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On the Overconfidence-Effect in Teams

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Abstract

This paper analyses the effects of overconfidence on a coordination problem within a team of two agents and in the presence of effort complementarities. We show that in several settings an overconfidence bias or the mere anticipation of having an overconfident partner might not only help mitigate the coordination problem but also result in a Pareto improvement.

JEL-Codes: D21, D62, L23

Der Overconfidence-Effekt in Teams

Zusammenfassung

In diesem Papier werden die Effekte eines Overconfidence-Bias auf das Koordinationsproblem innerhalb eines Teams betrachtet. In einem Team aus zwei Agenten, deren Arbeitseinsätze komplementär sind, zeigt sich, dass ein Overconfidence-Bias oder aber auch die Antizipation eines overconfidenten Partners das entstandene Koordinationsproblem abschwächen und möglicherweise sogar zu einer Pareto-Verbesserung führen können.

Im Internet unter:

<http://www.wiwi.uni-muenster.de/io/forschen/dp/DPIO-03-2010.pdf>

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On the Overconfidence-Effect in Teams*

1 Introduction

Research in economics as well as psychology shows that individuals seldom are the well-calibrated information processors homo oeconomicus is stated to be. In particular individuals seem to be prone to overestimate their abilities in absolute terms and/or relative to others, these phenomena are best described as overconfidence (Weinstein, 1980; Svenson, 1981; Taylor and Brown, 1988; for an excellent review see Skata, 2008). The economic consequences of this misperception recently started to attract interest and are twofold: On the one hand overconfidence seems to foster daring behaviour and therefore results in unfavourable outcome in the form of management decisions which are too risky (Larwood and Whittaker, 1977; Russo and Shoemaker, 1992; Heaton, 2002; or Malmendier and Tate, 2005; 2008) or risky behaviour on asset markets (Barber and Odean, 2002) on the other hand one might argue that overconfidence need to be beneficial at least to some extent since it otherwise would be eliminated by economic forces. Benabou and Tirole (2002) as well as Weinberg (2009) give theoretical arguments for benefits of overconfidence by stating that individuals might have some form of self-esteem-utility. Furthermore empirical and experimental evidence shows that overconfidence increases motivation and results in greater efforts (Felson, 1984; Locke and Latham, 1990; Heath et al., 1999; and Hirshleifer and Luo, 2001).

Focusing on the upside effect of overconfident self-perception, Gervais and Goldstein (2007) address its economic consequences within a model of team production. They focus on a coordination problem which arises as soon as agents make their choice of (unobservable) effort and how it may be overcome by the presence of an overconfident agent and strong effort

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complementarities. Both assumptions are intuitive as overconfidence seems to be a widespread phenomenon¹ and coordination and cooperation within a firm are essential for its success. Alchian and Demsetz (1972) show that firms form in order to utilise synergies; but at the same time, when trying to, firms face a problem of moral hazard as agents tend to rely on their partners' effort (see Holmström, 1982). Gervais and Goldstein (2007) show that this problem might be mitigated by the presence of an overconfident agent whose increased effort induces his rational partner to exert more effort as well, which gives rise to a Pareto improvement, leaving both the agents and the principal better off.

This paper picks up on an extension Gervais and Goldstein (2007) briefly discuss: They show how bias awareness of one agent might develop a similar impact. Yet we think this point should be further examined and find that the effort and welfare enhancing effect of overconfidence may also persist within an intuitive model of team production, if the agents are not completely informed about the self-perception of their partner but have a certain bias awareness: The agents are aware of the fact that overconfidence is as widespread a phenomenon as empirical and experimental research suggests and assign a certain probability to their partner(s) being overconfident. This assumption is in line with a broad body of psychological research, showing that indeed individuals are aware of others' biases to some extent (see e.g. Ludwig and Nafziger, forthcoming). In this context Gervais and Goldstein (2007) focus on the fact that "a rational agent knows his effort will only contribute to the project's success through synergy with the other agent". This assumption may be useful in order to derive a certain intuition for the resulting equilibria but we add on this matter by applying the notion of bias awareness into a more general model of teamwork.

Our results are in line with the findings of Gervais and Goldstein (2007) as we are able to identify possible upsides of overconfident self-perception in teams as the described problem of moral hazard and free riding is mitigated.

¹On overconfidence see also: Fischhoff et al. (1977) or Griffin and Tversky (1992). For an opposing position see Gigerenzer et al. (1991) or Juslin (1994) and a reply by Kahnemann and Tversky (1996). More recent meta-studies by Koehler et al. (2002) and Brenner and Griffin (2004) suggest that overconfidence is a valid phenomenon.

Bias awareness (as well as an actual bias) leads both types of agents to exert more effort, as they anticipate an overconfident agent to work harder and in so doing perceive their marginal productivity as increased. A welfare comparison shows that this increase of effort is beneficial not only for rational but also for overconfident agents. We distinguish several settings of different teams and are able to identify potential benefits of overconfidence and/or bias awareness even for the case of two in fact overconfident agents.² Due to the incentive to exert greater effort given by the mere possibility of being teamed up with an overconfident agent, the coordination problem is mitigated leaving the principal better off as well, i.e. a Pareto improvement might occur. These results hold for the case of a team with an overconfident and a rational agent (as discussed by Gervais and Goldstein, 2007) as well as a team of rational agents.

This paper adds to a growing strand of research focusing on the welfare effects of behavioral biases and their potential benefits – closely related literature studies the positive impact of overconfident self-perception in principal agent settings (see e.g. Hvide, 2002; De la Rosa, 2007; Santos-Pinto, 2008)

The paper is organised as follows. Section 2 sets up the baseline model. Section 3 specifies the agents' overconfidence and bias awareness and analyses the impact on the effort levels exerted by the agents as well as the resulting individual welfare in various settings of teams. Finally, Section 4 summarises our main arguments and concludes. All proofs and technical derivations are gathered in the Appendix.

2 The Baseline Model

In order to model the coordination problem which a team of rational agents faces, we follow the approach of Gervais and Goldstein (2007) and consider an all equity firm owned by risk neutral shareholders, requiring the effort of two

²Furthermore we personalise an agent's bias awareness as there might be differences between the significance of bias awareness of an actually biased agent and that of a rational agent as Ludwig and Nafziger (2009) suggest.

risk neutral³ agents, $i = 1, 2$, for production. Output generates from a single one-period project which will be a success with probability π . The project's value is given by its expected cash-flow. The probability of success is set by the agents' effort, $e_i \in [0, 1]$, their abilities, $a_i \in [0, 1]$, and a synergy-effect:

$$\pi = a_i e_i + a_{-i} e_{-i} + s e_i e_{-i}. \quad (1)$$

For simplicity we assume the agents being of the same level of skill, $a_i = a_{-i} = a$; a possible intuition might be that the described production technology demands for workforce of the same kind in order to exploit complementarities effectively, which the agents are not aware of. Taking this into account the principal has already screened the agents' abilities and assigned them to a project which best suits their skill. Furthermore, effort cost are convex, with $c(e_i) = \frac{1}{2}e_i^2$. Since actual effort levels and abilities are unobservable for the principal, wages condition only on the expected outcome of the project and we fix the wages of both agents at w (with $0 < w \leq 1$) exogenously in order to study the effects of overconfidence and bias awareness on the resulting equilibrium (without the additional incentives set by contracts).⁴ Wages are only paid if the project was successful. Accordingly the maximisation problem of agent i is given by:

$$\max_{e_i \in [0,1]} w(ae_i + ae_{-i} + se_i e_{-i}) - \frac{1}{2}e_i^2, \quad (2)$$

with $2a + s < 1$ and $sw < \frac{1}{2}$. In an analogue setting Gervais and Goldstein (2007) find that the equilibrium efforts are below the social optimum as the agents do not account for the positive externalities of effort, i.e. a first best effort level cannot be implemented. In this context, Gervais and Goldstein (2007) are able to show how overconfidence may lead to a Pareto improvement.

³The focused effect of overconfidence on the coordination problem within the team allows for this simplifying assumption. Risk averse agents could be a problem on its own to analyse in further research.

⁴The analysis of contracts in this scenario is an interesting problem on its own, but not focused in this paper.

3 Overconfidence and Bias Awareness

Social biases, like overconfidence, are a widespread phenomenon and well-examined experimentally and empirically as well as theoretically - nonetheless, research on the awareness of such biases is scarce and therefore we try to incorporate the notion of bias-awareness (in particular: the awareness of a partner's overconfidence) into an intuitive model of team-production. In our setting the agents are aware of the fact that others might be overconfident (whereas they are not aware of their own - potentially biased - self-perception). These extensions enable us to shed additional light onto the effects of social biases in the sense of overconfidence.

The agents assign a certain probability to the fact that they might be teamed up with a biased agent and so the maximisation problem of a rational agent is:

$$\max_{e_i \in [0,1]} w(ae_i + a\bar{e}_R + se_i\bar{e}_R) - \frac{1}{2}e_i^2, \quad (3)$$

with $\bar{e}_R = qe_B + (1 - q)e_R$, e_B as the equilibrium effort of an biased agent and e_R as the equilibrium effort of a rational agent respectively. Accordingly the maximisation problem of an overconfident agent is:

$$\max_{e_i \in [0,1]} w((a + b)e_i + a\bar{e}_B + se_i\bar{e}_B) - \frac{1}{2}e_i^2, \quad (4)$$

with $\bar{e}_B = \tilde{q}e_B + (1 - \tilde{q})e_R$. A biased agent thinks of himself as more skilled than he truly is, therefore he overestimates his abilities, a ; the degree of overconfidence by the agent is referred to by parameter b . The general line of inquiry is closely related to Gervais and Goldstein (2007) with some distinction regarding the derivation of welfare effects since we do not focus on marginal welfare effects of overconfidence or bias awareness.

Considering that agents do not know the true ability of their partner but are well aware of the fact, that he might be overconfident with some probability, the expected effort of an agent's partner is given by \bar{e}_R for a rational agent and \bar{e}_B for an overconfident agent. Therefore the maximisation

problems (3) and (4) give the effort reaction function of a rational agent:

$$wa + ws\bar{e}_R \equiv e_R, \quad (5)$$

and of an overconfident agent:

$$w(a + b) + ws\bar{e}_B \equiv e_B. \quad (6)$$

Note that an overconfident agent is not aware of his own bias as well as he is not aware of the fact that a rational agent might assign a different probability to being teamed up with an overconfident agent than he does and the rational agent is not aware of the fact that the overconfident partner, whose effort he anticipates, might assign a different probability as well. Dissolving e_R and e_B , (5) and (6) give:

$$\bar{e}_R = \frac{w(a + qb)}{1 - sw} \quad (7)$$

and

$$\bar{e}_B = \frac{w(a + \tilde{q}b)}{1 - sw}. \quad (8)$$

3.1 Two Rational Agents

In order to segregate the effect of bias awareness from the actual bias, we consider a team of two rational agents and get the equilibrium efforts of (see Appendix B.i for a derivation):

$$e_i^{11} = \frac{w(a + sqbw)}{1 - sw}. \quad (9)$$

As a rational agent expects his partner to be overconfident with a certain probability, he perceives his marginal productivity to be increased (as he anticipates an overconfident agent to work harder) and since so doing tries to utilise this increase in his marginal productivity by increasing his own effort as well. Since the agents face a problem of free riding, greater effort might,

⁵The agents' types is referred to by the superscripted number, where 1 means "rational" and 2 means "overconfident", whereas the first number refers to the first agent's type and the second number to the second agent's type respectively.

if not excessively increased, increase welfare as well. A comparison of the resulting welfare and that of the reference situation⁶ without overconfidence shows (see Appendix B.ii for a derivation):

Proposition 1: *If both agents are rational and assign a probability of q to their partner being overconfident, both agents are better off, if:*

$$b < \frac{a}{sqw(\frac{1}{2} - sw)}. \quad (10)$$

If the bias the agents take into account as well as the probability they assign to the possibility of their partners being overconfident is sufficiently small, the agents' welfare is increased, compared to a situation without overconfidence or according awareness. This is due to the fact that an overconfident partner is anticipated to exert more effort and by that a rational agent's own marginal productivity is increased which warrants an extra effort by an unbiased agent as well. This welfare effect is illustrated in figure 1. As the welfare reducing coordination problem two rational agents face can be overcome by the mere possibility of being teamed up with an overconfident partner, the equilibrium effort and welfare is increased as well as the project's probability of success, i.e. a Pareto improvement might occur.

3.2 One Overconfident and One Rational Agent

Taking a team of one overconfident and one rational agent into account we get the equilibrium efforts of (see Appendix C.i for a derivation):

$$e_1^{12} = \frac{w(a + sqbw)}{1 - sw} \quad (11)$$

and

$$e_2^{12} = \frac{w(a + s\tilde{q}bw)}{1 - sw} + bw. \quad (12)$$

⁶A derivation of the reference values can be found in Appendix A.

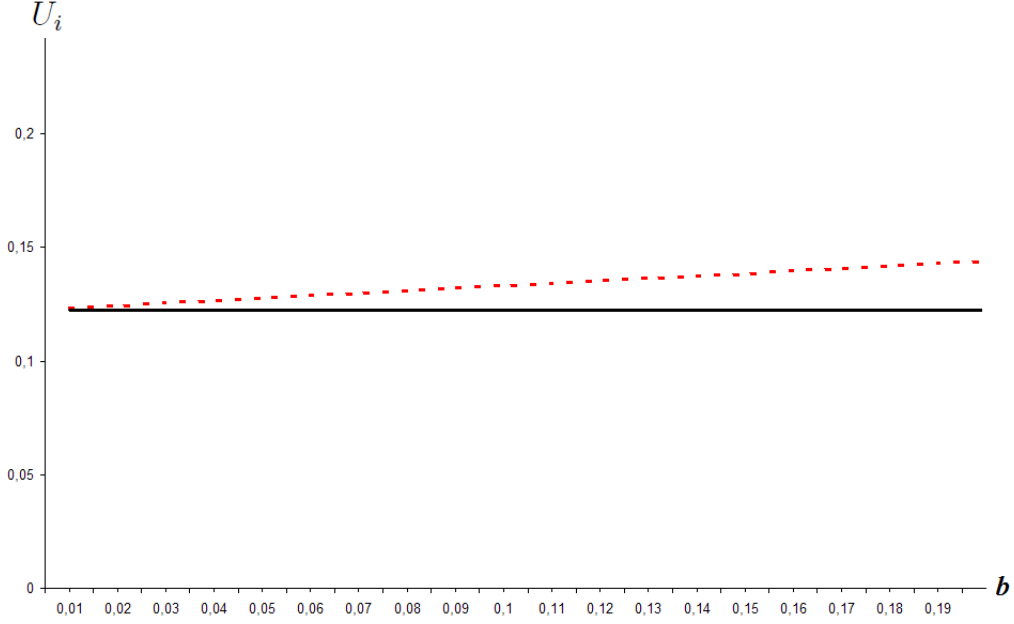


Figure 1: The individual welfare for $a = 0,2$; $s = 0,4$; $w = 1$ and $q = 0,5$. The continuous line shows the reference welfare of a rational agent in a situation without overconfidence. The dotted line shows the welfare of a rational agent being aware of the fact that his partner might be overconfident (and assigning the probability q to this circumstance).

Note that this time the overconfident agent's (agent 2) incentives to upgrade his own effort are twofold: His bias awareness and his own overconfidence bias. Both induce a higher effort on their own and by that, the overconfident agent exerts more effort than the rational one. Analysing the welfare consequences of these efforts, we find (see Appendix C.ii for a derivation):

Proposition 2 *If one agent is overconfident and one is rational and both assign a certain probability (q and \tilde{q}) to their partner being overconfident, the rational agent is always better off. The overconfident agent is better off, if:*

$$b < \frac{2sqwa}{(1 - sw)^2 + sw(\tilde{q} - sqw)[2(1 - sw) + s\tilde{q}w] - s^3q\tilde{q}w^3}. \quad (13)$$

Note this time that the biased agent increases his effort for two reasons (his bias awareness and his own overconfidence) and by that works harder than

his rational partner. This welfare effect is illustrated in figure 2. While

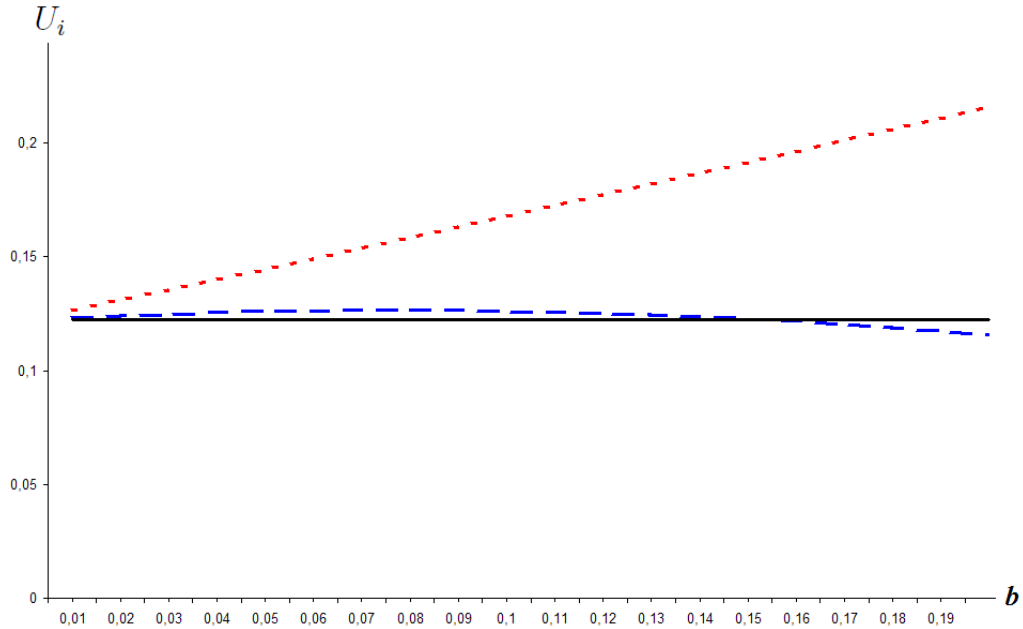


Figure 2: The individual welfare for $a = 0,2$; $s = 0,4$; $w = 1$; $q = 0,5$ and $\tilde{q} = 0,5$. The continuous line shows the reference welfare of a rational agent in a situation without overconfidence. The dotted line shows the welfare of a rational agent and the dashed line shows the welfare of an overconfident agent. Both are aware of the fact that their partner might be overconfident (the rational agent assigns the probability q and the overconfident agent assigns the probability \tilde{q} to this circumstance).

the project’s probability of success is increased, compared to the previous situation, the overexertion of effort by the overconfident agent is not fully compensated by the synergetic feedback induced by the rational agent’s increased effort. The overconfident agent is better off, compared to a situation without overconfidence but at the same time his rational partner has a relative welfare advantage compared to him.

By incorporating the notion that an overconfident agent might be less “bias aware” ($q > \tilde{q}$) than his rational partner, this relative welfare disadvantage will be – at least to some degree – mitigated. Since the overconfident agent exerts less effort than the rational agent anticipates him to and by that the overconfident agent receives the same synergetic feedback while actually

working less than his partner anticipates. At this point our results are in line with Ludwig et al. (2008) who find that biased agents are better off by assuming their partners' being rational, even if this is not true.

3.3 Two Overconfident Agents

Since overconfidence is a widespread phenomenon, as empirical and experimental research suggest, it might be reasonable to analyse the effort coordination problem a team of two overconfident agents faces. The equilibrium efforts are given by (see Appendix D.i for a derivation):

$$e_i^{22} = \frac{w(a + s\tilde{q}bw)}{1 - sw} + bw. \quad (14)$$

Now both agents increase their effort for two reasons and an analysis of the resulting welfare gives (see Appendix D.ii for a derivation):

Proposition 3 *If both agents are overconfident and assign a probability of \tilde{q} to their partner being overconfident, both agents are better off, if:*

$$b < \frac{2a[1 - sw(1 - \tilde{q})]}{(1 - 2sw)[(1 - sw)^2 + s\tilde{q}w(2(1 - sw) + sqw)]}. \quad (15)$$

Again the welfare enhancing effects of overconfidence and bias awareness are obvious as also for a team of two overconfident agents a greater welfare might result from their biases. This welfare effect is illustrated in figure 3. The dynamics are similar to the previous case of a team of one overconfident and one rational agent, with the key distinction that this time both agents create a larger synergetic feedback to compensate for their miscalibrated self-perception. Yet, even a team of two overconfident agents might generate a Pareto improvement.

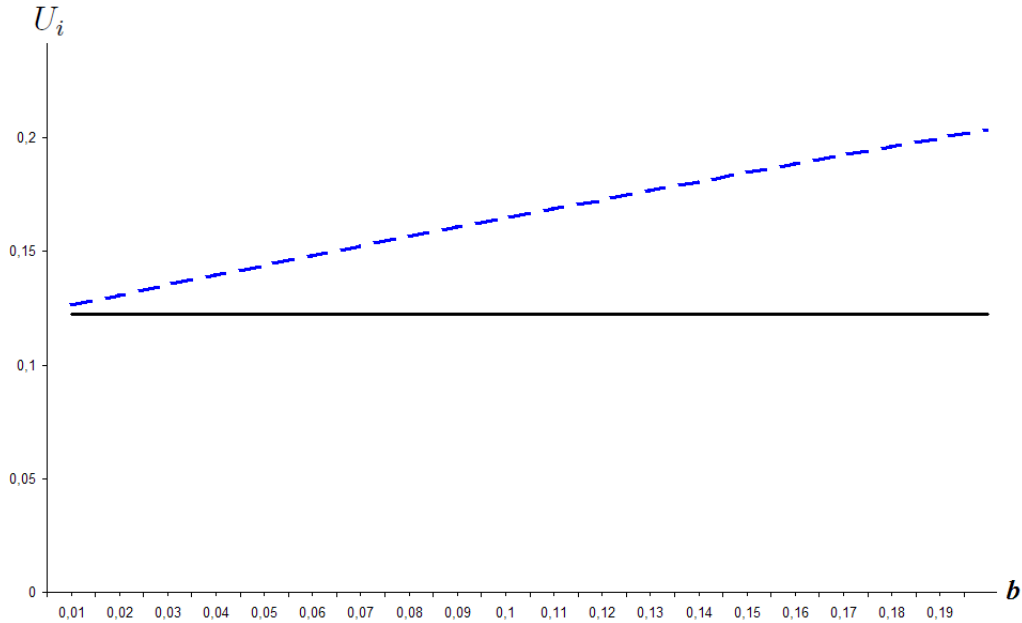


Figure 3: The individual welfare for $a = 0,2$; $s = 0,4$; $w = 1$ and $\tilde{q} = 0,5$. The continuous line shows the reference welfare of a rational agent in a situation without overconfidence. The dashed line shows the welfare of an overconfident agent being aware of the fact that his partner might be overconfident (and assigning the probability \tilde{q} to this circumstance).

4 Conclusion

Regarding team production, cooperation and effort complementarities have long been identified as essential factors of an organisation's success. Alchian and Demsetz (1982) point out that firms form endogenously in order to utilise synergy effects. However, even if these synergy effects are put together, the realisation of their potential is not self-evident. In a classic model of teamwork by Holmström (1982), moral hazard and free riding arise, if effort choices are unobservable and outcome is shared, since the agents sustain the full cost of their effort but receive only a fraction of its outcome. These problems are exacerbated in the presence of effort complementarities, as an agent does not fully internalise the effect of his decision on those of others. Gervais and Goldstein (2007) use insight from psychology on the self-perception of agents and model a situation in which an overconfident agent (in the sense

of agents who overestimate their marginal productivity) not only helps overcome the abounding coordination problem, as an overconfident agent works harder and by that reduces free riding, but also generates a Pareto improvement as his own choice of effort causes a synergetic feedback by his rational partner (who has to be informed about the partner's bias), which – at least to some degree of overconfidence – can overcompensate for his initial welfare loss due to his mistaken marginal productivity.

This paper extends the analysis of Gervais and Goldstein (2007) on the notion that agents may be aware of the fact that overconfidence is a widespread phenomenon in several ways. First, we incorporate this idea into a modified team model, which displays the coordination problem teams face. Even in this case we are able to verify the beneficial effects of an overconfident agent. Regarding the agents' bias awareness, the mere possibility of being teamed up with an overconfident agent induces a rational agent as well as an overconfident agent to exert more effort, since both anticipate an overconfident agent to work harder and by that try to utilise their own increased (through synergy) marginal productivity. The welfare effects of these greater efforts through bias awareness and actual biases are examined in several team settings and beneficial overconfidence effects are shown for a team of two rational agents, a team of one overconfident and one rational agent as well as a team of two overconfident agents. At least to some extent of overconfidence, in every setting a Pareto improvement might occur.

Since our model personalises the probability an agent assigns to the possibility of being teamed up with an overconfident agent, the model enables us to further examine on the notion that biased agents may perceive biases of other agents to be less significant than they actually are. In fact an overconfident agent will be better off, if he assigns a smaller probability to the possibility of his partner being overconfident than his rational partner, since his increase of effort is less significant but the synergetic feedback of the rational agent's effort stays the same.

It should be noted that our model leaves interesting questions unanswered, for example risk averse agents should be examined, with the all or nothing type of payment the agents receive in our model this could strengthen

our results. Additionally the analysis of endogenous payments would add to our analysis, as the incentives chosen by a welfare maximising firm in interaction with biases and awareness of such could shed additional light on this matter.

Finally, we need to specify on the notion of overconfidence as our results are not limited to such a biased perception of agents' abilities. Rather any behavioural pattern which induces greater effort of agents might result in comparable effects. For example, altruistic agents as well as the seeking for social recognition might generate similar welfare improvements.

Appendix

A. Reference Values

- (i) In a situation without overconfidence ($q = \tilde{q} = 0$), a rational agent maximises:

$$\max_{e_{R_i} \in [0,1]} w(ae_{R_i} + ae_{R_{-i}} + se_{R_i}e_{R_{-i}}) - \frac{1}{2}e_{R_i}^2.$$

The resulting reaction functions are given by: $e_{R_i} = wa + swe_{R_{-i}}$ and $e_{R_{-i}} = wa + swe_{R_i}$. Resolving for e_{R_i} and $e_{R_{-i}}$ gives:

$$e_{R_i} = \frac{wa}{1 - sw}.$$

- (ii) In the first best allocation the effort by the agents ($e_i = e_{-i} = e$) maximises:

$$\max_{e_{FB_i} \in [0,1]} w(ae_{FB_i} + ae_{FB_{-i}} + se_{FB_i}e_{FB_{-i}}) - \frac{1}{2}e_{FB_i}^2.$$

The first best effort of agent i is:

$$e_{FB_i} = \frac{wa}{\frac{1}{2} - sw}.$$

■

B. Two Rational Agents

- (i) (9) is given by combining (5) and (7).
- (ii) Taking (9) into account, the resulting welfare of a rational agent is given by:

$$U_i^{11} = U_{R_i} + \frac{sqbw^3}{(1 - sw)^2} [s^2qbw^2 + a - \frac{1}{2}sqbw].$$

The last term is positive and by that the resulting welfare is greater than in a situation without overconfidence, if (10) holds.

■

C. One Overconfident and One Rational Agent

- (i) The derivation of (11) is similar the that of (9). (12) is given by combining (6) and (8).
- (ii) Taking (11) and (12) into account, the resulting welfare of a rational agent is given by:

$$U_1^{12} = U_{R_2} + \frac{bw^2}{(1-sw)^2} [a(1-sw) + s\tilde{q}wa + s^2qbw^2(s\tilde{q}w + 1 - sw - \frac{1}{2}q)].$$

The last term is positive, since $sw + \frac{1}{2}q < 1$. The resulting welfare of the rational agent is always greater than in a situation without overconfidence. Similarly the welfare of the overconfident agent can be derived:

$$U_2^{12} = U_{R_2} + \frac{bw^2}{(1-sw)^2} [sqwa - b[(1-sw)(sw(\tilde{q} - sqw) + \frac{1}{2}(1-sw)) + s^2\tilde{q}w^2(\frac{1}{2}\tilde{q} - sqw)]].$$

The last term is positive and by that the resulting welfare is greater than in a situation without overconfidence, if (13) holds.

■

D. Two Overconfident Agents

- (i) The derivation of (14) is similar to that of (12).
- (ii) Taking (14) into account, the resulting welfare of an overconfident agent is given by:

$$U_i^{22} = U_{R_i} + \frac{bw^2}{(1-sw)^2} [a(1-sw(1-\tilde{q})) - b[s\tilde{q}w(1+2s^2w^2-3sw) - \frac{1}{2}s\tilde{q}w(2sw-1)] - sw(2 - \frac{5}{2}sw + s^2w^2) + \frac{1}{2}].$$

The last term is positive and by that the resulting welfare is greater than in a situation without overconfidence, if (15) holds.



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