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Abstract

This theoretical paper explores the impact of gender diversity on team production. The key assumption is that men derive utility from signaling high ability to female colleagues. The analysis shows that some gender diversity maximizes expected team production if (i) men and women have similar expected ability, and (ii) monetary incentives to exert effort are not too strong. The study generates important and testable economic implications: the presence of women changes the behavior of male team members, gender diversity has the biggest effects in young teams, and monetary incentives crowd-out the impact of gender diversity.

JEL-Code: D020, D030, D230, D820, L230, M500.

Keywords: team production, gender diversity, male courtship behavior.

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1 Introduction

Important decisions in many firms and organizations are taken by groups or teams. Examples for such teams include management committees, executive boards, and university councils. Teams and groups indeed often take better decisions than individuals, arguably because more diverse views and preferences can enter the team decision process.[1] Team diversity therefore has an important influence on the quality of organizational choices.

Promoting gender diversity is one promising way to increase diversity in management teams. Croson & Gneezy (2009) and Bertrand (2010) summarize the extensive empirical literature on gender differences in preferences. The evidence indicates that women are more risk-averse, less competitive, and more responsive to the social context than men. Men and women thus differ in their preferences and relatedly in their views on the world.[2] Women are at the same time not well represented in many executive boards and management committees. Catalyst (2014) reports that in 2013 only 16.9 % of Fortune 500 board seats are held by women.[3] This suggests that organizations might improve their performance by promoting gender diversity in their management teams. The reason is that promoting gender diversity at the same time promotes preference and knowledge diversity.

In their recent empirical studies, Apesteguia, Azmat & Iriberri (2012) and Hoogendoorn, Oosterbeek & van Praag (2013) find that gender diversity improves team performance.[4] But their and further empirical evidence suggests that gender diversity does not only influence team performance by making team preferences and team knowledge more diverse. Instead,

[1] Cooper & Kagel (2005), Kocher & Sutter (2005), Kocher, Strauß & Sutter (2006), and Rockenbach, Sadrieh & Mathauschek (2007) document in their experiments that teams outperform individuals in certain decision environments. Crémer (1993), Lazear (1999) and Prat (2002) study theoretically how more diverse team information affects team production.

[2] Recent empirical evidence suggests that there might exist further behavioral differences. For example, Friebel & Seabright (2011) show that men and women differ in their communication strategies. This can have importance consequences for the formation of social networks.

[3] See also Azmat (2014) for an overview of the literature on gender diversity in teams.

[4] The empirical evidence also shows that the presence of female team members renders team behavior more female. For example, in Apesteguia et al. (2012) all-female teams invest much less in R&D, price less aggressively, and invest more in social sustainability than all-male teams. See also Adams & Ferreira (2009), Ahern & Dittmar (2012), and Matsa & Miller (forthcoming) who study the impact of gender diversity on the behavior of corporate boards. These important studies are further discussed in the conclusion.

the mere exposure to the other gender affects the behavior of team members. Dufwenberg & Muren (2006) find that all-female teams are more altruistic than all-male teams, but mixed-gender teams are the most altruistic. Team preferences are therefore not simply a convex combination of the preferences of the team members. Ivanova-Stenzel & Kübler (2011) show that men outperform women in an isolated memory puzzle task, but only in the presence of women. Men thus change their individual behavior in mixed-gender teams. Taken together this suggests that gender diversity has a fundamental effect on team production, an effect that transcends the impact of sheer preference or knowledge diversity.

To better understand the fundamental effect of gender diversity on team production, the present paper analyzes how gender diversity influences the social interaction between team members that is concurrent to the technological team production process itself. The crucial assumption is that during team production, men might engage in courtship behavior to signal their high ability to female colleagues.[5] It is well established among social psychologists that the presence of women induces male courtship behavior. For example, Ronay & von Hippel (2010) show that a female spectator increases testosterone levels and performance of male skateboarders. And Frankenhuis & Karremans (2012) document that men in no stable sexual relationship adjust their risk-taking behavior so as to match the preferences of the female experimenter. Seabright (2012) discusses extensively how the desire to reproduce shapes the interaction between women and men. The present paper formalizes the idea that men want to impress women to derive organizational implications in the spirit of Becker (1971).

The theoretical model considers a team with female and male team members. These team members simultaneously exert costly effort, which yields some individual monetary return. Team members have high or low ability, and ability affects their marginal effort costs. Ability is initially private information. The key assumption is that men derive extra utility if female colleagues believe them to have high ability. This extra utility is increasing in the number of female colleagues. Because ability is private information ex-ante, but effort is observable ex-post, the team production process constitutes a signaling game once men care for the impression they make on the other gender.

[5]Courtship behavior is clearly present at work. Cacioppo, Cacioppo, Gonzaga, Ogburn & van der Weele (2013) report that - even in the times of the internet - still around 14% of their representative US sample met their future spouse offline at work. The workplace is the most important offline meeting point.

The paper derives two main results. First, some gender diversity maximizes expected team production if average ability of men and women is similar. This holds since increasing the number of female team members has an incentive and a substitution effect: it increases the incentives to signal high ability for male team members, but at the same time reduces the number of male team members affected by the presence of female colleagues. Second, male image motivation affects team production only if monetary incentives are weak. The intuitive argument runs as follows. Team members with high ability exert much higher effort than team members with low ability if monetary incentives are very strong. This holds even if team members ignore the impression they make on female colleagues. But all team members exert the same – zero – effort if there are no monetary incentives and no image concerns. The constraint on the minimum effort ensuring credible revelation of high ability is thus binding only if monetary incentives are low.

The analysis has important and empirically testable economic implications. First, gender diversity impacts team production by fundamentally changing the behavior of male team members. Although this typically benefits team performance, the effect can depend on the considered team task. It might be less pronounced or negative if the cognitive performance of teams is paramount.[6] Second, the impact of gender diversity on team performance is strong only if teams face weak monetary incentives. Thus, gender diversity has no big impact on team production in management consultancies, investment banks, or law firms. Thirdly, the effect of gender diversity is very pronounced in young teams in which many team members are not yet in a stable sexual relationship. All these implications differ decidedly from the predictions based on preference or knowledge diversity. The second implication results only from the strategic considerations of men in the signaling game.

Although the present paper focuses on gender diversity, the underlying idea is much more general. The empirical literature on team diversity typically takes some form of diversity as input and relates it to team production as output. Due to data restrictions it can only speculate about the transformation process that translates input into output. The existing

[6]It is not obvious that men necessarily engage in signaling activities that increase team performance. Ronay & von Hippel (2010) indeed find that the presence of a female spectator reduces cognitive performance of the male participants in a reverse-learning task. See also Koellinger & Block (2012) who show that the presence of a female supervisor reduces the performance of male participants in Sudoku puzzles and a practice exam. But from an evolutionary perspective it seems unlikely that men consistently engage in activities that hurt the female team members they want to impress.

theoretical literature on team diversity by Crémer (1993), Lazear (1999), Prat (2002), and Hamilton, Nickerson & Owan (2012) concentrates on what one might call the technological team production process. Although the importance of social interaction is acknowledged, the emphasis is on the technological team production function.

The contribution of the present article is to shift attention to the social interaction among team members.[7] This social interaction is at the same time inseparable from and concurrent to the technological team production process. The present analysis shows that psychological or behavioral motivations during this strategic social interaction – presently men want to impress women – generate genuine gender effects with important economic implications. Other interesting motives currently not covered include the signaling of altruism, confidence, or competence. The need or desire to signal certain properties further depends on the social and cultural context. The present paper therefore does not only generate organizational recommendations with respect to gender diversity. It might also inspire new theoretical and empirical research to deepen our understanding of the social mechanisms through which team diversity in general affects team performance.

2 Model

Consider a team with $n \in \mathbb{N}$ workers, out of which $w \in \mathbb{N}$ are women. Each worker has high or low ability. Let $\theta \in \{\ell, h\}$ be the ability and $\gamma \in \{f, m\}$ the gender of a worker. Gender is observable, but ability is private information. Let $\lambda(\theta, \gamma)$ be the commonly known ex-ante probability for a worker with gender γ to have ability θ. Workers exert effort $a \in \mathbb{R}^+$. To focus on the social interaction concurrent to the technological team production process, all direct complementarities in the production function are excluded.[8] Effort simply yields individual marginal monetary returns $b \in \mathbb{R}^+$ at individual effort costs $d(\theta)\, c(a)$. Function

[7] Dur (2009), Dur, Non & Roelfsma (2010), Dur & Sol (2010), and Non (2012) study the interplay between social preferences, monetary incentives, and social interaction at the workplace. They do not consider team diversity and image motivation with respect to team members of the other gender.

[8] Extending the model so that optimal effort absent reputation concerns depends on the effort chosen by team colleagues should be unproblematic. A previous version of the paper shows that including a direct impact of gender diversity on productivity leaves results unaffected. The analysis is agnostic as to what constitutes efficient team effort, since team output is not taken into account. In that sense the paper differs from the large literature following Holmström (1982) that focuses on incentive problems in teams. Last but not least, the paper does not consider the aggregation of information in the team decision process. This contrasts team theory as discussed in, for example, Crémer (1993) and Prat (2002).

$c : \mathbb{R}_+ \to \mathbb{R}^+$ satisfies $c'(a) > 0$, $c''(a) > 0$ and $c'''(a) \leq 0$ for all $a > 0$. For simplicity $\lim_{a\to 0} c'(a) = 0$ and $\lim_{a\to\infty} c'(a) = +\infty$. Constants $d(h) \in \mathbb{R}^+$ and $d(\ell) \in \mathbb{R}^+$ formalize how ability affects effort costs, where $d(h) < d(\ell)$. Workers with high ability thus have lower effort costs and lower marginal effort costs than workers with low ability.

Gender heterogeneity possibly affects team production via male courtship behavior. Men care for the probability with which female colleagues believe them to have high ability. Let $\mu(a) \in [0, 1]$ be the probability with which women believe a male colleague to have high ability if that colleague has chosen effort a. The utility of male workers with ability θ choosing effort a can then be expressed as

$$b\,a - d(\theta)\,c(a) + \mu(a)\,k(w) \tag{1}$$

where $k(w)$ is the reduced-form return to a high-ability rather than a low-ability reputation in the social interaction between team members. $k(0)$ is set to zero since there are no returns from signaling high ability if there are no women around. A larger pool of women makes it more likely to find a suitable matching partner. More women w also implies fewer men $n - w$ and thus less competition among male workers for female colleagues. Function k is thus strictly increasing. Function k can have any curvature. Women have the same utility function as men except that they do not care for their ability reputation.[9]

The strategic interaction within teams is as follows. Nature first determines the ability of each team member. Workers learn their own ability but not the ability of their colleagues. All workers then simultaneously exert effort. Effort choices are observed. Women update their beliefs concerning the ability of their male colleagues. A pure strategy characterizes an effort choice $\alpha(\gamma, \theta, w, b)$ conditional on the worker's gender, ability, and the number of women in the team. The analysis focuses on perfect Bayesian equilibria in pure strategies. In a Perfect Bayesian equilibrium, the equilibrium strategy α^* maximizes expected utility given colleagues' strategic behavior and equilibrium beliefs. Updated beliefs are consistent with equilibrium strategies whenever possible. The analysis focuses on equilibria in pure strategies.

[9]This should be considered a simplifying assumption inspired by the empirical evidence. Most studies in psychology argue that signaling motives are stronger for men, since these compete more fiercely for mating partner due to biological reasons (child bearing). Maybe for that reason research focuses on men; there actually seem to be no studies that systematically investigate whether women change their behavior in the presence of the other gender. Note that in the context of this study, all results are strengthened if women also want to signal their high ability to men by exerting higher effort.

3 Results

The above strategic situation constitutes a game with productive signaling: workers have incentives to exert more than minimum effort, even if exerting more or less effort has no impact on their reputation. Since optimal effort increases in ability, workers with high ability might automatically separate themselves from colleagues with low ability. Reputation concerns then do not affect effort choices. The latter holds if monetary incentives are strong. The theory makes this intuition exact.

3.1 Best Separating Equilibrium

Consider the best separating equilibrium. By their monetary incentives, workers optimally exert effort even in the absence of reputation concerns. Implicitly define these optimal effort levels $a_{ri}(\theta, b)$ by

$$b - d(\theta)\, c'\big(a_{ri}(\theta, b)\big) = 0 \tag{2}$$

where subscript ri stands for reputation-independent effort. By the properties of c there exist unique and weakly positive effort levels satisfying this equation for all (θ, b). There are no differences between men and women with equal ability.

In a best separating equilibrium, all but male workers with high ability chooses the above defined effort levels corresponding to their ability. Male workers with high ability might have to exert more effort than $a_{ri}(h, b)$ to signal their ability. For separation their effort a must satisfy the separation constraint

$$b\, a_{ri}(\ell, b) - d(\ell) c\big(a_{ri}(\ell, b)\big) - b\, a + d(\ell) c(a) - k(w) \geq 0. \tag{3}$$

At effort a equal so $a_{ri}(\ell, b)$ the left hand side of (3) is negative. For larger effort it is strictly increasing in effort by the strict convexity of the cost function c. It is continuous and unbounded above, therefore there exists a unique effort $a_s(b, w) \geq a_{ri}(\ell, b)$ such that the constraint holds for all $a \geq a_s(b, w)$. Subscripts s stands for separation. Note that male workers might possibly signal their ability by exerting an effort much smaller than $a_{ri}(\ell, b)$. The proof in the appendix shows that this is never optimal, since male workers with high ability forgo large returns while reducing their effort costs only by little. To single out the impact of male image motivation, define

$$\Gamma(b, w) = \min\{a_s(b, w) - a_{ri}(h, b), 0\}. \tag{4}$$

$\Gamma(b, w)$ is the extra effort male workers with high ability must exert to separate themselves from their male colleagues with low ability. It is strictly positive if and only if the separation constraint is binding. It is also weakly increasing in the number of women w. The reason is that the presence of more women w increases the returns to signaling high ability $k(w)$, thus makes the separation constraint more difficult to satisfy, and thereby increases the minimum effort $a_s(b, w)$ signaling high ability. There is the following result.

Result 1 (Best Separating Equilibrium)**.** *The best separating equilibrium always exists. It is the unique Perfect Bayesian Equilibrium in pure strategies that satisfies the intuitive criterion. In this equilibrium*

$$\alpha^*(m, h, w, b) = a_{ri}(h, b) + \Gamma(b, w) \text{ and} \tag{5}$$

$$\alpha^*(\gamma, \theta, w, b) = a_{ri}(\theta, b) \text{ for all } (\gamma, \theta) \neq (m, h) \tag{6}$$

characterizes workers' effort choices, and

$$\mu^*(\alpha^*(m, h, w, b)) = 1 \text{ and } \mu^*(a) = 0 \text{ for all } a \neq \alpha^*(m, h, w, b) \tag{7}$$

characterizes the equilibrium beliefs concerning male workers' ability. The equilibrium beliefs concerning female workers' ability are arbitrary.

The remaining analysis focuses on the best separating equilibrium.

3.2 Production and Gender Diversity

Expected team production in a team with w female team members is

$$\big(n - w\big)\,\big(E_m\big(a_{ri}(\theta, b)\big) + \lambda(h, m)\,\Gamma(b, w)\big) + w\,\big(E_f\big(\,a_{ri}(\theta, b)\big)\big) \tag{8}$$

where the gender-specific expectations E_m and E_f are formed with respect to workers' ability. Suppose the number of women increases by one. Then the effect on team production that is not related to potential male courtship behavior is simply

$$\big(\lambda(h, f) - \lambda(h, m)\big)\,\big(a_{ri}(h, b) - a_{ri}(\ell, b)\big). \tag{9}$$

It is close to zero if $\lambda(h, f)$ is close to $\lambda(h, m)$ so that the expected ability of men and women is very similar. It is also close to zero if $a_{ri}(h, b)$ is close to $a_{ri}(\ell, b)$. The latter holds if either monetary incentives b or the difference in $d(h)$ and $d(\ell)$ are small. In these cases workers with high and low ability exert similar effort absent reputation concerns. The change in expected team production related to male image motivation is given by

$$\big(n - w\big)\,\lambda(h, m)\,\big(\Gamma(b, w + 1) - \Gamma(b, w)\big) - \lambda(h, m)\,\Gamma(b, w + 1). \tag{10}$$

The first term captures the incentive effect. Since returns to signaling high ability increase in the number of female colleagues, the mark-up Γ is weakly increasing in w. It is only weakly increasing as changing gender diversity has no impact on effort if the separation constraint is not binding. The second term captures the substitution effect, since increasing the number of women decreases the number of men, and thus the number of workers who might engage in courtship behavior.

The interplay between incentive and substitution effect implies that some gender diversity maximizes the effect of image motivation on team production. Courtship behavior does not occur in all-male teams, since then there are no women to impress. Male image motivation also plays no role in all-female teams, because then there are no men who want to impress their female colleagues. Since by assumption the benefit of signaling high ability is increasing in the number of female colleagues, male image motivation is most likely to be behaviorally relevant in teams with all but one female team members. Suppose that the remaining male worker must then exert extra effort to credibly signal high ability. There then exists some level of gender diversity at which male courtship behavior increases expected team production. Suppose that compared to this positive effect of male courtship behavior, ability differences between men and women are small. Then some gender diversity maximizes team production. This is summarized in the following result.

Result 2 (Gender Diversity and Team Output)**.** *The number of women $\tilde{w}$ that maximizes expected team production satisfies $0 < \tilde{w} < n$ if (i) the expected ability of men and women is sufficiently similar, and (ii) male image motivation is behaviorally relevant for teams with $w = n - 1$ female worker.*

3.3 Effects of Gender Diversity and Incentive Strength

Male image motivation matters if and only if (i) there are female and male team members, and (ii) male workers with high ability must exert extra effort $\Gamma(b, w) > 0$ to credibly signal their high ability. If the monetary incentives b are low, workers with both high and low ability choose low and thus similar effort absent reputation concerns. In that case the separation constraint is binding. Yet if the monetary incentives are high, workers with high ability automatically choose much more effort than workers with low ability. If the monetary incentives are sufficiently high, it is too costly for male workers with low ability to mimic their colleagues with high ability. In that case the separation constraint is not binding, and

male image motivation has no impact on equilibrium effort. This intuition is made precise in the following result.

Result 3 (Courtship Behavior and Incentives)**.** *For given team composition, there exists a strictly positive and finite cutoff incentive intensity* $\tilde{b}$ *such that male image motivation affects the equilibrium effort of male workers with high ability if and only if* $b < \tilde{b}$*.*

4 Summary and Discussion

The present analysis studies the impact of gender diversity on team production if male team members receive extra utility from signaling high ability to female colleagues. The resulting male courtship behavior renders some gender diversity optimal if (i) men and women are similar in expected ability, and (ii) monetary incentives are not too strong. These results are consistent with the existing empirical evidence. Hoogendoorn et al. (2013) study student ventures in an entrepreneurship course. They find that gender diverse ventures perform best. Apesteguia et al. (2012) investigate student teams in an online business game. They find that all-female teams perform worse than gender diverse and all-male teams. They also present evidence suggesting that mixed-gender teams perform best among the highest ability teams. The latter fits nicely with the present paper, which argues that only workers with high ability respond to gender diversity by increasing their effort. In contrast to the above, Adams & Ferreira (2009), Ahern & Dittmar (2012), and Matsa & Miller (forthcoming) conclude that gender diversity decreases firm performance. They investigate how the gender diversity of corporate boards influences firm performance in the US and in Norway.

The studies on corporate boards and student teams of course differ in many dimensions. Yet two differences are particularly striking. First, the studies on corporate boards investigate top managers, who are more mature and thus very different from typical university students. In particular, students are less likely to be in a stable sexual relationship, which makes male courtship motivation more likely to be important.[10] Moreover, the present paper demonstrates that male courtship motivation is irrelevant in the presence of strong monetary incentives. Monetary rewards are substantial in corporate boards; they are much smaller

[10]Baker & Maner (2009) show that male participants change their behavior only in the presence of a female confederate who signals her sexual interest. Frankenhuis & Karremans (2012) find that uncommitted men adjust their behavior in line with the perceived preferences of the female spectator, whereas committed men adjust their behavior so as not to be in line with the perceived preferences of the female spectator.

in the student studies.[11] The present theoretical results are thus very much in line with the empirical evidence, which suggests that gender diversity increases the production of student teams, whereas it has no beneficial effect on the more mature and strongly incentivized corporate boards.

Appendix

Proof of Result 1 (Characterization Best Separating Equilibrium)

The proof first characterizes the equilibrium effort choices of all but male workers with high ability. Female workers' effort choices follow from (2). In a best separating equilibrium, male workers with low ability reveal their type. Their effort maximizes their utility given that everybody believes them to have low ability. It is also characterized by (2).

The proof proceeds to derive the effort that maximizes the utility of male workers with high ability in any separating equilibrium. This equilibrium effort maximizes their utility of male workers with high ability given the separation constraint (3). But since exerting effort is productive, male workers with high ability might credibly signal their ability not only by exerting more, but also by exerting less effort than male workers with low ability. The proof now shows that it is better for workers with high ability to signal their type by exerting more rather than less effort than male workers with low ability if the separation constraint (3) is binding. Reputation gains $k(w)$ must then be strictly positive. There then exists a second effort $\tilde{a} < a_{ri}(\ell, b)$ such that all $a \leq \tilde{a}$ satisfy (3). It is strictly negative and thus irrelevant if $k(w) - d(\ell)c(0)$ exceeds the equilibrium utility of male workers with low ability. Otherwise, male workers with high ability prefer the higher effort if and only if $b\,(a_s - \tilde{a}) \geq d(h)\left(c(a_s) - c(\tilde{a})\right)$. Male workers with low ability are by definition indifferent

[11] In Hoogendoorn et al. (2013) subjects participate in the study in the context of a university course. 19% dropped out of the study. This suggests that not completing the course was not catastrophic. Receiving a better grade also does not seem to be utterly important to many; this is commonly lamented as the "sesjes cultuur" in the Netherlands. Self-determined wages were around 20 euros for the entire academic year. Total profits to be divided among all share-holders of the student firms ranged from -1016 Euros to 477 Euros. In Apesteguia et al. (2012) the two winners of the business games received 10.000 Euros and might be hired by the organizing company L'Oréal. Yet about 16.000 teams participated in the studies, thus the expected payoffs from performing better were probably not overly large. Although monetary incentives are clearly present, they are thus less pronounced than in corporate boards. Adams & Ferreira (2009) report that the mean director compensation was around 96.000 USD, out if which around 40% was equity pay, while meeting fees accounted to around 1.000 USD. The numbers are likely to be smaller but still substantial in the samples of Norwegian firms of Ahern & Dittmar (2012) and Matsa & Miller (forthcoming)

between $a_s(b,w)$ and effort $\tilde{a}$. But then male workers with high ability prefer $a_s(b,w)$ over $\tilde{a}$ since $d(\ell) > d(h)$.

The proof next describes the equilibrium effort of male workers with high ability. The effort maximizes the utility of male workers with high ability given the separation constraint (3). The solution depends on whether the separation constraint (3) is binding. Unconstrained maximization yields $a_{ri}(h,b)$ as the optimal effort of male workers with high ability. If $a_{ri}(h,b) \geq a_s(b,w)$, then the unconstrained and thus reputation-independent effort choices ensure separation. Otherwise, the separation constraint is binding. By the above argument male workers with high ability then choose effort $a_s(b,w)$. This yields the condition on the equilibrium effort of male workers with high ability in the proposition.

The proof finally shows that given their equilibrium effort, male workers with high ability have no incentives to deviate from their equilibrium choice. Out-of-equilibrium beliefs are such that workers believe other workers to have low ability whenever they choose any effort different from the equilibrium effort of workers with high ability. Their best alternative effort choice is $a_{ri}(h,b)$ given that women believe them to have low ability for all effort choices other than $a_s(b,w)$. Then

$$b\,a - d(h)\,c(a) + k(w) \geq b\,a_{ri}(h,b) - d(h)\,c\big(a_{ri}(h,b)\big) \tag{11}$$

ensures that workers with high ability do not deviate. Suppose the separation constraint (3) is binding. Then the binding separation constraint, the fact that male workers with low ability prefer $a_{ri}(\ell,b)$ over $a_{ri}(h,b)$ absent reputation concerns, $d(\ell) > d(h)$, and $a_s(b,w) > a_{ri}(h,b)$ imply that condition (11) holds. The latter holds directly if the separation constraint is not binding. The above arguments ensure equilibrium existence. *Q.E.D.*

Proof of Result 1 (Equilibrium Uniqueness)

The proof continues to show that the best separating equilibrium is the only Perfect Bayesian Equilibrium in pure strategies that satisfies the intuitive criterion. It first shows that there exists no other separating equilibrium that satisfies the intuitive criterion. Consider first any other separating equilibrium. Male workers with low and high ability then get respective equilibrium utilities $u^*(\ell)$ and $u^*(h)$. Let $\tilde{a}$ be the effort of male workers with high ability in the best separating equilibrium. Then $u^*(h) < b\,\tilde{a} - d(h)c(\tilde{a}) + k(w)$ since the considered equilibrium is not the best separating equilibrium. Male workers with low ability get the

same equilibrium utility in all separating equilibria. Then $u^*(\ell) = b\,\tilde{a} - d(\ell)c(\tilde{a}) + k(w)$ holds by construction of the best separating equilibrium. By the properties of the cost function c there exists an alternative effort $\hat{a} > \tilde{a} > a_{ir}(\ell, b)$ so that

$$u^*(h) < b\,\hat{a} - d(h)c(\hat{a}) + k(w) \tag{12}$$

and at the same time

$$u^*(\ell) > b\hat{a} - d(\ell)c(\hat{a}) + k(w). \tag{13}$$

(12) implies $\mu^*(\hat{a}) < 1$ because otherwise male workers with high ability prefer $\hat{a}$ over their equilibrium effort. But (12) and (13) and the intuitive criterion require $\mu^*(\hat{a}) = 1$. Thus the considered separating equilibrium violates the intuitive criterion.

Following a similar logic, the proof finally shows that there exists no pooling equilibrium that satisfies the intuitive criterion. Consider any pooling equilibrium. Male workers with ability $\theta \in \{\ell, h\}$ set equilibrium effort a^* to get utility $u^*(\theta) = b\,a^* - d(\theta)c(a^*) + \lambda(h, m)\,k(w)$. Consider the effort $\tilde{a} > a^*$ that is implicitly defined by $u^*(h) = b\,\tilde{a} - d(h)c(\tilde{a}) + k(w)$. This effort is unique and exists by the properties of the cost function c. It must differ from $a_{ri}(h, b)$ since $\lambda(h, m) < 1$. Suppose female colleagues believe male colleagues to have high ability with probability one if they exert effort $\tilde{a}$. Then increasing effort from a^* to $\tilde{a}$ increases the utility of male workers with high ability by zero by the choice of $\tilde{a}$. It increases the utility of male workers with low ability by $b\,(\tilde{a} - a^*) - d(\ell)\big(c\big(\tilde{a}\big) - c\big(a^*\big)\big) + \big(1 - \lambda(h, m)\big)\,k(w) < 0$. This inequality holds by the definition of $\tilde{a}$ and because $\tilde{a} > a^*$ and $d(\ell) > d(h)$. Effort $\tilde{a}$ differs from $a_{ri}(h, b)$ that by definition maximizes $b\,a - d(h)\,c(a)$. Thus the utility of male workers with high ability $b\,\hat{a} - d(h)c(\hat{a}) + k(w)$ must be either strictly increasing or strictly decreasing in effort. There thus exists an alternative effort $\hat{a}$ close to $\tilde{a}$ so that (12) and (13) hold. Then the considered pooling equilibrium must violate the intuitive criterion. *Q.E.D.*

Proof of Result 2

The proof first shows that male courtship motivation is behaviorally relevant if and only if it is relevant for teams with all but one female worker. Male courtship motivation is relevant if and only if $\Gamma(b, w) > 0$ for some $w < n$. In all-male teams we have $k(0) = 0$ and therefore $\Gamma(b, 0) = 0$. Function $\Gamma(b, w)$ is weakly increasing in w. There consequently exists $w \leq n - 1$ such that $\Gamma(b, w) > 0$ if and only if $\Gamma(b, n - 1) > 0$.

The proof now shows that some gender diversity maximizes production if (i) male courtship motivation is behaviorally relevant, and (ii) ability differences between men and women are not too large. By the above argument male courtship motivation is behaviorally relevant if and only if $\Gamma(b, n-1) > 0$. Then there must exist $\tilde{w} \leq n-1$ so that $\Gamma(b, \tilde{w}-1) = 0$ but $\Gamma(b, \tilde{w}) > 0$. This holds because $\Gamma(b, 0) = 0$ and Γ is increasing in w. Increasing the number of women from zero to $\tilde{w}$ thus has effect $(n-\tilde{w})\lambda(h, m)\Gamma(b, \tilde{w}) > 0$ on effort via male courtship behavior. Taking reputation-independent production into account, the total effect of increasing the number of women from zero to $\tilde{w}$ is

$$\tilde{w}\left(\lambda(h, f) - \lambda(h, m)\right)\left(a_{ri}(h, b) - a_{ri}(\ell, b)\right) + (n - \tilde{w})\lambda(h, m)\Gamma(b, \tilde{w}). \tag{14}$$

This effect is strictly positive if ability differences between men and women are sufficiently small.

The proof finally shows that an all-female team does not maximize expected production. Increasing the number of women w from $n-1$ to n has effect $-\lambda(h, m)\Gamma(b, n-1)$ via male courtship behavior. The total effect on expected team production is

$$\left(\lambda(h, f) - \lambda(h, m)\right)\left(a_{ri}(h, b) - a_{ri}(\ell, b)\right) - \lambda(h, m)\Gamma(b, n-1). \tag{15}$$

This effect is strictly negative if ability differences between men and women are sufficiently small. As all-male and all-female teams do not maximize production, some diversity maximizes the positive effect of male image motivation on team production. *Q.E.D.*

Proof of Result 3

The proof shows that the separation constraint (3) is binding if and only if b is strictly smaller than some strictly positive cutoff $\tilde{b}$. Define $\Delta(b, w)$ so that $a_s(b, w) = a_{ri}(\ell, b) + \Delta(b, w)$. The separation constraint (3) is then not binding if and only if

$$a_{ri}(h, b) - a_{ri}(\ell, b) - \Delta(b, w) \geq 0. \tag{16}$$

The proof next shows that the l.h.s. of inequality (16) is strictly increasing in b at a rate bounded away from zero for sufficiently large b. First, applying the implicit function theorem to (2) and rearranging implies that the difference $a_{ri}(h, b) - a_{ri}(\ell, b)$ is strictly increasing in incentive intensity b if and only if

$$d(\ell)\, c''(a_{ri}(\ell, b) - d(h)\, c''(a_{ri}(h, b) > 0. \tag{17}$$

This holds since $d(h) < d(\ell)$, $a_{ri}(\ell, b) \leq a_{ri}(h, b)$, and $c''' \leq 0$. The l.h.s. of the inequality is larger than $\big(d(\ell) - d(h)\big)c''(a_{ri}(h, b))$. The difference $a_{ri}(h, b) - a_{ri}(\ell, b)$ is thus strictly increasing at a rate bounded away from zero for sufficiently large b because a_{ri} is strictly increasing in b and $c''' \leq 0$.

Second, define $f(a) = b\,a - d(\ell)\,c(a)$ to analyze the slope of $\Delta(b, w)$. Then $\Delta(b, w)$ solves

$$f\big(a_{ri}(\ell, b) + \Delta(b, w)\big) + k(w) - f\big(a_{ri}(\ell, b)\big) = 0. \tag{18}$$

Differentiating this equation with respect to b yields

$$\frac{\partial a_{ri}(\ell, b)}{\partial b} + \frac{\partial \Delta(b, w)}{\partial b} = 0. \tag{19}$$

since by definition $f'(a_{ri}(\ell, b)) = 0$ and consequently $f'\big(a_{ri}(\ell, b) + \Delta(b, w)\big) < 0$ as $\Delta(b, w) > 0$ for all $b > 0$. Since $a_{ri}(\ell, b)$ is increasing in b, $\Delta(b, w)$ must be decreasing in b. The last two steps of the proof imply that the l.h.s. of (16) is strictly increasing in the incentive intensity b at a rate bounded away from zero for sufficiently large b.

It is now possible to show that the separation constraint is binding if and only if b is strictly smaller than some strictly positive cutoff. At zero incentives, workers with high and low ability choose the same effort absent reputation concerns. Thus at zero incentives the separation constraint must be binding and the l.h.s. of (16) is strictly negative. Since the l.h.s. of (16) is strictly increasing in b at some rate bounded away from zero, it must be strictly positive for sufficiently large b. As it is continuous, the intermediate value theorem implies the existence of a strictly positive and finite cutoff incentive intensity $\tilde{b}$ with properties as characterized in the proposition. This cutoff depends on the team composition w via $\Delta(b, w)$. *Q.E.D.*

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