Confidence Management: on interpersonal comparisons in teams*

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Abstract

Organizations differ in the degree to which they differentiate employees by ability. We analyze how the effect of differentiation on employee morale may explain this variation. We characterize sufficient conditions for the manager to refrain from differentiation. She refrains from differentiation when employees are of similar ability, especially if absolute levels are high. Avoiding differentiation boosts the self-image of employees. To limit the negative effects of differentiation, the manager's strategy often relies on the coarsest message set possible. The likelihood that the manager differentiates depends on the presence of synergies between employees and on the convexity of the cost of effort function. Finally, we show that in the absence of commitment no differentiation is chosen too often.

Keywords: feedback, differentiation, cheap talk, comparison, morale, information disclosure

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“There’s differentiation for all of us in our first 20 years. Why should it stop in the workplace?” (Jack Welch, former CEO of General Electric).

“Comparisons are odious” (Saying recorded from the mid Fifteenth century)

1 Introduction

An employee who has imperfect knowledge about his ability or his performance may try to infer information from how he is being treated by his supervisor. A manager should take this into account when deciding what information to disclose, either verbally or through the actions that she takes.

The idea that people increase their self-knowledge by viewing themselves through the eyes of others is well-known to social psychologists. It is known as the "looking-glass self". Benabou and Tirole (2003), BT, formalize this concept to show that rewards may have a hidden cost, because a reward may signal that the manager does not trust the employee. Giving a challenging task to a subordinate, by contrast, signals confidence and consequently motivates.[1] In BT an employee wants to have an accurate perception of his ability to make a proper decision on how much effort to exert.[2] With effort and ability being complements, the more the employee is confident about his ability, the more effort he exerts.[3] In such an environment, managers want employees to believe they are as able as possible.

The aim of the present paper is to analyze the looking-glass self in a context in which agents gain self-knowledge by considering how they are being treated in comparison with other agents. That is, we study multi-agent settings: the manager is responsible for the performance of a unit in which various employees work. Total output depends on individual contributions and possibly on a synergetic, team component.

Comparisons among employees also play a key role in the recent literature on interim performance feedback in tournaments. The main consideration is whether

[1] See also Ishida, 2006, and Swank and Visser, 2007.

[2] In BT, a person wants to learn about himself to maker better decisions. Psychologists have paid much attention to a person’s desire to obtain accurate self-knowledge from evaluations. One source of information are other persons’ appraisals (Felson, 1993; Baumeister, 1998). A problem is that accurate feedback on abilities is rare (Jones and Wortman, 1973). Feedback tends to be too positive (Brown and Dutton, 1995).

[3] BT also pay some attention to the case in which effort and ability are substitutes.

making differences among contestants public increases or decreases total performance of these contestants. The existing literature has uncovered a number of important effects that the provision of interim feedback can have on effort exerted before and after feedback is given. The exact effects depend on whether individual output is determined exclusively by effort or also by an employee's ability, and on the interaction between effort and ability, see Lizzeri et al. (2002), Ertac (2005), Gershkov and Perry (2009), Aoyagi (2010), Ederer (2010) and Goltsman and Mukherjee (2010).

Apart from the fact that the employees in our model are not contestants, our paper differs from the above papers and the literature on feedback in tournaments more generally as it relaxes two assumptions that are commonly made in that literature. First, that literature typically assumes that the manager *commits* to a disclosure policy before she observes actual interim information.[4] The main reason is that this "allows [one] to suppress considerations of incentive problems on behalf of the principal such as misreporting the first-period output difference to elicit higher efforts or to selectively announce interim information" (Ederer 2010, p. 740[5]). Second, the manager is constrained to choose between truthfully revealing any and all differences in realized interim outcomes and providing no information at all. As a result of these assumptions, considerations on what can be credibly conveyed through feedback, and the precision of that information are suppressed. In our paper, both the issue of incentive compatibility and of the informational content of feedback are key.

We develop a cheap talk model in which a unit manager considers whether and how to use differentiation to maximize the value of production of her unit. Our model has four key features. First, the manager has a more accurate estimate of the ability of the employees working in her unit than these have themselves. Second, ability and effort are complements in the objective function of both the manager and the employees. Third, we allow for the possibility of production synergies between the employees; we then talk about teams of employees. Finally, the manager chooses her cheap talk message *conditional* on the employees' observed ability levels. Her

[4] Gürtler and Harbring (2010) is an exception. We discuss their paper shortly.

[5] Ederer does discuss the implications of relaxing the commitment assumption but only in the context where effort and ability enter additively in the production of output. In the current paper, effort and ability are complements which raises interesting commitment issues.

message must be *incentive compatible*.

The timing is as follows. The manager first observes the realized abilities of the employees whereas these only know the distribution of abilities. Her information is unverifiable. Next the manager has to decide which cheap talk message to send publicly to both employees. Depending on the message sent (and on the whole equilibrium strategy of the manager), employees may be in a position to update their prior about their own ability. Third, employees decide how much effort to exert. Because of the complementarity between ability and effort, posterior beliefs about ability impact on the effort provision decision of the employees. In the type of cheap talk game we consider, the only credible type of message the manager can send is comparative in nature (see Chakraborty and Harbaugh 2007). Messages that contain statements about the absolute level of a single employee's ability are never believed in equilibrium.

We focus on the manager's incentives to differentiate between her employees by means of ordinary speech. We do so to emphasize that any effect of the manager's decision to differentiate on her unit's output is indirect—through a change in beliefs that the employees hold about their respective abilities. This is the looking-glass self at work in a multi-agent context. However, a manager has many more means at her disposition to transmit information that she has about her employees. Any organizational practice can be used. However, an organizational practice like the assignment of tasks typically also has direct effects. For example, for given beliefs and thus given effort levels, it is optimal that, say, the more able employee undertakes the more difficult task. The manager's decision to assign the difficult task to employee A rather than to B would then be a costly signal. In section 4, we briefly discuss a task assignment model, and highlight the analogies and differences with a cheap talk model.

Once the manager has observed the employees' abilities, she has to decide between sending two broad kinds of messages. A message of the first kind compares the two employees' abilities. This boosts the self-image of the favored employee but hurts that of the unfavored one. A message of the second kind does not compare abilities. This message guarantees that the two employees' posterior beliefs are identical (because of identical priors), even though, as we explain below, they may be different from the prior. Of course, because of the complementarity between ability and effort, if the manager chooses a comparative message, she will do so in favour of the more able employee.

Turning to our results, we characterize first sufficient conditions for the manager to abstain from differentiation with positive probability. We show that the manager avoids differentiation when employees are of similar abilities and in particular when absolute levels of abilities are high. An important implication is that avoiding differentiation *boosts* the self-images of the employees. This in turn encourages the manager to abstain from differentiation.

This finding adds to the literature that provides a rationale for the reluctance of managers to differentiate employees because of morale management considerations, as documented by Bewley (1999). He interviewed more than 300 businesspeople to answer questions about their management strategies. He was surprised by the extent to which "employers chose to impose bureaucratic constraints on their decision making" (Bewley, 1999, p. 75). Thus, numerous managers, when they differentiate at all, do this on the basis of rules that are not directly linked to merit or ability but, rather, to other dimensions, such as seniority.[6] Further, employers mentioned the repercussions of differentiation on internal harmony and morale as the main reason why they were reluctant to distinguish between employees on the basis of their performance.

Second, we provide conditions that guarantee that the differentiation strategy is characterized by a single threshold, implying that the manager differentiates to a limited extent. If the ratio of observed abilities is lower than the value of this threshold, the manager refrains from differentiation; if the ratio exceeds the value, she does differentiate in favour of the employee with the higher ability. Had she used, say, two threshold values, she could have indicated degrees to which one employee is better than the other. The reason that the manager often avoids introducing higher degrees of differentiation is that it hardly, if at all, motivates the more able

[6] This is confirmed by the large literature on internal labour markets. These contributions show that managers sometimes, but not always, eschew from differentiation on the basis of merit. In particular, performance differences sometimes exert an influence on pay differences, but the employees' position held is also very important (Doeringer and Piore, 1971, Baker, Jensen, and Murphy, 1988, Baker, Gibbs and Holmstrom, 1994a and 1994b, Gibbs, 1994). Does this mean that good performance is rewarded through promotion? Not always. Seniority and formal rule also play an important role in promotion decisions. In this context, Prendergast (1999) observes that bureaucracy is a central feature of organizations.

employee, but severely demotivates the other.

Third, we identify two factors that moderate a manager's incentive to differentiate. We show that the existence of synergies between employees decreases the likelihood of differentiation. Furthermore, we find that the more convex the costs of effort are, the more inclined the manager is to abstain from differentiation.

Finally, we show that, if the manager could commit to a differentiation strategy before observing the realized abilities of her employees, she would refrain from differentiation less often than she does under the case of no commitment. The intuition for this result is that when the manager commits ex-ante, she takes into account the morale repercussions of her strategy for *all* possible realized abilities of her employees, and not for the observed realized abilities only.

We already mentioned how our paper is related to the existing literature on feedback in tournaments. The only paper in that literature that we are aware of that focuses on the case of a manager who cannot commit to a feedback rule and who may not be able to credibly communicate her private information is Gürtler and Harbring (2010). They assume that with some probability, the manager knows the difference in ability between the two employees. Any information the manager may have is hard: it can be withheld but not misrepresented. As ability and effort are not complements in their model, but appear additively in the output production function, a level playing field among contestants creates the best incentives to exert effort. As a result, the manager is inclined to claim that she does not have any information if the difference in observed ability is large. As a result, if no information is revealed, her employees deduce that either the difference in ability is large, or that the manager did not have any information to reveal. Thus, both employees put in little effort in case the manager does not differentiate. Our paper is different because of its focus on team production and unverifiable information.

Another related paper is Chakraborty and Harbaugh (2007, CH for short). Translating their analysis to our setup, they show that allowing the manager to address publicly various employees makes comparative statements possible, thus widening the scope for cheap talk communication. Suppose, for example, that a manager supervises two employees, Peter and John, and has private information about their abilities. CH show that the manager can credibly convey information about the employees' abilities by publicly announcing that either Peter is more able than John, or John is more able than Peter. The reason that a ranking of employees contains credible information is that announcing that John is better than Peter is good news for John but bad news for Peter. In CH the manager cannot decide to publicly compare employees for some observed ability levels and avoid such comparisons for other levels. In CH, avoiding comparisons only exists as a pooling equilibrium. In this sense, this restriction in CH on the freedom of the manager generates an effect that is very similar to the commitment assumption in the literature on feedback: the incentive compatibility constraints of the manager are done away with. In our model we focus on the role of these very constraints: the decision to differentiate or not as part of an equilibrium is the key margin we wish to analyze.

Fang and Moscarini (2005) analyze the effect on morale stemming from wage differentiation. We adopt their individualistic approach to morale: "A worker's morale is interpreted as her confidence in her own ability" (Fang and Moscarini, 2005, pp. 750-51). An important assumption of their analysis is that in general agents are overconfident. Workers think they are more able than they really are. Because of the assumed overconfidence, a firm may refrain from differentiating. Gervais and Goldstein (2007) also analyze the effect of a worker's overconfidence about own ability on a firm's output and its workers' welfare. They show that, when there are synergies between workers, the presence of an overconfident worker can lead to an overall Pareto improvement in welfare through the impact of overconfidence on all workers' effort provision. We do not assume overconfidence. One implication of our model is that, if a manager decides to refrain from differentiation, employees are on average more confident about their abilities than if she were to differentiate. Thus, in our model a positive self-concept of employees is not the reason why managers do not differentiate. Rather, it is one of the implications of abstaining from differentiation.

We close this section by noting that there is mixed evidence from field (quasi-) experiments about the impact of the provision of relative performance information on workers' effort. Azmat and Iriberri (2009), Blanes i Vidal and Nossol (2009), and Delfgaauw et al. (2009) find that providing such information boosts performance while Bandiera et al. (2009) find the opposite effect.

The rest of the paper is organized as follows. The next section presents the model. Sections 3 presents three equilibria of a simple version of this model. In Section 4 we derive our main result that in a wide class of games managers abstain from differentiation with positive probability. In Section 5 we discuss two factors mediating managers' incentives to eschew differentiation. In Section 6 we show that the manager could benefit from committing to a strategy implying a higher probability of differentiations. Section 7 concludes. An appendix contains omitted proofs and omitted derivations.

2 The Model

Consider an organizational unit that is made up of an experienced manager and two employees, $i = 1, 2$. Each employee produces by exerting effort, e_i. It is the responsibility of the manager to maximize her unit's output. Output will depend on her employees' effort levels, on their ability levels a_i, and on the way the manager motivates them. We assume that the manager, based on years of experience with similar subordinates has a more accurate knowledge of her employees' abilities – contribution to the unit, really – than they have themselves. The simplest way of capturing this asymmetry is by assuming that she knows a_1 and a_2, whereas the employees only know that their abilities a_1 and a_2 are iid random variables, with continuous density functions $f(\cdot)$ on $[0, 1]$, and associated distribution functions $F(\cdot)$. Let $a^e = \int_0^1 a_i f(a_i)\, da_i$ denote the prior expected ability level. We assume that the information that the manager has is unverifiable.

The objective function of employee i equals $V(e_i; a_i)$, with $V_e, V_a \geq 0$, $V_{ee} < 0$. The key assumption we make is that the cross-partial derivative satisfies $V_{ea} > 0$. This complementarity between effort and ability implies that $e_i^*(a_i)$, the unique value of e_i that maximizes V, is increasing in a_i. A common way of writing $V(e_i; a_i)$ is

$$V(e_i; a_i) = U(e_i; a_i) - C(e_i), \tag{1}$$

with, besides the standard assumptions on U and C, the assumption that $U_{ea} > 0$. Note that we do not explicitly model pay. Of course, even though both effort and ability are non-verifiable, output may be contractible. Essentially[7], as long as the financial contract is offered before the manager observes the ability levels of her employees, the objective function (1) is a valid reduced form.

[7] See Ray (2007) who studies a single agent setting that is comparable to ours.

We assume that the manager maximizes the sum of individual outputs:

$$U_M\left(e_1, e_2, a_1, a_2\right) = a_1 e_1 + a_2 e_2 \tag{2}$$

In Section 4, we analyze a model in which the manager is also concerned about synergies between the employees.

The manager's decision whether or not to differentiate employees is modelled as follows. After the manager has observed the employees' abilities, she makes a public, cheap talk statement about these abilities.[8] Let M be the set of possible messages, and let $\mathcal{A} = [0,1] \times [0,1]$ be the space of abilities (a_1, a_2) of employees 1 and 2. Let m_l be the unique message the manager sends if $(a_1, a_2) \in \mathcal{A}_l$, such that $\cup_l \mathcal{A}_l = \mathcal{A}$. We call the mapping from observed abilities to messages the *differentiation strategy* of the manager. A manager abstains from differentiation if she sends a message m', for which $E(a_1|m') = E(a_2|m')$.

The timing is as follows. (1) Nature draws a_i, $i = 1, 2$, and reveals (a_1, a_2) to the manager, but not to the employees; (2) the manager sends a cheap talk message m_l to the employees; (3) having received the message, each employee decides how much effort to exert; (4) payoffs are realized.

To solve the game, we look for symmetric Perfect Bayesian Equilibria in pure strategies (a PBE), in which players' strategies are optimal responses to each other, given the beliefs about abilities, and beliefs are updated according to Bayes' rule wherever possible. In the present type of game babbling equilibria always exists.[9] We will ignore such equilibria. Our focus on symmetric equilibria is natural given the complete ex ante symmetry of the model. An asymmetric treatment of the employees by the manager would amount to discrimination for which there is no ground (justified or unjustified) in the assumptions of the model.

[8] Due to the fact that an employee's effort and ability are complements in the objective functions of both the manager and the employee, any cheap talk communication between the manager and a single employee is void.

[9] In such an equilibrium, the manager's message does not contain information about the employees' abilities, the employees ignore the manager's message, and posterior beliefs equal prior beliefs.

3 Benchmark

The benchmark is characterized by two assumptions concerning preferences and abilities: the objective function of employee i can be written as $V(e_i; a_i) = a_i e_i - e_i^2/2$, and abilities are uniformly distributed on $[0, 1]$. Given the objective function of the employee, the optimal level of effort conditional on a message m_l satisfies $e_i(m_l) = E(a_i|m_l)$.

Let the manager be able to send at most three messages m_l, $l \in \{1, 2, 3\}$, where m_1 (m_3) favours employee 1 (2), and m_2 means that the manager does not differentiate. In the next section, we discuss the implications of a richer message set. We now present three equilibria of the benchmark model.

Equilibrium 1: The manager sends m_1 if $a_1 \geq a_2$, and m_3 if $a_2 > a_1$. The posteriors are $E(a_1|m_1) = E(a_2|m_3) = \frac{2}{3}$, and $E(a_1|m_3) = E(a_2|m_1) = \frac{1}{3}$. The employees choose $e_i = E(a_i|m_l)$.

Proof: Given the posteriors and $e_i(m_l) = E(a_i|m_l)$, the manager prefers sending m_1 to sending m_3 if $\frac{2}{3}a_1 + \frac{1}{3}a_2 \geq \frac{1}{3}a_1 + \frac{2}{3}a_3$, implying $a_1 \geq a_2$. Likewise, sending m_3 yields a higher payoff to the manager than sending m_1 if $a_2 > a_1$. The posteriors corresponding to m_1 and m_3 directly follow from the manager's differentiation strategy. ■

Equilibrium 1 is the comparative cheap talk equilibrium of Chakraborty and Harbaugh (2007) in Theorem 1.

Equilibrium 2: The manager sends m_1 if $a_1 > a_2$, m_2 if $a_1 = a_2$ and m_3 if $a_2 > a_1$. The posteriors are $E(a_1|m_1) = E(a_2|m_3) = \frac{2}{3}$, $E(a_1|m_3) = E(a_2|m_1) = \frac{1}{3}$ and $E(a_1|m_2) = E(a_2|m_2) = \frac{1}{2}$. The employees choose $e_i = E(a_i|m_l)$.

Proof: The proof is as the proof of Equilibrium 1. Given the posteriors and employees strategies, it is a best-reply for the manager to send m_2 if $a_1 = a_2$.■

As $a_1 = a_2$ is a zero probability event, the observed outcomes of equilibrium 1 and 2 are the same, see Figure 1, panel a. However, the nature of these equilibria is different: in Equilibrium 2 m_2 is part of the message set of the manager whereas it is not in Equilibrium 1.

Equilibrium 3: The manager sends m_1 if $a_1 \geq \frac{1}{t}a_2$, m_2 if $a_1 \in \left(\frac{1}{t}a_2, ta_2\right)$, and m_3 if $a_1 < ta_2$, where $t = 2 - \sqrt{3} \approx 0.27$. The posteriors are $E(a_1|m_1) = E(a_2|m_3) = \frac{2}{3}$, $E(a_1|m_3) = E(a_2|m_1) = \frac{t}{3}$ and $E(a_1|m_2) = E(a_2|m_2) = \frac{1}{2} + \frac{t}{6}$. The employees

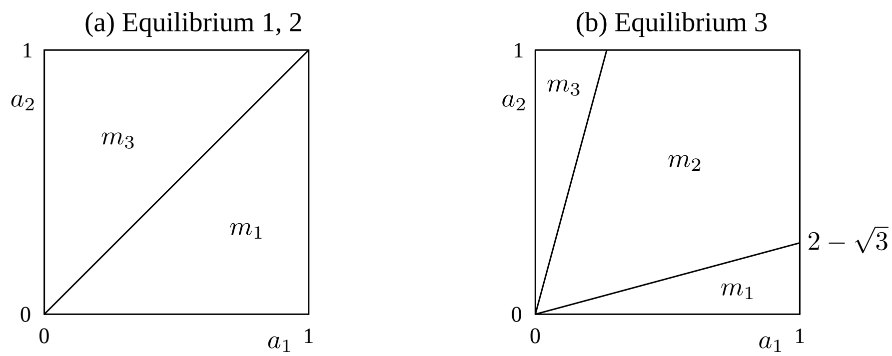

Figure 1: Equilibria in the benchmark case.

choose $e_i = E(a_i|m_l)$.

Proof: Derivations of the posteriors can be found in the Appendix. The manager is indifferent between sending m_1 and m_2 if and only if

$$\begin{aligned} a_1 E(a_1|m_1) + a_2 E(a_2|m_1) &= a_1 E(a_1|m_2) + a_2 E(a_2|m_2) \text{ or} \\ a_2 &= t a_1 \text{ with } t = \frac{E(a_1|m_1) - E(a_1|m_2)}{E(a_2|m_2) - E(a_2|m_1)}. \end{aligned} \quad (3)$$

Substituting the posteriors into (3), and solving for t yields $t = 2 - \sqrt{3}$. Hence, the locus of pairs (a_1, a_2) for which the manager is indifferent between sending m_1 and m_2 is given by the line $a_2 = \left(2 - \sqrt{3}\right) a_1$. Because of symmetry, the line $a_2 = \frac{1}{2-\sqrt{3}} a_1$ describes the locus of pairs (a_1, a_2) for which the manager is indifferent between sending m_2 and m_3.■

Figure 1 panel b depicts the differentiation strategy the manager follows in Equilibrium 3. The figure demonstrates that the manager abstains from differentiation with a high probability, $\Pr(m_2) = (1 - t) \approx 0.73$. In this respect, Equilibrium 3 is very different from Equilibrium 1 and 2. An important feature of Equilibrium 3 is that abstaining from differentiation boosts employees self-images: $E(a_i|m_2)$ exceeds the prior value of a_i. The reason is that the manager abstains from differentiation in particular for relatively high values of observed abilities. This in turn implies that m_2 indicates relatively high abilities, and employees' self-images improve accordingly.[10]

[10] CH use the term ranking or categorization. We here apply their terminology to Equilibria 1-3. In Equilibrium 1, the manager uses two ranks or categories: the employee with the higher ability is put in the higher category, and the employee with the lower rank in the lower category. With two employees this gives rise to two possible messages, m_1 and m_3. Note that the same number of ranks is used for all observed ability levels. In Equilibria 2 and 3, for some ability levels the

The existence of multiple equilibria raises the question which equilibrium is the more plausible one. The principle difference between Equilibrium 1 on the one hand and Equilibrium 2 and 3 on the other, is the possibility to abstain from differentiation (m_2). If the manager is in a situation where differentiation is the rule, as in tournaments, Equilibrium 1 is the more plausible outcome. If, by contrast, abstaining from differentiation is a natural option, Equilibria 2 and 3 seem more plausible. An appealing feature of Equilibrium 3 is that it can explain why managers abstain from differentiation (see introduction). Moreover, this explanation is consistent with Bewley in that differentiation is in expected terms bad for morale. In Section 5, we will discuss two extensions of the basic model. These extensions point to another appealing feature of Equilibrium 3 relative to Equilibrium 2: an equilibrium like equilibrium 3 (with the manager refraining from differentiation with strictly positive probability) continues to exist if we allow for synergies among agents, while equilibrium 2 (where the manager refrains to differentiate only if $a_1 = a_2$) fails to exist.

Another way of selecting among multiple equilibria is proposed by Farrell (1993). He calls a message that is not expected in equilibrium a neologism. He observes that if agents share a rich common language, like English, then, although a neologism is not expected in equilibrium, its meaning can expected to be understood. He calls an equilibrium neologism-proof if there does not exist a neologism message that the manager could profitably use and that is credible. A neologism is called credible if she wants to use the neologism if and only if it is true. In each of the equilibrium discussed above there are types of the manager who wish to distinguish themselves from other types. For example, consider Equilibrium 3 and suppose that the manager observes that $a_i > E\left[a_i|m_2\right]$ for $i \in \{1, 2\}$. Then the manager would like to deviate from the imputed equilibrium message by using a neologism that says that "$a_i > E\left[a_i|m_2\right]$ for $i \in \{1, 2\}$". However, if the manager were to observe that, say, $a_i < E\left[a_i|m_2\right]$ for $i \in \{1, 2\}$, she *also* would like to use the neologism "$a_i > E\left[a_i|m_2\right]$ for $i \in \{1, 2\}$": after all, if believed, it would lead to more effort, and the manager likes more effort for *any* observed pair of abilities. As a result, this neologism is not credible. The same line of reasoning applies to any neologism

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manager uses two ranks, and for others she uses one rank. In the latter case, the employees are ranked the same. As a result, there are three possible messages, m_1, m_2, and m_3.

that some type of manager would like to use to deviate from Equilibrium 3. Hence, neologism proofness does not help in eliminating equilibria. Chen et al. (2008) have proposed NITS – no incentive to separate – as an equilibrium refinement: "An equilibrium satisfies NITS if the Sender of the lowest type weakly prefers the equilibrium outcome to credibly revealing his type (if he somehow could)" (p. 118). Although developed in the context of games with a one-dimensional type space, its method can be applied to our two-dimensional case. Note that the payoff of the manager in case of the lowest type $(a_1, a_2) = (0, 0)$ equals 0 in all three equilibria. The manager also obtains zero if she were somehow able to tell the truth. As a result, every equilibrium satisfies NITS.

4 When differentiation can have indirect and direct effects on the unit's output

The goal of this paper is to shed light on the question whether or not a manager wants to reveal information about the ability levels of her employees. That means that we focus on cheap talk statements. This focus allows us to emphasize the indirect effect that the presence or absence of differentiation has on the objective of the manager, output. The effect is indirect as it operates through the employees' beliefs about their abilities – the looking glass self. We now want to come back to an observation made in the introduction: a manager has many more means at her disposition than mere talk to transmit information that she has about the abilities of her employees. A major example of such a means is the assignment of tasks. A key difference between cheap talk messages on the one hand and task assignment on the other is that there is typically also a *direct* effect of the assignment of tasks on output. One task is better performed by the more able employee, even keeping his level of effort constant. But if this is the case, there is also the indirect effect: being assigned one task rather than another boosts an employee's belief about his ability, which in turn boosts his effort. In the rest of this section, we turn to a task assignment model to show the analogies and some of the differences that exist if one also allows for these direct effects of differentiation.

Suppose that in the manager's unit two tasks have to be performed, task $\tau \in$

$\{L, H\}$. Task H yields output $y_H(a_i, e_i) = \theta a_i e_i$ with $\theta > 1$, while task L yields $y_L(a_i, e_i) = a_i e_i$. The objective of employee $i = 1, 2$ is to maximize the output of the task he performs, net of the costs of effort: $\max_{e_i} y_\tau(a_i, e_i) - \frac{1}{2}e_i^2$. The manager's goal is to maximize total output: $y_L(a_i, e_i) + y_H(a_j, e_j)$, where $i \neq j$. The only difference with the model discussed above is the presence of the multiplier θ. This means that even if the way in which tasks are assigned to employees does not affect the employee's belief of his ability, the manager would have an incentive to assign task H to the more able employee. That is, in this variant of the benchmark model, there is a direct benefit of allocating task H to the more able employee.

The timing of the task model is similar to that of the cheap-talk model. First, the manager observes the employees' abilities. Next, he decides how to allocate tasks. Important is that the way tasks are allocated contains information about the employees' abilities. By giving the H task to member 1 (2), the manager reveals that employee 1 (2) is the more able one. This corresponds to sending m_1 and m_3, respectively.

To mimic m_2, whether the H task is assigned to 1 or 2 should not be based on observed abilities. This can be attained by, for example, having the manager delegate the assignment of tasks to a subordinate who does not observe the employees' abilities. In this example, no cheap talk needs to accompany the assignment of task.[11] Alternatively, m_2 can be emulated by allocating tasks by seniority rule. To fix ideas, assume employee 1 is senior to employee 2. Then, by giving task H to employee 1 and appealing to seniority rule, the manager sends m_2. Of course, in the latter setting, if the H task is allocated to employee 1, the employees must know whether m_1 or m_2 has been sent. In this example, the manager needs to talk at the moment she assigns tasks.

Equilibrium 1′: The manager takes action m_1 (i.e., assigns task H to 1 and task L to 2) if $a_1 \geq a_2$, and takes action m_3 if $a_2 > a_1$. The posteriors are $E(a_1|m_1) = E(a_2|m_3) = \frac{2}{3}$, and $E(a_1|m_3) = E(a_2|m_1) = \frac{1}{3}$. If task H is assigned to employee i, then he chooses $e_i = \theta\frac{2}{3}$.
Proof: The proof is similar to the proof of Equilibrium 1. Note that the manager strictly prefers action m_1 over m_3 if and only if $\theta a_1 \theta \frac{2}{3} + a_2 \frac{1}{3} > \theta a_2 \theta \frac{2}{3} + a_1 \frac{1}{3} \Leftrightarrow$

[11] We are grateful to a co-editor for suggesting this interpretation.

$\frac{1}{3}\left(2\theta^2-1\right)(a_1-a_2)>0$. Clearly the inclusion of the ability combinations $(a_1,a_2)=(a,a)$, for all $a>0$, in the set of abilities for which the manager takes action m_1 rather than m_3 is immaterial. ■

Equilibrium 2′: An equilibrium in which the manager takes action m_2 if and only if $a_1=a_2$ does not exist because of the direct effect of task assignment on output, $\theta>1$.

Proof: Taking the action m_2 if and only if $a_1=a_2=a$ implies that $E(a_1|m_2)=E(a_2|m_2)=\frac{1}{2}$. But then the manager rather wants the employees to believe that their abilities are different, by taking action, say, m_1: $\theta a_1\theta\frac{2}{3}+a_2\frac{1}{3}>\theta a_1\theta\frac{1}{2}+a_2\frac{1}{2}\Leftrightarrow\frac{1}{6}a\left(\theta^2-1\right)>0$. ■

Equilibrium 3′: The manager takes action m_1 if $a_1\geq\frac{1}{\theta^2 t}a_2$, action m_2 if $a_1\in\left(\frac{1}{\theta^2 t}a_2,\theta^2 ta_2\right)$, and action m_3 if $a_1<\theta^2 ta_2$, where $t=\frac{3+\theta^2}{2\theta^2}-\frac{\sqrt{9+2\theta^2+\theta^4}}{2\theta^2}$. The posteriors are $E(a_1|m_1)=E(a_2|m_3)=\frac{2}{3}$, $E(a_1|m_3)=E(a_2|m_1)=\frac{\theta^2 t}{3}$ and $E(a_1|m_2)=E(a_2|m_2)=\frac{1}{2}+\frac{\theta^2 t}{6}$. The employee who performs task H chooses $e_i=\theta E(a_i|m_l)$, and the employee who performs task L chooses $e_i=E(a_i|m_l)$.

Proof: The proof is similar to the proof of Equilibrium 3. The manager is indifferent between sending m_1 and m_2 if and only if

$$\begin{aligned}\theta^2 a_1E(a_1|m_1)+a_2E(a_2|m_1) &= \theta^2 a_1E(a_1|m_2)+a_2E(a_2|m_2)\ \text{ or}\\ a_2 &= \theta^2 ta_1\text{ with }t=\frac{E(a_1|m_1)-E(a_1|m_2)}{E(a_2|m_2)-E(a_2|m_1)}.\end{aligned}\quad(4)$$

Substituting the posteriors into (4), and solving for t yields $t=\frac{3+\theta^2}{2\theta^2}-\frac{\sqrt{9+2\theta^2+\theta^4}}{2\theta^2}$. ■

If $\theta=1$, equilibrium 3′ reduces to equilibrium 3. In general, in equilibrium 3′ the manager differentiates for a wider set of (a_1,a_2) than in equilibrium 3. Of course, the reason is the direct benefit of letting the more able employee perform task H. At the margin, the manager faces a trade-off between the direct benefits of differentiation and the indirect benefits of abstaining from differentiation. If $\theta\to\infty$, then $\theta^2 t\to 1$. This means that in that case the manager always differentiates.

All in all, the above analysis shows that some organizational practices can make verbal communication as a means to transmit information about employees' abilities superfluous, whereas others reduce the need to communicate verbally.

5 Equilibria in the More General Model

In the previous section, we have shown that in a simple version of the model of Section 2 an equilibrium exists in which the manager avoids differentiation with a high probability. In this section, we investigate whether in the more general model presented in Section 2 such an equilibrium survives. So, in comparison with the model of the previous section we relax the assumption that $f(x) = 1$, and that the employees' payoff functions are linear-quadratic in effort. We derive two main results. First, we show that for a class of density functions, the manager uses in equilibrium at most three messages to describe employees' abilities. Our first finding provides a sufficient condition such that managers differentiate to a limited extent. Second, we derive sufficient conditions for the existence of an equilibrium in which the manager avoids differentiation with positive probability. Our second finding is consistent with observations discussed in the introduction that managers are reluctant to differentiate.

Let us return to the general model as specified in Section 2. For an equilibrium message m_l, let $f(a_i|m_l)$ denote the density of a_i conditional on this message. The employee uses this updated belief to determine his optimal effort level,

$$e_i(m_l) = \arg\max_{e_i} \int_0^1 V(e_i; a_i) f(a_i|m_l)\, da_i. \tag{5}$$

The meaning of a cheap talk message is determined by the mapping from types (observed ability levels) to actions (effort levels). Differences in messages that do not give rise to differences in this mapping are economically irrelevant. Say that an equilibrium message m' is *different* from another equilibrium message $m'' \neq m'$ if $(e_1(m'), e_2(m')) \neq (e_1(m''), e_2(m''))$. Consider a pair of different equilibrium messages. As the objective function (2) of the manager is increasing in both effort levels, it must be the case that if, say, $e_1(m') > e_1(m'')$, then $e_2(m') < e_2(m'')$ as otherwise the manager would never send m'' in equilibrium: message m' would lead to more effort for 1 and at least as much effort for 2. This means that in any equilibrium in which n different messages are being used, the following is true:

Lemma 1 *In any equilibrium with $n \geq 2$ different messages, the messages can be ordered such that $e_1(m_1) > e_1(m_2) > \cdots > e_1(m_n)$ and $e_2(m_1) < e_2(m_2) < \cdots < e_2(m_n)$.*

Proof: Consider a candidate equilibrium in which the manager uses a pair of different messages m_x and m_y such that $e_1(m_x) > e_1(m_y)$ and $e_2(m_x) \geq e_2(m_y)$ holds. Suppose the observed pair of abilities satisfies $(a_1, a_2) \in \mathcal{A}_y$. Then, the manager wants to deviate from the candidate equilibrium: sending m_x yields a strictly higher payoff. Hence, in any equilibrium, if $e_1(m_x) > e_1(m_y)$, then $e_2(m_x) < e_2(m_y)$. Analogously, if $e_1(m_x) < e_1(m_y)$, then $e_2(m_x) > e_2(m_y)$. Finally, if $e_1(m_x) = e_1(m_y)$, then, for the messages to be different, either (i) $e_2(m_x) < e_2(m_y)$ or (ii) $e_2(m_x) > e_2(m_y)$. In case (i), the manager does not want to use m_x, while in (ii) she does not want to use m_y. That is, in any equilibrium with $n \geq 2$ different messages, the messages can be ordered as in the statement of the lemma.■

For $(a_1, a_2) = (a, 0)$, with $a > 0$, the manager wants employee 1 to exert the highest level of effort possible and does not care about the effort of employee 2. By continuity of the manager's objective function in ability and effort, the manager also prefers 1 to exert the highest effort level and 2 the lowest in a neighborhood of the a_1-axis. On the other hand, for $(a_1, a_2) = (0, a)$ with $a > 0$, and for values of (a_1, a_2) close to the a_2-axis, the reverse holds. This means that there exists an equilibrium in which the manager uses at least two messages. We have proved the following Lemma.

Lemma 2 *For the class of games described in Section 2, a non-babbling PBE with some degree of differentiation on the basis of ability exists.*

Does an equilibrium exist in which the manager reveals her private information for a set of observed pairs of abilities? Note that this set cannot be an open ball: in any open ball there would be two pairs $a' = (a_1', a_2')$ and $a'' = (a_1'', a_2'')$ such that $a_i' > a_i''$ for $i = 1, 2$. As a result, if the manager observes (a_1'', a_2'') she would prefer to lie to exploit the complementarity between ability and effort. Hence, the only possible set of pairs of abilities for which she could tell the truth is a decreasing graph in the ability space. Such a set would have measure zero, and will therefore be ignored in what follows. What remains to be shown is that an equilibrium with a continuum of semi-pooling messages does not exist. In line with Eq (3), any such semi-pooling message would be described by a line segment starting at the origin, and with slope τ, $\{(a_1, a_2) : a_1 \in [0,1], a_2 = \tau a_1, \text{ with } \tau \in [0, \rightarrow)\}$, and messages would differ from ray to ray. Such an equilibrium would have a continuum of messages. Suppose it exist. Consider $\tau \in [0,1]$, and consider the effect a message has on the perceived ability of employee 1. Note that $f(a_1|m_\tau) = f(a_1)$ would hold. As a result, $e_1(m_\tau) = \bar{e}$, independent of the message. However, for employee 2, $f(a_2|m_\tau)$ would differ from message to message. Hence, the manager uniquivocally prefers to deviate from her equilibrium strategy by sending the message that gives rise to the highest value of e_2. The same holds, *mutatis mutandis*, for $\tau \in [1, \rightarrow)$. As a result, a continuum of messages cannot be part of an equilibrium, and in what follows we focus on equilibria with a countable number of messages."

As $e_1(m_l) > e_1(m_{l+1})$ for $l = 1, \ldots, n-1$, there are restrictions that should hold on the subspaces $\mathcal{A}_l$ for which messages are sent. With effort and ability complements in the objective function of the employee, these subspaces should be such that $\mathcal{A}_l$ contains "more favorable" information about a_1 than $\mathcal{A}_{l+1}$, and "less favorable" information about a_2. Hence, one can say that message 1 (and n) differentiate the employees more than message 2 (and $n-1$) etc.[12] In case of an even number of messages, the messages that differentiate the least are messages $\frac{n}{2}$ and $\frac{n}{2}+1$. Thanks to the symmetry of the model, these messages are the ones closest to the main diagonal in the (a_1, a_2) space. With an even number of messages, differentiation cannot be avoided. In case of an odd number of messages, the manager can avoid comparisons by using message $(n+1)/2$. Of course, ability pairs on the main diagonal are part of the set for which this message is sent. In this case, both employees hold the same posterior beliefs. Recall from Equilibrium 3 in Section 3 that the posterior may be different from the prior.

Is there a limit to the degree of differentiation the manager wants to use in equilibrium? The next Proposition gives a condition that is sufficient to guarantee that three is the maximum number of messages.

[12] Suppose $a_1 \geq a_2$. We say that message m_l differentiates the employees more than $m_{l'}$ if $E(a_1|m_l) > E(a_1|m_l')$ and $E(a_2|m_l) < E(a_2|m_l')$.

Proposition 1 *Suppose that abilities have a power function distribution,* $f(a_i; d) = da_i^{d-1}$ *on* $[0,1]$ *for some* $d > 0$*. Then, the maximum number of messages the manager uses in equilibrium equals three.*

Proof**:** Suppose the manager uses $n > 3$ messages. The manager is indifferent between sending m_{l-1} and sending m_l (where $l \leq \frac{1}{2}(n+1)$, i.e., both m_{l-1} and m_l are sent for pairs of abilities below the main diagonal) if

$$\begin{aligned} a_1 e_1(m_{l-1}) + a_2 e_2(m_{l-1}) &= a_1 e_1(m_l) + a_2 e_2(m_l) \text{ or} \\ a_1 &= \frac{1}{\beta_l} a_2 \text{ with } \frac{1}{\beta_l} = \frac{e_2(m_l) - e_2(m_{l-1})}{e_1(m_{l-1}) - e_1(m_l)}. \end{aligned} \tag{6}$$

It follows that the area $\mathcal{A}_l$ for which m_l is sent is a two-dimensional cone through the origin: $\mathcal{A}_l = \left\{(a_1, a_2) : a_1 \in [0,1], a_2 \in \left[\beta_{l-1} a_1, \beta_l a_1\right]\right\}$ with $0 \leq \beta_{l-1} < \beta_l \leq 1$. Then,

$$\mathsf{E}\left[a_1 | a_2 \in \left[\beta_{l-1} a_1, \beta_l a_1\right]\right] = \frac{\int_0^1 \int_{\beta_{l-1} a_1}^{\beta_l a_1} a_1 f(a_1) f(a_2)\, da_2 da_1}{\int_0^1 \int_{\beta_{l-1} a_1}^{\beta_l a_1} f(a_1) f(a_2)\, da_2 da_1} = \frac{2d}{2d+1},$$

where the last equality holds as $f(a_i; d) = da_i^{d-1}$. In particular, it is independent of β_{l-1} and β_l. This means that any message that is sent for values of (a_1, a_2) below the diagonal induces employee 1 to exert the same level of effort: $e_1(m_1) = e_1(m_2) = \cdots = e_1(m_n)$. This conflicts with Lemma 1, which states that in any equilibrium with $n \geq 2$, we have that $e_1(m_1) > e_1(m_2) > \cdots > e_1(m_n)$.■

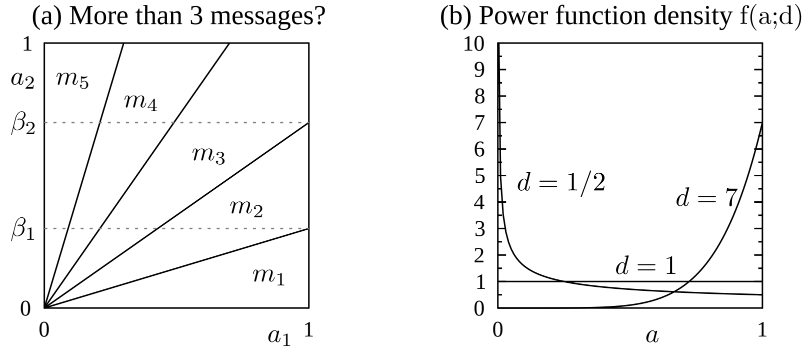

Figure 2: Panel (a): more than three messages hurts morale of worse agent and may leave self-esteem of better agent unaffected. Panel (b): Power function densities for various values of d.

With the help of Figure 2, panel a, one can grasp the intuition behind Proposition 1. It depicts a situation where the manager wants to use five messages. Notice that sending m_1 rather than m_2 contains much information about a_2: m_1 shows that $a_2 < \beta_1$ while m_2 shows that $a_2 < \beta_2$. For the uniform distribution, we have that $E(a_2|m_1) = \beta_1/3 < E(a_2|m_2) = (\beta_1 + \beta_2)/3$. Sending m_1 rather than m_2 thus demotivates employee 2 ($\beta_1 < \beta_1 + \beta_2$). By contrast, the effect of sending m_1 rather than m_2 on the expected value of a_1 is less clear. Irrespective of whether the manager sends m_1 or m_2, a_1 can lie in the range $[0, 1]$. In fact, if $f(a_i; d) = da_i^{d-1}$, then $E(a_1|m_1) = E(a_1|m_2)$. Hence, if $f(a_i; d) = da_i^{d-1}$, sending m_1 rather than m_2 discourages employee 2, but does not encourage employee 1. The manager is thus better off by reducing the number of messages used.

Note that the power function density is decreasing for $d \in (0, 1)$, equals the uniform for $d = 1$, and is increasing for $d > 1$, see panel (b) of Figure 2.

We now provide sufficient conditions such that an equilibrium exists in which the manager avoids differentiation with positive probability.

Proposition 2 *Suppose $n = 3$. A non-babbling equilibrium exists in which the manager avoids differentiation with strictly positive probability if*
(i) $af(a)$ is non-decreasing, or $f(a)$ is symmetric; and
(ii) $V_{eee} \leq 0$ and $V_{eea} \leq 0$.

The proof can be found in the Appendix. Recall that if the manager avoids differentiation, it follows from the incentive compatibility constraint (6) that she does so in particular for high values of (a_1, a_2). Condition (i) guarantees that such values are sufficiently likely relative to low values of (a_1, a_2) such that not differentiating indeed boosts an employee's self-image relative to what it is *a priori*. As a result, $e_1(m_2) > e^p$, where e^p is the optimal effort level based on the prior distribution, and $e_1(m_2)$ the effort level in case the manager refrains from differentiation. Condition (ii) guarantees that in equilibrium $e_1(m_1) + e_2(m_1) \leq 2e^p$. Together with $e_1(m_2) > e^p$, it then follows that $e_1(m_1) + e_2(m_1) < 2e_1(m_2)$. As a result, the manager does not want to differentiate if employees are of comparable ability level.

A common way of writing V is $V(e_i; a_i) = U(e_i; a_i) - C(e_i)$. The literature on tournaments with interim performance feedback (see e.g. Lizzeri et al. (2002), Aoyagi (2010), and Ederer (2010)) has shown that if marginal costs are convex (i.e.,

$C'' > 0$ and $C''' \geq 0$), then a principal who can choose whether or not to commit to credibly revealing any and all differences between employees decides not to reveal any information. Note that under the standard assumptions about U, the convexity of the marginal cost function implies that $V_{eee} \leq 0$. The condition we find is very similar to the one found in the tournament literature as similar forces are at work: revealing information creates differences in effort levels, and whether the drop in the effort level of one agent is more than compensated by an increase in the effort level of the other depends on the shape of the marginal cost function.

6 Factors that Further Reduce the Incentive to Differentiate

In the previous section, we have presented a fairly general model that can explain why managers are reluctant to differentiate employees by ability. In this section, we identify two factors that mediate the manager's incentives to differentiate. To this end, we extend the benchmark model of Section 3 in two directions. First, we allow for a more general cost of effort function $C(e_i)$. We show that the shape of the cost function influences the probability with which the manager differentiates. Second, we analyze a situation where there are synergies between employees. We show that such synergies discourage the manager to differentiate. In this section, we focus on the equilibrium in which the manager can both differentiate and abstain from it. However, in both games an equilibrium *à la* Chakraborty and Harbaugh (2007) exists. In such an equilibrium, the manager differentiates with probability one (like Equilibrium 1 in Section 3).

6.1 Convexity of the Cost of Effort Function

Consider the benchmark model, but write the employee's objective function as

$$V(e_i; a_i) = a_i e_i - \frac{1}{q}(e_i)^q. \tag{7}$$

The family of cost functions $C(e_i; q) = \frac{1}{q}(e_i)^q$ is parametrized by $q \in \mathbb{R}$, with $q > 1$. Within this family, q can be interpreted as a degree of convexity. The higher is q, the more convex the cost function is. It follows from (7) that

$$e_i^* = (\mathsf{E}(a_i|m))^{\frac{1}{q-1}}. \tag{8}$$

The quadratic case, $q = 2$, was discussed in Section 3.

Given (8), the manager is indifferent between sending m_1 and m_2 if $a_1 e_1(m_1) + a_2 e_2(m_1) = a_1 e_1(m_2) + a_2 e_2(m_2)$ or for

$$a_1 = \frac{1}{\beta_2} a_2 \text{ with } \frac{1}{\beta_2} = \frac{e_2(m_2) - e_2(m_1)}{e_1(m_1) - e_1(m_2)} \tag{9}$$

Using (8) and the fact that $E(a_1|m_1) = \frac{2}{3}$, $E(a_2|m_1) = \frac{\beta_2}{3}$, and $E(a_1|m_2) = E(a_2|m_2) = \frac{1}{2} + \frac{\beta_2}{6}$, β_2 can be written as

$$\beta_2 = \frac{\left(\frac{2}{3}\right)^{\frac{1}{q-1}} - \left(\frac{1}{2} + \frac{\beta_2}{6}\right)^{\frac{1}{q-1}}}{\left(\frac{1}{2} + \frac{\beta_2}{6}\right)^{\frac{1}{q-1}} - \left(\frac{\beta_2}{3}\right)^{\frac{1}{q-1}}}, \tag{10}$$

Equation (10) implicitly defines β_2. Using (10), we have calculated the probability that the manager abstains from differentiation (i.e., $\Pr(m_2) = (1 - \beta_2)$) as a function of q. The dotted line in Figure 3 depicts the results.

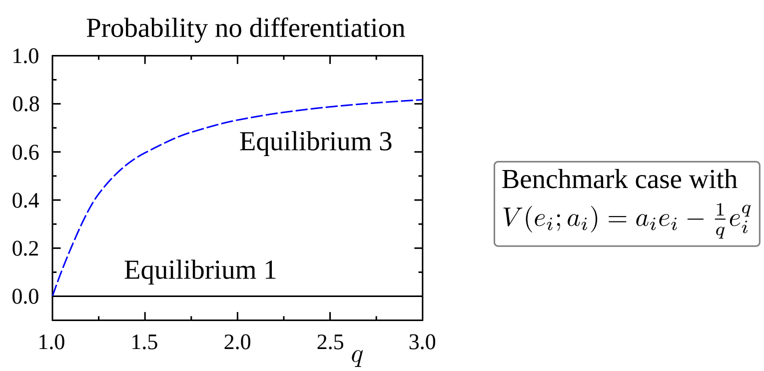

Figure 3: The probability with which the manager avoids differentiation as a function of the degree q of convexity of the employee's cost function in Equilibria 1 and 3.

Clearly, the more convex are the costs, the larger is the area for which the manager avoids differentiation. The intuition behind this result is straightforward. The advantage of differentiating is a higher effort level of one employee. The drawback is a lower effort level of the other employee. The more convex are the costs, the smaller is the advantage relative to the drawback in terms of effort provision. To see this suppose that the marginal benefit of effort increases for employee 1, but decreases to the same extent for employee 2. Then, for small values of q ($q < 2$), employee 1's effort increases more than employee 2's effort decreases. This gives the manager strong incentives to differentiate. For larger values of q, by contrast, the assumed change in the marginal benefits of effort increases employee 1's effort less than that it decreases employee 2's effort. As a result the manager has weaker incentives to differentiate.

6.2 Synergies between Employees

In this section, we extend the benchmark model by allowing for synergies between the employees. Specifically, we assume that the manager's payoff function is given by

$$U_M(e_1, e_2, a_1, a_2) = a_1 e_1 + a_2 e_2 + k a_1 e_1 a_2 e_2, \tag{11}$$

where $k \geq 0$ represents the strength of the synergy between the two employees. As an example of a situation the present model describes, think of the manager as being responsible for the development of a new car. This development requires the specialist contributions of employees, say, a paint expert, a body expert, and an engine expert. Each specialist cares about or is responsible for his own, identifiable, contribution, whereas the manager is responsible for the end product. The whole may be more than the sum of its parts, and the parameter k captures this difference.[13] The main result of this section is that synergies reinforce the manager's incentives to refrain from differentiating between employees when they are of similar (enough) ability, and that these incentives are strongest for very able employees.

Suppose the manager observes (a_1, a_2). If the manager sends m_1, she obtains $a_1 e_1(m_1) + a_2 e_2(m_1) + k a_1 a_2 e_1(m_1) e_2(m_1)$, while she gets $a_1 e_1(m_2) + a_2 e_2(m_2) + k a_1 a_2 e_1(m_2) e_2(m_2)$ if she sends m_2. The manager prefers to differentiate rather than to avoid it if and only if

$$a_2 < h_-(a_1; k) := a_1 \frac{e_1(m_1) - e_1(m_2)}{e_2(m_2) - e_2(m_1) + a_1 k \left[e_1(m_2) e_2(m_2) - e_1(m_1) e_2(m_1)\right]}.$$

[13] For simplicity, we assume that the synergy term does not enter into the payoff functions of the employees. However, we can show that adding those terms would not alter our main results.

Similarly, the manager prefers sending m_2 to m_3 if and only if:

$$a_2 < h_+ (a_1; k) := a_1 \frac{e_1 (m_2) - e_1 (m_3)}{e_2 (m_3) - e_2 (m_2) + a_1 k [e_1 (m_3) e_2 (m_3) - e_1 (m_2) e_2 (m_2)]}.$$

Thus, the equilibrium differentiation strategy of the manager when $k > 0$ becomes:

$$D = \begin{cases} m_1 & \text{if } a_2 < h_- (a_1; k) \\ m_2 & \text{if } a_2 \in [h_- (a_1; k), h_+ (a_1; k)] \\ m_3 & \text{if } a_2 > h_+ (a_1; k). \end{cases}$$

It is easy to check that $h_- (0; k) = 0$, and that h_- and h_+ are increasing in a_1.[14] As we are not able to derive analytical expressions for the posteriors given the differentiation strategy D, we have to determine the exact locations of $h_- (a_1; k)$ and $h_+ (a_1; k)$ by solving the game numerically. We have found that if in equilibrium the manager follows D, h_- is concave and below the diagonal.

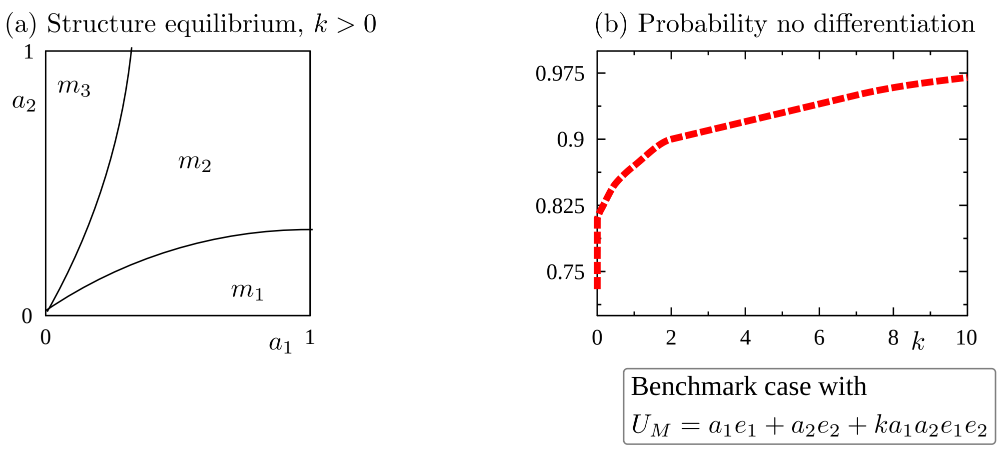

Figure 4: Panel (a) shows the structure of equilibrium in case of synergy. Panel (b) shows that the probability with which the manager avoids differentiation increases steeply for low values of k. For $k = 0.001$, the probability equals 0.81.

Panel (a) in Figure 4 illustrates the two key features of the differentiation strategy. First, the more a_1 deviates from a_2, the more inclined is the manager to differentiate. Second, the more able both employees are, the more the manager tends to eschew comparisons. Both features highlight that the manager faces a dilemma when deciding whether or not to differentiate. On the one hand, a manager wants

[14] See the Appendix.

to differentiate in order to properly match effort and ability. This relates to the first feature. On the other hand, the manager wants to exploit synergy between the employees. This gives an incentive to the manager to abstain from differentiation. As the synergetic value increases in a_1 and a_2, higher values of a_1 and a_2 weaken the manager's incentive to differentiate. This explains the concavity of $h_-(a_1;k)$ and relates to the second feature of panel a.

This panel is also helpful in understanding how the manager's differentiation strategy affects the two employees' beliefs about their abilities. Since the manager abstains from differentiation for high values of a_1 and a_2, not differentiating, rather than leaving an employee's belief about his ability unaffected, *boosts* employees' confidence in their abilities. The flip side of the coin is that m_1 severely damages employee 2's perception of his ability.

The exact location of $h_-(a_1;k)$, and therefore of $h_+(a_1;k)$, depends on k. The higher is k, the more important is synergy between the employees for the manager, and the weaker is the incentive to differentiate. Panel b in Figure 4 shows the likelihood that the manager refrains from differentiation as a function of k.[15] As k tends to zero, this likelihood tends to $2-\sqrt{3}$, the probability that we obtained in Equilibrium in Section 3, and $h_-(a_1;k)$ becomes a straight line.

Ertac (2005) also established that for $k>0$ the manager has an interest in withholding comparative information from her employees. The model she uses does not allow, however, for the manager to condition the decision to reveal information or not on the observed ability differences. Instead, the decision to reveal information or not is made ex ante, before observing the true ability levels.

Can Equilibrium 2 of Section 3 be an equilibrium in the presence of synergy, $k>0$, or with a cost function with $q>2$? As far as synergy is concerned, for any positive value of k, there are pairs of observed ability levels (a_1,a_2) close to (a,a), such that the manager prefers m_2 over either m_1 or m_3, and thus deviates from Eq 2.[16] Concerning the cost of effort function, in case of quadratic costs, the manager is indifferent between m_1 and m_2 for $(a_1,a_2)=(a,a)$. But for any

[15] We have to rely on numerical simulations as it is not possible to obtain an analytical solution for the equilibrium of this game.

[16] This can be most easily seen for values of (a_1,a_2) close to $(1,1)$. If Equilibrium 2 is the imputed equilibrium, then for $(a_1,a_2)=(1,1)$ sending m_2 yields strictly more than sending m_1, $\frac{1}{2}+\frac{1}{2}+k\frac{1}{4}>\frac{2}{3}+\frac{1}{3}+k\frac{2}{9}$. This implies that there exists a neighbourhood of $(1,1)$, with $a_2<a_1\leq 1$, such that the manager wants to deviate from equilibrium 2 by sending m_2 rather than m_1.

$q > 2$, this indifference no longer holds. By continuity of the objective function, the manager wants to deviate from Eq 2 by sending m_2 for values of (a_1, a_2) close to the main diagonal. In other words, for any $k > 0$ and for cost functions with $q > 2$, equilibrium 2 fails to exist. Instead,an equilibrium in which the manager abstains from differentiation with a strictly positive probability does exist.

7 Differentiation under commitment

So far, we have assumed that the manager cannot commit to a message strategy. In this section, we return to the benchmark case of Section 3, and show the importance of the presence or absence of commitment to a specific strategy for the likelihood of differentiation.[17]

Consider the benchmark situation, and the differentiation strategy m_1 if $a_1 \geq \frac{1}{t}a_2$; m_2 if $a_1 \in \left(\frac{1}{t}a_2, ta_2\right)$; and m_3 if $a_1 \leq ta_2$, where $t \in (0, 1]$. Assume that the manager can commit to a value of t. The manager can then ignore incentive compatibility considerations. This value is simply chosen to maximize the manager's expected payoff $W(t)$,

$$\begin{aligned} W(t) &= 2\int_0^1 \int_0^{ta_1} \left(\frac{2}{3}a_1 + \frac{1}{3}ta_2\right) da_2 da_1 + \\ &\quad \int_0^t \int_{ta_1}^{\frac{a_1}{t}} \left(\frac{1}{2} + \frac{1}{6}t\right)(a_1 + a_2)\, da_2 da_1 + \int_t^1 \int_{ta_1}^1 \left(\frac{1}{2} + \frac{1}{6}t\right)(a_1 + a_2)\, da_2 da_1 \\ &= \frac{1}{18}t^3 - \frac{5}{18}t^2 + \frac{5}{18}t + \frac{1}{2}. \end{aligned} \tag{12}$$

This expression is maximized for $t^C = \frac{5-\sqrt{10}}{3} \approx 0.61$, which is larger than $t^{NC} = 2 - \sqrt{3} \approx 0.27$, the equilibrium value in the absence of commitment. It is straightforward to check that the manager benefits from a commitment to $t = t^C$, $W\left(t^C\right) > W\left(2 - \sqrt{3}\right)$. The reason is that when the manager decides *ex post* she only considers whether differentiation or no differentiation yields more for a *given* pair of observed ability levels and *given* the inferences that the employees draw from the messages. If the manager can commit *ex ante* to a differentiation strategy, she takes into account what the repercussions are for the self-images of the employees of a

[17] In the literature on delegation, Alonso and Matouschek (2007, 2008) study the role of commitment to a message strategy in a cheap talk setting.

choice to differentiate or not. Moreover, she considers the effect of this change of self-image not only for a given pair of ability levels but for all possible pairs for which she contemplates sending a particular message. In particular, the larger is the area around the 45° degree line for which the manager does not differentiate, the lower is the boost in self-image in case of no differentiation for all ability pairs in that area. Hence, the area in which the manager refrains from differentiation in case of $t = t^{NC}$ (see Equilibrium 3 in Section 3) is too large from an ex ante point of view. Hence, $t^C > t^{NC}$. Similarly, the fact that the manager differentiates for all pairs (a_1, a_2) in case of $t = 1$ (see Equilibria 1 and 2 in Section 3) means that there is too much differentiation from an ex ante point of view, $t^C < 1$.

The next proposition summarizes.

Proposition 3 *If the manager can commit to a 3-message differentiation strategy in the benchmark model, then* $t^C = \frac{5-\sqrt{10}}{3}$. *Relative to the case without commitment, commitment increases the probability of differentiation.*

8 Conclusion

This paper studies the pros and cons of differentiating employees by ability. The model developed here focuses on situations in which the effort an employee exerts depends positively on his perception of his ability. A key aspect of our model is that inter-personal comparisons lead to higher effort levels by the more able, but to lower effort levels by the less able. We identify three features of the environment that may affect an employer's decision whether or not to differentiate on the basis of ability: realized abilities, synergies between the employees, and the convexity of the cost of effort function.

A higher degree of synergies weakens the incentive for the employer to differentiate. One implication of this result is that employers are reluctant to differentiate when total performance depends on the "weakest link" in the team. In such a situation, the benefit of boosting the morale of the more able is unlikely to exceed the cost of undermining the morale of the weakest link. A higher degree of convexity of the cost of effort function (more precisely, the presence of convex marginal costs) also reduces the employer's inclination to differentiate.

One finding of the paper is that the more the realized abilities of the employees differ, the more the employer is inclined to differentiate. We have argued that the driving force behind this result is that differentiating leads to a better matching of abilities and effort levels. Notice that the nature of this last feature deviates from the nature of the two we reported in the previous paragraph. These two may help us to explain why differentiation varies across different types of organizations. Realized abilities are important for understanding variation of differentiation for a given type of organization.

Although we have identified conditions under which managers differentiate, testing the predictions of our model is difficult for at least two reasons. First, we have found that the incentive to differentiate depends on synergies in the production process and on the curvature of the costs of effort functions. Those features of an organization are generally hard to observe and to measure. Second, our model predicts that depending on the employees' abilities, the same type of organizations may pursue different differentiation policies. These differences across organizations stem from private information on part of managers. This further complicates a full-fledged empirical analysis. Some specific predictions of our model might be tested, however. Our model predicts that in environment where strong synergies exist, think of environments with o-ring production functions, differentiating employees on the basis of abilities will be rare. Interestingly, Frank (1985) finds a weaker link between pay and individual performance in environments where employees are relatively complementary (research teams versus sales persons). Another prediction that might be tested is that organizations that are able to commit themselves to HRM practices perform better than organizations that are not able to commit themselves.

In this paper, we have analyzed a situation in which effort and ability are complements in the objective function of both the employees and the manager. This assumption accurately describes many real life situations. Of course, there is no denying that effort and ability could be substitutes in the employees' objective functions: they may just care about achieving a set goal. Then, communication problems that exist in an interaction between the manager and one employee cannot be overcome by treating two employees differently.

Further, we have limited attention to the two-employee case. Increasing the number of employees the manager can differentiate between will increase the manager's ability to tailor effort levels to each employee's realized ability. This suggests that different organizations may be associated to teams of different optimal sizes, as the management may have to trade off the comparative statement benefits of increasing team size with other costs, such as those associated to team coordination. We leave the analysis of this issue to future work.

In this paper, we have limited attention to situations where *ex ante* the agents are identical to each other. Relaxing this assumption would imply that the distributions of abilities vary across agents. Potentially, allowing for asymmetries affect our results. To illustrate, suppose that in the benchmark model, employee 1's abilities are uniformly distributed on $[0, \beta]$ with $\beta > 1$. One can verify that relative to the benchmark model, the manager would be more reluctant to claim that employee 2 is the more able employee. The reason is that employee 1 would not only learn that $a_2 > a_1$. He would also learn that $a_1 < \beta$. Consequently, a claim that employee 2 is the better employee would motivate employee 2 less than it would demotivate employee 1.

Students of human resource management often speak of high commitment hrm practices. This term refers to a broad and varied array of hrm practices that are expected to improve the commitment of employees and managers to organizational goals and thus organizational performance, see *e.g.* Becker et al. 1997 and Delaney et al. 1989. Synonyms include 'high performance' and 'high involvement' practices, see Gould-Williams (2004, p. 63). Our paper illustrates the value of commitment to attain organizational goals and some of the dilemmas that managers should overcome if they want to stick to 'high performance' feedback and differentiation practices.

9 Appendix

Derivation of the beliefs in Equilibrium 3, page 9:

$$\mathsf{E}\left(a_1|m_1\right) = \frac{\int_0^1 \int_0^{a_1 t} a_1 da_2 da_1}{\int_0^1 \int_0^{a_1 \frac{1}{\gamma}} da_2 da_1} = \frac{2}{3}, \ \mathsf{E}\left(a_1|m_3\right) = \frac{\int_0^t \int_{a_1 \frac{1}{t}}^1 a_1 da_2 da_1}{\int_0^t \int_{a_1 \frac{1}{t}}^1 da_2 da_1} = \frac{t}{3}$$

and

$$\mathsf{E}\left(a_1|m_2\right) = \frac{\int_0^t \int_{a_1 t}^{a_1 \frac{1}{t}} a_1 da_2 da_1 + \int_t^1 \int_{a_1 t}^1 a_1 da_2 da_1}{\int_0^t \int_{a_1 t}^{a_1 \frac{1}{t}} da_2 da_1 + \int_t^1 \int_{a_1 t}^1 da_2 da_1} = \frac{1}{2} + \frac{t}{6}.$$

Proof of Proposition 2: Recall that we assume $V_{ee} < 0,\ V_{ea} > 0$ and $V_e(0, a) \geq 0$. An equilibrium in which the manager avoids differentiation with strictly positive probability exists if and only if there exists a $t \in (0, 1)$ such that she sends m_1 if $a_1 \geq \frac{1}{t}a_2$, m_2 if $a_1 \in \left(\frac{1}{t}a_2, ta_2\right)$, and m_3 if $a_1 < ta_2$. For any t, this strategy defines the updated beliefs $E(a_i|m)$ as functions of t, and effort levels are best-replies given these beliefs. Consider employee 1 (2). Let $e^H(t)$ be his best reply to m_1 (m_3); let $e^M(t)$ be his best reply to m_2 (m_2); and let $e^L(t)$ be his best reply to m_3 (m_1). The manager is indifferent between m_1 and m_2 if and only if $a_1e^H(t) + a_2e^L(t) = a_1e^M(t) + a_2e^M(t)$. For the desired equilibrium to exist the fixed point condition

$$t = G(t), \text{ with } G(t) = \frac{e^H(t) - e^M(t)}{e^M(t) - e^L(t)}$$

must allow for a solution $t \in (0, 1)$.

The expression for the objective functions of the employee conditional on a message m, and the associated first order condition for an interior solution are

$$\begin{aligned} E(V(e,a)|m_1) &= \frac{\int_0^1 \int_0^{ta} V(e,a)\,dF(b)\,dF(a)}{\int_0^1 \int_0^{ta} dF(b)\,dF(a)} = \frac{\int_0^1 V(e,a)\,F(ta)\,dF(a)}{\int_0^1 F(ta)\,dF(a)} \\ &\rightarrow \frac{\int_0^1 V_e(e,a)\,F(ta)\,dF(a)}{\int_0^1 F(ta)\,dF(a)} = 0 \end{aligned}$$

$$\begin{aligned} E(V(e,a)|m_2) &= \frac{\int_0^t \int_{ta}^{\frac{1}{t}a} V(e,a)\,dF(b)\,dF(a) + \int_t^1 \int_{ta}^1 V(e,a)\,dF(b)\,dF(a)}{\int_0^t \int_{ta}^{\frac{1}{t}a} dF(b)\,dF(a) + \int_t^1 \int_{ta}^1 dF(b)\,dF(a)} \\ &= \frac{\int_0^t V(e,a)\left[F\left(\frac{1}{t}a\right) - F(ta)\right]dF(a) + \int_t^1 V(e,a)\left[1 - F(ta)\right]dF(a)}{\int_0^t \left[F\left(\frac{1}{t}a\right) - F(ta)\right]dF(a) + \int_t^1 \left[1 - F(ta)\right]dF(a)} \\ &\rightarrow \frac{\int_0^t V_e(e,a)\left[F\left(\frac{1}{t}a\right) - F(ta)\right]dF(a) + \int_t^1 V_e(e,a)\left[1 - F(ta)\right]dF(a)}{\int_0^t \left[F\left(\frac{1}{t}a\right) - F(ta)\right]dF(a) + \int_t^1 \left[1 - F(ta)\right]dF(a)} = 0 \end{aligned}$$

$$
\begin{aligned}
E\left(V\left(e,a\right)|m_3\right) &= \frac{\int_0^t \int_{\frac{1}{t}a}^1 V\left(e,a\right) dF\left(b\right) dF\left(a\right)}{\int_0^t \int_{\frac{1}{t}a}^1 dF\left(b\right) dF\left(a\right)} = \frac{\int_0^t V\left(e,a\right)\left[1-F\left(\frac{1}{t}a\right)\right] dF\left(a\right)}{\int_0^t \left[1-F\left(\frac{1}{t}a\right)\right] dF\left(a\right)} \\
&\rightarrow \frac{\int_0^t V_e\left(e,a\right)\left[1-F\left(\frac{1}{t}a\right)\right] dF\left(a\right)}{\int_0^t \left[1-F\left(\frac{1}{t}a\right)\right] dF\left(a\right)} = 0
\end{aligned}
$$

Because of the continuity of $G\left(t\right)$ in t, to establish that the fixed point condition has an interior solution, it suffices to show that $\lim_{t\to 0} G\left(t\right) > 0$ and $\lim_{t\to 1} G\left(t\right) < 1$. For $G\left(0\right) > 0$, we need to show that $e^H\left(0\right) > e^M\left(0\right) > e^L\left(0\right)$. Taking limits of the above first-order conditions and using de L'Hôpital's rule, we obtain

$$
\begin{aligned}
\int_0^1 V_e\left(e^H\left(0\right),a\right) a dF\left(a\right) &= 0 && (13)\\
\int_0^1 V_e\left(e^M\left(0\right),a\right) dF\left(a\right) &= 0 && (14)\\
V_e\left(e^L\left(0\right),0\right) &= 0. && (15)
\end{aligned}
$$

Note that

$$
\begin{aligned}
\int_0^1 V_e\left(e^L\left(0\right),a\right) dF\left(a\right) &= \int_0^1 \left[V_e\left(e^L\left(0\right),0\right) + \int_0^a V_{ea}\left(e^L\left(0\right),x\right) dx\right] dF\left(a\right) \\
&= \int_0^1 \int_0^a V_{ea}\left(e^L\left(0\right),x\right) dx dF\left(a\right) > 0 = \int_0^1 V_e\left(e^M\left(0\right),a\right) dF\left(a\right),
\end{aligned}
$$

where the second equality holds because of (15), the inequality sign because of $V_{ea} > 0$, and the last equality by (14). Then, because of $V_{ee} < 0$, we know $e^M\left(0\right) > e^L\left(0\right)$.

To prove $e^H\left(0\right) > e^M\left(0\right)$, it follows from (14), in combination with $V_{ea} > 0$, that

$$
\int_0^1 V_e\left(e^M\left(0\right),a\right) a dF\left(a\right) > 0 = \int_0^1 V_e\left(e^H\left(0\right),a\right) a dF\left(a\right),
$$

where the equality follows from (13). Again, because of $V_{ea} > 0$, we then have $e^H\left(0\right) > e^M\left(0\right)$. Hence, we have shown that $\lim_{t\to 0} G\left(t\right) > 0$.

Turning to the proof of $\lim_{t\to 1} G\left(t\right) < 1$, this requires that we show that $e^M\left(1\right) > e^L\left(1\right)$ and $\left[e^H\left(1\right) + e^L\left(1\right)\right]/2 < e^M\left(1\right)$. From the first-order conditions we derive that

$$\begin{aligned}\int_0^1 V_e\left(e^H(1),a\right)dF^2(a) &= 0\\ \int_0^1 V_e\left(e^M(1),a\right)af(a)\,dF(a) &= 0\\ \int_0^1 V_e\left(e^L(1),a\right)[1-F(a)]\,dF(a) &= 0,\end{aligned}$$

where we rearranged the first condition to highlight that it rests on the distribution of the maximum of two i.i.d. variables.

Let e^p denote the optimal level of effort in case of the *prior* density $f(a)$. It satisfies $\int_0^1 V_e(e^p,a)\,dF(a)=0$. Using $V_{ee}<0$ and $V_{ea}>0$, we have that $e^p<e^M(1)$ if either $af(a)$ is non-decreasing or $f(a)$ is symmetric. Hence, if (i) in the statement of the Proposition holds, then to show $\left[e^H(1)+e^L(1)\right]/2<e^M(1)$, it suffices to show that $e^H(1)+e^L(1)\leq 2e^p$. Then,

$$\begin{aligned}0 &= \int_0^1 V_e(e^p,a)f(a)\,da=\int_0^1 V_e(e^p,a)(1-F(a))\,dF(a)+\int_0^1 V_e(e^p,a)F(a)\,dF(a)\\ &= \int_0^1 V_e\left(e^H(1)-\left(e^H(1)-e^p\right),a\right)F(a)\,dF(a)+\\ &\quad \int_0^1 V_e\left(e^L(1)-\left(e^L(1)-e^p\right),a\right)(1-F(a))\,dF(a)\\ &= -\left(e^H(1)-e^p\right)\int_0^1 V_{ee}(\bar{e},a)F(a)\,dF(a)-\\ &\quad \left(e^L(1)-e^p\right)\int_0^1 V_{ee}(\underline{e},a)(1-F(a))\,dF(a),\end{aligned}$$

where $\bar{e}\in\left(e^p,e^H(1)\right)$ and $\underline{e}\in\left(e^L(1),e^p\right)$ by the mean-value theorem for derivatives. Thus, for $e^H(1)+e^L(1)\leq 2e^p$ to hold, we need

$$\int_0^1 V_{ee}(\bar{e},a)F(a)\,dF(a)<\int_0^1 V_{ee}(\underline{e},a)(1-F(a))\,dF(a).$$

This is indeed the case if $V_{eee}\leq 0$ and $V_{eea}\leq 0$.

Finally, note that $e^H(1)+e^L(1)=2e^p$ if and only if V_{ee} is constant.■

Expression for $h'_-(a_1;k)$:

$$h'_-(a_1;k) = \frac{[e_1(m_1) - e_1(m_2)]\,[e_2(m_2) - e_2(m_1)]}{(e_2(m_2) - e_2(m_1) + a_1 k\,[e_1(m_2)\,e_2(m_2) - e_1(m_1)\,e_2(m_1)])^2} > 0$$

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