend its publication. You might also be a reader choosing whether to read further or to stop after this paragraph.

There are other economically more relevant examples: a stakeholder that communicates to convince a politician to select a policy; a board of administrators/retail investor that decides whether or not to follow the CEO's/analyst's recommendation; a manager who chooses his communication strategy with his workers; a consumer that reacts positively to or remains unconvinced by an advertisement/public information campaign; a politician that chooses his level of communication efforts in order to win over potential voters; an employer that decides whether to hire a potential employee...

In this paper, I extend Dewatripont and Tirole's model by introducing separately 4 features into the analysis:

1) Social preferences

In the examples cited, it is unlikely that people are exclusively motivated by their material self-interest.

Communication raises the agents' awareness that their payoffs are interdependent.

Even if the primary objective of communication is to transmit information, communication may also generate emotions (empathy, attraction, envy...) and lead agents to judge one another. One's opinion of the other person is either positive or negative and may therefore involve social preferences.

Moreover, there is evidence in the psychological literature about the possible effect of emotions (such as guilt, envy, compassion,...) on persuasion (e.g. Dillar and Peck 2000, Nabi 2002). Our feelings, moods and emotions can influence the agents' evaluations of people and issues (Petty et al. 1988). Social/other-regarding preferences (reciprocity, altruism...) and communication seem therefore interrelated.

2) Agents are uncertain about the other agent's social preferences

Although people view self-interest as essential for motivating human behavior, they view it as a more crucial motivator of others than of themselves (Pronin 2007).

3) The sender may choose the kind of arguments he communicates

The sender may not only choose the amount of information that he communicates, his effort, but also its nature. The sender can decide whether to communicate about the positive aspects of the project or about the absence of negative ones.

4) Both agents are uncertain about their revenue attached to the project.

By extending Dewatripont and Tirole's model (2005) to these 4 cases, the main result of this paper is that there are two types/styles of communication differing in their objective.

In Dewatripont and Tirole's model, the receiver may only communicate *to get a high quality project*: he accepts the project if and only if he knows that it is of high quality (first communication outcome). Communication increases the receiver's probability of earning the revenue of a high quality project.

In this paper, the receiver may also communicate *in order to avoid getting a low quality project*: he accepts the project unless he knows it is of low quality (second communication outcome). In this case, the sender warns to some extent the receiver against accepting a low quality project. Communication decreases the receiver's probability of earning the revenue of a low quality project.

In each of the 4 extensions, let me explain why the sender communicates while the receiver accepts the project when communication fails:

1) The sender is willing to sacrifice to some extent his material payoff in order to raise the receiver's one.

2) The sender communicates because he is not certain about the receiver's communication objective; the sender does not know whether he is matched with a receiver that will rubber-stamp his recommendation (accepting the project without communication).

3) The sender communicates arguments about the negative aspects of the project in order to decrease the probability of the receiver of facing a low quality project. The sender's objective is to convince the receiver to accept the project when communication fails (third communication outcome). In this extension, if communication fails, you do not know whether communication has failed because the agents' communication efforts were too low or because the project is of high quality. Therefore the higher the communication efforts, the more likely the project is of high quality when communication fails.

4) The sender communicates because he wants to learn his revenue attached to the project.

The model initial setup is presented in the section 2.

In the 4 next sections, I extend the model in four separate ways in order to show that there might be two styles of communication. In the third section, I will also study the impact of social preferences on communication.

Finally, I present my concluding remarks in the last section.

2 Initial Setup

There are two parties : S, the sender, and R, the receiver. R is the decision maker and has 2 choices: the status quo, yielding zero revenue for both agents and an action A that, if implemented, yields revenue $s > 0$ for S, but might lead to a loss for R.

R's revenue r from action A is either r_H or r_L, with $r_H > 0 > r_L$. Let α denote the ex-ante (before communication) probability of r_H, measuring thus the riskiness of the project. It also represents the alignment of the 2 parties' interests regarding action A: $\alpha \in (0, 1)$. If α is close to 1 (0), R's and S's revenues are highly and positively (negatively) correlated.

To give an example, imagine from now on that this is a job market paper, and that you are the receiver and that I am the sender. You are a professor that decides whether to hire me, the candidate.

Based on my curriculum vitae, you estimate the probability that this is a high quality paper. For example, if I come from a very good university, you might think that α is quite high. You estimate before communication that hiring me will increase the reputation of your research unit by an amount r_H with probability α and will decrease its value by an amount $-r_L$ with probability $1-\alpha$.

S has information that, if assimilated by R, tells the agents whether R's revenue for taking action A is high or low. Both agents have to choose a communication effort: x for S and y for R. Both efforts are assumed to jointly determine the probability $p(x, y)$ that S's information is properly assimilated by R. Therefore, the information is hard with probability p and remains soft with probability $1-p$. To illustrate the results in the simplest manner, it is assumed that $p(x, y) = xy$.

There are thus 3 possible outcomes of communication:

1) with a probability $1-xy$, communication fails and the agents do not learn the quality of the project, whether $r = r_H$ or r_L;

2) with a probability $\alpha\ xy$, communication succeeds and the agents learn that the project is of high quality, $r = r_H$;

3) with a probability $(1-\alpha)xy$, communication succeeds and the agents learn that the project is of low quality, $r = r_L$.

Communication involves increasing and convex private costs $C_S(x)$ for S and $C_R(y)$ for R, with $\frac{\partial C_S(1)}{\partial x} = \frac{\partial C_R(1)}{\partial y} = \infty$; communication is thus subject to moral hazard in teams (à la Holmström 1982). I assume that $C_S(x)$ and $C_R(y)$ are continuous and differentiable on $(0, 1)$ and I allow for potential communication setup costs.

I have to spend time in preparing my presentation and in writing my paper. Conversely, you have to pay attention, decode and challenge the strengths and weaknesses of my paper.

Your time for analyzing and challenging my paper is costly. Similarly, writing my paper and preparing my presentation is time costly.

Concerning the timing of the different stages in the model, efforts are first chosen simultaneously. The agents' efforts and chance then determines whether communication is successful. Finally, R chooses whether to take action A.

3 Social Preferences

3.1 Setup

This section is built on the economic literature about social preferences. The models about social preferences assume that economic agents may also be concerned about the other agents' payoffs (Charness and Rabin 2002).

The objective of this section is to provide insights into the impact of social preferences on communication and not to compare the effects of various models of social preferences. This is the same reasoning as Fehr et al. (2001) who study the impact of fairness considerations on contractual choices; as Driscoll and Holden (2002) who explain inflation persistence through social preferences; or as Itoh (2004) who analyzes the optimal contract between a principal and an agent in the presence of moral hazard and social preferences.

For tractability reasons, I use a very simple form of interdependent preferences where agents are either altruistic or spiteful/envious. S's and R's utility functions are the following:

$$\begin{aligned} U_S =& E(\Pi_S) + \beta_S E(\Pi_R) \\ U_R =& E(\Pi_R) + \beta_R E(\Pi_S) \end{aligned}$$

$E(\Pi_R)$ and $E(\Pi_S)$ represent respectively R's and S's expected material payoffs. I assume that R cares about S's payoff and vice versa: the parameter β_S (β_R) captures the extent to which S (R) takes R's (S's) expected material payoff into consideration.

If β_S (β_R) is greater than 0, S (R) has altruistic concerns. If β_S (β_R) is lower than 0, S (R) is envious.

These utility functions are comparable to the ones in the literature about motivated agents (e.g. Besley and Ghatak 2005). A motivated agent perceives intrinsic benefits from pursuing his principal's pro-social mission.

On the one hand, I, the job-market candidate, may care positively about your expected material payoff because I am a motivated agent. I may share to some extent the pro-social goal of your research unit. This goal is to advance knowledge, in this case by recruiting a high quality candidate.

On the other hand, you, the recruiting professor, might care positively about my expected material payoff because you are a pro-social person caring about young colleagues. Alternately, I might have been strongly recommended by a friend of yours. Your decision whether to hire me may therefore affect your relationship with your friend.

3.2 The players' types of strategies and expected material payoffs

S's strategy consists of his level of effort x.

In contrast, R's strategy combines his level of effort, y, and his decision, z, concerning action A for any possible communication outcome. The variable z can take 8 values; only two of these values are relevant:

(1) $z = A$ iff $r = r_H$: R takes action A/accepts the project if and only if he learns through communication that $r = r_H$;

(2) $z = A$ unless $r = r_L$: R takes action A unless he learns through communication that $r = r_L$.

The classes of strategies playing another value of z are proven in appendix A to be either strictly dominated or equivalent to a strategy playing either action 1 or 2.

The players' expected material payoffs can therefore be of 2 types:

$$E(\Pi_R) = \begin{cases} xy\alpha r_H - C_R(y) & if\ z = A\ iff\ r = r_H; \\ \alpha r_H + (1 - xy)(1 - \alpha) r_L - C_R(y) & if\ z = A\ unless\ r = r_L. \end{cases}$$

$$E(\Pi_S) = \begin{cases} xy\alpha s - C_S(x) & if\ z = A\ iff\ r = r_H; \\ (1 - xy(1 - \alpha))s - C_S(x) & if\ z = A\ unless\ r = r_L. \end{cases}$$

When $z = A$ iff $r = r_H$, R $[S]$ gets a revenue r_H $[s]$ if communication is successful (with a probability xy) and if the project is of high quality (with a probability α).

When $z = A$ unless $r = r_L$, R always takes the action A yielding a revenue $\alpha r_H + (1 - \alpha) r_L$ $[s]$ for R $[S]$ unless R learns that the project is of low quality (with a probability $xy(1 - \alpha)$).

3.3 The Results

3.3.1 2 Types of Equilibria involving communication

The purpose of this paper is to study the characteristics of the equilibria involving communication. Before doing so, note that there always exists an equilibrium with zero effort levels ($x = y = 0$) for every possible value of α ($\alpha \in (0, 1)$) (proof: see appendix B).

There are two possible equilibria involving communication: the *communicating to get a high quality project* and the *communicating in order to avoid getting a low quality project* equilibria. The second equilibrium is the novelty of this paper because it does not exist without considering one of the 4 extensions of this paper.

1) In the ***communicating to get a project of high quality*** (***CH***) equilibrium, the agents communicate and R takes action A if and only if he learns that A is of high quality ($y^{*H} \neq 0$; $x^{*H} \neq 0$ and $z^* = A$ iff $r = r_H$).

In this equilibrium, R's and S's utilities are:

$$U_R = x^{*H} y^{*H} \alpha r_H - C_R(y^{*H}) + \beta_R E(\Pi_S)$$
$$U_S = x^{*H} y^{*H} \alpha s - C_S(x^{*H}) + \beta_S E(\Pi_R)$$

Therefore, R's and S's optimal efforts are a function of:

$$\frac{\partial C_R(y^{*H})}{\partial y} = x^{*H}\alpha(r_H + \beta_R s)$$
$$\frac{\partial C_S(x^{*H})}{\partial x} = y^{*H}\alpha(s + \beta_S r_H)$$

I present my job market paper while you, the recruiting professor, search for my strengths and challenge my arguments. You hire me if and only if you are convinced of my high quality.

2) In the ***communicating in order to avoid getting a low quality project*** (***CL***) equilibrium, S and R communicate and R takes action A unless he learns that the project is of low quality ($y^{*L} \neq 0$; $x^{*L} \neq 0$ and $z^* = A$ unless $r = r_L$).

In this equilibrium, R's and S's utilities are:

$$U_R = \alpha r_H + (1-\alpha)(1 - x^{*L}y^{*L})r_L - C_R(y^{*L}) + \beta_R E(\Pi_S)$$
$$U_S = (1 - x^{*L}y^{*L}(1-\alpha))s - C_S(x^{*L}) + \beta_S E(\Pi_R)$$

Therefore, R's and S's optimal efforts are a function of:

$$\frac{\partial C_R(y^{*L})}{\partial y} = x^{*L}(1-\alpha)(-r_L - \beta_R s)$$
$$\frac{\partial C_S(x^{*L})}{\partial x} = y^{*L}(1-\alpha)(-s - \beta_S r_L)$$

Notice that the higher the value of α, the lower both agents' communication efforts.

In this equilibrium, I present my job-market paper and let you search for my possible weaknesses. You recruit me unless you identify an important shortcoming through communication. You hire me even if you do not understand every point of the seminar.

This *equilibrium* is in certain respects the opposite one of the *CH* equilibrium: the agents communicate in order to avoid getting r_L and not in order to get r_H. It could also be called the *authorized vigilance* or the *warning equilibrium* because S prevents to some extent R from accepting a bad project.

Before characterizing the conditions of existence of the *CH* and the *CL* equilibria, let me first define the variables that determine the lower and upper bounds of the intervals of α in which each of these equilibria exist:

Definition 1

$$\alpha_R^* = \frac{-r_L - \beta_R\ s}{r_H - r_L}$$

If R exerts an effort $y \in [0,1]$, the variable α_R^* represents the level of α for which R is indifferent between $z = A$ iff $r = r_H$ and $z = A$ unless $r = r_L$.

Definition 2

$$i)\ \alpha_S^{**} = \frac{C_S(x^*)}{x^{*H}y^{*H}(s+\beta_S r_H)}$$
$$ii)\ \alpha_R^{**} = \frac{C_R(y^*)}{x^{*H}y^{*H}(r_H+\beta_R s)}$$

If $\beta_S > -\frac{s}{r_H}$, if R chooses $z = A$ iff $r = r_H$ and exerts a strictly positive effort y^{*H}, the variable α_S^{**} represents the minimum congruence parameter above which S does not deviate from x^{*H} to a zero effort.

Similarly, if $\beta_R > -\frac{r_H}{s}$, if R chooses $z = A$ iff $r = r_H$ and if S exerts a strictly positive effort x^{*H}, the variable α_R^{**} represents the level of α making R indifferent between exerting a strictly positive effort y^{*H} and not communicating at all.

Definition 3

$$i)\ \alpha_S^{***} = 1 - \frac{C_S(x^{*L})}{x^{*L}y^{*L}(-s-\beta_S r_L)}$$
$$ii)\ \alpha_R^{***} = 1 - \frac{C_R(y^{*L})}{x^{*L}y^{*L}(-r_L-\beta_R s)}$$

If $\beta_S > \frac{s}{-r_L}$, if R exerts a strictly positive effort y^{*L} and chooses the action $z = A$ unless $r = r_L$, the variable α_S^{***} represents the highest level of α under which S does not deviate from x^{*L} to a zero effort.

Similarly, if $\beta_R < \frac{-r_L}{s}$, if $z = A$ unless $r = r_L$ and if S exerts a strictly positive effort x^{*L}, the variable α_R^{***} represents the level of α making R indifferent between exerting an effort y^{*L} and not communicating at all.

Proposition 1 *The CH equilibrium exists provided that the following conditions hold:*

$$i)\ \max\{\alpha_S^{**};\ \alpha_R^{**}\} \leq \alpha \leq \alpha_R^*$$
$$ii)\ -\frac{s}{r_H} < \beta_S \text{ and } -\frac{r_H}{s} < \beta_R$$

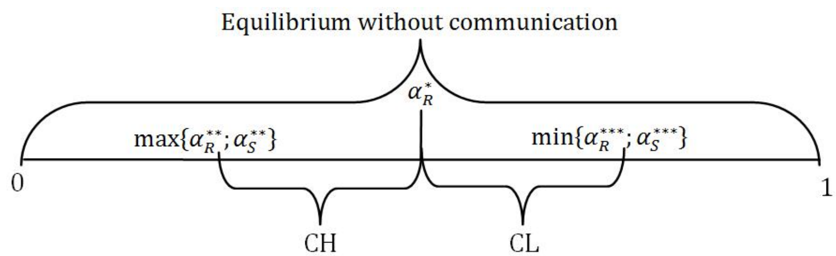
Proof: see appendix C.

Proposition 2 *The CL equilibrium exists provided that the following conditions hold:*

$$i)\ \alpha_R^* \leq \alpha \leq \min\{\alpha_S^{***}; \alpha_R^{***}\}$$
$$ii)\ \beta_R < \frac{-r_L}{s} \text{ and } \beta_S > \frac{s}{-r_L}$$

Proof: see appendix D.

The following figure shows the conditions of existence of the possible equilibria:



Before explaining the conditions of existence of the CH and of the CL equilibria, let me describe this figure.

For very low values of α ($\alpha < \max\{\alpha_R^{**}; \alpha_S^{**}\}$) and for very high values of α ($\alpha > \min\{\alpha_R^{***}; \alpha_S^{***}\}$), only an equilibrium without communication exists.

For low values of α ($\max\{\alpha_R^{**}; \alpha_S^{**}\} \leq \alpha \leq \alpha_R^*$), the *CH* equilibrium exists; and for high values of α ($\alpha_R^* \leq \alpha \leq \min\{\alpha_R^{***}; \alpha_S^{***}\}$), the *CL* equilibrium exists.

- The conditions on β_S and β_R:

This graphic is correct only if $\frac{-r_H}{s} < \beta_R < \frac{-r_L}{s}$ and $\beta_S > \frac{s}{-r_L}$.

If $\beta_S \leq \frac{s}{-r_L}$, the *CL* equilibrium cannot exist. In the *CL* equilibrium, S sacrifices a part of his expected material payoff $(x^{*L}y^{*L}(1-\alpha)s + C_S(x^{*L}))$ in order to increase R's expected material payoff $(-x^{*L}y^{*L}(1-\alpha)r_L - C_R(y^{*L}))$. S's altruistic concerns must therefore dominate S's interest about his own expected material payoff ($\beta_S > \frac{s}{-r_L}$).

The *CH* equilibrium can only exist if S is not too spiteful: $\beta_S > -\frac{s}{r_H}$. When R accepts a project of good quality, S benefits from a revenue s but possibly suffers from spiteful concerns $\beta_S r_H$. If $\beta_S \leq -\frac{s}{r_H}$ and if $\alpha \leq \alpha_R^*$, S does not communicate so that R never accepts any project.

Moreover, if $\beta_R \leq \frac{-r_H}{s}$ or $\beta_R \geq \frac{-r_L}{s}$, only an equilibrium without communication exists for every value of α. If $\beta_R \leq \frac{-r_H}{s}$, R is so envious that he never wants S to get a revenue s; therefore, R does not communicate and never accept the project ($z = A$ iff $r = r_H$). If $\beta_R \geq \frac{-r_L}{s}$, R is so altruistic that he always wants S to get a revenue s; therefore, R does not communicate and always accept the project ($z = A$ unless $r = r_L$).

- The boundaries α_R^{**}, α_S^{**}, α_R^{***} and α_S^{***}:

This graphic also supposes that there are communication setup costs for S and/or for R. Otherwise, the variable $\max\{\alpha_R^{**}; \alpha_S^{**}\}$ would be equal to 0 and the variable $\min\{\alpha_R^{***};\ \alpha_S^{***}\}$ would be equal to 1. On the other hand, the setup costs can be so high that the *CH* (*CL*) equilibrium does not exist for any value of α because $\max\{\alpha_S^{**};\ \alpha_R^{**}\}$ ($\min\{\alpha_S^{***};\ \alpha_R^{***}\}$) would be higher (lower) than α_R^*.

If $\alpha \geq \alpha_S^{**}$ ($\alpha \leq \alpha_S^{***}$) and if $\beta_S > -\frac{s}{r_H}$ ($\beta_S > \frac{s}{-r_L}$), S's cost of communication is lower than its overall benefits in the *CH* (*CL*) equilibrium. Therefore, if $\alpha < \alpha_S^{**}$ ($\alpha > \alpha_S^{***}$), the *CH* (*CL*) equilibrium does not exist because S would otherwise deviate to a zero communication effort. A comparable reasoning holds for R.

- The boundary α_R^*:

For a given effort y, the difference between $z = A$ iff $r = r_H$ and $z = A$ unless $r = r_L$ is that in the latter case R accepts the project when communication fails. Accepting the project when communication fails yields for R a payoff of $r_H + \beta_R s$ with probability α and a payoff of $r_L + \beta_R s$ with probability $1 - \alpha$. If $\beta_R > \frac{-r_H}{s}$, the higher α, the higher the opportunity cost of choosing $z = A$ iff $r = r_H$ in place of $z = A$ unless $r = r_L$. Therefore, in the *CH* (*CL*) equilibrium, if α was strictly higher (lower) than α_R^*, R would deviate to $z = A$ unless $r = r_L$ ($z = A$ unless $r = r_L$).

This section is needed in order to assess the impact of the agents' social preferences on the conditions of existence of the *CH* and the *CL* equilibria.

Corollary 1 *In the CH equilibrium, an increase in β_R and/or in β_S raises both agents' optimal communication efforts.*

In the CL equilibrium, an increase in β_R decreases both agents' optimal efforts while an increase in β_R raises both agents' optimal efforts.

Proof: see appendix E.

The following table shows the impact of β_R and β_S on both agents' efforts:

	CH	CL
$\nearrow \beta_R$	$\nearrow$ x and y	$\searrow$ x and y
$\nearrow \beta_S$	$\nearrow$ x and y	

On the one hand, an increase in β_S raises both agents' efforts in the *CH* and in the *CL* equilibria.

On the other hand, the impact of β_R on the efforts is of opposite sign in these two equilibria. Regarding the *CH* equilibrium, the higher β_R, the greater both agents' efforts; while in the *CL* equilibrium, a higher β_R implies lower efforts of both agents. *If you accept to hire me unless you learn that I am a low quality candidate, the higher your altruism, the less effort you exert because you do not want to be too picky/tough with me.*

Let me explain intuitively the impact of an increase in β_R/β_S on both agents' efforts. It affects agents' efforts in two ways: a direct and an indirect effect.

1) *The direct effect:*

If β_R (β_S) increases, R (S) cares more about S's (R's) expected material payoff.

In the *CH* equilibrium, the higher R's (S's) effort, the higher the probability that R accepts the project and that S (R) gets his revenue s (r_H). R (S) therefore chooses a higher effort in order to raise S's (R's) expected material payoff.

In the *CL* equilibrium, the higher R's (S's) effort, the lower the probability that R accepts the project and that S (R) gets his revenue s (r_L). R (S) therefore chooses a lower (higher) effort in order to raise S's (R's) expected material payoff.

2) *The indirect effect:*

An increase in an agent's effort raises linearly the other agent's benefit of communication while it does not affect the other agent's cost of communication. Higher effort by one agent raises thus the marginal return of the other agent's effort. Each agent is willing to try harder to communicate if the other also tries harder (assumption of complementary efforts).

Therefore, in the *CH* equilibrium, the increase in R's (S's) effort (due to the direct effect see point 1) raises in turn S's (R's) optimal efforts.

In the *CL* equilibrium, the decrease (increase) in R's (S's) effort (due to the direct effect see point 1) decreases (increases) in turn the S's (R's) optimal efforts.

Lastly, notice that in the *CH* equilibrium, an agent's utility is higher when he is matched with an altruistic player than when he is matched with an envious one. The higher an agent's altruism, the higher his effort. R and S prefer that the other agent exerts an higher effort.

In the *CL* equilibrium, an altruistic sender's effort and utility are higher when he is matched with an envious receiver than when he is matched with an altruistic one. The higher R's altruism, the lower his effort. S prefers that R exerts a higher effort. Note that in the *CL* equilibrium, R is never matched with an envious sender: this equilibrium exists only if $\beta_S > \frac{s}{-r_L} > 0$.

3.3.2 Comparison of the Agents' Efforts in the *CH* and in the *CL* Equilibria

There are 3 major differences between the agents' efforts in the *CH* and in the *CL* equilibria.

First, in the *CH* (*CL*) equilibrium, the agents' efforts depend on r_H (r_L) and not on r_L (r_H). R's communication objective is to increase (decrease) his probability of getting r_H (r_L). R is only interested in the communication outcome that tells that $r = r_H$ ($r = r_L$).

Second, the higher s and/or α, the higher (lower) both agents' efforts in the *CH* (*CL*) equilibrium.

Lastly, let me compare the agents' efforts when α crosses α_R^* in the *CH* and in the *CL* equilibria.

Proposition 3 *If the agents' efforts are not maximal (equal to 1) in the CL equilibrium, if* $\frac{-r_H}{s} < \beta_R < \frac{-r_L}{s}$ *and if* $\beta_S > \frac{s}{-r_L}$*, there is a downward discontinuity in both agents' efforts between the CH and the CL equilibria when* α *crosses* α_R^* *provided that* $\beta_R\ \beta_S < 1$*.*

This proposition is proven in the appendix F.

Notice that if $\beta_S \leq \frac{-r_L}{s}$, the *CL* equilibrium does not exist (see proposition 3). Similarly, if $\beta_R \geq \frac{-r_L}{s}$ and/or if $\beta_R \leq \frac{-r_H}{s}$, the *CH* and/or the *CL* equilibria do not exist (see propositions 2 and 3).

There is therefore a downward discontinuity in both agents' efforts unless R and S are strongly altruistic.

3.3.3 The Impact of Social Preferences on the Conditions of Existence of the Equilibria

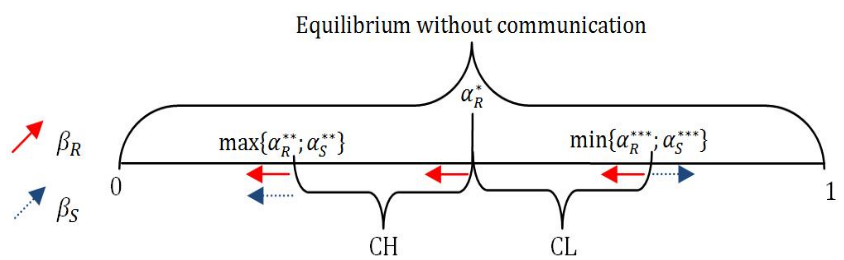
Proposition 4 *i) The higher β_R, the lower the upper (lower) bound, α_R^*, of the interval of α in which the CH (CL) equilibrium exists.*

ii) The higher β_R and/or β_S, the lower the lower bound, $\max\{\alpha_S^{**};\ \alpha_R^{**}\}$, *of the interval of α in which the CH equilibrium exists.*

iii) An increase in β_R (β_S) decreases (raises) the upper bound, $\min\{\alpha_S^{***};\alpha_R^{***}\}$, *of the interval of α in which the CL equilibrium exists.*

Proof: see appendix H.

The following figure shows the impact of the agents' social preferences on the conditions of existence of the possible equilibria:



The higher β_S and/or β_R, the lower the lower bound of the interval of α above which the *CH* equilibrium exists.

S's social preferences have no impact on α_R^* while an increase in β_R decreases α_R^*.

Finally, β_S and β_R have an opposite impact on the upper bound of the interval of α under which the *CL* equilibrium exists: β_R decreases this upper bound while β_S increases it.

Let me explain the impact of an increase in β_R/β_S on the boundaries of the *CH* and of the *CL* equilibria.

i) Impact on α_R^*

Recall that if α was strictly higher (lower) than α_R^* in the *CH* (*CL*) equilibrium, R would deviate to $z = A$ unless $r = r_L$ ($z = A$ iff $r = r_H$). For a given effort y, the difference between $z = A$ iff $r = r_H$ and $z = A$ unless $r = r_L$ is that in the latter case R accepts the project when communication fails. Accepting the project when communication fails yields for S a revenue s. This deviation increases thus S's expected material payoff. This is why an increase in β_R raises α_R^*.

On the other hand, S's social preferences have no impact on α_R^*. The reason is that S's strategy, x, does not influence R's decision about the value of z.

ii) Impact on α_S^{**} and α_R^{**}

An increase in β_S and/or in β_R decreases α_S^{**} and α_R^{**} in two ways: a direct and an indirect effect.

1) *The direct effect:*

An increase in β_S (β_R) decreases directly the variable α_S^{**} (α_R^{**}) through the increase of interest in R's (S's) expected material payoff.

Recall that if α was strictly lower than α_S^{**} (α_R^{**}) in the *CH* equilibrium, S (R) would deviate to a zero communication effort. The *CH* equilibrium exists provided that both agents are willing to communicate. If an agent deviates to a zero communication, it would take the communication benefit away from the other agent. This deviation decreases thus the other agent's expected material payoff. Therefore, the higher β_S (β_R), the more S (R) cares about the other agent's expected material payoff, the less likely S (R) deviates from the *CH* equilibrium to a zero communication effort.

2) *The indirect effect:*

An increase in β_S and/or in β_R decreases indirectly α_S^{**} and α_R^{**} through the increase in the other agent's effort (see corollary 1).

The increase in S's and/or in R's effort raises R's and S's expected material payoff and utility in the *CH* equilibrium and not when R and/or S deviates to a zero communication effort.

iii) Impact on α_S^{***} and α_R^{***}

An increase in β_S (β_R) raises (decreases) α_S^{***} and α_R^{***} in two ways: a direct and an indirect effect.

1) *The direct effect:*

An increase in β_S (β_R) raises (decreases) directly α_S^{***} (α_R^{***}) through the increase of interest in the other agent's material payoff.

Recall that if α was strictly higher than α_S^{***} (α_R^{***}) in this equilibrium, S (R) would deviate to a zero communication effort. If S (R) deviates so, it would to some extent prevent R (S) from getting the revenue r_L (s). This deviation decreases (increases) thus R's (S's) expected material payoff. Therefore, the higher β_S (β_R), the more S (R) cares about R's (S's) expected material payoff, the less (more) likely S (R) deviates from this equilibrium to a zero communication effort.

2) *The indirect effect:*

An increase in β_S (β_R) raises (decreases) indirectly α_S^{***} and α_R^{***} through the increase (decrease) in the other agent's effort (see corollary 1).

The decrease (increase) in R's (S's) effort lowers (raises) R's and S's utility in this equilibrium and not when R and/or S deviates to a zero communication effort.

4 Uncertainty about the Other Agent's Social Preferences

4.1 Setup

It is assumed in this section that the world is composed of two types of receivers that differ in their social preferences. S may thus be uncertain about R's effort and about R's decision concerning the project. *For example, I, the job-market candidate, do not know whether you, the recruiting professor, are envious or altruistic.*

The receiver is of type 1, $R1$, with probability $\lambda \in (0, 1)$ and is of type 2, $R2$, with probability $1 - \lambda$.

R1 (R2) is characterized by his social preferences β_{R1} (β_{R2}) with $\beta_{R1} > \beta_{R2}$; and chooses his communication efforts y_1 (y_2) and his decision z_1 (z_2).

The agents' utility functions are:

$$\begin{aligned} U_{Ri} &= E(\Pi_{Ri}) + \beta_{Ri} E(\Pi_S^i) \textit{ with } i \in \{1; 2\} \\ U_S &= \lambda U_S^1 + (1 - \lambda) U_S^2 \\ &= \lambda \left[E(\Pi_S^1) + \beta_S E(\Pi_{R1}) \right] + (1 - \lambda) \left[E(\Pi_S^2) + \beta_S E(\Pi_{R2}) \right] \end{aligned}$$

Where
- U_S^1 (U_S^2) is S's utility when he is matched with R1 (R2);
- $E(\Pi_S^1)$ $\left(E(\Pi_S^2)\right)$ is S's expected material payoff when he is matched with R1 (R2); and
- $E(\Pi_{R1})$ ($E(\Pi_{R2})$) is R1's (R2's) expected material payoff.

Let me first define two crucial thresholds before presenting the results:

Definition 4

$$\begin{aligned} \alpha_{R1}^* &= \frac{-r_L - \beta_{R1} s}{r_H - r_L} \\ \alpha_{R2}^* &= \frac{-r_L - \beta_{R2} s}{r_H - r_L} \end{aligned}$$

If R1 (R2) exerts an effort y_1 (y_2) $\in [0, 1]$, the threshold α_{R1}^* (α_{R2}^*) represents the level of α making R1 (R2) indifferent between choosing z_1 (z_2) $= A$ iff $r = r_H$ and z_1 (z_2) $= A$ unless $r = r_L$.

On the one hand, when $\alpha \leq \alpha_{R1}^*$ (α_{R2}^*), R1 (R2) chooses the action z_1 (z_2) $= A$ iff $r = r_H$. On the other hand, when $\alpha \geq \alpha_{R1}^*$ (α_{R2}^*), R1 (R2) chooses the action z_1 (z_2) $= A$ unless $r = r_L$.

4.2 Results

If $\alpha \leq (\geq) \alpha_{R1}^*$, R1 chooses $z_1 = A$ iff $r = r_H$ ($z_1 = A$ unless $r = r_L$); a similar reasoning holds for R2. This is proven in appendix H.

Again, there exists an equilibrium without communication for every value of α (proof: see appendix I).

Let me compare the intervals of α in which R1 and/or R2 communicate *to get a high quality project* ($z_1/z_2 = A$ iff $r = r_H$) or *in order to avoid a low quality project* ($z_1/z_2 = A$ unless $r = r_L$) between the **uncertainty case** (S does not know the receiver's social preferences), and the previous case, the **standard** case (S knows R's social preferences).

Since α^*_{R1} is always lower than α^*_{R2} (recall that $\beta_{R1} > \beta_{R2}$), the variables α^*_{R1} and α^*_{R2} determine three separate regions of α:

1) When $\alpha \leq \alpha^*_{R1}$, both types of receivers choose the action $z_1/z_2 = A$ iff $r = r_H$. If R1 and/or R2 exert a positive effort, they communicate *to get a high quality project.*

In this region of α, there exist 2 types of equilibria involving communication:

- An equilibrium A in which both types of receivers communicate *to get a high quality project.*

- An equilibrium B in which R1 communicates *to get a high quality project* and R2 refuses to listen while S tries to communicate. S talks to a brick wall when he is matched with R2.

I may present my paper during a job-market seminar while the audience is thinking and reading information about something else. I exert some communication effort because I do not know that I am facing an audience that does not listen.

2 results hold when $\alpha < \alpha^*_{R1}$:

a) R1 exerts a weakly higher effort than R2.

b) If R1 exerts a strictly positive effort in the standard case, R1 exerts a lower effort in the uncertainty case than in the standard case.

If R2 exerts a strictly positive effort in the uncertainty case, R2 exerts a higher effort in the uncertainty case than in the standard case.

This is due to the fact that R1 (R2)'s optimal effort influences S's optimal effort that in turn affects R2 (R1)'s optimal effort. In order to understand the intuition, recall two facts already explained in the section 3. First, when a receiver communicates to get a high quality project, the higher his altruism, the higher his effort. Second, the higher an agent's effort, the higher the other agent's effort.

I face with some probability an audience (R2) that does not exert any effort. The higher this probability, the lower the other agents' (S and R1) efforts.

These results are proven in the appendix J.

2) When $\alpha \geq \alpha^*_{R2}$, both types of receivers choose the action $z_1/z_2 = A$ unless $r = r_L$. If R1 and/or R2 exert a strictly positive effort, they communicate *in order to avoid getting a low quality project.*

In this region of α, there exist 2 types of equilibria involving communication:

- An equilibrium C in which both types of receivers communicate *in order to avoid getting a low quality project.*

- An equilibrium D in which R2 communicates *in order to avoid getting a low quality project* and R1 does not pay attention to S's communication.

2 results hold when $\alpha > \alpha^*_{R2}$:

a) R2 exerts a weakly higher effort than R1.

b) If R1 exerts a strictly positive effort in the uncertainty case, R1 exerts a higher effort in the uncertainty case than in the standard case.

Similarly, if R2 exerts a strictly positive effort in the standard case, R2 exerts a higher effort in the standard case than in the uncertainty case.

These results are proven in the appendix K.

3) When $\alpha^*_{R1} \leq \alpha \leq \alpha^*_{R2}$, R1 chooses the action $z_1 = A$ unless $r = r_L$ while R2 chooses action $z_2 = A$ iff $r = r_H$. If R1 (R2) exerts a positive effort, he communicates *in order (not) to get a high (low) quality project.*

In this region of α, there exist 3 types of equilibria involving communication:

- An equilibrium E in which both types of receivers communicate. R1 communicates *in order to avoid getting a low quality project* while R2 communicates *to get a high quality project.*

Importantly, R1 may communicate *in order to avoid getting a low quality project* even if S has no altruistic concerns when $\alpha^*_{R1} \leq \alpha \leq \alpha^*_{R2}$ (a non sufficient condition of existence of the equilibrium E).

Additionally to altruism, the uncertainty about R's communication objective may explain why S communicates although he is matched with R1. S is not certain that he is matched with a receiver that would accept the project without communication.

If I am not strongly altruistic ($\beta_S \leq \frac{-r_L}{s}$), I take time to prepare my presentation because I do not know my audience's communication objective. R1 rubber-stamps my recommendation to hire me ($z_1 = A$ unless $r = r_L$) while R2 does not ($z_2 = A$ iff $r = r_H$).

- An equilibrium F in which R1 communicates *in order to avoid getting a low quality project* and R2 refuses to listen to S's communication and never accepts the project.

- An equilibrium G in which R2 communicates *to get a high quality project* and R1 does not pay attention to S's communication and always accepts the project.

These results are proven in the appendix L.

Note that these results are not specific to the uncertainty about the other agent's social preferences. Uncertain about R's gain (for example, S believes that r_H is equal to r_{H1} with probability λ_{rH} and is equal to r_{H2} with probability $1 - \lambda_{rH}$, with $r_{H2} > r_{H1} > 0$ and $\lambda_{rH} \in (0, 1)$) and/or about the congruence parameter α (for example, S believes that α is equal to α_1 with probability λ_α and is equal to α_2 with probability $1 - \lambda_\alpha$, with $0 < \alpha_1 < \alpha_2 < 1$ and $\lambda_\alpha \in (0, 1)$) would lead to comparable results.

5 S chooses the kinds of arguments he communicates

5.1 Setup

In some situations, it is likely that S may not only choose the amount of information that he communicates, x, but also its nature, T. S can decide whether to communicate about the positive aspects of the project or about the absence of negative ones.

During my job market talk, I choose to some extent the kind of arguments I am going to present.

Let me explain what changes in this setup compared to the one about social preferences.

In this section, S's strategy is composed of his effort x and of the valence of his arguments T.

This variable T is observable and is chosen simultaneously with the actions x and y, and can take two values:

a) $T = H$: S chooses to communicate arguments that might tell R that his revenue is r_H.

I can present my seminar pretty much in the same way as a salesperson: I present my results as being outstanding; I present only the positive aspects of my research that could tell you I am a high quality candidate.

In this case, there are 2 possible outcomes of communication:

i) With probability $\alpha\, xy$, R learns through communication that $r = r_H$.

ii) With probability $1 - xy\alpha$, communication fails. R becomes more uncertain about the high quality of the project: the project is of high quality with a probability $\frac{(1-xy)\alpha}{1-xy\alpha}$ and the project is of low quality with a probability $\frac{1-\alpha}{1-xy\alpha}$.

If communication fails, you do not know whether communication has failed because our efforts were too low (for example, I was having an off day or you were not sufficiently concentrated on my seminar) or because I am a low quality candidate. When communication fails, you become more certain about my low quality than before the seminar.

b) $T = L$: S chooses to communicate arguments that might tell R that his revenue is r_L.

I can present my seminar as if I have a lack of self confidence and undersell my results. I insist for example on the limitations of my research that could tell you I am a low quality candidate.

In this case, there are 2 possible outcomes of communication:

i) With probability $xy(1-\alpha)$, R learns through communication that $r = r_L$.

ii) With probability $1-xy(1-\alpha)$, communication fails. The project is of high quality with a probability $\frac{\alpha}{1-xy(1-\alpha)}$ and the project is of low quality with a probability $\frac{(1-xy)(1-\alpha)}{1-xy(1-\alpha)}$.

If communication fails, you do not know whether communication has failed because our efforts were too low or because I am a high quality candidate. When communication fails, you become more certain about my high quality than before the seminar.

5.2 Results

The objective of this section is to show that even if agents are selfish, there are two types of communication: R may communicate *to get a high quality project* or *in order to avoid getting a low quality project.*

Proposition 5 *Selfish agents communicate about the positive aspects of the project ($T^* = H$) and R chooses action $z^* = A$ iff $r = r_H$, with efforts $\frac{\partial C_S(x^{*H})}{\partial x} = y^{*H}\alpha s$, $\frac{\partial C_R(y^{*H})}{\partial y} = x^{*H}\alpha r_H$, provided that the following conditions* *hold:*

$$i)\ \alpha \leq \frac{-r_L}{r_H - r_L};$$
$$ii)\ \alpha \geq \frac{C_R(y^{*H})}{x^{*H}y^{*H}r_H};\ \alpha \geq \frac{C_S(x^{*H})}{x^{*H}y^{*H}s};$$
$$iii)\ x^{*H}y^{*H}\alpha s - C_S(x^{*H}) \geq s(1 - x^{dev}y^{*H}(1-\alpha)) - C_S(x^{dev})$$
$$if\ \alpha \geq \frac{-(1-y^{*H})r_L}{r_H - (1-y^{*H})r_L}\ with\ x^{dev} = \frac{-\alpha r_H - (1-\alpha)r_L}{-y^{*H}(1-\alpha)r_L}$$

Proof: see appendix M. Let me briefly comment the conditions of this proposition.

i) This condition means that if the congruence parameter α is too high, S prefers not to communicate because R would accept the project without communication.

ii) If α is too low, the communication setup costs are too high for R and/or for S to be willing to communicate. The reasoning and the threshold are the same as in the section about social preferences but with $\beta_R = \beta_S = 0$.

iii) S should not prefer to communicate about the absence of negative aspects of the project ($T = L$). If S deviates so, S chooses the lowest level of effort that convinces R to accept the project when communication fails. The congruence parameter α should therefore not be too low, otherwise even the highest S's effort ($x = 1$) does not convince R to rubber-stamp S's recommendation ($z = A$ unless $r = r_L$).

Proposition 6 *Selfish agents communicate about the absence of negative aspects of the project ($T^* = L$) and R chooses action $z^* = A$ unless $r = r_L$, with efforts $x^{*L} = \frac{-\alpha r_H - (1-\alpha)r_L + C_R(y^{*L})}{-y^{*L}(1-\alpha)r_L}$, $\frac{\partial C_R(y^{*L})}{\partial y} = -x^{*L}(1-\alpha)r_L$, provided that the following conditions hold:*

$$i)\ \alpha \geq \frac{C_R(y^{*L}) - (1-y^{*L})r_L}{r_H - (1-y^{*L})r_L};$$
$$ii)\ \alpha < \frac{-r_L}{r_H - r_L};$$
$$iii)\ s(1 - x^{*L}y^{*L}(1-\alpha)) - C_S(x^{*L}) \geq x^{dev}y^{*L}\alpha s - C_S(x^{dev})\ if\ \alpha \geq \frac{C_S(x^{dev})}{x^{dev}y^{*L}s}$$
$$\alpha \geq \frac{-r_L C_S(x^{*L}) + C_R(y^{*L})s}{s\ r_H}\ if\ \alpha < \frac{C_S(x^{dev})}{x^{dev}y^{*L}s}\ with\ \frac{\partial C_S(x^{dev})}{\partial x} = y^{*L}\alpha s.$$

Proof: see appendix N. Let me briefly comment the conditions of this proposition.

i) The condition i means that if the congruence parameter α is too low, even the highest S's effort does not convince R to accept the project when communication fails ($z = A$ unless $r = r_L$).

ii) If α is too high, S does not need to exert a positive effort in order to convince R to accept the project when communication fails ($z = A$ unless $r = r_L$).

S chooses a strictly positive effort only if otherwise ($x = 0$), R would not accept the project ($z = A$ iff $r = r_H$).

Prior to communication, the project yields a negative expected payoff to R. By contrast, after a failed communication, the project yields a null expected material payoff to R.

iii) S should not prefer to communicate about the positive aspects of the project ($T = H$).

Notice that the model could be extended by differentiating the costs of the two types of communication. If communicating about the positive aspects of the project ($T = H$) is for example much more costly than communicating about the absence of negative ones ($T = L$), this would facilitate the condition *iii*.

It might be argued that S is not able to choose whether he communicates about the positive aspects of the project or about the absence of negative ones. The value of T may depend on S's personality. In such a case, first, only one type of equilibrium involving communication would exist for a particular sender. Second, the conditions iii of the propositions 6 and 7 would not be needed anymore.

6 Both agents are uncertain about their revenue

6.1 Setup

As R, S might also be uncertain about his revenue attached to the project. S may not know whether the project yields to him a positive or a negative revenue.

In the job market example, I might be uncertain about the quality of the unit research I am applying to. By meeting and getting to know to some extent the members of the unit research, S may learn the strengths and weaknesses of accepting the position. In this setup, we are both a sender and a receiver: I send you information for your decision and vice versa.

In this section, for the easiness of the notations, I consider that the 2 parties are receivers: R_i with $i \in \{0; 1\}$. R_i's revenue of action A, r_i, is either r_H or r_L, with $r_H > 0 > r_L$. Let $\alpha_i \in (0, 1)$ denote the ex-ante R_i's probability of r_H.

The agents learn about the quality of R_i's project, whether $r_i = r_H$ or r_L, with probability p_i. It is therefore assumed that the possible revenues are the same for both agents.

The variables α_1, α_2, p_1 and p_2 are independent, with $\frac{\partial p_i}{\partial y_i} > 0$ and $\frac{\partial^2 p_i}{\partial y_i^2} < 0$.

Communication involves increasing and convex private costs $C_1(y_1)$ for R_1 and $C_2(y_2)$ for R_2, with $\frac{\partial C_1(1)}{\partial y_1} = \frac{\partial C_2(1)}{\partial y_2} = \infty$. $C_1(y_1)$ and $C_2(y_2)$ are assumed to be continuous and differentiable on $(0, 1)$. Moreover, I allow for potential communication setup costs.

There are thus 3 possible outcomes of communication for R_1 (R_2):

1) with a probability $1-p_1$ $[1-p_2]$, communication fails and R_1 $[R_2]$ does not learn his revenue from the project, whether r_1 $[r_2] = r_H$ or r_L;

2) with a probability $\alpha_1\ p_1$ $[\alpha_2\ p_2]$, R_1 $[R_2]$ learns through communication that his revenue is r_H;

3) with a probability $(1-\alpha_1)p_1$ $[(1-\alpha_2)p_2]$, R_1 $[R_2]$ learns through communication that his revenue is r_L.

Concerning the timing of the different stages in the model, efforts are first chosen simultaneously. The agents' efforts and chance then determines whether communication is successful. Finally, R_1 and R_2 choose simultaneously whether to accept the action A. R_1 and R_2 get the revenue attached to the project provided that both agents accept the project.

R_i's strategy combines his level of effort, y_i, and his decision, z_i, concerning action A for any possible communication outcome.

Two values of z_i are relevant:

(1) $z_i = A$ iff $r_i = r_H$: R_i takes action A/accepts the project if and only if he learns through communication that $r_i = r_H$;

(2) $z_i = A$ unless $r_i = r_L$: R_i takes action A unless he learns through communication that $r_i = r_L$.

R_1's expected material payoff, $E(\Pi_1)$, can therefore be of 2 types:

$$E(\Pi_1) = \begin{cases} p_1\ p_2\ \alpha_1\ \alpha_2 r_H - C_1(y_1) \\ \quad if\ z_1 = A\ iff\ r_1 = r_H\ and\ if\ z_2 = A\ iff\ r_2 = r_H; \\ p_1\ \alpha_1(1-p_2\ (1-\alpha_2))r_H - C_1(y_1) \\ \quad if\ z_1 = A\ iff\ r_1 = r_H\ and\ z_2 = A\ unless\ r_2 = r_L; \\ p_2\ \alpha_2(\alpha_1 r_H + (1-p_1)(1-\alpha_1)r_L) - C_1(y_1) \\ \quad if\ z_1 = A\ unless\ r_1 = r_L\ and\ z_2 = A\ iff\ r_2 = r_H; \\ (1-p_2(1-\alpha_2))(\alpha_1 r_H + (1-p_1)(1-\alpha_1)r_L) - C_1(y_1) \\ \quad if\ z_1 = A\ unless\ r_1 = r_L\ and\ if\ z_2 = A\ unless\ r_2 = r_L \end{cases}$$

There are 3 possible types of equilibria involving communication:

Proposition 7 ***I)*** *R_1 communicates in order to avoid getting a low quality project ($z_1^* = A$ unless $r_1 = r_L$) and R_2 communicates to get a high quality project ($z_2^* = A$ iff $r_2 = r_H$) provided that:*

$$i)\alpha_2 \leq \frac{-r_L}{r_H - r_L} \leq \alpha_1$$
$$ii)\alpha_2 \geq \frac{C_2(y_2^*)}{p_2^*(1-p_1^*(1-\alpha_1))r_H}$$
$$iii)\alpha_1 \geq \frac{\frac{C_1(y_1^*)}{p_2^*\ \alpha_2} - (1-p_1^*)r_L}{r_H - (1-p_1^*)r_L}$$

II) *R_1 and R_2 communicate in order to avoid getting a low quality project ($z_1^* = A$ unless $r_1 = r_L$ and $z_2^* = A$ unless $r_2 = r_L$) provided that:*

$$i)\min\{\alpha_1, \alpha_2\} \geq \frac{-r_L}{r_H - r_L}$$

$$ii)\alpha_1 \leq \frac{-p_1^* r_L - p_2^*\ (1-\alpha_2) r_L (1-p_1^*) - C_1(y_1^*)}{p_2^*\ (1-\alpha_2) r_H - p_2^*\ (1-\alpha_2) r_L (1-p_1^*) - p_1^* r_L}$$

$$\alpha_2 \leq \frac{-p_2^* r_L - p_1^*\ (1-\alpha_1) r_L (1-p_2^*) - C_2(y_2^*)}{p_1^*\ (1-\alpha_1) r_H - p_1^*\ (1-\alpha_1) r_L (1-p_2^*) - p_2^* r_L}$$

III)*R_1 and R_2 communicate to get a high quality project ($z_1^* = A$ iff $r_1 = r_H$ and $z_2^* = A$ iff $r_2 = r_H$) provided that:*

$$i)\max\{\alpha_1, \alpha_2\} \leq \frac{-r_L}{r_H - r_L}$$

$$ii)\alpha_1 \geq \frac{C_1(y_1^*)}{p_1^*\ p_2^*\ \alpha_2 r_H}\ \textit{and}\ \alpha_2 \geq \frac{C_2(y_2^*)}{p_1^*\ p_2^*\ \alpha_1 r_H}$$

Proof: see appendix O.

Let me comment the conditions of existence of these equilibria.

I) i) If α_1 was too low, R_1 would deviate from $z_1^* = A$ unless $r_1 = r_L$ to $z_1 = A$ iff $r_1 = r_H$. Similarly, if α_2 was too high, R2 would deviate from $z_2^* = A$ iff $r_2 = r_H$ to $z_2 = A$ unless $r_2 = r_L$. Notice that the threshold $\frac{-r_L}{r_H - r_L}$ is the same as α_R^* in the section 3 but without social preferences ($\beta_R = \beta_S = 0$).

ii) If α_2 was too low, R_2 would deviate to a zero communication effort with $z_2 = A$ iff $r_2 = r_H$. R_2's cost of communication has to be lower than its benefits.

R_2 communicates in order to learn whether his revenue from the project is r_H. However, besides its costs, R_2's effort has another drawback for R_2. It might reveal that R_1's revenue from the project is r_L so that R_1 refuses the project. Therefore, the higher p_1^*, the harder the condition ii.

iii) If α_1 was too low, R_1 would deviate to a zero communication effort with $z_1 = A$ unless $r_1 = r_L$. The difference compared to the other extensions is that R1's material payoff is null when he deviates to a zero communication effort with $z_1 = A$ unless $r_1 = r_L$. The reason is that R_1 needs to convince R_2 to accept the project even if R_1 is ready to accept it without knowing its quality.

II) i) If α_1 (α_2) was too low, R_1 (R_2) would deviate to z_1 (z_2) $= A$ iff r_1 (r_2) $= r_H$.

ii) If α_1 was too high and/or if α_2 was too low, R_1 would deviate to a zero effort with $z_1 = A$ unless $r_1 = r_L$.

On the one hand, the higher α_1, the less likely the project is of low quality for R_1, the less R_1 is interested in knowing whether his revenue attached to the project is r_L.

On the other hand, R_1 communicates in order to prevent him from getting a low quality project. However, besides its costs, R_1's effort has another drawback for R_1. It might reveal that R_2's revenue from the project is r_L so that R_2 refuses the project. Therefore, the higher p_2^* and/or the lower α_2, the harder the condition ii.

A similar reasoning holds for R_2.

III) i) If α_1 (α_2) was too high, R_1 (R_2) would deviate to z_1 (z_2) $= A$ unless r_1 (r_2) $= r_L$.

ii) If α_1 (α_2) was too low, R_2 would deviate to a zero communication with z_1 (z_2) $= A$ iff r_1 (r_2) $= r_H$. R_1 (R_2) wants R_2's (R_1's) communication to succeed: R_2 (R_1) accepts the project if and only if he learns through communication that his revenue from the project is r_H. Therefore, a higher p_2^* (p_1^*) facilitates the condition ii.

7 Conclusion

I have shown that in each of the 4 extensions, the receiver may have two possible communication objectives. He communicates either to increase his probability of getting a high quality project, or to decrease his probability of getting a low quality project.

References

1. Aghion Philippe and Tirole Jean, *Formal and Real Authority in Organizations*, Journal of Political Economy, **105**, 1997, 1-29

2. Bertrand Marianne and Schoar Antoinette, *Managing with Style: The Effect of Managers on Firm Policies*, the Quarterly Journal of Economics, **118 (4)**,November 2003, 1169-1208

3. Becker Gary S., *A Theory of Social Interactions*, Journal of Political Economy, **82 (6)**,1974, 1063-1093

4. Besley Timothy and Ghatak Maitreesh, *Competition and Incentives with Motivated Agents*, The American Economic Review, **95 (3)**, June 2005, 616-636

5. Bolton E Gary and Ockenfels Axel, *ERC: A Theory of Equity, Reciprocity, and Competition*, American Economic Review, **90 (1)**, March 2000, 166-193

6. Charness Gary and Rabin Matthew, *Understanding Social Preferences with Simple Tests*, The Quarterly Journal of Economics, **117 (3)**, August 2002, 817-869

7. Dewan Torun and Myatt David P., *The Qualities of Leadership: Direction, Communication, and Obfuscation*, American Political Science Review, **102**, 2008, 351-368, Cambridge University Press

8. Dewatripont Mathias and Tirole Jean, *Modes of Communication*, Journal of Political Economy, **113 (6)**, 2005, 1217-1238

9. Dillard Jams Price and Peck Eugenia, *Affect and Persuasion: Emotional Responses to Public Service Announcements*, Communication Research, **27 (4)**, August 2000, 461-495

10. Driscoll John C. and Holden Steinar, *Coordination, Fair Treatment and Inflation Persistence*, NBER Working Paper No. 9174, 2002.

11. Dufwenberg Martin and Kirchsteiger Georg, *A Theory of Sequential Reciprocity*, Games and Economic Behavior, **47 (6)**, 2004, 268-298

12. Falk Armin and Fischbacher Urs, *A theory of reciprocity*, Games and Economic Behavior, **54 (2)**, February 2006, 293-315

13. Fehr Ernst and Schmidt M. Klaus, *A Theory of Fairness, Competition, and Cooperation*, Quarterly Journal of Economics, **114 (3)**, August 1999, 817-868

14. Fehr Ernst, Klein Alexander and Schmidt M. Klaus,*Fairness, Incentives and Contractual Incompleteness*,Institute for Empirical Research in Economics University of Zurich, February 2001, ISSN 1424-0459

15. Holmström Bengt, *Moral Hazard in Teams*, Bell J. Econ., **13**, 1982, 324-340

16. House Robert J. and Howell Jane M., *Personality and charismatic leadership*, The Leadership Quarterly, **3 (2)**, Summer 1992, 81-108

17. Itoh Hideshi, *Moral Hazard and Other-Regarding Preferences*, The Japanese Economic Review, **55 (1)**, 2004, 18-45

18. Nabi L. Robin, *Discrete Emotion and Persuasion*, In Dillard James Price and Pfau Michael (Eds.), The persuasion handbook: developments in theory and practice, Sage Publications, 2002, 289308

19. Petty E. Richard, Cacioppo T. John, Sedikides Constantine and Strathman J. Alan, *Affect and Persuasion: A Contemporary Perspective*, American Behavioral Scientist, **31 (3)**, January/February 1988, 355-371

20. Petty E. Richard, Cacioppo T. John, Strathman J. Alan and Priester R. Joseph, *To think or not to think: Exploring two routes to persuasion*, In Brock C. Timothy and Green C. Melanie (Eds.), Persuasion: Psychological insights and perspectives (2nd ed.), Sage Publications, 2005, 81-116

21. Emily Pronin, *Perception and misperception of bias in human judgment*, Trends in Cognitive Sciences, **11 (1)**, January 2007, 37-43

22. Rabin Matthew, *Incorporating Fairness into Game Theory and Economics*, American Economic Review, **83 (5)**, December 1993, 1281-1302

23. Radner Roy, *The Economics of Managing*, Journal of Economic Literature, **30 (3)**, September 1992, 1382-1415

24. Rotemberg Julio J. and Saloner Garth, *Leadership Style and Incentives*, Management Science, **39 (11)**, November 1993, 1299-1318

25. Sah Raj and Joseph Stiglitz, *The Architecture of Economic Systems: Hierarchies and Polyarchies*, American Economic Review, **76**, 1982, 716-727

26. Sobel Joel, *Interdependent Preferences and Reciprocity*, Journal of Economic Literature, **43**, June 2005, 392-436

27. van Engen Marloes L., van der Leeden Rien, Willemsen Tineke M., *Gender, context and leadership styles: a field study*, Journal of Occupational and Organizational Psychology, **74 (5)**, December 2001, 581-598

Appendix:

Two Styles of Communication

Very Preliminary Version - Not to be Cited

Olivier Body

September 2011

A The dominated strategies

Recall that there are three possible outcomes of communication:

a) communication fails and the agents do not know whether the project is of high or low quality; or

b) communication succeeds and the agents learn that the project is of high quality ($r = r_H$); or

c) communication succeeds and the agents learn that the project is of low quality ($r = r_L$).

The variable z can take 8 values:

(action 1) $z = A$ *iff* $r = r_H$: R takes action A if and only if he learns through communication that $r = r_H$ (R accepts the project if and only if the outcome of communication is b);

(action 2) $z = A$ *unless* $r = r_L$: R takes action A unless he learns through communication that $r = r_L$ (R accepts the project if and only if the outcome of communication is a or b);

(action 3) $z = A$ *iff* $r = r_L$: R takes action A if and only if he learns through communication that $r = r_L$ (R accepts the project if and only if the outcome of communication is c);

(action 4) $z = A$ *unless* $r = r_H$: R takes action A unless he learns through communication that $r = r_H$ (R accepts the project if and only if the outcome of communication is a or c);

(action 5) $z = A$ *iff* $r = r_L$ *or* $r = r_H$: R takes action A if and only if he learns through communication that $r = r_L$ or $r = r_H$ (R accepts the project if and only if the outcome of communication is b or c);

(action 6) $z = A$ *unless* $r = r_L$ *or* $r = r_H$: R takes action A unless he learns through communication that $r = r_L$ or $r = r_H$ (R accepts the project if and only if the outcome of communication is a);

(action 7) $z = A$: R always takes action A (R accepts the project whatever the outcome of communication);

(action 8) $z = 0$: R never takes action A (R does not accept the project whatever the outcome of communication).

The players' expected material payoffs are the following:

$$E(\Pi_R) = \begin{cases} xy\alpha r_H - C_R(y) & \Leftrightarrow z = A \ iff \ r = r_H; \\ \alpha r_H + (1-xy)(1-\alpha)r_L - C_R(y) & \Leftrightarrow z = A \ unless \ r = r_L; \\ xy(1-\alpha)r_L - C_R(y) & \Leftrightarrow z = A \ iff \ r = r_L; \\ (1-\alpha)r_L + (1-xy)\alpha r_H - C_R(y) & \Leftrightarrow z = A \ unless \ r = r_H; \\ xy(\alpha r_H + (1-\alpha)r_L) - C_R(y) & \Leftrightarrow z = A \ iff \ r = r_L or \ r = r_H; \\ (1-xy)(\alpha r_H + (1-\alpha)r_L) - C_R(y) & \Leftrightarrow z = A \ unless \ r = r_L \ or \ r = r_H; \\ \alpha r_H + (1-\alpha)r_L - C_R(y) & \Leftrightarrow z = A; \\ -R(y) & \Leftrightarrow z = 0. \end{cases}$$

$$E(\Pi_S) = \begin{cases} xy\alpha s - C_S(x) & \Leftrightarrow z = A \ iff \ r = r_H; \\ (1 - xy(1-\alpha))s - C_S(x) & \Leftrightarrow z = A \ unless \ r = r_L; \\ xy(1-\alpha)s - C_S(x) & \Leftrightarrow z = A \ iff \ r = r_L; \\ (1-xy\alpha)s - C_S(x) & \Leftrightarrow z = A \ unless \ r = r_H; \\ xys - C_S(x) & \Leftrightarrow z = A \ iff \ r = r_L or \ r = r_H; \\ (1-xy)s - C_S(x) & \Leftrightarrow z = A \ unless \ r = r_L \ or \ r = r_H; \\ s - C_S(x) & \Leftrightarrow z = A; \\ -C_S(x) & \Leftrightarrow z = 0. \end{cases}$$

Let me first consider the strategies that might be equivalent to one another.

If R does not communicate ($y = 0$), the actions 1, 3, 5 and 8 are equivalent; they lead to the same payoff outcomes:

$$\begin{aligned} If \ y = 0, U_R(z = A \ iff \ r = r_H) &= U_R(z = A \ iff \ r = r_L) \\ &= U_R(z = A \ iff \ r = r_L \ or \ r = r_H) = U_R(z = 0) = 0 \end{aligned}$$

If R does not communicate ($y = 0$), the actions 2, 4, 6 and 7 are equivalent.

$$\begin{aligned} &If \ y = 0, U_R(z = A \ unless \ r = r_L) = U_R(z = A \ unless \ r = r_H) = \\ &\qquad U_R(z = A \ unless \ r = r_L \ or \ r = r_H) = U_R(z = A) = \alpha r_H + (1-\alpha)r_L \end{aligned}$$

If S does not communicate ($x = 0$); the action 1 is equivalent to the action 3, and the action 2 is equivalent to the action 4.

$$\begin{aligned} &If \ x = 0, \ U_R(z = A \ iff \ r = r_H) = U_R(z = A \ iff \ r = r_L) = 0 \\ &\quad U_R(z = A \ unless \ r = r_L) = U_R(z = A \ unless \ r = r_H) = \alpha r_H + (1-\alpha)r_L \end{aligned}$$

Therefore, we are going to consider two simplifications.
1) If $y = 0$, only the actions 1 and 2 will be considered.
2) If $x = 0$, the actions 3 and 4 will not be considered.

Let me at present prove that with these two simplifications, the classes of strategies playing the actions 3 to 8 are strictly dominated by a strategy playing either action 1 or 2.

***a) The class of strategies playing action 3*:**

If $x \neq 0$ (cf. simplification 2), the strategies playing action 3 and an effort $y \in (0, 1]$ (cf. simplification 1) are strictly dominated by:

i) the strategy playing action 1 and $y = 0$ if $\beta_R \leq \frac{-r_L}{s}$; and by

ii) the strategy playing action 5 and a same effort y if $\beta_R > \frac{-r_H}{s}$.

$$i)\ U_R(z = A \textit{ iff } r = r_H;\ y = 0) > U_R(z = A \textit{ iff } r = r_L;\ y \neq 0)$$
$$\Leftrightarrow 0 > xy(1-\alpha)(r_L + \beta_R s) - C_R(y) \Leftrightarrow \beta_R \leq \frac{-r_L}{s}$$
$$ii)\ U_R(z = A \textit{ iff } r = r_L \textit{ or } r = r_H) > U_R(z = A \textit{ iff } r = r_L)$$
$$\Leftrightarrow xy\alpha r_H + xy(1-\alpha)r_L - C_R(y) + \beta_R(xys - C_S(x)) > xy(1-\alpha)r_L - C_R(y) + \beta_R(xy(1-\alpha)s - C_S(x))$$
$$\Leftrightarrow xy\alpha(r_H + \beta_R s) > 0 \Leftrightarrow \beta_R > \frac{-r_H}{s}$$

***b) The class of strategies playing action 5*:**

The strategies playing action 5 and an effort $y \in (0, 1]$ (cf. simplification 1) are strictly dominated by:

i) the strategy playing action 1 and $y = 0$ if $\alpha \leq \frac{-r_L - \beta_R s}{r_H - r_L}$; and by

ii) the strategy playing action 2 and $y = 0$ if $\alpha \geq \frac{-r_L - \beta_R s}{r_H - r_L}$.

$$i)\ U_R(z = A \textit{ iff } r = r_H;\ y = 0) > U_R(z = A \textit{ iff } r = r_L \textit{ or } r = r_H;\ y \neq 0)$$
$$\Leftrightarrow -\beta_R C_S(x) > xy(\alpha r_H + (1-\alpha)r_L + \beta_R s) - \beta_R C_S(x) - C_R(y)$$
$$\Leftrightarrow \alpha \leq \frac{-r_L - \beta_R s}{r_H - r_L}$$
$$ii)\ U_R(z = A \textit{ unless } r = r_L;\ y = 0) > U_R(z = A \textit{ iff } r = r_L \textit{ or } r = r_H;\ y \neq 0)$$
$$\Leftrightarrow \alpha r_H + (1-\alpha)r_L + \beta_R s - \beta_R C_S(x) > xy(\alpha r_H + (1-\alpha)r_L + \beta_R s) - \beta_R C_S(x)$$
$$\Leftrightarrow \alpha \geq \frac{-r_L - \beta_R s}{r_H - r_L}$$

***c) The class of strategies playing action 4*:**

If $x \neq 0$ (cf. simplification 2), the strategies playing action 4 and an effort $y \in (0, 1]$ (cf. simplification 1) are strictly dominated by

i) the strategy playing action 6 and a same effort y if $\beta_R < \frac{-r_L}{s}$; and by

ii) the strategy playing action 7 and a same effort y if $\beta_R > \frac{-r_H}{s}$.

$$i)\ U_R(z = A\ unless\ r = r_L\ or\ r = r_H) > U_R(z = A\ unless\ r = r_H)$$
$$\Leftrightarrow (1 - xy)(\alpha r_H + (1-\alpha)r_L + \beta_R s) - \beta_R C_S(x) - C_R(y) > xy(1-\alpha)(r_L + \beta_R s)$$
$$+ (1 - xy)(\alpha r_H + (1-\alpha)r_L + \beta_R s) - \beta_R C_S(x) - C_R(y) \Leftrightarrow \beta_R < \frac{-r_L}{s}$$
$$ii)\ U_R(z = A) > U_R(z = A\ unless\ r = r_H)$$
$$\Leftrightarrow (1-\alpha)r_L + \alpha r_H + \beta_R s - \beta_R C_S(x) - C_R(y) > xy(1-\alpha)(r_L + \beta_R s)$$
$$+ (1 - xy)(\alpha r_H + (1-\alpha)r_L + \beta_R s) - \beta_R C_S(x) - C_R(y)$$
$$\Leftrightarrow \beta_R > \frac{-r_H}{s}$$

***d) The class of strategies playing action 6*:**

The strategies playing action 6 and an effort $y \in (0, 1]$ (cf. simplification 1) are strictly dominated by

i) the strategy playing action 1 and $y = 0$ if $\alpha \leq \frac{-r_L - \beta_R s}{r_H - r_L}$; and by

ii) the strategy playing action 2 and $y = 0$ if $\alpha \geq \frac{-r_L - \beta_R s}{r_H - r_L}$.

$$i)\ U_R(z = A\ iff\ r = r_H;\ y = 0) > U_R(z = A\ unless\ r = r_L\ or\ r = r_H;\ y \neq 0)$$
$$\Leftrightarrow -\beta_R C_S(x) > (1 - xy)(\alpha r_H + (1-\alpha)r_L + \beta_R s) - \beta_R C_S(x) - C_R(y)$$
$$\Leftrightarrow \alpha \leq \frac{-r_L - \beta_R s}{r_H - r_L}$$
$$ii)\ U_R(z = A\ unless\ r = r_L;\ y = 0) > U_R(z = A\ unless\ r = r_L\ or\ r = r_H;\ y \neq 0)$$
$$\Leftrightarrow \alpha r_H + (1-\alpha)r_L + \beta_R s - \beta_R C_S(x) > (1 - xy)(\alpha r_H + (1-\alpha)r_L + \beta_R s)$$
$$- \beta_R C_S(x) - C_R(y) \Leftrightarrow \alpha \geq \frac{-r_L - \beta_R s}{r_H - r_L}$$

***e) The class of strategies playing either action 7 or 8*:**

The strategies playing action 7 and an effort $y \in (0, 1]$ (cf. simplification 1) are strictly dominated by the strategy playing action 2 and $y = 0$:

$$U_R(z = A\ unless\ r = r_L;\ y = 0) > U_R(z = A;\ y \neq 0)$$
$$\Leftrightarrow (1-\alpha)r_L + \alpha r_H + \beta_R(s - C_S(x)) > (1-\alpha)r_L + \alpha r_H + \beta_R(s - C_S(x)) - C_R(y)$$

The strategies playing action 8 and an effort $y \in (0, 1]$ (cf. simplification 1) are strictly dominated by the strategy playing action 1 and $y = 0$:

$$U_R(z = A\ iff\ r = r_H;\ y = 0) > U_R(z = 0;\ y \neq 0)$$
$$\Leftrightarrow -\beta_R C_S(x) > -\beta_R C_S(x) - C_R(y)$$

B Proof of proposition 1

I am going to show that:

i) if $\alpha \leq \alpha_R^*$, the *babbling equilibrium* ($x^* = y^* = 0$; $z^* = A$ iff $r = r_H$) always exists; and

ii) if $\alpha \geq \alpha_R^*$, the *real authority equilibrium* ($x^* = y^* = 0$; $z^* = A$ unless $r = r_L$) always exists.

i) The *babbling equilibrium* exists provided that the following conditions hold:

1) S (R) does not deviate to a strictly positive effort $x \neq 0$ ($y \neq 0$ with $z = A$ iff $r = r_H$); and

2) R does not deviate to $z = A$ unless $r = r_L$.

1) S (R) never deviates to a strictly positive effort because communicating when the other player is not exerting any effort is useless. It decreases S's (R's) own expected material payoff and it does not affect the other agent's expected material payoff.

2) R does not deviate to $z = A$ unless $r = r_L$ and $y = 0$ provided that:

$$\begin{aligned}
&U_R(y^* = x^* = 0;\ z^* = A\ iff\ r = r_H) \geq U_R(y = x^* = 0;\ z = A\ unless\ r = r_L)\\
&\geq U_R(y \neq 0;\ x^* = 0;\ z = A\ unless\ r = r_L)\\
&\Leftrightarrow 0 \geq \alpha r_H + (1-\alpha) r_L - C_R(y) + \beta_R s\\
&\Leftrightarrow \alpha \leq \frac{-r_L - \beta_R s}{r_H - r_L} = \alpha_R^*
\end{aligned}$$

Notice that when $x = 0$, R strictly prefers the strategy $y = 0$ and $z = A$ unless $r = r_L$ to the strategy $y \neq 0$ and $z = A$ unless $r = r_L$. It is the same reasoning as in point 1).

ii) The *real authority equilibrium* exists provided that R does not deviate to the strategy consisting in playing $y = 0$ and $z = A$ iff $r = r_H$:

$$\begin{aligned}
U_R(y^* = x^* = 0;\ z^* = A\ unless\ r = r_L) &\geq U_R(y = x^* = 0;\ z = A\ iff\ r = r_H)\\
&\Leftrightarrow \alpha r_H + (1-\alpha) r_L + \beta_R s \geq 0\\
&\Leftrightarrow \alpha \geq \frac{-r_L - \beta_R s}{r_H - r_L} = \alpha_R^*
\end{aligned}$$

It is not necessary to study the deviation to any other strategy because R strictly prefers not to communicate with $z = A$ iff $r = r_H$ ($z = A$ unless $r = r_L$) than to exert a strictly positive effort with $z = A$ iff $r = r_H$ ($z = A$ unless $r = r_L$).

C Proof of proposition 2

The *CH equilibrium* exists provided that the following conditions hold :

1) a) S does not deviate to $x = 0$;

b) R does not deviate to $y = 0$ and $z = A$ iff $r = r_H$;

2) R does not deviate to $z = A$ *unless* $r = r_L$:

a) R does not deviate to $y \neq 0$ and $z = A$ unless $r = r_L$;
b) R does not deviate to $y = 0$ and $z = A$ unless $r = r_L$.

Notice first that this equilibrium exists only if $\beta_R > -\frac{r_H}{s}$ and $\beta_S > -\frac{s}{r_H}$. Both conditions must hold in order for R and S to communicate in this equilibrium: $\frac{\partial C_R(y^{*H})}{\partial y} = x^{*H}\alpha(r_H + \beta_R s) > 0$ and $\frac{\partial C_S(x^{*H})}{\partial x} = y^{*H}\alpha(s + \beta_S r_H) > 0$ (see page 7 of the paper).

1) a) S does not deviate to $x = 0$ provided that:

$$U_S(y^{*H};\ x^{*H};\ z^* = A \ iff\ r = r_H) \geq U_S(y^{*H}; x = 0; z^* = A \ iff\ r = r_H)$$
$$\Leftrightarrow x^{*H}y^{*H}\alpha s - C_S(x^{*H}) + \beta_S(x^{*H}y^{*H}\alpha r_H - C_R(y^{*H})) \geq -\beta_S C_R(y^{*H})$$
$$\Leftrightarrow \alpha \geq \frac{C_S(x^{*H})}{x^{*H}y^{*H}(s + \beta_S r_H)} = \alpha_S^{**}$$

b) R does not deviate to $y = 0$ and $z = A$ iff $r = r_H$ provided that:

$$U_R(y^{*H};\ x^{*H};\ z^* = A \ iff\ r = r_H) \geq U_R(y = 0;\ x_H^*;\ z = A \ iff\ r = r_H)$$
$$\Leftrightarrow x^{*H}y^{*H}\alpha r_H - C_R(y^{*H}) + \beta_R(x^{*H}y^{*H}\alpha s - C_S(x^{*H})) \geq -\beta_R C_S(x^{*H})$$
$$\Leftrightarrow \alpha \geq \frac{C_R(y^{*H})}{x^{*H}y^{*H}(r_H + \beta_R s)} = \alpha_R^{**}$$

2)a) R does not deviate to the strategy $z = A$ unless $r = r_L$ and $y \neq 0$ provided that:

$$U_R(y \neq 0; x^{*H};\ z^* = A \ iff\ r = r_H) \geq U_R(y \neq 0; x^{*H}; z = A \ unless\ r = r_L)$$
$$\Leftrightarrow x^{*H}y\alpha r_H - C_R(y) + \beta_R(x^{*H}y\alpha s - C_S(x_H^*))$$
$$\geq x^{*H}y\alpha r_H + (1 - x_H^* y)(\alpha r_H + (1-\alpha)r_L) + \beta_R(x^{*H}y\alpha s + (1 - x^{*H}y)s - C_S(x^{*H}))$$
$$\Leftrightarrow \alpha \leq \frac{-r_L - \beta_R s}{r_H - r_L} = \alpha_R^*$$

b) R does not deviate to the strategy $z = A$ unless $r = r_L$ with $y = 0$ provided that:

$$U_R(y^{*H}; x^{*H}; z^* = A \ iff\ r = r_H) \geq U_R(y = 0; x^{*H}; z = A \ iff\ r = r_H)$$
$$\geq U_R(y = 0; x^{*H}; z = A \ unless\ r = r_L)$$

The first inequality holds if $\alpha \geq \alpha_R^{**}$ and $\beta_R > -\frac{r_H}{s}$, see point 1)a) and the preliminary point. The second inequality holds if $\alpha \leq \alpha_R^*$, see point 2)a). Therefore, when $\alpha \geq \alpha_R^{**}$, $\beta_R > -\frac{r_H}{s}$ and $\alpha \leq \alpha_R^*$, R does not deviate to the strategy $z = A$ unless $r = r_L$ and $y = 0$.

D Proof proposition 3

The CL equilibrium exists if the following conditions hold:

1) S does not deviate to $x = 0$;
2) R does not deviate to $y = 0$ and $z = A$ unless $r = r_L$;
3) R does not deviate to $y \neq 0$ and $z = A$ iff $r = r_H$;
4) R does not deviate to $y = 0$ and $z = A$ iff $r = r_H$.

Notice first that this equilibrium exists only if $\beta_R < \frac{-r_L}{s}$ and $\beta_S > \frac{s}{-r_L}$. Both conditions must hold in order for R and S to communicate in this equilibrium: $\frac{\partial C_R(y^{*L})}{\partial y} = x^{*L}(1-\alpha)(-r_L - \beta_R s) > 0$ and $\frac{\partial C_S(x^{*L})}{\partial x} = (1-\alpha)y^{*L}(-s - \beta_S r_L) > 0$ (see page 7 of the paper).

1) S does not deviate to $x = 0$ provided that:

$$\begin{aligned}
&U_S(y^{*L}; x^{*L};\ z^* = A \textit{ unless } r = r_L) \geq U_S(y^{*L};\ x = 0;\ z^* = A \textit{ unless } r = r_L)\\
&\Leftrightarrow x^{*L}y^{*L}\alpha s + (1 - x^{*L}y^{*L})s - C_S(x^{*L}) + \beta_S(x^{*L}y^{*L}\alpha r_H + (1 - x^{*L}y^{*L})(\alpha r_H\\
&+ (1-\alpha)r_L) - C_R(y^{*L})) \geq s + \beta_S(\alpha r_H + (1-\alpha)r_L - C_R(y^{*L}))\\
&\Leftrightarrow \alpha \leq 1 - \frac{C_S(x^{*L})}{x^{*L}y^{*L}(-s - \beta_S r_L)} = \alpha_S^{***}
\end{aligned}$$

2) R does not deviate to $y = 0$ and $z = A$ unless $r = r_L$ provided that:

$$\begin{aligned}
&U_R(y^{*L};\ x^{*L};\ z^* = A \textit{ unless } r = r_L) \geq U_R(y = 0;\ x^{*L};\ z = A \textit{ unless } r = r_L)\\
&\Leftrightarrow x^{*L}y^{*L}\alpha r_H + (1 - x^{*L}y^{*L})(\alpha r_H + (1-\alpha)r_L) - C_R(y^{*L}) + \beta_R(x^{*L}y^{*L}\alpha s\\
&+ (1 - x^{*L}y^{*L})s - C_S(x^{*L})) \geq \alpha r_H + (1-\alpha)r_L + \beta_R(s - C_S(x^{*L}))\\
&\Leftrightarrow \alpha \leq 1 - \frac{C_R(y^{*L})}{x^{*L}y^{*L}(-r_L - \beta_R s)} = \alpha_R^{***}
\end{aligned}$$

3) R does not deviate to $y \neq 0$ and $z = A$ iff $r = r_H$ provided that:

$$\begin{aligned}
&U_R(y \neq 0;\ x^{*L};\ z^* = A \textit{ unless } r = r_L) \geq U_R(y \neq 0;\ x^{*L};\ z = A \textit{ iff } r = r_H)\\
&\Leftrightarrow x^{*L}y\alpha r_H + (1 - x^{*L}y)(\alpha r_H + (1-\alpha)r_L) - C_R(y) + \beta_R(x^{*L}y\alpha s\\
&+ (1 - x^{*L}y)s - C_S(x^{*L})) \geq x^{*L}y\alpha r_H - C_R(y) + \beta_R(x^{*L}y\alpha s - C_S(x^{*L}))\\
&\Leftrightarrow \alpha \geq \frac{-r_L - \beta_R s}{r_H - r_L} = \alpha_R^*
\end{aligned}$$

4) R does not deviate to the strategy $z = A$ iff $r = r_H$ and $y = 0$ provided that:

$$\begin{aligned}
&U_R(y^{*L}; x^{*L}; z^* = A \textit{ unless } r = r_L) \geq U_R(y = 0; x^{*L}; z = A \textit{ unless } r = r_L)\\
&\geq U_R(y = 0; x^{*L}; z = A \textit{ iff } r = r_H)
\end{aligned}$$

The first inequality holds if $\alpha \leq \alpha_R^{***}$ and $\beta_R < -\frac{r_L}{s}$, see point 2) and the preliminary point. The second inequality holds if $\alpha \geq \alpha_R^*$, see point 3). Therefore, when $\alpha \leq \alpha_R^{***}$, $\beta_R < -\frac{r_L}{s}$ and $\alpha \geq \alpha_R^*$, R does not deviate to the strategy $z = A$ iff $r = r_H$ with $y = 0$.

E Proof of corollary 1

$$\begin{aligned}
\frac{\partial^2 C_R(y^{*H})}{\partial\beta_R \partial y} &= \frac{\partial x^{*H}}{\partial \beta_R}\alpha(r_H+\beta_R s)+x^{*H}\alpha s>0\\
\frac{\partial^2 C_R(y^{*H})}{\partial\beta_S \partial y} &= \frac{\partial x^{*H}}{\partial \beta_S}\alpha(r_H+\beta_R s)>0\\
\frac{\partial^2 C_S(x^{*H})}{\partial\beta_R \partial x} &= \frac{\partial y^{*H}}{\partial \beta_R}\alpha(s+\beta_S r_H)>0\\
\frac{\partial^2 C_S(x^{*H})}{\partial\beta_S \partial x} &= \frac{\partial y^{*H}}{\partial \beta_S}\alpha(s+\beta_S r_H)+y^{*H}\alpha r_H>0
\end{aligned}$$

$$\begin{aligned}
\frac{\partial^2 C_R(y^{*L})}{\partial\beta_R \partial y} &= (1-\alpha)\left(\frac{\partial x^{*L}}{\partial \beta_R}(-r_L-\beta_R s)-x^{*L}s\right)<0\\
\frac{\partial^2 C_R(y^{*L})}{\partial\beta_S \partial y} &= (1-\alpha)\frac{\partial x^{*L}}{\partial \beta_S}(-r_L-\beta_R s)>0\\
\frac{\partial^2 C_S(x^{*L})}{\partial\beta_R \partial x} &= (1-\alpha)\frac{\partial y^{*L}}{\partial \beta_R}(-s-\beta_S r_L)<0\\
\frac{\partial^2 C_S(x^{*L})}{\partial\beta_S \partial x} &= (1-\alpha)\left(\frac{\partial y^{*L}}{\partial \beta_S}(-s-\beta_S r_L)-y^{*L}r_L\right)>0
\end{aligned}$$

F Proof of proposition 4

First, when $\alpha=\alpha^*_R$, R's optimal effort in the CH equilibrium (y^{*H}) is strictly higher than in the CL equilibrium (y^{*L}) provided that:

$$\begin{aligned}
\frac{\partial C_R(y^{*H})}{\partial y} &= x^{*H}\alpha^*_R(r_H+\beta_R s)=x^{*H}\frac{-r_L-\beta_R s}{r_H-r_L}(r_H+\beta_R s)\\
\frac{\partial C_R(y^{*L})}{\partial y} &= x^{*L}(1-\alpha^*_R)(-r_L-\beta_R s)=x^{*L}\frac{r_H+\beta_R s}{r_H-r_L}(-r_L-\beta_R s)\\
\Rightarrow & y^{*H}>y^{*L}\Leftrightarrow x^{*H}>x^{*L}
\end{aligned}$$

Second, when $\alpha=\alpha^*_R$, S's optimal effort is strictly higher in the CH equilibrium (x^*_H) than in the CL equilibrium (x^*_L).

$$\begin{aligned}
&\begin{cases}
\frac{\partial C_S(x^{*H})}{\partial x} = \alpha^*_R y^{*H}(s+\beta_S r_H) = \frac{-r_L-\beta_R s}{r_H-r_L}y^{*H}(s+\beta_S r_H)\\[2ex]
\frac{\partial C_S(x^{*L})}{\partial x} = (1-\alpha^*_R)y^{*L}(-s-\beta_S r_L) = \frac{r_H+\beta_R s}{r_H-r_L}y^{*L}(-s-\beta_S r_L)
\end{cases}\\
&\Rightarrow x^{*H}>x^{*L}\ \left(\rightarrow\ y^{*H}>y^{*L}\right)\\
&\Leftrightarrow (-r_L-\beta_R s)(s+\beta_S r_H)>(r_H+\beta_R s)(-s-\beta_S r_L)\\
&\Leftrightarrow \beta_R\beta_S<1
\end{aligned}$$

G Proof of proposition 5

The CH equilibrium exists only if $-\frac{s}{r_H} < \beta_S$ and $-\frac{r_H}{s} < \beta_R$ (see proposition 2). Let me calculate the impact of the agents' social preferences on α_S^{**} and α_R^{**} when $-\frac{s}{r_H} < \beta_S$ and $-\frac{r_H}{s} < \beta_R$.

$$\begin{aligned}
\frac{\partial \alpha_S^{**}}{\partial \beta_S} &= \frac{A \ - \ B}{\left(x^{*H} y^{*H}(s+\beta_S r_H)\right)^2} \\
with\ A &= \frac{\partial C_S(x^{*H})}{\partial x}\frac{\partial x^{*H}}{\partial \beta_S} x^{*H} y^{*H}(s+\beta_S r_H) \\
&= \frac{\partial x^{*H}}{\partial \beta_S}\alpha_S^{**} x^{*H}(y^{*H})^2(s+\beta_S r_H)^2 \\
&= C_S(x^{*H})\frac{\partial x^{*H}}{\partial \beta_S} y^{*H}(s+\beta_S r_H) \\
with\ B &= C_S(x^{*H})\left(\left(\frac{\partial x^{*H}}{\partial \beta_S} y^{*H} + \frac{\partial y^{*H}}{\partial \beta_S} x^{*H}\right)(s+\beta_S r_H) + x^{*H} y^{*H} r_H\right)
\end{aligned}$$

$$\begin{aligned}
\Rightarrow \frac{\partial \alpha_S^{**}}{\partial \beta_S} &= \frac{-C_S(x^{*H})\left(\frac{\partial y^{*H}}{\partial \beta_S}(s+\beta_S r_H) + y^{*H} r_H\right)}{x^{*H}\left(y^{*H}(s+\beta_S r_H)\right)^2} < 0 \\
\Rightarrow \frac{\partial \alpha_S^{**}}{\partial \beta_R} &= \frac{-C_S(x^{*H})\frac{\partial y^{*H}}{\partial \beta_R}}{x^{*H}(s+\beta_S r_H)(y^{*H})^2} < 0 \\
\Rightarrow \frac{\partial \alpha_R^{**}}{\partial \beta_R} &= \frac{-C_R(y^{*H})\left(\frac{\partial x^{*H}}{\partial \beta_R}(r_H+\beta_R s) + x^{*H} s\right)}{y^{*H}\left(x^{*H}(r_H+\beta_R s)\right)^2} < 0 \\
\Rightarrow \frac{\partial \alpha_R^{**}}{\partial \beta_S} &= \frac{-C_R(y^{*H})\frac{\partial x^{*H}}{\partial \beta_S}}{(x^{*H})^2 y^{*H}(r_H+\beta_R s)} < 0
\end{aligned}$$

These 4 terms are negative because $\frac{\partial x^{*H}}{\partial \beta_S}$, $\frac{\partial y^{*H}}{\partial \beta_S}$, $\frac{\partial x^{*H}}{\partial \beta_R}$ and $\frac{\partial y^{*H}}{\partial \beta_R}$ are strictly higher than zero (see corollary 1).

The CL equilibrium exists only if $-\frac{s}{r_L} < \beta_S$ and $\beta_R < \frac{-r_L}{s}$ (see proposition 5). Let me calculate the impact of the agents' social concerns on α_S^{***} and α_R^{***}

when $-\frac{s}{r_L} < \beta_S$ and $-\frac{r_H}{s} < \beta_R < \frac{-r_L}{s}$.

$$\begin{aligned}
\frac{\partial \alpha_S^{***}}{\partial \beta_S} &= \frac{-\frac{\partial C_S(x^{*L})}{\partial x}\frac{\partial x^{*L}}{\partial \beta_S} x^{*L} y^{*L}(-s-\beta_S r_L)}{\left(x^{*L} y^{*L}(-s-\beta_S r_L)\right)^2} \\
&+ \frac{C_S(x^{*L})\left[\left(\frac{\partial x^{*L}}{\partial \beta_S} y^{*L} + \frac{\partial y^{*L}}{\partial \beta_S} x^{*L}\right)(-s-\beta_S r_L) - r_L x^{*L} y^{*L}\right]}{\left(x^{*L} y^{*L}(-s-\beta_S r_L)\right)^2} \\
&= \frac{C_S(x^{*L})\left[\frac{\partial y^{*L}}{\partial \beta_S}(-s-\beta_S r_L) - r_L y^{*L}\right]}{x^{*L}\left(y^{*L}(-s-\beta_S r_L)\right)^2} > 0
\end{aligned}$$

$$\begin{aligned}
\frac{\partial \alpha_S^{***}}{\partial \beta_R} &= \frac{-\frac{\partial C_S(x^{*L})}{\partial x}\frac{\partial x^{*L}}{\partial \beta_R} x^{*L} y^{*L}(-s-\beta_S r_L)}{\left(x^{*L} y^{*L}(-s-\beta_S r_L)\right)^2} \\
&+ \frac{C_S(x^{*L})\left(\frac{\partial x^{*L}}{\partial \beta_R} y^{*L} + \frac{\partial y^{*L}}{\partial \beta_R} x^{*L}\right)(-s-\beta_S r_L)}{\left(x^{*L} y^{*L}(-s-\beta_S r_L)\right)^2} \\
&= \frac{C_S(x^{*L})\frac{\partial y^{*L}}{\partial \beta_R}}{x^{*L}\left(y^{*L}\right)^2(-s-\beta_S r_L)} < 0
\end{aligned}$$

$$\begin{aligned}
\frac{\partial \alpha_R^{***}}{\partial \beta_R} &= \frac{-\frac{\partial C_R(y^{*L})}{\partial y}\frac{\partial y^{*L}}{\partial \beta_R} x^{*L} y^{*L}(-r_L-\beta_R s)}{\left(x^{*L} y^{*L}(-r_L-\beta_R s)\right)^2} \\
&+ \frac{-C_R(y^{*L})\left[\left(\frac{\partial x^{*L}}{\partial \beta_R} y^{*L} + \frac{\partial y^{*L}}{\partial \beta_R} x^{*L}\right)(-r_L-\beta_R s) - s x^{*L} y^{*L}\right]}{\left(x^{*L} y^{*L}(-r_L-\beta_R s)\right)^2} \\
&= \frac{C_R(y^{*L})\left[\frac{\partial x^{*L}}{\partial \beta_R}(-r_L-\beta_R s) - s x^{*L}\right]}{y^{*L}\left(x^{*L}(-r_L-\beta_R s)\right)^2} < 0
\end{aligned}$$

$$\begin{aligned}
\frac{\partial \alpha_R^{***}}{\partial \beta_S} &= \frac{-\frac{\partial C_R(y^{*L})}{\partial y}\frac{\partial y^{*L}}{\partial \beta_S} x^{*L} y^{*L}(-r_L-\beta_R s)}{\left(x^{*L} y^{*L}(-r_L-\beta_R s)\right)^2} \\
&+ \frac{C_R(y^{*L})\left(\frac{\partial x^{*L}}{\partial \beta_S} y^{*L} + \frac{\partial y^{*L}}{\partial \beta_S} x^{*L}\right)(-r_L-\beta_R s)}{\left(x^{*L} y^{*L}(-r_L-\beta_R s)\right)^2} \\
&= \frac{C_R(y^{*L})\frac{\partial x^{*L}}{\partial \beta_S}}{\left(x^{*L}\right)^2 y^{*L}(-r_L-\beta_R s)} > 0
\end{aligned}$$

The terms $\frac{\partial \alpha_S^{***}}{\partial \beta_S}$ and $\frac{\partial \alpha_R^{***}}{\partial \beta_S}$ are strictly positive because $\frac{\partial x^{*L}}{\partial \beta_S}$ and $\frac{\partial y^{*L}}{\partial \beta_S}$ are strictly higher than zero. The terms $\frac{\partial \alpha_S^{***}}{\partial \beta_R}$ and $\frac{\partial \alpha_R^{***}}{\partial \beta_R}$ are strictly negative because

$\frac{\partial x^{*L}}{\partial \beta_R}$ and $\frac{\partial y^{*L}}{\partial \beta_R}$ are strictly lower than zero (see corollary 2).

Finally, the impact of social preferences on the threshold α_R^* is straightforward: $\frac{\partial \alpha_R^*}{\partial \beta_R} = \frac{-s}{r_H - r_L}$ and $\frac{\partial \alpha_R^*}{\partial \beta_S} = 0$.

H Choice between the action z_1 $(z_2) = A$ iff $r = r_H$ and the action z_1 $(z_2) = A$ unless $r = r_L$

R1 prefers to choose action $z_1 = A$ iff $r = r_H$ than the action $z_1 = A$ unless $r = r_L$ provided that:

$$U_{R1}(z_1 = A \; iff \; r = r_H) \geq U_{R1}(z_1 = A \; unless \; r = r_L) \Leftrightarrow xy_1\alpha(r_H + \beta_{R1}s)$$
$$- C_R(y_1) \geq xy_1\alpha(r_H + \beta_{R1}s) + (1 - xy_1)(\alpha r_H + (1-\alpha)r_L + \beta_{R1}s) - C_R(y_1)$$
$$\Leftrightarrow \alpha \leq \frac{-r_L - \beta_{R1}s}{r_H - r_L} = \alpha_{R1}^*$$

Similarly, R2 prefers to choose action $z_2 = A$ iff $r = r_H$ than the action $z_2 = A$ unless $r = r_L$ if and only if $\alpha \leq \frac{-r_L - \beta_{R2}s}{r_H - r_L} = \alpha_{R2}^*$.

I Uncertainty: proof that there always exists an equilibrium without communication

I am going to show that:

i) if $\alpha \leq \alpha_{R1}^*$, the *babbling equilibrium* ($x^* = y_1^* = y_2^* = 0$; $z_1^* = z_2^* = A$ iff $r = r_H$) always exists;

ii) if $\alpha \geq \alpha_{R2}^*$, the *real authority equilibrium* ($x^* = y_1^* = y_2^* = 0$; $z_1^* = z_2^* = A$ unless $r = r_L$) always exists; and

iii) if $\alpha_{R1}^* \leq \alpha \leq \alpha_{R2}^*$, the *babbling - real authority equilibrium* ($x^* = y_1^* = y_2^* = 0$; $z_1^* = A$ unless $r = r_L$ and $z_2^* = A$ iff $r = r_H$) always exists.

i) In the *babbling* equilibrium, no one communicates and both types of receivers never accept the project ($y_1^* = y_2^* = x^* = 0$ and $z_1^* = z_2^* = A$ iff $r = r_H$).

In this equilibrium, the agents' utility are equal to zero.

The *babbling equilibrium* exists provided that the following conditions hold :

1) S, R1 and R2 never deviate to a strictly positive effort because communicating when the other player is not exerting any effort is useless.
2) R1 does not deviate to $z_1 = A$ unless $r = r_L$ provided that $\alpha \leq \alpha_{R1}^*$.

Similarly, R2 does not deviate to $y_2 = 0$ and $z_2 = A$ unless $r = r_L$ provided that $\alpha \leq \alpha^*_{R2}$.

The variable α^*_{R2} is always higher than the variable α^*_{R1} since $\beta_{R1} > \beta_{R2}$.

ii) In the *real authority* equilibrium, no one communicates and both types of receivers always accept the project ($y^*_1 = y^*_2 = x^* = 0$ and $z^*_1 = z^*_2 = A$ unless $r = r_L$).

In this equilibrium, the agents' utility functions are the following:

$$
\begin{aligned}
U_{R1} &= \alpha r_H + (1-\alpha) r_L + \beta_{R1} s \\
U_{R2} &= \alpha r_H + (1-\alpha) r_L + \beta_{R2} s \\
U_S &= s + \beta_S \left(\alpha r_H + (1-\alpha) r_L\right)
\end{aligned}
$$

This equilibrium exists provided that the following conditions hold:

1) R1 (R2) does not deviate to the strategy $y_1 = 0$ ($y_2 = 0$) and z_1 (z_2) $= A$ iff $r = r_H$ provided that $\alpha \geq \alpha^*_{R1}$ ($\alpha \geq \alpha^*_{R2}$).

Since $\beta_{R1} > \beta_{R2}$, α^*_{R1} is lower than α^*_{R2}.

It is not necessary to study the deviation to any other strategy because S, R1 and/or R2 never deviate to a positive effort. Communicating while the other player is not exerting any effort is useless.

iii) In the *babbling - real authority equilibrium*, no one communicates; R1 always accepts the project and R2 never accepts the project ($y^*_1 = y^*_2 = x^* = 0$; $z^*_1 = A$ unless $r = r_L$ and $z^*_2 = A$ iff $r = r_H$).

In this equilibrium, the agents' utilities are the following:

$$
\begin{aligned}
U_{R1} &= \alpha r_H + (1-\alpha) r_L + \beta_{R1} s \\
U_{R2} &= 0 \\
U_S &= \lambda s + \beta_S \lambda \left(\alpha r_H + (1-\alpha) r_L\right)
\end{aligned}
$$

The *babbling - real authority equilibrium* exists provided that the following conditions hold:

1) R1 does not deviate to the strategy $y_1 = 0$ and $z_1 = A$ iff $r = r_H$ provided that $\alpha \geq \alpha^*_{R1}$.

2) R2 does not deviate to the strategy $y_2 = 0$ and $z_2 = A$ unless $r = r_L$ provided that $\alpha \leq \alpha^*_{R2}$.

3) It is not necessary to study the deviation to any other strategy because S, R1 and R2 never deviate to a positive communication effort. Communicating while the other player is not exerting any effort is useless.

This proof follows the same reasoning as when S knows the receiver's social preferences.

J Uncertainty: proofs of the statements when $\alpha \leq \alpha^*_{R1}$

Let me first state and prove the 3 possible equilibria when $\alpha \leq \alpha^*_{R1}$.

J.1 Equilibrium A

In this equilibrium, everyone communicates; R1 and R2 take action A if and only if they learn through communication that the project is of high quality ($y_1^{*A} \neq 0$; $y_2^{*A} \neq 0$; $x^{*A} \neq 0$ and $z_1^* = z_2^* = A$ iff $r = r_H$).

In this *equilibrium*, the agents' utilities are the following:

$$
\begin{aligned}
U_{R1} &= x^{*A} y_1^{*A} \alpha (r_H + \beta_{R1} s) - C_R(y_1^{*A}) - \beta_{R1} C_S(x^{*A}) \\
U_{R2} &= x^{*A} y_2^{*A} \alpha (r_H + \beta_{R2} s) - C_R(y_2^{*A}) - \beta_{R2} C_S(x^{*A}) \\
U_S &= x^{*A} (\lambda y_1^{*A} + (1-\lambda) y_2^{*A}) \alpha (s + \beta_S r_H) - C_S(x^{*A}) \\
&\quad - \beta_S (\lambda C_R(y_1^{*A}) + (1-\lambda) C_R(y_2^{*A}))
\end{aligned}
$$

Therefore, the agents' optimal communication efforts are a function of:

$$
\begin{aligned}
\frac{\partial C_R(y_1^{*A})}{\partial y_1} &= x^{*A} \alpha (r_H + \beta_{R1} s) \\
\frac{\partial C_R(y_2^{*A})}{\partial y_2} &= x^{*A} \alpha (r_H + \beta_{R2} s) \\
\frac{\partial C_S(x^{*A})}{\partial x} &= \lambda y_1^{*A} \alpha (s + \beta_S r_H)
\end{aligned}
$$

Before stating and proving the conditions of existence of the equilibrium A, let me define the variables that determine the lower bound of the interval of α in which this equilibrium exists.

$$
\begin{aligned}
\alpha_{R1}^{**A} &= \frac{C_R(y_1^{*A})}{x^{*A} y_1^{*A} (r_H + \beta_{R1} s)} \\
\alpha_S^{**A} &= \frac{C_S(x^{*A})}{x^{*A} (\lambda y_1^{*A} + (1-\lambda) y_2^{*A})(s + \beta_S r_H)} \\
\alpha_{R2}^{**A} &= \frac{C_R(y_2^{*A})}{x^{*A} y_2^{*A} (r_H + \beta_{R2} s)}
\end{aligned}
$$

If S exerts a strictly positive effort x^{*A} and if $\beta_{R1} > -\frac{r_H}{s}$ ($\beta_{R2} > -\frac{r_H}{s}$), the variable α_{R1}^{**A} (α_{R2}^{**A}) represents the minimum congruence parameter above which R1 (R2) does not deviate from y_1^{*A} (y_2^{*A}) with z_1 (z_2) $= A$ iff $r = r_H$ to a zero communication effort with z_1 (z_2) $= A$ iff $r = r_H$.

Note that α_{R1}^{**A} is lower than α_{R2}^{**A} because $\beta_{R1} > \beta_{R2}$.

If R1 and R2 exert a strictly positive effort, respectively y_1^{*A} and y_2^{*A}, and if $\beta_S > -\frac{s}{r_H}$, the variable α_S^{**A} represents the minimum congruence parameter above which S does not deviate to a zero communication effort.

The equilibrium A exists provided that the following conditions hold:

$$i) \max\left\{\alpha_{R2}^{**A};\ \alpha_S^{**A}\right\} \leq \alpha \leq \alpha_{R1}^{*}$$
$$ii) -\frac{s}{r_H} < \beta_S \textit{ and } -\frac{r_H}{s} < \beta_{R2}$$

Proof. Notice first that this equilibrium exists only if $\beta_{R2} > -\frac{r_H}{s}$ and $\beta_S > -\frac{s}{r_H}$. Both conditions must hold in order for R1, R2 and S to communicate in this equilibrium: $\frac{\partial C_R(y_1^{*A})}{\partial y_1} = x^{*A}\alpha(r_H + \beta_{R1}s) > 0$, $\frac{\partial C_R(y_2^{*A})}{\partial y_2} = x^{*A}\alpha(r_H + \beta_{R2}s) > 0$ and $\frac{\partial C_S(x^{*A})}{\partial x} = (\lambda y_1^{*A} + (1-\lambda)y_2^{*A})\alpha(s + \beta_S r_H) > 0$.

The equilibrium A exists provided that the following conditions hold:

1) S does not deviate to $x = 0$ provided that $\alpha \geq \frac{C_S(x^{*A})}{x^{*A}(\lambda y_1^{*A}+(1-\lambda)y_2^{*A})(s+\beta_S r_H)} = \alpha_S^{**A}$.

2) R1 does not deviate to $y_1 = 0$ and $z_1 = A$ iff $r = r_H$ provided that $\alpha \geq \frac{C_R(y_1^{*A})}{x^{*A}y_1^{*A}(r_H+\beta_{R1}s)} = \alpha_{R1}^{**A}$.

Similarly, R2 does not deviate to $y_2 = 0$ and $z_2 = A$ iff $r = r_H$ provided that $\alpha \geq \frac{C_R(y_2^{*A})}{x^{*A}y_2^{*A}(r_H+\beta_{R2}s)} = \alpha_{R2}^{**A}$.

3)a) R1 does not deviate to the strategy $z_1 = A$ unless $r = r_L$ with $y_1 \neq 0$ provided that $\alpha \leq \frac{-r_L-\beta_{R1}s}{r_H-r_L} = \alpha_{R1}^{*}$.

Similarly, R2 does not deviate to the strategy $z_2 = A$ unless $r = r_L$ with $y_2 \neq 0$ provided that $\alpha \leq \frac{-r_L-\beta_{R2}s}{r_H-r_L} = \alpha_{R2}^{*}$.

b) R1 does not deviate to the strategy $z_1 = A$ unless $r = r_L$ with $y_1 = 0$ provided that:

$$U_{R1}(y_1^{*A}; x^{*A}; z_1^{*} = A \textit{ iff } r = r_H)) \geq U_{R1}(y_1 = 0; x^{*A}; z_1 = A \textit{ iff } r = r_H)$$
$$\geq U_{R1}(y_1 = 0; x^{*A}; z_1 = A \textit{ unless } r = r_L)$$

The first inequality holds if $\alpha \geq \alpha_{R1}^{**A}$ and $\beta_{R1} > -\frac{r_H}{s}$, see point 2) and the preliminary point. The second inequality holds if $\alpha \leq \alpha_{R1}^{*}$, see point 3)a). Therefore, when $\alpha \geq \alpha_{R1}^{**A}$, $\beta_{R1} > -\frac{r_H}{s}$ and $\alpha \leq \alpha_{R1}^{*}$, R1 does not deviate to the strategy $z_1 = A$ unless $r = r_L$ with $y_1 = 0$.

A similar reasoning holds for R2.

The proof follows the same reasoning as when S knows the receiver's social preferences.

■

J.2 Equilibrium B

This equilibrium could be called *the talking to a brick wall - communicating to get a project of high quality* equilibrium. In this equilibrium, everyone communicates except R2 (with $\beta_{R1} > \beta_{R2}$); R2 never takes action A and R1 takes action A if and only if he learns that the project is of high quality ($y_1^{*B} \neq 0;\ y_2^{*B} = 0;\ x^{*B} \neq 0$ and $z_1^* = z_2^* = A$ iff $r = r_H$).

In this *equilibrium*, the agents' utilities are the following:

$$\begin{aligned}
U_{R1} &= x^{*B} y_1^{*B} \alpha (r_H + \beta_{R1} s) - C_R(y_1^{*B}) - \beta_{R1} C_S(x^{*B}) \\
U_{R2} &= -\beta_{R2} C_S(x^{*B}) \\
U_S &= \lambda x^{*B} y_1^{*B} \alpha (s + \beta_S r_H) - C_S(x^{*B}) - \beta_S \lambda C_R(y_1^{*B})
\end{aligned}$$

Therefore, the agents' optimal communication efforts are a function of:

$$\begin{aligned}
\frac{\partial C_R(y_1^{*B})}{\partial y_1} &= x^{*B} \alpha (r_H + \beta_{R1} s) \\
\frac{\partial C_S(x^{*B})}{\partial x} &= \lambda y_1^{*B} \alpha (s + \beta_S r_H)
\end{aligned}$$

Before stating and proving the conditions of existence of the equilibrium B, let me define the variables that determine the lower and the upper bounds of the interval of α in which this equilibrium exists.

$$\begin{aligned}
\alpha_{R1}^{**B} &= \frac{C_R(y_1^{*B})}{x^{*B} y_1^{*B} (r_H + \beta_{R1} s)} \ \textit{and}\ \alpha_S^{**B} = \frac{C_S(x^{*B})}{x^{*B} \lambda y_1^{*B} (s + \beta_S r_H)} \\
\alpha_{R2}^{**B} &= \frac{C_R(y_2)}{x^{*B} y_2^{dev} (r_H + \beta_{R2} s)} \ \textit{with}\ \frac{\partial C_R(y_2^{dev})}{\partial y_2} = x^{*B} \alpha (r_H + \beta_{R2} s)
\end{aligned}$$

If S exerts a strictly positive effort x^{*B}, if $z_1 = A$ iff $r = r_H$ and if $\beta_{R1} > -\frac{r_H}{s}$, the variable α_{R1}^{**B} represents the minimum congruence parameter above which R1 does not deviate from this equilibrium to a zero communication effort with $z_1 = A$ iff $r = r_H$.

If R1 exerts a strictly positive effort y_1^{*B} with $z_1 = A$ iff $r = r_H$, if R2 does not communicate with $z_2 = A$ iff $r = r_H$, and if $\beta_S > -\frac{s}{r_H}$, the variable α_S^{**B} represents the minimum congruence parameter above which S does not deviate from this equilibrium to a zero communication effort.

If S exerts a strictly positive effort x^{*B}, if $z_2 = A$ iff $r = r_H$ and if $\beta_{R2} > -\frac{r_H}{s}$, the variable α_{R2}^{**B} represents the maximum congruence parameter under which R2 does not deviate from this equilibrium to a strictly positive effort with $z_2 = A$ iff $r = r_H$.

The *equilibrium B* exists provided that the following conditions hold:

$$i)\max\left\{\alpha_{R1}^{**B};\ \alpha_{S}^{**B}\right\} \leq \alpha \leq \alpha_{R1}^{*}$$
$$ii)\alpha \leq \alpha_{R2}^{**B}\ if\ \beta_{R2} > -\frac{r_H}{s}\ OR\ \beta_{R2} \leq -\frac{r_H}{s}$$
$$iii) -\frac{s}{r_H} < \beta_S\ and\ -\frac{r_H}{s} < \beta_{R1}$$

Proof. Notice first that this equilibrium exists only if $\beta_{R1} > -\frac{r_H}{s}$ and $\beta_S > -\frac{s}{r_H}$. Both conditions must hold in order for R1 and S to communicate in this equilibrium: $\frac{\partial C_R(y_1^{*B})}{\partial y_1} = x^{*B}\alpha(r_H + \beta_{R1}s) > 0$ and $\frac{\partial C_S(x^{*B})}{\partial x} = \lambda y_1^{*B}\alpha(s + \beta_S r_H) > 0$.

This equilibrium exists provided that the following conditions hold:

1) a) S does not deviate to $x = 0$ provided that $\alpha \geq \frac{C_S(x^{*B})}{x^{*B}y_1^{*B}\lambda(s+\beta_S r_H)} = \alpha_S^{**B}$.

b) R1 does not deviate to $y_1 = 0$ and $z_1 = A$ iff $r = r_H$ provided that $\alpha \geq \frac{C_R(y_1^{*B})}{x^{*B}y_1^{*B}(r_H+\beta_{R1}s)} = \alpha_{R1}^{**B}$.

2) Notice first that if $\beta_{R2} \leq -\frac{r_H}{s}$, R2 does not deviate to a strictly positive effort with $z_2 = A$ iff $r = r_H$: $\frac{\partial C_R(y_2^{dev})}{\partial y_2} = x^{*B}\alpha(r_H + \beta_{R2}s) \leq 0$ if $\beta_{R2} \leq -\frac{r_H}{s}$.

If $\beta_{R2} > -\frac{r_H}{s}$, R2 does not deviate to $y_2^{dev} \neq 0$ and $z_2 = A$ *iff* $r = r_H$ provided that $\alpha \leq \frac{C_R(y_2^{dev})}{x^{*B}y_2^{dev}(r_H+\beta_{R2}s)} = \alpha_{R2}^{**B}$.

3)a) R1 does not deviate to the strategy $z_1 = A$ unless $r = r_L$ with $y_1 \neq 0$ provided that $\alpha \leq \alpha_{R1}^{*}$.

b) R2 does not deviate to the strategy $z_2 = A$ unless $r = r_L$ with $y_2 = 0$ provided that $\alpha \leq \alpha_{R2}^{*}$.

c) R1 does not deviate to the strategy $z_1 = A$ unless $r = r_L$ with $y_1 = 0$ provided that:

$$U_{R1}(y_1^{*B}; x^{*B}; z_1^{*} = A\ iff\ r = r_H)) \geq U_{R1}(y_1 = 0; x^{*B}; z_1 = A\ iff\ r = r_H)$$
$$\geq U_{R1}(y_1 = 0; x^{*B}; z_1 = A\ unless\ r = r_L)$$

The first inequality holds if $\alpha \geq \alpha_{R1}^{**B}$ and $\beta_{R1} > -\frac{r_H}{s}$, see point 1)b) and the preliminary point. The second inequality holds if $\alpha \leq \alpha_{R1}^{*}$, see point 3)a). Therefore, when $\alpha \geq \alpha_{R1}^{**B}$, $\beta_{R1} > -\frac{r_H}{s}$ and $\alpha \leq \alpha_{R1}^{*}$, R1 does not deviate to the strategy $z_1 = A$ unless $r = r_L$ with $y_1 = 0$.

d) R2 does not deviate to the strategy $z_2 = A$ unless $r = r_L$ with $y_2 \neq 0$ provided that:

$$U_{R2}(y_2^{*B} = 0;\ x^{*B};\ z_2^{*} = A\ iff\ r = r_H) \geq U_{R2}(y_2 \neq 0;\ x^{*B};\ z_2 = A\ iff\ r = r_H)$$
$$\geq U_{R2}(y_2 \neq 0;\ x^{*B}; z_2 = A\ unless\ r = r_L)$$

The first inequality holds if one of the two following conditions hold: i) $\alpha \leq \alpha_{R2}^{**B}$ if $\beta_{R2} > -\frac{r_H}{s}$; or ii) $\beta_{R2} \leq -\frac{r_H}{s}$, see point 2). The second inequality holds if $\alpha \leq \alpha_{R2}^{*}$, see point 3)b).

The proof follows the same reasoning as when S knows the receiver's social preferences. ■

The results are now straightforward to prove.

Result a) *When $\alpha < \alpha^*_{R1}$, R1 exerts a weakly higher effort than R2.*
Let me compare R1's and R2's optimal efforts in these 3 equilibria

In the *babbling equilibrium* (see section I of the appendix), R1 and R2 do not communicate.

In equilibrium A, R1 exerts a higher effort than R2 since $\beta_{R1} > \beta_{R2}$.

In equilibrium B, R1 exerts a strictly positive effort while R2 does not communicate.

Result b) *When $\alpha < \alpha^*_{R1}$, if R1 exerts a strictly positive effort in the standard case (S knows R's social preferences), R1 exerts a lower effort in the uncertainty case (S does not know the receiver's social preferences) than in the standard case.*
When $\alpha < \alpha^*_{R1}$, if R2 exerts a strictly positive effort in the uncertainty case, R2 exerts a higher effort in the uncertainty case than in the standard case.

In order prove this result, I am going to compare, between the standard and the uncertainty cases, first the agents' effort and then the conditions of existence of the equilibria prevailing when $\alpha < \alpha^*_{R1}$.

When $\alpha < \alpha^*_{R1}$, the agents communicate only in the *CH* equilibrium of the standard case and only in the equilibria A and B when S does not know the receiver's social preferences (except for R2 that does not communicate in equilibrium B).

R1 (R2)'s level of effort is a function of:

- In the CH equilibrium: $\frac{\partial C_R(y_1^{*H})}{\partial y_1} = \alpha x^{*H}(r_H + \beta_{R1} s)$ ($\frac{\partial C_R(y_2^{*H})}{\partial y_2} = \alpha x^{*H}(r_H + \beta_{R2} s)$;
- In the equilibrium A: $\frac{\partial C_R(y_1^{*A})}{\partial y_1} = \alpha x^{*A}(r_H + \beta_{R1} s)$ ($\frac{\partial C_R(y_2^{*A})}{\partial y_2} = \alpha x^{*H}(r_H + \beta_{R2} s)$;
- In the equilibrium B: $\frac{\partial C_R(y_1^{*B})}{\partial y_1} = \alpha x^{*B}(r_H + \beta_{R1} s)$ ($y_2^{*B} = 0$).

Therefore, both types of receivers' efforts in the uncertainty case differ from the ones in the standard case only because of S's effort (except for R2 in equilibrium B):

- In the CH equilibrium: $\frac{\partial C_S(x^{*H})}{\partial x} = \alpha y_1^{*H}(s + \beta_S r_H)$ ($\frac{\partial C_S(x^{*H})}{\partial x} = \alpha y_2^{*H}(s + \beta_S r_H)$) when S is matched with R1 (R2);
- In the equilibrium A: $\frac{\partial C_S(x^{*A})}{\partial x} = \alpha(\lambda y_1^{*A} + (1-\lambda) y_2^{*A})(s + \beta_S r_H)$;
- In the equilibrium B: $\frac{\partial C_S(x^{*B})}{\partial x} = \alpha\lambda y_1^{*B}(s + \beta_S r_H)$.

Therefore, all other things being equal,

i) R1 (R2) and S's effort is lower (higher) in the equilibrium A than in the *CH* equilibrium;

ii) R1/R2 and the S's effort is lower in the equilibrium B than in the *CH* equilibrium.

In these statements *i* and *ii*, it is assumed that these equilibria exist for a same value of α; let me at present compare the conditions of existence of these equilibria.

In the region $\alpha \leq \alpha^*_{R1}$, the upper bound is:

- In the CH equilibrium: α^*_{R1};
- In the equilibrium A: α^*_{R1};
- In the equilibrium B: α^{**B}_{R2} if $\alpha^{**B}_{R2} < \alpha^*_{R1}$ and if $\beta_{R2} > \frac{-r_H}{s}$; otherwise it is α^*_{R1}.

In the region $\alpha \leq \alpha^*_{R1}$, the lower bound is:

- In the CH equilibrium: $\max\{\alpha^{**}_R;\ \alpha^{**}_S\}$;
- In the equilibrium A: $\max\left\{\alpha^{**A}_{R2};\ \alpha^{**A}_S\right\}$;
- In the equilibrium B: $\max\left\{\alpha^{**B}_{R1};\ \alpha^{**B}_S\right\}$.

Therefore, on the one hand, if the equilibria A and/or B exist in the uncertainty case, the *CH* equilibrium also exists for R1 and S in the standard case. Thus, if R1 exerts a strictly positive effort in the standard case, R1 exerts a lower effort in the uncertainty case than in the standard case.

On the other hand, if the *CH* equilibrium exists for R2 and S in the standard case, the equilibrium A also exists for R2 and S in the uncertainty case. Therefore, if R2 exerts a strictly positive effort in the uncertainty case, R2 exerts a higher effort in the uncertainty case than in the standard case.

K Uncertainty: proofs of the statements when $\alpha \geq \alpha^*_{R2}$

Let me first state and prove the 2 possible equilibria involving communication when $\alpha \geq \alpha^*_{R2}$.

K.1 Equilibrium C

In this equilibrium, everyone communicates and both types of receivers accept the project unless they learn that the project is of low quality ($y^{*C}_1 \neq 0$, $y^{*C}_2 \neq 0$, $x^{*C} \neq 0$ and $z^*_1 = z^*_2 = A$ unless $r = r_L$).

In this equilibrium, the agents' utility functions are the following:

$$U_{R1} = \alpha r_H + (1 - x^{*C} y_1^{*C})(1-\alpha) r_L - C_R(y_1^{*C}) + \beta_{R1}((1 - x^{*C} y_1^{*C}(1-\alpha))s - C_S(x^{*C}))$$
$$U_{R2} = \alpha r_H + (1 - x^{*C} y_2^{*C})(1-\alpha) r_L - C_R(y_2^{*C}) + \beta_{R2}((1 - x^{*C} y_2^{*C}(1-\alpha))s - C_S(x^{*C}))$$
$$U_S = (1 - x^{*C}(\lambda y_1^{*C} + (1-\lambda) y_2^{*C})(1-\alpha))s - C_S(x^{*C}) + \beta_S(\alpha r_H +$$
$$(1 - x^{*C}(\lambda y_1^{*C} + (1-\lambda) y_2^{*C}))(1-\alpha) r_L - \lambda C_R(y_1^{*C}) - (1-\lambda) C_R(y_2^{*C}))$$

The agents' optimal efforts are a function of:

$$\frac{\partial C_R(y_1^{*C})}{\partial y_1} = x^{*C}(1-\alpha)(-r_L - \beta_{R1} s)$$
$$\frac{\partial C_R(y_2^{*C})}{\partial y_2} = x^{*C}(1-\alpha)(-r_L - \beta_{R2} s)$$
$$\frac{\partial C_S(x^{*C})}{\partial x} = (\lambda y_1^{*C} + (1-\lambda) y_2^{*C})(1-\alpha)(-s - \beta_S r_L)$$

Before stating and proving the conditions of existence of the equilibrium C, let me define the variables that determine the lower bound of the interval of α in which this equilibrium exists.

$$\alpha_S^{***C} = 1 - \frac{C_S(x^{*C})}{x^{*C}(\lambda y_1^{*C} + (1-\lambda) y_2^{*C})(-s - \beta_S r_L)}$$
$$\alpha_{R1}^{***C} = 1 - \frac{C_R(y_1^{*C})}{x^{*C} y_1^{*C}(-r_L - \beta_{R1} s)}$$
$$\alpha_{R2}^{***C} = 1 - \frac{C_R(y_2^{*C})}{x^{*C} y_2^{*C}(-r_L - \beta_{R2} s)}$$

If S exerts a strictly positive effort x^{*C}, if $z_1(z_2) = A$ unless $r = r_L$ and if $\beta_{R1} < \frac{-r_L}{s}$ ($\beta_{R2} < \frac{-r_L}{s}$), the variable α_{R1}^{***C} (α_{R2}^{***C}) represents the maximum congruence parameter under which R1 (R2) does not deviate from y_1^{*C} (y_2^{*C}) with z_1 $(z_2) = A$ unless $r = r_L$ to a zero effort with z_1 $(z_2) = A$ unless $r = r_L$.

If R1 and R2 exert a strictly positive effort, respectively y_1^{*C} and y_2^{*C}, if $z_1 = z_2 = A$ unless $r = r_L$ and if $\beta_S > -\frac{s}{r_L}$, the variable α_S^{***C} represents the maximum congruence parameter under which S does not deviate from an effort x^{*C} to a zero effort.

The equilibrium C exists provided that the following conditions hold:

$$i) \alpha_{R2}^{*} \leq \alpha \leq \min\left\{\alpha_S^{***C}; \alpha_{R1}^{***C}\right\}$$
$$ii) \beta_{R1} < \frac{-r_L}{s} \; and \; \beta_S > \frac{s}{-r_L}$$

Proof. Notice first that this equilibrium exists only if $\beta_{R1} < \frac{-r_L}{s}$ and $\beta_S > \frac{s}{-r_L}$. Both conditions must hold in order for R1, R2 and S to communicate in this equilibrium: $\frac{\partial C_R(y_1^{*C})}{\partial y_1} = x^{*C}(1-\alpha)(-r_L - \beta_{R1} s) > 0$, $\frac{\partial C_R(y_2^{*C})}{\partial y_2} = x^{*C}(1-$

$\alpha)(-r_L - \beta_{R2}s) > 0$ and $\frac{\partial C_S(x^{*C})}{\partial x} = (1-\alpha)(\lambda y_1^{*C} + (1-\lambda)y_2^{*C})(-s - \beta_S r_L) > 0$.

This equilibrium exists provided that the following conditions hold:

1) S does not deviate to $x = 0$ provided that $\alpha \leq \alpha_S^{***C}$.

2) R1 (R2) does not deviate to $y_1 = 0$ ($y_2 = 0$) and z_1 (z_2) $= A$ unless $r = r_L$ provided that $\alpha \leq \alpha_{R1}^{***C}$ ($\alpha \leq \alpha_{R2}^{***C}$).

The variable α_{R2}^{***C} is higher than the variable α_{R1}^{***C} because $\beta_{R2} < \beta_{R1}$.

3) R1 (R2) does not deviate to $y_1 \neq 0$ ($y_2 \neq 0$) and z_1 (z_2) $= A$ iff $r = r_H$ provided that $\alpha \geq \alpha_{R1}^*$ ($\alpha \geq \alpha_{R2}^*$).

Similarly, R2 does not deviate to $y_2 \neq 0$ and $z_2 = A$ iff $r = r_H$ provided that $\alpha \geq \alpha_{R2}^*$.

The variable α_{R1}^* is lower than the variable α_{R2}^* because $\beta_{R2} < \beta_{R1}$.

4) R1 does not deviate to the strategy $z_1 = A$ iff $r = r_H$ with $y_1 = 0$ provided that:

$$U_{R1}(y_1^{*C};\ x^{*C}; z_1^* = A \text{ } unless \text{ } r = r_L) \geq U_{R1}(y_1 = 0; x^{*C}; z_1 = A \text{ } unless \text{ } r = r_L)$$
$$\geq U_{R1}(y_1 = 0; x^{*C}; z_1 = A \text{ } iff \text{ } r = r_H)$$

The first inequality holds if $\alpha \leq \alpha_{R1}^{***C}$ and $\beta_{R1} < -\frac{r_L}{s}$, see point 2) and the preliminary point. The second inequality holds if $\alpha \geq \alpha_{R1}^*$, see point 3). Therefore, when $\alpha \leq \alpha_{R1}^{***C}$, $\beta_{R1} < -\frac{r_L}{s}$ and $\alpha \geq \alpha_{R1}^*$, R1 does not deviate to the strategy $z_1 = A$ iff $r = r_H$ with $y_1 = 0$.

A similar reasoning holds for R2.

The proof follows the same reasoning as when S knows the receiver's social preferences. ■

K.2 Equilibrium D

In this equilibrium, R1 does not communicate while S and R2 communicate; R1 always accepts the project while R2 accepts the project unless he learns through communication that the project is of low quality ($y_1^{*D} = 0;\ y_2^{*D} \neq 0;\ x^{*D} \neq 0;$ $z_1^* = z_2^* = A$ unless $r = r_L$).

S's *authority* towards R1 is not imposed but chosen. R1 could communicate with S but this would decrease his utility.

In this equilibrium, the agents' utility functions are the following:

$$U_{R1} = \alpha r_H + (1-\alpha)r_L + \beta_{R1}(s - C_S(x^{*D}))$$
$$U_{R2} = \alpha r_H + (1 - x^{*D}y_2^{*D})(1-\alpha)r_L - C_R(y_2^{*D}) + \beta_{R2}((1 - x^{*D}y_2^{*D}(1-\alpha))s - C_S(x^{*D}))$$
$$U_S = \lambda s + (1 - x^{*D}y_2^{*D}(1-\alpha))(1-\lambda)s - C_S(x^{*D}) + \beta_S$$
$$\Big(\alpha r_H + \Big(\lambda(1-\alpha)r_L + (1-\lambda)(1 - x^{*D}y_2^{*D})(1-\alpha)r_L\Big) - (1-\lambda)C_R(y_2^{*D})\Big)$$

Therefore, R2's and S's optimal efforts are a function of:

$$\frac{\partial C_R(y_2^{*D})}{\partial y_2} = x^{*D}(1-\alpha)(-r_L - \beta_{R2}s)$$
$$\frac{\partial C_S(x^{*D})}{\partial x} = (1-\lambda)y_2^{*D}(1-\alpha)(-s-\beta_S r_L)$$

Before stating and proving the conditions of existence of the equilibrium D, let me define the variables that determine the lower and the upper bounds of the interval of α in which this equilibrium exists.

$$\alpha_S^{***D} = 1 - \frac{C_S(x^{*D})}{x^{*D}(1-\lambda)y_2^{*D}(-s-\beta_S r_L)}; \alpha_{R2}^{***D} = 1 - \frac{R(y_2^{*D})}{x^{*D}y_2^{*D}(-r_L - \beta_{R2}s)};$$
$$if\ \beta_{R1} < -\frac{r_L}{s},\ \alpha_{R1}^{***D} = 1 - \frac{C_R(y_1^{dev})}{x^{*D}y_1^{dev}(-r_L-\beta_{R1}s)}$$
$$with\ \frac{\partial C_R(y_1^{dev})}{\partial y_1} = x^{*D}(1-\alpha)(-r_L-\beta_{R1}s)$$

If R2 exerts a strictly positive effort y_2^{*D} with $z_2 = A$ unless $r = r_L$, if R1 does not communicate with $z_1 = A$ unless $r = r_L$, and if $\beta_S > \frac{s}{-r_L}$, the variable α_S^{***D} represents the maximum congruence parameter under which S does not deviate from this equilibrium to a zero communication effort.

If S exerts a strictly positive effort x^{*D}, if $z_1 = A$ unless $r = r_L$ and if $\beta_{R1} < -\frac{r_L}{s}$, the variable α_{R1}^{***D} represents the minimum congruence parameter above which R1 does not deviate from this equilibrium to a communication effort y_1^{dev} with $z_1 = A$ unless $r = r_L$.

If S exerts a strictly positive effort x^{*D}, if $z_2 = A$ unless $r = r_L$ and if $\beta_{R2} < \frac{-r_L}{s}$, the variable α_{R2}^{***D} represents the maximum congruence parameter under which R2 does not deviate from this equilibrium to a zero effort with $z_2 = A$ unless $r = r_L$.

The equilibrium D exists provided that the following conditions hold:

$$i)\alpha_{R2}^{*} \leq \alpha \leq \min\left\{\alpha_S^{***D}; \alpha_{R2}^{***D}\right\}$$
$$ii)\alpha \geq \alpha_{R1}^{***D}\ if\ \beta_{R1} < \frac{-r_L}{s}\ OR\ \beta_{R1} \geq \frac{-r_L}{s}$$
$$iii)\beta_{R2} < \frac{-r_L}{s}\ and\ \beta_S > \frac{s}{-r_L}$$

Proof. The proof follows the same reasoning as when S knows the receiver's social preferences.

Notice first that this equilibrium exists only if $\beta_{R2} < \frac{-r_L}{s}$ and $\beta_S > \frac{s}{-r_L}$. Both conditions must hold in order for R2 and S to communicate in this equilibrium: $\frac{\partial C_R(y_2^{*D})}{\partial y_2} = x^{*D}(1-\alpha)(-r_L-\beta_{R2}s) > 0$ and $\frac{\partial C_S(x^{*D})}{\partial x} = (1-\lambda)y_2^{*D}(1-\alpha)(-s-\beta_S r_L) > 0$.

The equilibrium D exists provided that the following conditions hold:

1) S does not deviate to $x = 0$ provided that $\alpha \leq \alpha_S^{***D}$.

2)a) R2 does not deviate to $y_2 = 0$ and $z_2 = A$ unless $r = r_L$ provided that $\alpha \leq \alpha_{R2}^{***D}$.

2)b) Notice first that if $\beta_{R1} \geq \frac{-r_L}{s}$, R1 does not deviate to a strictly positive effort with $z_1 = A$ unless $r = r_L$: $\frac{\partial C_R(y_1^{dev})}{\partial y_1} = x^{*D}(1-\alpha)(-r_L - \beta_{R1}s) \leq 0$.

If $\beta_{R1} < \frac{-r_L}{s}$, R1 does not deviate to a strictly positive effort y_1^{dev} and $z_1 = A$ unless $r = r_L$ provided that:

$$U_{R1}(y_1^{*D} = 0;\ x^{*D};\ z_1^* = A\ unless\ r = r_L) \geq U_{R1}(y_1^{dev};\ x^{*D}; z_1 = A\ unless\ r = r_L)$$

$$\Leftrightarrow \alpha r_H + (1-\alpha)r_L + \beta_{R1}(s - C_S(x^{*D})) \geq x^{*D}y_1^{dev}\alpha r_H + (1 - x^{*D}y_1^{dev})$$

$$(\alpha r_H + (1-\alpha)r_L) - C_R(y_1^{dev}) + \beta_{R1}(x^{*D}y_1^{dev}\alpha s + (1 - x^{*D}y_1^{dev})s - C_S(x^{*D}))$$

$$\Leftrightarrow \alpha \geq 1 - \frac{C_R(y_1^{dev})}{x^{*D}y_1^{dev}(-r_L - \beta_{R1}s)} = \alpha_{R1}^{***D}$$

3)a) R2 does not deviate to $y_2 \neq 0$ and $z_2 = A$ iff $r = r_H$ provided that $\alpha \geq \alpha_{R2}^*$.

b) R1 does not deviate to $y_1 = 0$ and $z_1 = A$ iff $r = r_H$ provided that $\alpha \geq \alpha_{R1}^*$.

4) R2 does not deviate to the strategy $z_2 = A$ iff $r = r_H$ with $y_2 = 0$ provided that:

$$U_{R2}(y_2^{*D}; x^{*D};\ z_2^* = A\ unless\ r = r_L)) \geq U_{R2}(y_2 = 0; x^{*D}; z_2^* = A\ unless\ r = r_L)$$

$$\geq U_{R2}(y_2 = 0; x^{*D}; z_2 = A\ iff\ r = r_H)$$

The first inequality holds if $\alpha \leq \alpha_{R2}^{***D}$ and $\beta_{R2} < \frac{-r_L}{s}$, see point 2)a) and the preliminary point. The second inequality holds if $\alpha \geq \alpha_{R2}^*$, see point 3)a). Therefore, when $\alpha \leq \alpha_{R2}^{***D}$, $\beta_{R2} < \frac{-r_L}{s}$ and $\alpha \geq \alpha_{R2}^*$, R2 does not deviate to the strategy $z_2 = A$ iff $r = r_H$ with $y_2 = 0$.

5) R1 does not deviate to the strategy $z_1 = A$ iff $r = r_H$ with $y_1 \neq 0$ provided that:

$$U_{R1}(y_1^{*D} = 0; x^{*D}; z_1 = A\ unless\ r = r_L) \geq U_{R1}(y_1 \neq 0; x^{*D}; z_1 = A\ unless\ r = r_L)$$

$$\geq U_{R1}(y_1 \neq 0; x^{*D}; z_1 = A\ iff\ r = r_H)$$

The first inequality holds if one of the two following conditions hold: i) $\alpha \geq \alpha_{R1}^{***D}$ if $\beta_{R1} < -\frac{r_L}{s}$; or ii) $\beta_{R1} \geq -\frac{r_L}{s}$, see point 2)b). The second inequality holds if $\alpha \geq \alpha_{R1}^*$, see point 3)b).

■

The results are now straightforward to prove.

Result a) When $\alpha \geq \alpha_{R2}^*$, R2 exerts a weakly higher effort than R1.

Let me compare R1's and R2's optimal efforts in these 3 equilibria.

There always exist an equilibrium without communication (cf. section I of the appendix).

In the equilibrium C, R2 exerts a strictly higher effort than R1 since $\beta_{R1} > \beta_{R2}$.

In the equilibrium D, R2 exerts a strictly positive effort while R1 does not communicate.

Result b) *When $\alpha \geq \alpha^*_{R2}$, if R1 exerts a strictly positive effort in the uncertainty case, R1 exerts a higher effort in the uncertainty case than when he does.*

Similarly, when $\alpha \geq \alpha^*_{R2}$, if R2 exerts a strictly positive effort when S knows the receiver's social preferences, R2 exerts a lower effort in the uncertainty case than when he does.

In order prove this result, I am going to compare, between the uncertainty case and the standard case, first the agents' effort and then the conditions of existence of the equilibria prevailing when $\alpha > \alpha^*_{R2}$.

When $\alpha > \alpha^*_{R2}$, the agents communicate only in the *CL* equilibrium in the uncertainty case and in the equilibria C and D in the uncertainty case (except for R1 that does not communicate in equilibrium D).

R2's (R1's) level of effort is a function of:

- In the CL equilibrium: $\frac{\partial C_R(y_2^{*L})}{\partial y_2} = (1-\alpha)x^{*L}(-r_L - \beta_{R2}s)$ ($\frac{\partial C_R(y_1^{*L})}{\partial y_1} = (1-\alpha)x^{*L}(-r_L - \beta_{R1}s)$);

- In the equilibrium C: $\frac{\partial C_R(y_2^{*C})}{\partial y_2} = (1-\alpha)x^{*C}(-r_L - \beta_{R2}s)$ ($\frac{\partial C_R(y_1^{*C})}{\partial y_1} = (1-\alpha)x^{*C}(-r_L - \beta_{R1}s)$);

- In the equilibrium D: $\frac{\partial C_R(y_2^{*D})}{\partial y_2} = (1-\alpha)x^{*D}(-r_L - \beta_{R2}s)$ ($y_1^{*D} = 0$).

Therefore, R1's (R2's) effort in the uncertainty case differs from the standard case because of S's effort (except for R1 in the equilibrium D):

- In the CL equilibrium: $\frac{\partial C_S(x^{*L})}{\partial x} = (1-\alpha)y_1^{*L}(-s - \beta_S r_L)$ ($\frac{\partial C_S(x^{*L})}{\partial x} = (1-\alpha)y_2^{*L}(-s - \beta_S r_L)$) when S is matched with R1 (R2);

- In the equilibrium C $\frac{\partial C_S(x^{*C})}{\partial x} = (1-\alpha)(\lambda y_1^{*C} + (1-\lambda)y_2^{*C})(-s - \beta_S r_L)$;

- In the equilibrium D $\frac{\partial C_S(x^{*D})}{\partial x} = (1-\alpha)(1-\lambda)y_2^{*D}(-s - \beta_S r_L)$.

Therefore, all other things being equal,

i) R2's (R1's) and S's efforts are lower (higher) in the equilibrium C than in the *CL* equilibrium;

ii) R1's/R2's and the S's efforts are lower in the equilibrium D than in the *CL* equilibrium.

In these statements i and ii, it is assumed that these equilibria exist for a same value of α; let me at present compare the conditions of existence of these equilibria.

In the region $\alpha \geq \alpha^*_{R2}$, the lower bound is:
- In the CL equilibrium: α^*_{R2};
- In the equilibrium C: α^*_{R2};
- In the equilibrium D: α^{***D}_{R1} if $\alpha^{***D}_{R1} > \alpha^*_{R2}$ and if $\beta_{R1} < \frac{-r_L}{s}$; otherwise it is α^*_{R2}.

In the region $\alpha \geq \alpha^*_{R2}$, the upper bound is:
- In the CL equilibrium: $\min \{\alpha^{***}_{R};\ \alpha^{***}_{S}\}$;
- In the equilibrium C: $\min \left\{\alpha^{***C}_{R1};\ \alpha^{***C}_{S}\right\}$;
- In the equilibrium D: $\min \left\{\alpha^{***D}_{R2};\ \alpha^{***D}_{S}\right\}$.

Therefore, on the one hand, if the equilibria C or D exist in the uncertainty case, the *CL* equilibrium also exists for R2 and S in the standard case. Thus, if R2 exerts a strictly positive effort in the standard case, R2 exerts a lower effort in the uncertainty case than in the standard case.

On the other hand, if the *CL* equilibrium exists for R1 and S in the standard case, the equilibrium C also exists for R1 and S in the uncertainty case. Therefore, if R1 exerts a strictly positive effort in the uncertainty case, R1 exerts a higher effort in the uncertainty case than in the standard case.

L Uncertainty: proofs of the statements when $\alpha^*_{R1} \leq \alpha \leq \alpha^*_{R2}$

Let me prove the conditions of existence of the 3 possible equilibria involving communication when $\alpha^*_{R1} \leq \alpha \leq \alpha^*_{R2}$.

L.1 Equilibrium E

In this equilibrium, every agent communicates; R1 accepts the project unless he learns that it is of low quality and R2 accepts the project if and only if he learns that the project is of high quality ($y^{*E}_1 \neq 0;\ y^{*E}_2 \neq 0;\ x^{*E} \neq 0;\ z^*_1 = A$ unless $r = r_L$; and $z^*_2 = A$ iff $r = r_H$).

In this equilibrium, the agents' utilities are the following:

$$U_{R1} = \alpha r_H + (1 - x^{*E} y^{*E}_1)(1 - \alpha) r_L - R(y^{*E}_1) + \beta_{R1}((1 - x^{*E} y^{*E}_1(1 - \alpha))s - C_S(x^{*E}))$$
$$U_{R2} = x^{*E} y^{*E}_2 \alpha r_H - C_R(y^{*E}_2) + \beta_{R2}(x^{*E} y^{*E}_2 \alpha s - C_S(x^{*E}))$$
$$U_S = s\left(\alpha\left(\lambda + (1-\lambda) x^{*E} y^{*E}_2\right) + \lambda(1 - x^{*E} y^{*E}_1)(1-\alpha)\right) - C_S(x^{*E}) + \beta_S \Big(\lambda$$
$$\left(\alpha r_H + (1 - x^{*E} y^{*E}_1)(1-\alpha) r_L - C_R(y^{*E}_1)\right) + (1-\lambda)\left(x^{*E} y^{*E}_2 \alpha r_H - C_R(y^{*E}_2)\right)$$

Therefore, the agents' optimal efforts are a function of:

$$\frac{\partial C_R(y_1^{*E})}{\partial y_1} = x^{*E}(1-\alpha)(-r_L - \beta_{R1}s)$$
$$\frac{\partial C_R(y_2^{*E})}{\partial y_2} = x^{*E}\alpha(r_H + \beta_{R2}s)$$
$$\frac{\partial C_S(x^{*E})}{\partial x} = (1-\lambda)y_2^{*E}\alpha(s+\beta_S r_H) + (1-\alpha)\lambda y_1^{*E}(-s-\beta_S r_L)$$

Before stating and proving the conditions of existence of the equilibrium E, let me define the variables that determine the lower and the upper bounds of the interval of α in which this equilibrium exists.

$$\alpha_{R1}^{***E} = 1 - \frac{R(y_1^{*E})}{x^{*E}y_1^{*E}(-r_L - \beta_{R1}s)};\ \alpha_{R2}^{**E} = \frac{R(y_2^{*E})}{x^{*E}y_2^{*E}(r_H + \beta_{R2}s)}$$
$$\alpha_S^{****} = \frac{C_S(x^{*E}) + \lambda x^{*E}y_1^{*E}(s+\beta_S r_L)}{x^{*E}\left((1-\lambda)y_2^{*E}(s+\beta_S r_H) + \lambda y_1^{*E}(s+\beta_S r_L)\right)}$$

If R1 exerts a strictly positive effort y_1^{*E} with $z_1 = A$ unless $r = r_L$, if R2 exerts a strictly positive effort y_2^{*E} with $z_2 = A$ iff $r = r_H$ and if $(1-\lambda)y_2^{*E}(s+\beta_S r_H) + \lambda y_1^{*E}(s+\beta_S r_L) < (\geq) 0$, the variable α_S^{****} represents the maximum (minimum) congruence parameter under (above) which S does not deviate from this equilibrium to a zero communication effort.

If S exerts a strictly positive effort x^{*E}, if $z_1 = A$ unless $r = r_L$ and if $\beta_{R1} < -\frac{r_L}{s}$, the variable α_{R1}^{***E} represents the maximum congruence parameter under which R1 does not deviate from this equilibrium to a zero communication effort with $z_1 = A$ unless $r = r_L$.

If S exerts a strictly positive effort x^{*E}, if $z_2 = A$ iff $r = r_H$ and if $\beta_{R2} > \frac{-r_H}{s}$, the variable α_{R2}^{**E} represents the minimum congruence parameter above which R2 does not deviate from this equilibrium to a zero communication effort with $z_2 = A$ iff $r = r_H$.

The equilibrium E exists provided that the following conditions hold:

$$i)\max\left\{\alpha_{R1}^{*};\ \alpha_{R2}^{**E}\right\} \leq \alpha \leq \min\left\{\alpha_{R1}^{***E};\ \alpha_{R2}^{*}\right\}$$
$$ii)\frac{-r_H}{s} < \beta_{R2}\ ;\ \beta_{R1} < \frac{-r_L}{s}\ and\ \beta_S > \frac{-(1-\lambda)y_2^{*E}\alpha s + (1-\alpha)\lambda y_1^{*E}s}{(1-\lambda)y_2^{*E}\alpha r_H - (1-\alpha)\lambda y_1^{*E}r_L}$$
$$iii)\alpha \leq (\geq)\alpha_S^{****} if\ (1-\lambda)y_2^{*E}(s+\beta_S r_H) + \lambda y_1^{*E}(s+\beta_S r_L) < (\geq)0$$

Proof. A part of the proof follows the same reasoning as when S knows the receiver's social preferences.

Notice first that this equilibrium exists only if $\beta_S > \frac{-(1-\lambda)y_2^{*E}\alpha s + (1-\alpha)\lambda y_1^{*E}s}{(1-\lambda)y_2^{*E}\alpha r_H - (1-\alpha)\lambda y_1^{*E}r_L}$, $\beta_{R1} < \frac{-r_L}{s}$, and $\beta_{R2} > \frac{-r_H}{s}$. Both conditions must hold in order for S, R1 and R2 to communicate in this equilibrium: $\frac{\partial C_S(x^{*E})}{\partial x} = (1-\lambda)y_2^{*E}\alpha(s+\beta_S r_H) +$

$(1-\alpha)\lambda y_1^{*E}(-s-\beta_S r_L) > 0$, $\frac{\partial C_R(y_1^{*E})}{\partial y_1} = x^{*E}(1-\alpha)(-r_L-\beta_{R1}s) > 0$ and $\frac{\partial C_R(y_2^{*E})}{\partial y_2 1} = x^{*E}\alpha(r_H+\beta_{R2}s) > 0$.

This equilibrium exists provided that the following conditions hold:

1) S does not deviate to $x=0$ provided that:

$$
\begin{aligned}
&U_S(y_1^{*E}; y_2^{*E}; x^{*E};\ z_1^* = A \ unless\ r = r_L;\ z_2^* = A \ iff\ r = r_H)\\
&\geq U_S(y_1^{*E}; y_2^{*E};\ x = 0;\ z_1^* = A \ unless\ r = r_L;\ z_2^* = A \ iff\ r = r_H)\\
&\Leftrightarrow s\left(\alpha\left(\lambda + (1-\lambda)x^{*E}y_2^{*E}\right) + \lambda(1-x^{*E}y_1^{*E})(1-\alpha)\right) - C_S(x^{*E}) + \beta_S\,[\\
&\lambda\left(\alpha r_H + (1-x^{*E}y_1^{*E})(1-\alpha)r_L - C_R(y_1^{*E})\right) + (1-\lambda)\left(x^{*E}y_2^{*E}\alpha r_H - C_R(y_2^{*E})\right)\\
&\geq s\lambda + \beta_S\left(\lambda\left(\alpha r_H + (1-\alpha)r_L - C_R(y_1^{*E})\right) - (1-\lambda)C_R(y_2^{*E})\right)\\
&\Leftrightarrow \alpha \geq (\leq)\ \frac{C_S(x^{*E}) + \lambda x^{*E}y_1^{*E}(s+\beta_S r_L)}{x^{*E}\left((1-\lambda)y_2^{*E}(s+\beta_S r_H) + \lambda y_1^{*E}(s+\beta_S r_L)\right)} = \alpha_S^{****}\\
&if\ (1-\lambda)y_2^{*E}(s+\beta_S r_H) + \lambda y_1^{*E}(s+\beta_S r_L) \geq (<)\ 0
\end{aligned}
$$

2) R1 does not deviate to $y_1 = 0$ and $z_1 = A$ unless $r = r_L$ provided that $\alpha \leq \alpha_{R1}^{***E}$.

3)a) R1 does not deviate to $y_1 \neq 0$ and $z_1 = A$ iff $r = r_H$ provided that $\alpha \geq \alpha_{R1}^*$.

b) R2 does not deviate to $y_2 \neq 0$ and $z_2 = A$ unless $r = r_L$ provided that $\alpha \leq \alpha_{R2}^*$.

4) R1 does not deviate to the strategy $y_1 = 0$ and $z_1 = A$ iff $r = r_H$ provided that:

$$
\begin{aligned}
&U_{R1}(y_1^{*E}; x^{*E}; z_1^* = A\ unless\ r = r_L) \geq U_{R1}(y_1 = 0; x^{*E}; z_1 = A\ unless\ r = r_L)\\
&\geq U_{R1}(y_1 = 0; x^{*E}; z_1 = A\ iff\ r = r_H)
\end{aligned}
$$

The first inequality holds if $\alpha \leq \alpha_{R1}^{***E}$ and $\beta_{R1} < -\frac{r_L}{s}$, see point 2) and the preliminary point. The second inequality holds if $\alpha \geq \alpha_{R1}^*$, see point 3)a). Therefore, when $\alpha \leq \alpha_{R1}^{***E}$, $\beta_{R1} < -\frac{r_L}{s}$ and $\alpha \geq \alpha_{R1}^*$, R1 does not deviate to the strategy $z_1 = A$ iff $r = r_H$ with $y_1 = 0$.

5) R2 does not to $y_2 = 0$ and $z_2 = A$ iff $r = r_H$ provided that $\alpha \geq \alpha_{R2}^{**E}$.

6) R2 does not deviate to the strategy $y_2 = 0$ and $z_2 = A$ unless $r = r_L$ provided that:

$$
\begin{aligned}
&U_{R2}(y_2^{*E}; x^{*E}; z_2^* = A\ iff\ r = r_H) \geq U_{R2}(y_2 = 0; x^{*E}; z_2 = A\ iff\ r = r_H)\\
&\geq U_{R2}(y_2 = 0; x^{*E}; z_2 = A\ unless\ r = r_L)
\end{aligned}
$$

The first inequality holds if $\alpha \geq \alpha_{R2}^{**E}$ and $\beta_{R2} > -\frac{r_H}{s}$, see point 5) and the preliminary point. The second inequality holds if $\alpha \leq \alpha_{R2}^*$, see point 3)b). Therefore, when $\alpha \geq \alpha_{R2}^{**E}$, $\beta_{R2} > -\frac{r_H}{s}$ and $\alpha \leq \alpha_{R2}^*$, R2 does not deviate to the strategy $y_2 = 0$ and $z_2 = A$ unless $r = r_L$. ■

L.2 Equilibrium F

In this equilibrium, R2 does not communicate while S and R1 communicate; R1 accepts the project unless he learns that it is of low quality and R2 never accepts the project ($y_1^{*F} \neq 0$; $y_2^{*F} = 0$; $x^{*F} \neq 0$; $z_1^* = A$ unless $r = r_L$; and $z_2^* = A$ iff $r = r_H$).

In this equilibrium, the agents' utilities are the following:

$$U_{R1} = \alpha r_H + (1 - x^{*F} y_1^{*F})(1-\alpha) r_L - C_R(y_1^{*F}) + \beta_{R1}((1 - x^{*F} y_1^{*F}(1-\alpha))s - C_S(x^{*F}))$$
$$U_{R2} = -\beta_{R2} C_S(x^{*F})$$
$$U_S = \lambda(1 - x^{*F} y_1^{*F}(1-\alpha))s - C_S(x^{*F}) + \beta_S \lambda \left(\alpha r_H + (1 - x^{*F} y_1^{*F})(1-\alpha) r_L - C_R(y_1^{*F})\right)$$

Therefore, R1's and S's optimal efforts are a function of:

$$\frac{\partial C_R(y_1^{*F})}{\partial y_1} = x^{*F}(1-\alpha)(-r_L - \beta_{R1} s)$$
$$\frac{\partial C_S(x^{*F})}{\partial x} = \lambda y_1^{*F}(1-\alpha)(-s - \beta_S r_L)$$

Before stating and proving the conditions of existence of the equilibrium F, let me define the variables that determine the lower and the upper bounds of the interval of α in which this equilibrium exists.

$$\alpha_{R1}^{***F} = 1 - \frac{R(y_1^{*F})}{x^{*F} y_1^{*F}(-r_L - \beta_{R1} s)}; \ \alpha_S^{***F} = 1 - \frac{C_S(x^{*F})}{x^{*F} \lambda y_1^{*F}(-s - \beta_S r_L)}$$
$$\alpha_{R2}^{**F} = \frac{C_R(y_2^{dev})}{x^{*F} y_2^{dev}(r_H + \beta_{R2} s)} \ with \ \frac{\partial C_R(y_2^{dev})}{\partial y_2} = x^{*F} \alpha (r_H + \beta_{R2} s)$$

If R1 exerts a strictly positive effort y_1^{*F} with $z_1 = A$ unless $r = r_L$, if R2 does not communicate with $z_2 = A$ iff $r = r_H$, and if $\beta_S > \frac{s}{-r_L}$, the variable α_S^{***F} represents the maximum congruence parameter under which S does not deviate from this equilibrium to a zero communication effort.

If S exerts a strictly positive effort x^{*F}, if $z_1 = A$ unless $r = r_L$ and if $\beta_{R1} < -\frac{r_L}{s}$, the variable α_{R1}^{***F} represents the maximum congruence parameter under which R1 does not deviate from this equilibrium to a zero communication effort with $z_1 = A$ unless $r = r_L$.

If S exerts a strictly positive effort x^{*F}, if $z_2 = A$ iff $r = r_H$ and if $\beta_{R2} > \frac{-r_H}{s}$, the variable α_{R2}^{**F} represents the minimum congruence parameter above which R2 does not deviate from this equilibrium to a strictly positive effort with $z_2 = A$ iff $r = r_H$.

The equilibrium F exists provided that the following conditions hold:

$$i)\alpha^*_{R1} \le \alpha \le \min\left\{\alpha^{***F}_S; \alpha^{***F}_{R1};\ \alpha^*_{R2}\right\}$$
$$ii)\alpha \le \alpha^{**F}_{R2}\ if\ \beta_{R2} > -\frac{r_H}{s} OR\ \beta_{R2} \le -\frac{r_H}{s}$$
$$iii)\beta_{R1} < \frac{-r_L}{s}\ and\ \beta_S > \frac{s}{-r_L}$$

Proof. The proof follows the same reasoning as when S knows the receiver's social preferences.

Notice first that this equilibrium exists only if $\beta_S > \frac{s}{-r_L}$ and $\beta_{R1} < \frac{-r_L}{s}$. Both conditions must hold in order for S and R1 to communicate in this equilibrium: $\frac{\partial C_S(x^{*F})}{\partial x} = (1-\alpha)\lambda y_1^{*F}(-s-\beta_S r_L) > 0$ and $\frac{\partial C_R(y_1^{*F})}{\partial y_1} = x^{*F}(1-\alpha)(-r_L - \beta_{R1}s) > 0$.

The equilibrium F exists provided that the following conditions hold:

1) S does not deviate to $x = 0$ provided that $\alpha \le \alpha^{***F}_S$.

2) R1 does not deviate to $y_1 = 0$ and $z_1 = A$ unless $r = r_L$ provided that $\alpha \le \alpha^{***F}_{R1}$.

3)a) R1 does not deviate to $y_1 \ne 0$ and $z_1 = A$ iff $r = r_H$ provided that $\alpha \ge \alpha^*_{R1}$.

b) R2 does not deviate to $y_2 = 0$ and $z_2 = A$ unless $r = r_L$ $\alpha \le \alpha^*_{R2}$.

4) R1 does not deviate to the strategy $y_1 = 0$ and $z_1 = A$ iff $r = r_H$ provided that:

$$U_{R1}(y_1^{*F}; x^{*F}; z_1^* = A\ unless\ r = r_L) \ge U_{R1}(y_1 = 0; x^{*F}; z_1 = A\ unless\ r = r_L)$$
$$\ge U_{R1}(y_1 = 0; x^{*F}; z_1 = A\ iff\ r = r_H)$$

The first inequality holds if $\alpha \le \alpha^{***F}_{R1}$ and $\beta_{R1} < -\frac{r_L}{s}$, see point 2) and the preliminary point. The second inequality holds if $\alpha \ge \alpha^*_{R1}$, see point 3)a). Therefore, when $\alpha \le \alpha^{***F}_{R1}$, $\beta_{R1} < -\frac{r_L}{s}$ and $\alpha \ge \alpha^*_{R1}$, R1 does not deviate to the strategy $y_1 = 0$ and $z_1 = A$ iff $r = r_H$.

5) Notice first that if $\beta_{R2} \le -\frac{r_H}{s}$, R2 does not deviate to a strictly positive effort with $z_2 = A$ iff $r = r_H$: $\frac{\partial C_R(y_2^{dev})}{\partial y_2} = x^{*F}\alpha(r_H + \beta_{R2}s) \le 0$.

If $\beta_{R2} > -\frac{r_H}{s}$, R2 does not deviate to y_2^{dev} and $z_2 = A$ iff $r = r_H$ provided that $\alpha \le \alpha^{**F}_{R2}$.

6) R2 does not deviate to the strategy $z_2 = A$ unless $r = r_L$ with $y_2 \ne 0$ provided that:

$$U_{R2}(y_2^{*F} = 0;\ x^{*F};\ z_2^* = A\ iff\ r = r_H) \ge U_{R2}(y_2 \ne 0;\ x^{*F};\ z_2 = A\ iff\ r = r_H)$$
$$\ge U_{R2}(y_2 \ne 0;\ x^{*F};\ z_2 = A\ unless\ r = r_L)$$

The first inequality holds if one of the two following conditions hold: i) $\alpha \le \alpha^{**F}_{R2}$ if $\beta_{R2} > -\frac{r_H}{s}$; or ii) $\beta_{R2} \le -\frac{r_H}{s}$, see point 5). The second inequality holds if $\alpha \le \alpha^*_{R2}$, see point 3)b). ■

L.3 Equilibrium G

In this equilibrium, R1 does not communicate while S and R2 communicate; R1 always accepts the project while R2 accepts the project if and only if he learns that it is of high quality ($y_1^{*G} = 0$; $y_2^{*G} \neq 0$; $x^{*G} \neq 0$; $z_1^* = A$ unless $r = r_L$ and $z_2^* = A$ iff $r = r_H$).

In this equilibrium, the agents' utilities are the following:

$$\begin{aligned}
U_{R1} &= \alpha r_H + (1-\alpha) r_L + \beta_{R1}(s - C_S(x^{*G})) \\
U_{R2} &= x^{*G} y_2^{*G} \alpha r_H - C_R(y_2^{*G}) + \beta_{R2}(x^{*G} y_2^{*G} \alpha s - C_S(x^{*G})) \\
U_S &= \lambda s + x^{*G}(1-\lambda) y_2^{*G} \alpha s - C_S(x^{*G}) \\
&\quad + \beta_S \left(\lambda \left(\alpha r_H + (1-\alpha) r_L\right) + (1-\lambda)(x^{*G} y_2^{*G} \alpha r_H - C_R(y_2^{*G}))\right)
\end{aligned}$$

Therefore, R2's and S's optimal efforts are a function of:

$$\begin{aligned}
\frac{\partial C_R(y_2^{*G})}{\partial y_2} &= x^{*G} \alpha (r_H + \beta_{R2} s) \\
\frac{\partial C_S(x^{*G})}{\partial x} &= (1-\lambda) y_2^{*G} \alpha (s + \beta_S r_H)
\end{aligned}$$

Before stating and proving the conditions of existence of the equilibrium *3.D*, let me define the variables that determine the lower and the upper bounds of the interval of α in which this equilibrium exists.

$$\begin{aligned}
\alpha_{R2}^{**G} &= \frac{C_R(y_2^{*G})}{x^{*G} y_2^{*G}(r_H + \beta_{R2} s)}; \ \alpha_S^{**G} = \frac{C_S(x^{*G})}{x^{*G}(1-\lambda) y_2^{*G}(s + \beta_S r_H)} \\
\alpha_{R1}^{***G} &= 1 - \frac{C_R(y_1^{dev})}{x^{*G} y_1^{dev}(-r_L - \beta_{R1} s)} \ with \ \frac{\partial C_R(y_1^{dev})}{\partial y_1} = x^{*G}(1-\alpha)(-r_L - \beta_{R1} s)
\end{aligned}$$

If R2 exerts a strictly positive effort y_2^{*G} with $z_2 = A$ iff $r = r_H$, if R1 does not communicate with $z_1 = A$ unless $r = r_L$, and if $\beta_S > \frac{s}{-r_H}$, the variable α_S^{**G} represents the minimum congruence parameter above which S does not deviate from this equilibrium to a zero communication effort.

If S exerts a strictly positive effort x^{*G}, if $z_1 = A$ unless $r = r_L$, and if $\beta_{R1} < -\frac{r_L}{s}$, the variable α_{R1}^{***G} represents the maximum congruence parameter under which R1 does not deviate from this equilibrium to a strictly positive communication effort with $z_1 = A$ unless $r = r_L$.

If S exerts a strictly positive effort x^{*G}, if $z_2 = A$ iff $r = r_H$ and if $\beta_{R2} > \frac{-r_H}{s}$, the variable α_{R2}^{**G} represents the minimum congruence parameter above which R2 does not deviate from this equilibrium to a zero effort with $z_2 = A$ iff $r = r_H$.

The equilibrium G exists provided that the following conditions hold:

$$i)\max\left\{\alpha^{**G}_{R2};\ \alpha^{**G}_{S};\ \alpha^{*}_{R1}\right\}\leq\alpha\leq\alpha^{*}_{R2}$$
$$ii)\alpha\geq\alpha^{***G}_{R1}\ if\ \beta_{R1}<\frac{-r_L}{s}\ OR\ \beta_{R1}\geq\frac{-r_L}{s}$$
$$iii)-\frac{s}{r_H}<\beta_S\ and\ -\frac{r_H}{s}<\beta_{R2}$$

Proof. Notice first that this equilibrium exists only if $\beta_S > -\frac{s}{r_H}$ and $\beta_{R2} > -\frac{r_H}{s}$. Both conditions must hold in order for S and R2 to communicate in this equilibrium: $\frac{\partial C_S(x^{*G})}{\partial x} = (1-\lambda)y_2^{*G}\alpha(s+\beta_S r_H) > 0$ and $\frac{\partial C_R(y_2^{*G})}{\partial y_2} = x^{*G}\alpha(r_H+\beta_{R2}s) > 0$.

The equilibrium G exists provided that the following conditions hold:

1) a) S does not deviate to $x=0$ provided that $\alpha\geq\alpha_S^{**G}$.

b) R2 does not deviate to $y_2=0$ and $z_2=A$ iff $r=r_H$ provided that $\alpha\geq\alpha_{R2}^{**G}$.

2) a) R1 does not deviate to $y_1=0$ and $z_1=A$ iff $r=r_H$ provided that $\alpha\geq\alpha_{R1}^{*}$.

b) Similarly, R2 does not deviate to $z_2=A$ unless $r=r_L$ with $y_2\neq 0$ provided that $\alpha\leq\alpha^*_{R2}$.

3) Notice first that if $\beta_{R1}\geq\frac{-r_L}{s}$, R1 does not deviate to a strictly positive effort with $z_1=A$ unless $r=r_L$: $\frac{\partial C_R(y_1^{dev})}{\partial y_1} = x^{*G}(1-\alpha)(-r_L-\beta_{R1}s)\leq 0$.

If $\beta_{R1}<\frac{-r_L}{s}$, R1 does not deviate to y_1^{dev} and $z_1=A$ *unless* $r=r_L$ provided that:

$$U_{R1}(y_1^{*G}=0;\ x^{*G};\ z_1^*=A\ unless\ r=r_L)\geq U_{R1}(y_1^{dev};x^{*G};z_1=A\ unless\ r=r_L)$$
$$\Leftrightarrow \alpha r_H+(1-\alpha)r_L+\beta_{R1}(s-C_S(x^{*G}))\geq x^{*G}y_1^{dev}\alpha r_H+(1-x^{*G}y_1^{dev})$$
$$(\alpha r_H+(1-\alpha)r_L)-C_R(y_1^{dev})+\beta_{R1}(x^{*G}y_1^{dev}\alpha s+(1-x^{*G}y_1^{dev})s-C_S(x^{*G}))$$
$$\Leftrightarrow \alpha\geq 1-\frac{R(y_1^{dev})}{x^{*G}y_1^{dev}(-r_L-\beta_{R1}s)}=\alpha^{***G}_{R1}$$

4) a) R1 does not deviate to $y_1\neq 0$ and $z_1=A$ iff $r=r_H$ provided that:

$$U_{R1}(y_1^{*G}=0;\ x^{*G};z_1=A\ unless\ r=r_L)\geq U_{R1}(y_1\neq 0;\ x^{*G};\ z_1=A\ unless\ r=r_L)$$
$$\geq U_{R1}(y_1\neq 0;\ x^{*G};\ z_1=A\ iff\ r=r_H)$$

The first inequality holds if $\alpha\geq\alpha_{R1}^{***G}$ and $\beta_{R1}<-\frac{r_L}{s}$, or if $\beta_{R1}\geq-\frac{r_L}{s}$, see point 2). The second inequality holds if $\alpha\geq\alpha^*_{R1}$, see point 1)c).

b) R2 does not deviate to the strategy $z_2=A$ unless $r=r_L$ with $y_2=0$ provided that:

$$U_{R2}(y_2^{*G};\ x^{*G};z_2^*=A\ iff\ r=r_H)\geq U_{R2}(y_2=0;\ x^{*G};\ z_2=A\ iff\ r=r_H)$$
$$\geq U_{R2}(y_2=0;\ x^{*G};\ z_2=A\ unless\ r=r_L)$$

The first inequality holds if $\alpha\geq\alpha_{R2}^{**G}$ and $\beta_{R2}>-\frac{r_H}{s}$, see point 1)b). The second inequality holds if $\alpha\leq\alpha^*_{R2}$, see point 4)a). ■

M Proof of proposition 6

Before prooving this proposition, let me state the utilities and the efforts of both agents, who are assumed to be selfish, in this equilibrium:

$$U_R = \alpha x^{*H} y^{*H} r_H - C_R(y^{*H})$$
$$U_S = \alpha x^{*H} y^{*H} s - C_S(x^{*H})$$
$$with\ \frac{\partial C_R(y^{*H})}{\partial y} = x^{*H} \alpha r_H$$
$$and\ \frac{\partial C_S(x^{*H})}{\partial x} = y^{*H} \alpha s$$

This equilibrium exists provided that the following conditions hold:
1) a) R does not deviate to $y = 0$ with $z = A$ iff $r = r_H$;
b) S does not deviate to $x = 0$ with $T = H$;
2) S does not deviate to $T = L$;
3) R does not deviate to $z = A$ unless $r = r_L$.

1) a) R does not deviate to $y = 0$ with $z = A$ iff $r = r_H$ provided that:

$U_R(y^{*H};\ x^{*H};\ T^* = H;\ z^* = A\ iff\ r = r_H) \geq U_R(y = 0;\ x^{*H};\ T^* = H;\ z^* = A\ iff\ r = r_H) \Leftrightarrow x^{*H} y^{*H} \alpha r_H - C_R(y^{*H}) \geq 0 \Leftrightarrow \alpha \geq \dfrac{C_R(y^{*H})}{x^{*H} y^{*H} r_H}$

b) S does not deviate to $x = 0$ with $T = H$ provided that:

$U_S(x^{*H};\ y^{*H};\ T^* = H;\ z^* = A\ iff\ r = r_H) \geq U_S(x = 0;\ y^{*H};\ T^* = H;\ z^* = A\ iff\ r = r_H) \Leftrightarrow x^{*H} y^{*H} \alpha s - C_S(x^{*H}) \geq 0 \Leftrightarrow \alpha \geq \dfrac{C_S(x^{*H})}{x^{*H} y^{*H} s}$

2) When S deviates to $T = L$, R deviates after the communication to $z = A$ unless $r = r_L$ provided that:

$U_R(y^H;\ x;\ T = L;\ z^* = A\ iff\ r = r_H) \geq U_R(y^H;\ x;\ T = L;\ z = A\ unless\ r = r_L) \Leftrightarrow -C_R(y^{*H}) \geq \alpha r_H + (1 - xy^{*H})(1 - \alpha) r_L - C_R(y^{*H})$

When S deviates to $T = L$, S's utility is given by:

$$U_S(y^H;\ x;\ T = L;\ z = A\ unless\ r = r_L) = s(1 - xy^{*H}(1 - \alpha)) - C_S(x)$$

Notice first that if $\alpha > \frac{-r_L}{r_H - r_L}$, S always prefers not to communicate and R always prefers to choose $z = A$ unless $r = r_L$.

Because S's utility is decreasing in x when S deviates to $T = L$ and when R chooses $z = A$ unless $r = r_L$, if $\alpha < \frac{-r_L}{r_H - r_L}$, S chooses the lowest strictly positive effort $x^{dev} = \frac{-\alpha r_H - (1-\alpha) r_L}{-y^{*H}(1-\alpha) r_L}$ that convinces R to choose $z = A$ unless $r = r_L$ instead of $z = A$ iff $r = r_H$:

$$\begin{aligned}
&U_R(y^{*H};\ T = L;\ z = A \ unless\ r = r_L) = U_R(y^{*H};\ T = L;\ z = A \ iff\ r = r_H) \\
\Leftrightarrow&\alpha r_H + (1 - x^{dev} y^{*H})(1-\alpha) r_L - C_R(y^{*H}) = -C_R(y^{*H}) \\
\Leftrightarrow&x^{dev} = \frac{-\alpha r_H - (1-\alpha) r_L}{-y^{*L}(1-\alpha) r_L}
\end{aligned}$$

This optimal effort x^{dev} should be strictly higher than 0:

$$\begin{aligned}
\Leftrightarrow&\frac{-\alpha r_H - (1-\alpha) r_L}{-y^{*H}(1-\alpha) r_L} > 0 \\
\Leftrightarrow&\alpha < \frac{-r_L}{r_H - r_L}
\end{aligned}$$

This optimal effort x^{*L} should also be lower than 1:

$$\begin{aligned}
\Leftrightarrow&\frac{-\alpha r_H - (1-\alpha) r_L}{-y^{*H}(1-\alpha) r_L} \leq 1 \\
\Leftrightarrow&\alpha \geq \frac{-(1 - y^{*H}) r_L}{r_H - (1 - y^{*H}) r_L}
\end{aligned}$$

When S deviates to $T = L$, S prefers that R chooses $z = A$ unless $r = r_L$ to $z = A$ iff $r = r_H$ provided that:

$$\begin{aligned}
&U_S(x^{dev};\ y^{*H};\ T = L;\ z = A \ unless\ r = r_L) \geq U_S(x = 0;\ y^{*H};\ T = L;\ z = A \\
&iff\ r = r_H) \Leftrightarrow s(1 - x^{dev} y^{*H}(1-\alpha)) - C_S(x^{dev}) \geq 0 \Leftrightarrow \alpha \geq 1 + \frac{C_S(x^{dev}) - s}{x^{dev} y^{*H} s}
\end{aligned}$$

a) If $\alpha \geq 1 + \frac{C_S(x^{dev}) - s}{x^{dev} y^{*H} s}$ and if $\alpha \geq \frac{-(1-y^{*H}) r_L}{r_H - (1-y^{*H}) r_L}$, S does not deviate to $T = L$ provided that:

$$\begin{aligned}
&U_S(x^{*H};\ y^{*H};\ T^* = H;\ z^* = A \ iff\ r = r_H) \geq U_S(x^{dev};\ y^{*H};\ T = L;\ z = A \\
&unless\ r = r_L) \Leftrightarrow x^{*H} y^{*H} \alpha s - C_S(x^{*H}) \geq s(1 - x^{dev} y^{*H}(1-\alpha)) - C_S(x^{dev})
\end{aligned}$$

Since $\alpha \geq \frac{C_R(y^{*H})}{x^{*H} y^{*H} r_H}$ (see condition 1)a)), the condition $\alpha \geq \frac{-(1-y^{*H}) r_L}{r_H - (1-y^{*H}) r_L}$ is not needed.

b) if $\alpha \leq 1 + \frac{C_S(x^{dev}) - s}{x^{dev} y^{*H} s}$, S does not deviate to $T = L$ provided that:

$$\begin{aligned}
&U_S(x^{*H};\ y^{*H};\ T^* = H;\ z^* = A \ iff\ r = r_H) \geq U_S(x = 0;\ y^{*H};\ T = L;\ z = A \\
&iff\ r = r_H) \Leftrightarrow x^{*H} y^{*H} \alpha s - C_S(x^{*H}) \geq 0 \Leftrightarrow \alpha \geq \frac{C_S(x^{*H})}{x^{*H} y^{*H} s}
\end{aligned}$$

This is the same condition as point 2b.

3) Notice first that if S exerts a strictly positive effort with $T = H$ and if $z = A$ unless $r = r_L$, R strictly prefers not to communicate than to exert a strictly positive effort. Likewise, if S exerts a strictly positive effort with $T = L$ and if $z = A$ iff $r = r_H$, R strictly prefers not to communicate than to exert a strictly positive effort.

R does not deviate to $z = A$ unless $r = r_L$ with $y = 0$ provided that:

$$U_R(y^{*H};\ x^{*H};\ T^* = H;\ z^* = A\ iff\ r = r_H) \geq U_R(y = 0; x^{*H}; T^* = H;\ z = A\ unless$$
$$r = r_L) \Leftrightarrow x^{*H}y^{*H}\alpha r_H - C_R(y^{*H}) \geq \alpha r_H + (1-\alpha)r_L$$
$$\Leftrightarrow \alpha \leq \frac{-r_L - C_R(y^{*H})}{r_H(1 - x^{*H}y^{*H}) - r_L}$$

The variable $\frac{-r_L - C_R(y^{*H})}{r_H(1-x^{*H}y^{*H})-r_L}$ is higher than the variable $\frac{-r_L}{r_H - r_L}$ provided that:

$$\frac{-r_L - C_R(y^{*H})}{r_H(1 - x^{*}y^{*H}) - r_L} \geq \frac{-r_L}{r_H - r_L}$$
$$\Leftrightarrow C_R(y^{*H})(r_H - r_L) \leq x^*_H y^{*H}(-r_L)r_H$$
$$\Leftrightarrow \frac{C_R(y^{*H})}{x^{*H}y^{*H}r_H} \leq \frac{-r_L}{r_H - r_L}$$

This equilibrium exists only if $\frac{C_R(y^{*H})}{x^{*H}y^{*H}r_H} \leq \frac{-r_L}{r_H-r_L}$. The variable $\frac{-r_L - C_R(y^{*H})}{r_H(1-x^{*H}y^{*H})-r_L}$ has therefore no impact on the conditions of existence of this equilibrium.

N Proof of the proposition 7

Before prooving this proposition, let me state the utilities and the efforts of both agents, who are assumed to be selfish, in this equilibrium:

$$U_R = \alpha r_H + (1 - x^{*L}y^{*L})(1-\alpha)r_L - C_R(y^{*L})$$
$$U_S = s\left(1 - x^{*L}y^{*L}(1-\alpha)\right) - C_S(x^{*L})$$
$$with\ \frac{\partial C_R(y^{*L})}{\partial y} = -x^{*L}(1-\alpha)r_L$$
$$and\ x^{*L} = \frac{-\alpha r_H - (1-\alpha)r_L + C_R(y^{*L})}{-y^{*L}(1-\alpha)r_L}$$

This equilibrium exists provided that the following conditions hold:

1) R does not deviate to $z = A$ iff $r = r_H$ with $y = 0$ or $y \neq 0$;
2) R does not deviate to $y = 0$ with $z = A$ unless $r = r_L$;
3) S does not deviate to:
   a) another level of communication with $T = L$;
   b) $T = H$

1) Notice first that if S exerts a strictly positive effort with $T = L$ and if $z = A$ iff $r = r_H$, R strictly prefers not to communicate than to exert a strictly positive effort.

In this equilibrium, a selfish sender chooses the lowest strictly positive effort x^{*L} with $T^* = L$ that convinces R to choose $z^* = A$ unless $r = r_L$ and y^{*L} instead of $z = A$ iff $r = r_H$ with $y = 0$:

$$U_R(y^{*L};\ T^* = L;\ z^* = A \textit{ unless } r = r_L) = U_R(y = 0;\ T^* = L;\ z = A \textit{ iff } r = r_H) \Leftrightarrow \alpha r_H + (1 - x^* y^{*L})(1-\alpha) r_L - C_R(y^{*L}) = 0$$

$$\Leftrightarrow x^{*L} = \frac{-\alpha r_H - (1-\alpha) r_L + C_R(y^{*L})}{-y^{*L}(1-\alpha) r_L}$$

When $x = 0$, R chooses $z = A$ iff $r = r_H$ instead of $z = A$ unless $r = r_L$. Otherwise, it is no more optimal for S to choose a strictly positive effort:

$$U_R(x = 0;\ z = A \textit{ unless } r = r_L) < U_R(x = 0;\ z = A \textit{ iff } r = r_H)$$

$$\Leftrightarrow \alpha r_H + (1-\alpha) r_L < 0 \Leftrightarrow \alpha < \frac{-r_L}{r_H - r_L}$$

This optimal effort x^{*L} should be strictly higher than 0:

$$\Leftrightarrow \frac{-\alpha r_H - (1-\alpha) r_L + C_R(y^{*L})}{-y^{*L}(1-\alpha) r_L} > 0$$

$$\Leftrightarrow \alpha < \frac{C_R(y^{*L}) - r_L}{r_H - r_L}$$

This optimal effort x^{*L} should also be lower than 1:

$$\Leftrightarrow \frac{-\alpha r_H - (1-\alpha) r_L + C_R(y^{*L})}{-y^{*L}(1-\alpha) r_L} \leq 1$$

$$\Leftrightarrow \alpha \geq \frac{C_R(y^{*L}) - (1 - y^{*L}) r_L}{r_H - (1 - y^{*L}) r_L}$$

2) R does not deviate to $y = 0$ with $z = A$ unless $r = r_L$ provided that:

$$U_R(y^{*L};\ x^{*L};\ T^* = L; z^* = A \textit{ unless } r = r_L) \geq U_R(y = 0;\ x^{*L};\ T^* = L;\ z = A \textit{ unless } r = r_L) \Leftrightarrow \alpha r_H + (1 - x^* y^{*L})(1-\alpha) r_L - C_R(y^{*L}) \geq \alpha r_H + (1-\alpha) r_L$$

$$\Leftrightarrow \alpha \leq \frac{-r_L}{r_H - r_L}$$

3) a) Because S's utility is decreasing in x for $x \geq x^{*L}$, S never chooses a higher level of effort than $x^{*L} = \frac{-\alpha r_H - (1-\alpha) r_L + C_R(y^{*L})}{-y^{*L}(1-\alpha) r_L}$. S does not deviate to a lower level of effort because otherwise R deviates to a zero effort with $z = A$ iff $r = r_H$ (see point 1)).

b) When S deviates to $T = H$, R strictly prefers to choose $z = A$ iff $r = r_H$ instead of $z = A$ unless $r = r_L$:

$$U_R(T = H;\ x;\ y^{*L};\ z = A \textit{ iff } r = r_H) \geq U_R(T = H;\ x;\ y^{*L};\ z = A \textit{ unless } r = r_L)$$

$$\Leftrightarrow \underbrace{x y^{*L} \alpha r_H}_{\geq 0} - C_R(y^{*L}) \geq \underbrace{\alpha r_H + (1-\alpha) r_L}_{\leq 0} - C_R(y^{*L})$$

When S deviates to $T = H$, S prefers to exert a strictly positive effort x^{dev} $\left(\frac{\partial C_S(x^{dev})}{\partial x} = y^{*L}\alpha s\right)$ provided that:

$$U_S(T = H;\ x^{dev};\ y^{*L};\ z = A\ iff\ r = r_H) \geq U_S(T = H;\ x = 0;\ y^{*L};\ z = A\ iff\ r = r_H) \Leftrightarrow x^{dev}y^{*L}\alpha s - C_S(x^{dev}) \geq 0 \Leftrightarrow \alpha \geq \frac{C_S(x^{dev})}{x^{dev}y^{*L}s}$$

If $\alpha \geq \frac{C_S(x^{dev})}{x^{dev}y^{*L}s}$, S does not deviate to a strictly positive communication effort with $T = H$ provided that:

$$\begin{aligned}
&U_S(T^* = L;\ x^{*L};\ y^{*L};\ z^* = A\ unless\ r = r_L) \\
&\geq U_S(T = H;\ x^{dev};\ y^{*L};\ z = A\ iff\ r = r_H) \\
&\Leftrightarrow s(1 - x^{*L}y^{*L}(1-\alpha)) - C_S(x^{*L}) \geq x^{dev}y^{*L}\alpha s - C_S(x^{dev})
\end{aligned}$$

If $\alpha < \frac{C_S(x^{dev})}{x^{dev}y^{*L}s}$, S does not deviate to zero effort provided that:

$$\begin{aligned}
&U_S(T^* = L;\ x^{*L};\ y^{*L};\ z^* = A\ unless\ r = r_L) \\
&\geq U_S(T = H;\ x = 0;\ y^{*L};\ z = A\ iff\ r = r_H) \\
&\Leftrightarrow s(1 - x^{*L}y^{*L}(1-\alpha)) - C_S(x^{*L}) \geq 0 \\
&\Leftrightarrow \alpha \geq \frac{-r_L C_S(x^{*L}) + C_R(y^{*L})s}{sr_H}
\end{aligned}$$

O Proof of proposition 8

- In the equilibrium I, both agents communicate; R1 accepts the project unless he learns that his revenue from the project is low while R2 accepts the project if and only if he learns that his revenue from the project is high ($y_1^* \neq 0;\ y_2^* \neq 0;\ z_1^* = A$ unless $r_1 = r_L$ and $z_2^* = A$ iff $r_2 = r_H$).

Before proving this proposition, let me state the utilities of both agents in this equilibrium:

$$\begin{aligned}
&U_1 = p_2^*\ \alpha_2(\alpha_1 r_H + (1-p_1^*)(1-\alpha_1)r_L) - C_1(y_1^*) \\
&U_2 = p_2^*\ \alpha_2(1 - p_1^*\ (1-\alpha_1))r_H - C_2(y_2^*) \\
&with\ y_1^* = \arg\max_{y_1}\ U_1(y_1;\ y_2^*;\ z_1^* = A\ unless\ r_1 = r_L;\ z_2^* = A\ iff\ r_2 = r_H);\ and \\
&\quad y_2^* = \arg\max_{y_2}\ U_2(y_2;\ y_1^*;\ z_1^* = A\ unless\ r_1 = r_L;\ z_2^* = A\ iff\ r_2 = r_H)
\end{aligned}$$

This equilibrium exists provided that the following conditions hold:

1)a) R_1 does not deviate to $y_1 \neq 0$ with $z_1 = A$ *iff* $r_1 = r_H$ provided that:

$$
\begin{aligned}
&U_1(y_1 \neq 0;\ y_2^*;\ z_1^* = A \ unless \ r_1 = r_L;\ z_2^* = A \ iff \ r_2 = r_H) \\
&\geq U_1(y_1 \neq 0;\ y_2^*;\ z_1 = A \ iff \ r_1 = r_H;\ z_2^* = A \ iff \ r_2 = r_H) \\
\Leftrightarrow & p_2 \ \alpha_2(\alpha_1 r_H + (1-p_1)(1-\alpha_1)r_L) - C_1(y_1) \geq p_1 \ p_2 \ \alpha_1 \ \alpha_2 r_H - C_1(y_1) \\
\Leftrightarrow & \alpha_1 \geq \frac{-r_L}{r_H - r_L}
\end{aligned}
$$

b) R_2 does not deviate to $y_2 \neq 0$ with $z_2 = A$ *unless* $r_2 = r_L$ provided that:

$$
\begin{aligned}
&U_2(y_2 \neq 0;\ y_1^*;\ z_1^* = A \ unless \ r_1 = r_L;\ z_2^* = A \ iff \ r_2 = r_H) \\
&\geq U_2(y_2 \neq 0;\ y_1^*;\ z_1^* = A \ unless \ r_1 = r_L;\ z_2 = A \ unless \ r_2 = r_L) \\
\Leftrightarrow &(1 - p_1(1-\alpha_1))p_2 \ \alpha_2 r_H - C_2(y_2) \geq (1 - p_1(1-\alpha_1))(\alpha_2 r_H + (1-p_2)(1-\alpha_2) \\
& r_L) - C_2(y_2) \Leftrightarrow \alpha_2 \leq \frac{-r_L}{r_H - r_L}
\end{aligned}
$$

2) R_2 does not deviate to a zero communication with $z_2 = A$ iff $r_2 = r_H$ provided that:

$$
\begin{aligned}
&U_2(y_2^*;\ y_1^*;\ z_1^* = A \ unless \ r_1 = r_L;\ z_2^* = A \ iff \ r_2 = r_H) \\
&\geq U_2(y_2 = 0;\ y_1^*;\ z_1^* = A \ unless \ r_1 = r_L;\ z_2 = A \ iff \ r_2 = r_H) \\
&\Leftrightarrow p_2^* \ \alpha_2(1 - p_1^*(1-\alpha_1))r_H - C_2(y_2^*) \geq 0 \Leftrightarrow \alpha_2 \geq \frac{C_2(y_2^*)}{p_2^*(1 - p_1^*(1-\alpha_1))r_H}
\end{aligned}
$$

3) R_1 does not deviate to a zero communication (with $z_1 = A$ unless $r = r_L$ or $z_1 = A$ iff $r = r_H$) provided that:

$$
\begin{aligned}
&U_1(y_1^*;\ y_2^*;\ z_1^* = A \ unless \ r_1 = r_L;\ z_2^* = A \ iff \ r_2 = r_H) \\
&\geq U_1(y_1 = 0;\ y_2^*;\ z_2^* = A \ iff \ r_2 = r_H) \\
&\Leftrightarrow p_2^* \ \alpha_2(\alpha_1 r_H + (1-p_1^*)(1-\alpha_1)r_L) - C_1(y_1^*) \geq 0 \\
&\Leftrightarrow \alpha_1 \geq \frac{\frac{C_1(y_1^*)}{p_2^* \ \alpha_2} - (1-p_1^*)r_L}{r_H - (1-p_1^*)r_L}
\end{aligned}
$$

4) R_2 does not deviate to a zero communication with $z_2 = A$ unless $r_2 = r_L$ provided that:

$$
\begin{aligned}
&U_2(y_2^*; y_1^*; z_2^* = A \ iff \ r_2 = r_H; z_1^* = A \ unless \ r_1 = r_L) \\
\geq &U_2(y_2 = 0; y_1^*; z_2 = A \ iff \ r_2 = r_H; z_1^* = A \ unless \ r_1 = r_L) \\
\geq &U_2(y_2 = 0; y_1^*; z_2 = A \ unless \ r_2 = r_L; z_1^* = A \ unless \ r_1 = r_L)
\end{aligned}
$$

The first inequality holds if $\alpha_2 \geq \frac{C_2(y_2^*)}{p_2^*(1-p_1^*(1-\alpha_1))r_H}$, see point 2). The second inequality holds if $\alpha_2 \leq \frac{-r_L}{r_H - r_L}$, see point 1)b).

- In the equilibrium II, both agents communicate, R1/R2 accepts the project unless he learns that his revenue from the project is low ($y_1^* \neq 0;\ y_2^* \neq 0;$ $z_1^* = A$ unless $r_1 = r_L$ and $z_2^* = A$ unless $r_2 = r_L$).

Before proving this proposition, let me state the utilities of both agents in this equilibrium:

$$\begin{gathered}U_1 = (1 - p_2^*\ (1-\alpha_2))(\alpha_1 r_H + (1-p_1^*)(1-\alpha_1)r_L) - C_1(y_1^*)\\ U_2 = (1 - p_1^*\ (1-\alpha_1))(\alpha_2 r_H + (1-p_2^*)(1-\alpha_2)r_L) - C_2(y_2^*)\\ with\ y_1^* = arg_{y_1} max\ U_1(y_1;\ y_2^*;\ z_1^* = A\ unless\ r_1 = r_L;\ z_2^* = A\ unless\ r_2 = r_L);\\ and\ y_2^* = arg_{y_2} max\ U_2(y_2;\ y_1^*;\ z_1^* = A\ unless\ r_1 = r_L;\ z_2^* = A\ unless\ r_2 = r_L)\end{gathered}$$

This equilibrium exists provided that the following conditions hold:

1)a) R_1 does not deviate to $y_1 \neq 0$ with $z_1 = A\ iff\ r_1 = r_H$ provided that $\alpha_1 \geq \frac{-r_L}{r_H - r_L}$.

b) R_2 does not deviate to $y_2 \neq 0$ with $z_2 = A\ iff\ r_2 = r_H$ provided that $\alpha_2 \geq \frac{-r_L}{r_H - r_L}$.

2)a) R_2 does not deviate to a zero communication with $z_2 = A$ unless $r_2 = r_L$ provided that:

$$\begin{aligned}&U_2(y_2^*;\ y_1^*;\ z_1^* = A\ unless\ r_1 = r_L;\ z_2^* = A\ unless\ r_2 = r_L)\\ &\geq U_2(y_2 = 0;\ y_1^*;\ z_1^* = A\ unless\ r_1 = r_L;\ z_2 = A\ unless\ r_2 = r_L)\\ &\Leftrightarrow (1 - p_1^*\ (1-\alpha_1))(\alpha_2 r_H + (1-p_2^*)(1-\alpha_2)r_L) - C_2(y_2^*) \geq \alpha_2 r_H + (1-\alpha_2)r_L\\ &\Leftrightarrow \alpha_1 \geq 1 + \frac{C_2(y_2^*) + p_2^*(1-\alpha_2)r_L}{p_1^*(\alpha_2 r_H + (1-\alpha_2)r_L(1-p_2^*))}\\ &\Leftrightarrow \alpha_2 \leq \frac{-p_2^* r_L - p_1^*\ (1-\alpha_1)r_L(1-p_2^*) - C_2(y_2^*)}{p_1^*\ (1-\alpha_1)r_H - p_1^*\ (1-\alpha_1)r_L(1-p_2^*) - p_2^* r_L}\end{aligned}$$

2)b) Similarly, R_1 does not deviate to a zero communication with $z_1 = A$ unless $r = r_L$ provided that:

$$\begin{aligned}&\Leftrightarrow \alpha_2 \geq 1 + \frac{C_1(y_1^*) + p_1^*(1-\alpha_1)r_L}{p_2^*(\alpha_1 r_H + (1-\alpha_1)r_L(1-p_1^*))}\\ &\Leftrightarrow \alpha_1 \leq \frac{-p_1^* r_L - p_2^*\ (1-\alpha_2)r_L(1-p_1^*) - C_1(y_1^*)}{p_2^*\ (1-\alpha_2)r_H - p_2^*\ (1-\alpha_2)r_L(1-p_1^*) - p_1^* r_L}\end{aligned}$$

3)a) R_1 does not deviate to a zero communication with $z_1 = A$ iff $r_1 = r_H$ provided that:

$$\begin{aligned}&U_1(y_1^*; y_2^*; z_1^* = A\ unless\ r_1 = r_L; z_2^* = A\ unless\ r_2 = r_L)\\ \geq &U_1(y_1 = 0; y_2^*; z_1 = A\ unless\ r_1 = r_L; z_2^* = A\ unless\ r_2 = r_L)\\ \geq &U_1(y_1 = 0; y_2^*; z_1 = A\ iff\ r_1 = r_H; z_2^* = A\ unless\ r_2 = r_L)\end{aligned}$$

The first inequality holds if $\alpha_1 \leq \frac{-p_1^* r_L - p_2^*\ (1-\alpha_2)r_L(1-p_1^*) - C_1(y_1^*)}{p_2^*\ (1-\alpha_2)r_H - p_2^*\ (1-\alpha_2)r_L(1-p_1^*) - p_1^* r_L}$, see point 2)b). The second inequality holds if $\alpha_1 \geq \frac{-r_L}{r_H - r_L}$, see point 1)a).

b) R_2 does not deviate to a zero communication with $z_2 = A$ unless $r_2 = r_L$ provided that:

$$\begin{aligned}
&U_2(y_2^*; y_1^*; z_2^* = A \textit{ unless } r_2 = r_L; z_1^* = A \textit{ unless } r_1 = r_L)\\
\geq &U_2(y_2 = 0; y_1^*; z_2 = A \textit{ unless } r_2 = r_L; z_1^* = A \textit{ unless } r_1 = r_L)\\
\geq &U_2(y_2 = 0; y_1^*; z_2 = A \textit{ iff } r_2 = r_H; z_1^* = A \textit{ unless } r_1 = r_L)
\end{aligned}$$

The first inequality holds if $\alpha_2 \leq \frac{-p_2^* r_L - p_1^*\ (1-\alpha_1) r_L (1-p_2^*) - C_2(y_2^*)}{p_1^*\ (1-\alpha_1) r_H - p_1^*\ (1-\alpha_1) r_L (1-p_2^*) - p_2^* r_L}$, see point 2)a). The second inequality holds if $\alpha_2 \geq \frac{-r_L}{r_H - r_L}$, see point 1)b).

- In the equilibrium III, both agents communicate, R1/R2 accepts the project if and only if he learns that his revenue from the project is high ($y_1^* \neq 0$; $y_2^* \neq 0$; $z_1^* = A$ iff $r_1 = r_H$ and $z_2^* = A$ iff $r_2 = r_H$).

Before proving this proposition, let me state the utilities of both agents in this equilibrium:

$$\begin{aligned}
&U_1 = p_1^*\ p_2^*\ \alpha_1 \alpha_2 r_H - C_1(y_1^*)\\
&U_2 = p_1^*\ p_2^*\ \alpha_1 \alpha_2 r_H - C_2(y_2^*)\\
&\textit{with } y_1^* = arg_{y_1} max\ U_1(y_1;\ y_2^*;\ z_1^* = A \textit{ iff } r_1 = r_H;\ z_2^* = A \textit{ iff } r_2 = r_H);\\
&\textit{and } y_2^* = arg_{y_2} max\ U_2(y_2;\ y_1^*;\ z_1^* = A \textit{ iff } r_1 = r_H;\ z_2^* = A \textit{ iff } r_2 = r_H)
\end{aligned}$$

This equilibrium exists provided that the following conditions hold:

1)a) R_1 does not deviate to $y_1 \neq 0$ with $z_1 = A$ *unless* $r_1 = r_L$ provided that $\alpha_1 \leq \frac{-r_L}{r_H - r_L}$.

b) R_2 does not deviate to $y_2 \neq 0$ with $z_2 = A$ *unless* $r_2 = r_L$ provided that $\alpha_2 \leq \frac{-r_L}{r_H - r_L}$.

2)a) R_1 does not deviate to a zero communication with $z_1 = A$ iff $r_1 = r_H$ provided that:

$$\begin{aligned}
&U_1(y_1^*;\ y_2^*;\ z_1^* = A \textit{ iff } r_1 = r_H;\ z_2^* = A \textit{ iff } r_2 = r_H)\\
&\geq U_1(y_1 = 0;\ y_2^*;\ z_1 = A \textit{ iff } r_1 = r_H;\ z_2^* = A \textit{ iff } r_2 = r_H)\\
&\Leftrightarrow p_1^*\ p_2^*\ \alpha_1 \alpha_2 r_H - C_1(y_1^*) \geq 0\\
&\Leftrightarrow \alpha_1 \geq \frac{C_1(y_1^*)}{p_1^*\ p_2^*\ \alpha_2 r_H}
\end{aligned}$$

2)b) Similarly, R_2 does not deviate to a zero communication with $z_2 = A$ iff $r_2 = r_H$ provided that $\alpha_2 \geq \frac{C_2(y_2^*)}{p_1^*\ p_2^*\ \alpha_1 r_H}$.

3)a) R_1 does not deviate to a zero communication with $z_1 = A$ unless $r_1 = r_L$ provided that:

$$\begin{aligned}
&U_1(y_1^*; y_2^*; z_1^* = A \textit{ iff } r_1 = r_H; z_2^* = A \textit{ iff } r_2 = r_H)\\
\geq &U_1(y_1 = 0; y_2^*; z_1 = A \textit{ iff } r_1 = r_H; z_2^* = A \textit{ iff } r_2 = r_H)\\
\geq &U_1(y_1 = 0; y_2^*; z_1 = A \textit{ unless } r_1 = r_L; z_2^* = A \textit{ iff } r_2 = r_H)
\end{aligned}$$

The first inequality holds if $\alpha_1 \geq \frac{C_1(y_1^*)}{p_1^* \ p_2^* \ \alpha_2 r_H}$, see point 2)a). The second inequality holds if $\alpha_1 \leq \frac{-r_L}{r_H - r_L}$, see point 1)a).

b) R_2 does not deviate to a zero communication with $z_2 = A$ unless $r_2 = r_L$ provided that:

$$
\begin{aligned}
&U_2(y_2^*; y_1^*; z_2^* = A \ iff \ r_2 = r_H; z_1^* = A \ iff \ r_1 = r_H) \\
\geq &U_2(y_2 = 0; y_1^*; z_2 = A \ iff \ r_2 = r_H; z_1^* = A \ iff \ r_1 = r_H) \\
\geq &U_2(y_2 = 0; y_1^*; z_2 = A \ unless \ r_2 = r_L; z_1^* = A \ iff \ r_1 = r_H)
\end{aligned}
$$

The first inequality holds if $\alpha_2 \geq \frac{C_2(y_2^*)}{p_1^* \ p_2^* \ \alpha_1 r_H}$, see point 2)b). The second inequality holds if $\alpha_2 \leq \frac{-r_L}{r_H - r_L}$, see point 1)b).