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Worker Compliance under Female Regime

Antara Sharma
533216

Josse Delfgaauw
Anne Boring

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Acknowledgments

Abstract

Female representation at the top positions is remarkably low despite several efforts. Previous literature has discussed how gender discrimination, the gender wage gap, and biased access to opportunities amongst others can contribute to such skewed number of women on top. In this paper, I attempt to theoretically explain how a male subordinate's stereotypical beliefs against women and gendered communication within the team can also indirectly contribute to a low rise in female CEOs. I find that female leaders, when supervising male followers, experience a lowered utility than otherwise. Male followers also experience a lowered utility under a female regime which could act as a self-fulfilling prophecy about the leader's ability. I also find that introducing more followers to the team can alter the results for or against the performance of the team depending upon their gender.

Introduction

Men are strongly over-represented in top positions in firms. Percentage of female representation is fairly low (24.8%) in top-level governmental positions across the globe (IPU data-set, 2020[1]). World Bank(2019) data also indicates a biased male representation in the workforce around the world with only 38% of women occupying the workforce in organizations around the world. WEF has described that this percentage fell up to 21.2% at the board level and 5.8% at the executive level in S&P 500 Companies (World Economic Forum, 2020[2]). Despite several measures taken to ensure a balanced gender representation in higher-up positions. There's only a low rise in female representation at the CEO levels. Gender wage gap persists (OECD, 2020[3], Blau et al., 2017) and attempts to bring more women to the workforce by introducing gendered labour quotas have been met with mixed support (Bertrand et al., 2019) citing unclear benefits.

[1]As of June 28, 2020

[2]World Economic Forum had cited Catalyst, a female-centric global nonprofit, in their September 2019 research article.

[3]As of February, 2020

Given the interdisciplinary nature of this topic, arguments made in related literature explain the potential reasons behind such low rise in female representation. From low experience and gender norms to tokenism, Oakley (2000) explains how 'old boy networks' and communicative differences can be responsible for the shallow improvement in the same. Fitzsimmons et al. (2014) suggest that a gendered pattern in the access to opportunities and 'accumulation of career-relevant experiences' leads to poor female representation (Grossman et al., 2019). This paper explores how such gendered communication and stereotypical beliefs by male followers about a woman's abilities reflect on the female leaders and affect the performance of the leader and the follower.

Companies also form prejudices against a woman's commitment to work given her possible strong need to be at home catering to the motherly duties at the house. Motherhood's penalty on wage and career development have also been found to act as a deterrent for women aspiring for higher up positions (Budig et al., 2010, Heilman et al., 2008). Beja (2014) shows that women also find it happier to be working as a part-time worker or a housewife than as a full-time worker.

From a social standpoint, workplace discrimination is also found to be an important reason for determining a woman's rise to the top tier in an organization. Categorizing skill requirements or associating a particular gender to certain kinds of job role propagates the idea of women being less fulfilling for presumably typical male jobs. Bobbitt (2011) elaborates further on this by showing how gendered organizational policies and gender-based discrimination contributes to poorer opportunities for women. Biased opportunities and gendered workplace interactions could hamper the way women are seen in organizations (Olsson et al., 2003). The stereotypical belief about a woman's ability to lead could be a reason why men make up most of the labour force to date.

Evidence also tends to suggest that women are more likely to be more modest which could act negatively on their part when being considered as ideal leaders. Their subordinates may find it harder to follow disproportionately modest leaders (Rudman, 1998, Heilman, 2001). Given the male preference for male leaders at the executive level (Ozdemir, 2017) and the significantly biased male representation in an organization, one could see males favouring more males at executive levels. This gendered preference and potential dissatisfaction from working under a female leader could result in a varied performance by the followers.

This paper theoretically studies how distorted communication and stereotypical beliefs by male followers affect the performance of female leaders. The framework used in this paper takes its inspiration from Bolton et al. (2013) and Morris et al. (2002). The base model in this paper has a leader and a follower. For an organization to work optimally, the team (comprising of a leader and follower in this context) must coordinate their actions as well as align them with their environment. Both the leader and the follower receive a noisy signal from nature. The leader sends the follower a message about the signal she received. The follower's interpretation of the leader's message is also noisy which hampers their communication. Both the follower and leader then simultaneously choose their action. The follower can optimally assign the weights to his signal and his leader's message.

I find that that the follower attaches more weight to the leader's message if the communication is less noisy. Based on the literary evidence discussed above, I assume that communication is noisier if the leader and the follower are gender incongruent. Hence, the model predicts that male followers put less weight on communication by a female leader than on communication by a male leader. As a result, male followers make worse decisions under a female leader than under a male leader, leading to lower payoffs for both of them. In other words, male followers would less attentive to a female leader's message causing the team and the female leader to perform badly despite the female leader having the same innate abilities as the male leader.

We can extrapolate the results to a more general scenario. Given the gendered communication and prejudice against a female's skills, a mostly male team would perform better under a male leader. The same team might perform poorly under a female regime due to noisier communication. However, introducing more women to the team might induce some of the followers to act by their colleagues. I show this later by adding a third player (or the second follower) in the game, where the second follower's gender also matters in determining the communication and the payoffs. Gender congruent followers see similar results as the base model. The payoffs for all the players directly depend on how much communication varies and the weight on being right and being close to the other player's action.

Gender congruent communication between leaders and subordinates help increase performance significantly (Delfgaauw et al., 2013). Male perception of female leaders is also found to be prejudiced. This prejudice is higher when the woman leaders work in a non-stereotypical environment. This prejudiced perception can be explained through Role Congruity theory. Eagly et al. (2002) show that participants perceived that women would do less than men in executive roles as they perceived that the requirement of the roles are different from what women can offer. This paper aims to look at the one possible mechanism to explain such miss-communication and how it could lead to lowered overall performance for the team.

The signals sent are only through a one-time interaction, with no scope for revision. Gender congruence plays a vital role in establishing an important assumption in the paper. In this paper, I assume that gender congruent leader-follower pair would have better communication than an incongruent pair based on the results of Delfgaauw's (2013) results. This paired with role incongruency helps establish a key extension of the paper. One of the extensions of the model consists of multiple followers where their gender can alter the relationship between the leader and the first follower and therefore their payoffs. I will show that the gender of the second employee will act as a make-or-break for the team and the leader's payoff. In another extension, I explain how misjudged ability of a leader can cause both the leader and the follower to experience a lowered payoff. Likewise, I also look into how perfect communication alters their payoffs.

Literature Review

Corporate culture over the years has developed in a way that sustains and stimulates a gender-biased workforce. The percentage of female followers in the global labour force hasn't changed much, with less than 40% of all labour force, since the last two decades (World Bank, 2020). This skewed representation starts early with gendered hiring processes. Firms tend to categorize job requirements to fit for agents with feminine or masculine traits. This could cause firms to undertake a gendered hiring process. Gorman (2005) showed that women were more likely to be hired for a lawyer's position, which was associated with feminine character traits by the hiring firm. Job positions which were categorized with masculine requirements saw fewer newly hired women.

As we go further up the corporate ladder, the percentage of female representation in the global workforce declines further. There are many issues which may have perpetuated or caused a skewed presence of women in the organizational structure. Countless literature on the same from a social, political and economic standpoint discusses various mechanisms responsible. I will attempt to touch some of these issues in the literature review in light of the subject matter of my research question.

Several mechanisms can be used to explain the lack of well-balanced gender representation. Firstly, gender stereotypes can also influence the way an organization executes its promotion procedure. Prejudiced by stereotypical and gendered beliefs about abilities, companies classify job positions in the higher-ups as well. For the topmost strata of an organization, there's a stern need for agents to exhibit better leadership and decision-making skills. Women leaders are expected to show both strength and sensitivity to be a good leader, while men are expected to only be strong (Johnson, 2008). Eagly et al. (2002) showed that women were to be perceived as less suitable leaders based on a prejudiced belief that women aren't at par with men on their leadership and behavioural skills. Her paper elaborates on role congruity theory which says that the two prejudices determine a woman's perceived ability. Women are considered less suitable as leaders in comparison to men. When women are acting as leaders their behaviour as a leader can be perceived as less able even by their subordinates. A female leader's performance could reflect poorly than a similarly skilled male one with mostly male followers, despite being hired for adequate skills.

On the other hand, male leaders are perceived to be better at strong leadership roles (Coleman, 2003) thus contributing to a biased representation of the two genders. Garcia et al. (2006) showed that the participants in their experiment showed prejudice against women for leadership positions and a strong preference for men. This perpetuates a glass ceiling effect on women aspiring to be leaders and contributes to skewed preferences for the two genders (Elsesser et al., 2011).

Secondly, over decades of negligible female presence at the higher-ups could have dispirited potential female followers striving for executive positions (Hoyt, 2011). Seeing a better representation of women in top positions can not only help the firm diversify their information and gender pool, but it can also act as a source of inspiration for the women in middle management to aim for higher-ups(Dezsö, 2012). A significantly low number of female role models among the top positions could alter the way aspiring women judge their abilities, possibly affecting their ambitions of being a leader (Burke, 2006).

To add to that, gender congruence with the leader is also an important aspect in determining a follower's motivations and job satisfaction (Grissom,

2012) which ultimately affects their performance and ambitions within an organization. Male followers performed better when working under a male leader. Similar results were seen by Delfgaauw et al. (2013), although the mechanism they used to explain this increased performance under gender congruent store managers was better communication between same-gendered participants in the store.

Moreover, Linehan (2008) also explained how the lack of gender congruent role models for women lowers their chances for reaping the benefits of healthy business networking. Men can end up forming stronger social networks and expelling women from these while taking advantage of such opportunities (Durbin, 2011, Ibarra, 1992). Advancement in career and better access to career opportunities are some of the reasons why social networking outside of the work-related conversations help benefit employees. Biased access to these could also explain the fewer number of female executives. Although, Maume (2011) suggests in his paper that female leaders can either act as a *cog in the machine* (promote a male congenial corporate culture). He showed that female leaders continued favouring men and that under a female leader, men had access to more opportunities than women.

Lastly, male-dominated work environments tend to also ostracize females based on potential marriage desires, pregnancy and child bringing. Child penalty (Hipp 2020, Correll et al., 2007) and the threat of a faulty marriage for getting a promotion are few of the other possible mechanisms that explain why it's harder for women to make it to the top in organizations. Young women tend to not be ambitious to make sure they stay active in the marriage market (Kuziemko et al., 2018).

Many attempts have been made across organizations to make an all-inclusive and egalitarian workplace experience. Women-centric labour quotas are considered in many countries to ensure a fair representation of women in firms. Norway, in 2006, mandated that by 2009 not having at least 40% of women on company board could lead to penalties or company closure. Iceland, Spain and France amongst others had followed suit.

Having a diverse set of agents with varying characteristics can improve the company's performance (Low, 2015). Boulata's (2013) results suggest that women contribute to a healthier workplace environment and improve the CSR practices of the firm. Inclusion of more and more women over the years in firms indicates that the female talent pool is now pursuing their comparative advantage (Hsieh et. al, 2019). It suggests that a diverse talent pool is efficient for firms and countries alike.

Vial et al. (2016) indicated that women leaders are seen as less legitimate than men in leadership positions and received less respect for their leadership by their subordinates. Coupled with the prejudice against women for not being role congruent, noisier communication between gender incongruent leader and follower can explain why there may be less communication within the team. A female leader could be considered role incongruent and respected less for her work as a leader, causing the team to not coordinate with her. For a team to work successfully, there should be good communication and coordination within the team (Hoegl, 2000). This paper aims to explain the impact of the non-compliance by followers caused by perceived leader role incongruency and gendered communication by male followers on their performance and how it impacts the team dynamics.

Base Model

For ease of operation, the base model of this paper consists of only two players - a female leader and a male follower. This paper further extends the base model to three players later. The two base model players constitute a team whose performance would depend on how well they coordinate, communicate amongst each other and how well the follower respects the leader. I make a reasonable assumption here for all models to come that the leader is always more skilled than the follower.

This sequential game starts with both the leader and the follower receiving a signal about the state of the world. Using this and the information received from the leader, the follower chooses his action. However, in the base model, the leader receives a perfect signal from the nature indicating that they are more skilled than the follower. Communication between the players isn't perfect causing the follower to understand a noisy version of the message sent by the leader. This noise arises from a gendered communication between the two players and in this context would alter for different gender pairs e.g. a male leader - male follower pair would be able to communicate better than a female leader – male follower. This is consistent with gender congruency being preferred for job satisfaction and better performance.

The chronology of events for the base model is as follows:

- Nature sends the leader a signal θ. The leader receives a signal $s_b = \theta$. The leader uses this signal to send a message to the follower.
- Nature also sends a signal $s_b = \theta + \epsilon_i$ to the follower, but his signal is noisy as he's less skilled than the leader. Here, ϵ_i is the noise term

that causes a difference in understanding the leader's signal fully. It's normally distributed $\epsilon_i \approx N(0, V_s)$. 0 is the noise term's mean since its normally distributed (*i.i.d.*) and V_s is the variance in noise term.

- Leader sends a message m_s to the follower, but the message for the follower is noisy. This noise comes from the gendered communication between the two players. The follower hears m_b such that $m_b = m_s + \mu_i$, where μ_i is the noise term which causes imperfect communication. It's normally distributed $\mu_i \approx N(0, V_m)$. 0 is the mean and V_m is variance (*i.i.d.*). The noise term would differ for a gender congruent pair and an incongruous one. So V_m for a male-female pair would be higher than for a male-male pair.

- The follower acts a_i based on the leader's message to him m_b and his signal s_i. He wants to align his action to the leader's action a_b and the state of the world θ. Both the leader and the follower simultaneously decide on their actions in the last stage. Ex-post payoffs realize based on how they've acted.

I'm making an assumption backed by relevant literature throughout the paper that a gender congruent pair of leader and follower would have less noisy communication. Therefore, the variance in communication would be higher for a gender incongruent pair than otherwise. A female leader and a male follower will have noisier communication than a male-male team. Since we're only considering male follower, this would mean a noisy communication between a male follower and female leader. Therefore V_m is larger for female leader - male follower pair.

The utility functions both players are as follows:

- **Leader's utility function**: The leader wants her action to be as close to the state of the world as possible. She also wants to make sure the follower's action is aligned with hers.

$$U_b = -\alpha(a_b - \theta)^2 - \beta(a_b - a_i)^2$$

- **Follower's utility function**: He wants his action to be as close to the state of the world as possible and he also wants his actions to be aligned with the leader.

$$U_i = -\alpha(a_i - \theta)^2 - \beta(a_b - a_i)^2$$

The model uses quadratic loss utility functions for easily understandable and manageable results as used in Bolton et al. (2013) and Morris et al. (2002). The first term in both their utility functions denotes to the weight they put on getting their action close to the state of nature with α being the weight. The second term in both functions relates to the weight they put on coordinating with each other with β being the weight. Both α and β are positive since both the follower and leader value being close to nature's true signal and also being closer to the other's actions. The follower's actions are based on the weight he puts on communication and being close to the state of the world.

The player's form expectations about each other's actions and strategies ex-ante. Since the results from the game arise from a two-stage sequential game, where we don't know how noisy both player's signal or message is going to be, we solve for a Bayesian Nash Equilibrium. We start with the second stage where the follower has to decide on an action using backwards induction. As mentioned above, the follower accounts for both his signal and the message received from the leader.

From the paper written by Morris et al. (2002) with similar objective functions, we know that the actions of the follower with a *'quadratic loss'* utility function would be a linear function of his signal and his interpretation of leader's message. He would assign weights to both these pieces of information when choosing his action in the last stage. Given the utility functions in this paper which are depicted as quadratic loss functions, the follower's action would be a linear function of his signal s_i and his interpretation of the leader's message m_b such that:

$a_i = ws_i + (1 - w)m_b$

$a_i = w(\theta + \epsilon_i) + (1 - w)(m_s + \mu_i)$

where w is the weight that the follower puts on his signals and $1 - w$ is the weight he puts on the leader's message. I assume for now that the leader's message to the follower m_s is equal to her signal s_b and her action a_b. I will, later on, prove that in equilibrium, it is optimal for the leader to act the same as the message she sends to the follower which is essentially the same as the state of the world.

For the second stage of the game, we look into the follower's utility function to find out his action. With the expression for a_i in his utility function, we expand and simplify the expression further:

$U_i = -\alpha(a_i - \theta)^2 - \beta(a_b - a_i)^2$

$U_i = -\alpha[w(\theta+\epsilon_i)+(1-w)(\theta+\mu_i)-\theta]^2 - \beta[a_b-(w(\theta+\epsilon_i)+(1-w)(\theta+\mu_i))]^2$

Using $a_b = \theta$, based on the assumption we made earlier, we can cancel out a few terms up through simplification, leaving us with:

$U_i = -(\alpha+\beta)[w^2\epsilon_i^2 + w^2\mu_i^2 + \mu_i^2 - 2w\mu_i^2 - 2w\epsilon_m u_i + 2w^2\epsilon_i\mu_i]$

The follower's expected payoff can be found by taking an expectation of his objective function:

$E[U_i] = -(\alpha+\beta)[w^2V_s + w^2V_m + V_s - 2wV_m]$

Taking the first-order condition with respect to w, we get the weight to the follower's signal:

$$w = \frac{V_m}{V_s + V_m}$$

This expression for w indicates that the follower's weight on his signal would depend on how well the leader and the follower would communicate with each other. Since the communication between a female leader and a male follower would be noisier with higher variance V_m, the follower would choose to attach less weight to the leader's message m_b under a female regime. The follower would then assign a higher weight to his signal s_i when choosing an optimal strategy.

Using this result for w, we find the optimal action a_i of the follower as follows:

$$a_i = \frac{V_m S_i + V_s m_b}{V_s + V_m}$$

The follower's optimal action depends on the weight of w on his signal. We know that w depends on how noisy the communication is between him and the leader. Also, the weight $1-w$ on the leader's message depends on both his noisy signal and his communication with the leader. If the noise in his ability varies a lot (i.e. $1 - w$ is higher than w), then the follower gives a higher weightage to the leader's message. If w (or variance in noisy communication) is higher than $1-w$ (or variance in noisy signal), then he puts more weightage on his signal s_i when deciding an optimal action.

In the first stage of the game, I find that the leader's optimal message and action as $a_b = \theta = m_s$. This indicates that it is ideal for the team's optimal performance that the leader's message and his action are the same and that it's true to the state of the world. The detailed derivation of the leader's optimal action and message can be referred to in the Appendix A.1 To derive optimal results in the given setup it is ideal for the leader to act as required of her as per the state of the world and that her message to the follower is also the same as her action.

Using these insights, we find the expected payoffs of both the leader and the follower in terms of the variance in their noise terms and the weights α for keeping action close to the state of the world θ and β for aligning her action to the follower's action. For the leader, the payoff function is as follows:

$U_b = -\alpha(a_b - \theta)^2 - \beta(a_b - a_i)^2$

$U_b = -\beta[w^2\epsilon_i^2 + (1 - w)^2\mu_i^2 + 2w(1 - w)\epsilon_i\mu_i]$

From this, we get the leader's expected utility as:

$E[U_b] = -\beta[w^2 V_s + (1 - w)^2 V_m]$

Plugging in the values for w, we get:

$$E[U_b] = \frac{-\beta V_m V_s}{V_s + V_m}$$

We see that the leader's expected utility is directly proportional to the variance for noise in communication V_m, the variance for noise in follower's understanding V_s and the weight β for better communication. We know from the explained literature and the assumptions we've made that V_m is higher for a gender incongruent pair. A female leader would be seeing imperfect communication within the team and would thus experience a lowered utility than a male leader of the same skill. The variance V_m for noise in communication strongly impacts the leader's utility as it would be non-negative only when there's no variance in communication (perfect communication). We would further delve into this scenario in one of the extensions.

To further understand the effect of the variances in noise term, we derive this expression with respect to V_m and V_s, we see how the leader's expected payoff changes in both.

$$\frac{\partial E[U_b]}{\partial V_m} = \frac{-\beta V_s^2}{(V_s + V_m)^2}$$

This shows us that the expected utility for the female leader decreases in the variance for noise in communication. The higher the variance, the lower would be the expected utility of the leader. Thus, for a female leader working with a male follower, it would be worse than for a male leader in the same setup.

$$\frac{\partial E[U_b]}{\partial V_s} = \frac{-\beta V_m^2}{(V_s + V_m)^2}$$

The leader's expected utility decreases in the variance for noise in the follower's understanding. Leader's expected utility is lower if the follower's understanding of nature's signal is very noisy. This happens to a leader regardless of their gender. So both a male and a female leader would suffer due to the follower's lowered ability.

These results are intuitive as they indicate that while noise in communication between the two reduces the expected payoff of the leader, the variance for noise in follower's understanding of nature's signal also reduces leader's expected payoffs. A follower's noisy ability is detrimental to the productivity of a leader, but the communication between the players can also affect a female leader's payoff. The results suggest that better communication between the leader and the follower is crucial for the leader's maximization of utility. Perfect communication between the players would lead to higher utility maximization for a leader, regardless of the follower's imperfect ability.

However, if we recall the assumption of noisier communication within a gender incongruent pair, this would indicate that leaders in a gender incongruent pair would be seeing noisier communication within the team, which would also reflect on their utility maximization. As per the results derived here, male followers would have noisier communication with female leaders which would affect her payoff negatively. These results are also consistent with Delfgaauw et al. (2013), as they showed that teams with more female followers under a female manager or more male followers under a male manager performed better than otherwise due to better communication.

A female leader would be experiencing a lowered utility due to noisier communication with her male follower. These results are crucial as they indicate that the gender of the follower and leader could potentially hinder with the efficiency of the team. It's also intuitive to see that a mostly male populated organization with male employees under a female regime might lead the boss (leader) to experience a lower utility than in a more female populated one. This idea can be further explored with more than two players and in one of the later extensions, I will discuss the very same.

Having explored the leader's utility in the base model, we now look into followers expected utility:

$U_i = -\alpha(a_i - \theta)^2 - \beta(a_b - a_i)^2$

$U_i = -(\alpha + \beta)[(w\epsilon_i)^2 + ((1 - w)\mu_i)^2 + 2w(1 - w)\epsilon_i\mu_i]$

From this, we get the follower's expected utility as follows:

$E[U_i] = -(\alpha + \beta)[w^2 V_s + (1 - w)^2 V_m]$

$$E[U_i] = \frac{-(\alpha + \beta)V_m V_s}{V_s + V_m}$$

The follower's expected utility is determined by the sum of weights $-(\alpha+\beta)$ and the variances V_m and V_s. His expected utility is affected by the variance in the noisy communication between the leader and him. For the follower to experience a non-negative utility, it is important for him to have noiseless communication with the leader and that he has a perfect understanding of nature's signal.

If we derive the follower's expected utility with respect to the V_m, we see that the follower's expected utility decreases in V_m. As the variance in communication increases, the expected payoff of the follower reduces.

$$\frac{\partial E(U_i)}{\partial V_m} = \frac{-(\alpha + \beta)V_s^2}{(V_s + V_m)^2}$$

Similarly, taking the derivative of the follower's expected payoff with respect to V_s we see that the expected utility decreases in V_s.

$$\frac{\partial E[U_i}{\partial V_s} = \frac{-(\alpha+\beta)V_m^2}{(V_s+V_m)^2}$$

These results indicate that the expected utility of the follower is also dependent on the variance for noise in communication between the players and the follower's understanding of nature's signal. The follower is affected by his ability to understand nature's signal but also by the communication he has with his female leader. One way for the follower to offset the negative effect of the variance in communication would be to increase the weights for his signal and trying to be as close to nature as possible. Given that the variance in follower's low ability to understand nature's signal V_s, the utility of the follower would be lower under a gender incongruent pair. Under a female regime, V_m would be higher than otherwise, and we know that the follower's ability is noisy as well. Thus a male follower under a female regime would achieve a lower utility than in gender congruent pair due to poor communication, despite the weights on his signal being close to nature.

Ideally, in a gender congruent pair, there would be less variance in communication (Delfgaauw et al., 2013). However, in this case, this variance V_m in communication would be higher for a gender incongruent pair. This indicates that the leader's gender also matters for the follower's utility maximization. A follower under a gender incongruent leader would be worse off than under a congruent one regardless of the abilities of the leader due to noisier communication.

Such results on the player's expected payoffs also explain the detrimental nature of gender stereotyping in the workplace. Gender congruency can hence be seen as a make or break factor in the performance of the team leaders and followers. A lowered utility could potentially lead to lowered morale in the leaders or distrust in the follower. The followers might pay less attention to the messages sent by a skilled leader based on their gender. This would further propagate a cyclical process of poor performances backed by gender stereotyping.

In the next few sections, I will be focusing on a few extensions of this base model to explore different scenarios. The extensions further explore situations where the communication is perfect thus making the leader's message noiseless for the follower. Further on, I show that when the leader's signal isn't perfect, their understanding of nature's signal is noisy indicating their low ability. When the follower's perception is prejudiced about the leader's ability, the noise in communication increases further. Despite the true ability of the leader, follower's action depends on their perception of the leader's ability. With the help of these extensions, I will explain different mechanisms, from the literature mentioned above, through which gender stereotyping in workplaces can lead to suboptimal performance of the team players.

Extensions

In this section, I would look into special situations with varying aspects, like the leader's ability and communication etc, different from the base model. I would also introduce a new player to the team and a new factor that captures the follower's prejudiced perception of the leader's ability in two extensions.

By doing so, I aim to see how the leader's and follower's expected utility varies with these changes. I would make an overall comparison of payoffs under all scenarios to see which would be more detrimental to a female leader and her male followers.

Imperfect Leader Signal

We will start with a situation where the leader's signal from the nature isn't perfect i.e. the leader's understanding of nature's signal is noisy. We assume $s_b = \theta + \tau_b$, where τ_b is analogous to ϵ_i for the follower as it indicates the leader's ability to understand the state of the world. τ_b is the noise term that indicates the leader's ability to understand nature's signal. It's normally distributed $\tau_b \approx N(0, V_b)$ with 0 as the noise term's mean (*i.i.d.*) and V_b is the variance in noise term.

τ_b is the only new addition to the base model in this extension. All other aspects of the model remain unchanged in this extension. By introducing τ_b, the intention is to show how the leader's imperfect ability can also affect the expected payoffs of both players. The leader's imperfect message m_s to the follower would now be a sum of θ and τ_b, where τ_b signifies leader's noisy understanding of nature's true signal. Therefore, the message the leader sends to the follower would be ridden with τ_b. The follower's understanding of the leader's message would now account for both the noisy communication and the leader's noisy ability. The follower's interpretation of the leader's message would be $m_b = \theta + \tau_b + \mu_i$ (since $m_s = \theta + \tau_b$).

The follower knows that in equilibrium, the leader's optimal action is to do the same as his message m_s to the follower ($a_b = \theta + \tau_b$). Including this in the base model, we find the follower's weight to his signal and leader's message and finally his optimal action in the second stage through his utility function.

$U_i = -\alpha[a_i - \theta]^2 - \beta[a_b - a_i]^2$

$U_i = -\alpha[w^2\epsilon_i^2 + (1-w)^2(\tau_b^2 + \mu_i^2 + 2\tau_b\mu_i) + 2w\epsilon_i(1-w)(\tau_b + \mu_i)] - \beta[w^2(\tau_b^2 + \epsilon_i^2 + 2\tau_b\epsilon_i) + (1-w)^2\mu_i^2 + 2w(\epsilon_i + \tau_b)(1-w)\mu_i]$

After further simplification, we find the follower's expected utility as:

$E[U_i] = -\alpha[w^2V_s + (1-w)^2(V_m + V_b)] - \beta[w^2V_s + V_b) + (1-w)^2V_m]$

Taking the first-order condition of the follower's expected utility with respect to w, we find the follower's weight on his signal and then his optimal action:

$$w = \frac{(\alpha+\beta)V_m + \alpha V_b}{(\alpha+\beta)(V_s + V_m + V_b)}$$

We see that the follower's weight to his signal is dependent on the weights on acting close to nature (α) and acting similar to the leader (β). The follower's weight on his signal w is largely dependent ($\alpha + \beta$) on the variance in imperfect communication V_m and also on the variance in leader's imperfect ability (αV_b). Since α and β are two positive weights, the follower's decision to assign more weight to his signal is largely dependent on how well both players coordinate. A male follower would assign a higher weight to his signal under a female regime, given the imperfect communication, if he values aligning his action to nature more (higher α). Hence, this expression suggests that the follower would attach more weight to his noisy signal when the follower finds the leader's message to be noisier and the follower wants to be right.

Substituting this to the linear function for follower's action, we find the follower's optimal action as follows:

$a_i = ws_i + (1 - w)m_b$

Plugging in the value for weight w on his signal:

$$a_i = \frac{[(\alpha + \beta)V_m + \alpha V_b]s_i + [\alpha + \beta)V_s + \beta V_b]m_b}{(\alpha + \beta)(V_s + V_m + V_b)}$$

The follower's optimal action depends on the weight w to his signal. If the weight on acting accurately is higher than the weight on being close to the leader, given the leader's imperfect ability, the follower assigns a higher weight to his signal. If V_m (the variance for the noise in communication) is higher than the variance of his noisy ability to understand nature's signal (V_s), then the follower assigns more weight to his signal than the leader's message. As shown in the literature, the communication between a female leader and male follower would be noisier than under a gender incongruent pair. Therefore, a male follower would thus be paying lower attention to a female leader's message and would choose to value his signal more due to noisy communication between gender incongruent pairs and the leader's imperfect ability. If the follower values being right more than being close to the leader then the follower would assign a higher weight to his noisy signal and less on the leader's message.

In the first stage of the game, we find that the leader's optimal action and message are the same that in the base model (See Appendix A.1). It is interesting to notice that the optimal action and the message remained the same($a_b = \theta = m_s$) regardless of the noise in the leader's ability to understand nature's signal. They are not affected by the leader's ability or poorer communication in gender incongruent pairs. Regardless of the leader's ability, it is ideal in the given setup for the players that the leader's action is the same as the state of the world. This means that for the two players to experience a non-negative payoff, it is optimal for the leader's action and the message to be ideally the same as nature's signal. As this game is a one-time interaction, there's no scope for the leader to update his beliefs about the follower's strategies and payoff. Hence it is optimal for both the leader and the follower that the leader's action and her message to the follower is the same as the state of the world.

Given the optimal action, optimal message and the weights that the follower puts on his signal, we find the payoffs of the players as follows:
$U_b = -\alpha[a_b - \theta]^2 - \beta[a_b - a_i]^2$
$U_b = -\beta[w^2\epsilon_i^2 + (1-w)^2(\tau_b + \mu_i)^2 + 2w\epsilon_i(1-w)(\tau_b + \mu_i)]$
which gives the expected payoffs after plugging values for w as:
$E[U_b] = -\beta[w^2 V_s + (1-w)^2(V_m + V_b)]$

$$E[U_b] = \frac{-\beta[(\alpha+\beta)V_m + \alpha V_b]^2 V_s + [(\alpha+\beta)V_s + \beta V_b]^2(V_m + V_b)}{(\alpha+\beta)^2(V_s + V_m + V_b)^2}$$

The leader's expected payoff is directly proportional to the weight on acting similar to the leader $-\beta$, the variance in his noisy understanding (V_s), the variance in noisy communication and the leader's imperfect ability ($V_m + V_b$). The effects of V_s and V_m on the leader's utility are much the base model. The female leader thus experiences a negative expected payoff in a gender incongruent pair. The leader's ability as we have assumed in this extension is lower than in the base model. Thus the leader's utility depends on her lowered ability. The only way the leader can enjoy a non-negative expected payoff is when the players coordinate perfectly and both player's ability to understand nature's signal isn't noisy. In this case, however, both the leader's and the follower's abilities are imperfect and they are gender incongruent.

To further understand the relationship between the variances in communication and player ability, we take a first-order derivative of the leader's expected payoff with respect to V_s, V_m, and V_b. We found that the expected payoff decreases in all three[4]. It is intuitive to see that the leader's payoff decreases in her imperfect ability. Her payoff also decreases in the variance in the follower's understanding of the state of nature as it's the follower who acts in the last stage of the game based on all the information he has received. But the leader's payoff is also affected by how well her message is communicated to the follower. All these factors are important for the leader to ensure a non-negative payoff. However, gender incongruency also impacts the payoffs a leader would experience in the given setup.

Thus in this extension, we see that a leader's ability to understand nature's signal is also crucial in determining her payoff alongside the communication and follower's ability. This result is also consistent with the literature explained above.

Now we look into the follower's expected payoff, given the insights we found earlier:

$U_i = -\alpha[a_i - \theta]^2 - \beta[a_b - a_i]^2$

which gives us the expected payoffs as:

[4]The expressions though quite complicated for this document, do indicate that the expected payoff decreases in all three variances. It is easy to see the $-\beta$ being the negative constant here contributing to the aforementioned results.

$$E[U_i] = \frac{-[(\alpha+\beta)V_s + \beta V_b][(\alpha+\beta)V_m + \alpha V_b]}{(\alpha+\beta)(V_s+V_m+V_b)}$$

The follower's expected utility is directly dependent on the weight α on being close to nature and β on acting similar to a leader. The follower's payoff is dependent on how close he is to nature. The follower sees a lowered payoff if the V_m, V_s, α or β are higher. The effects of V_m and V_s are the same here as in the base model. In this extension, the follower could see a much lower expected payoff than in the base model due to the leader's lowered ability in understanding nature. Due to the leader's lowered ability, he might prefer increasing weights on his noisy signal. Since the follower's signal from nature is also noisy, he ultimately experiences a much lower utility than in the base model. The effects of the leader's ability aren't gendered.

If we take a first-order derivative of the follower's expected payoff with respect to V_s, V_m, and V_b, we see that the expected payoff decreases in all three[5]It is reasonable for the follower's payoff to reduce due to his imperfect ability. As we've shown above, a male follower under a female regime would assign higher weights to his noisy signal which ultimately contributes to his non-negative payoffs. The follower's expected payoff also decreases in the leader's ability. This is because the follower's decision of an optimal action also stems from the information he gets from the leader and because he also assigns a weight β on being close to the leader. So if the leader were to receive imperfect signals then that would end up reflecting in the message

[5]The expressions for this are much the same as the leader's expected payoff and thus aren't mentioned here in detail due to their complicated nature. Extensions further on would also see such complicated first-order derivatives causing me to not mention them here.

she sends to the follower.

The follower's payoff is also dependent on the noise in communication within the team. The follower would suffer the same under a female and male leader's regime due to their noisy ability, but more under a female leader due to noisier communication. This shows that gender stereotyping also seeps into situations where the leader's ability is lower than optimally needed and when the leader's abilities are the same regardless of their gender. We can see that gender stereotyping can cause both the leader and the follower to experience a much lower payoff than a gender congruent pair. It could even be that this poor performance acts as a self-fulfilling prophecy where the follower finds the leader's gender to be a reason for their poor performance, thus propagating the stereotype. We see that noisy communication due to gender incongruency can thus promote prejudices based on role incongruency. The followers might form discriminatory beliefs about the female leader's ability. Such prejudiced beliefs or discriminatory beliefs also have consequences on the player's expected payoffs ex-post. We would look into such a scenario later on in one of the extensions, where we discuss the impact of prejudice due to role incongruency on both player's performances.

Since this paper only looks into a one-time interaction, it's harder to derive a conclusion on how the dynamics would be affected in the long run. The players might learn about each other's abilities and might even interact with more new players in the team thus the ever-changing factors could affect the payoffs over time.

Prejudiced belief about ability

In this extension, we look into a special case for the previous extension where the follower perceives leader's ability differently than their actual ability. Since it's a one-time interaction, the leader doesn't know that their abilities are perceived differently than their true ability. To back up this premise, I restructure the previous model where the noise in the leader's ability is distributed normally in $\tau_b \approx N(0, V_b + V_p)$. Here V_p signifies the prejudice the follower has about the leader's ability τ_b. The variance for τ_b would be higher for a role incongruent leader. As we have shown earlier in the literature, male followers would perceive a female's role as a leader an incongruent match to the perceived masculine skill requirements of a leader. A male follower would have prejudiced requirements from a leader who idolizes a male as a suitable fit for the role of a leader. Thus, the variance term V_p would be higher for a male follower-female leader pair than a male follower-male leader pair.

This extension is to show that role incongruency can lead to followers follow, an otherwise skilled leader, less based on their perception of the leader's abilities. The follower assumes the leader's action to be the same as the last extension ($a_b = \theta + \tau_b$). With the addition of prejudice against a leader as a factor in determining the leader's perceived ability, this extension shows interesting results crucial to the paper and consistent with the literature.

We find the follower's expected utility from the payoff function as follows:
$U_i = -\alpha[a_i - \theta]^2 - \beta[a_i - a_b]^2$
$U_i = -\alpha[w^2\epsilon_i^2 + (1-w)^2(\tau_b^2 + \mu_i^2 + 2\tau_b\mu_i) + 2w\epsilon_i(1-w)(\tau_b + \mu_i)] - \beta[w^2(\tau_b^2 + \epsilon_i^2 - 2\tau_b\epsilon_i) + (1-w)^2\mu_i^2 + 2w(\epsilon_i - \tau_b)(1-w)\mu_i]$
which gives the expected payoffs as:

$$E[U_i] = -\alpha[w^2V_s + (1-w)^2(V_m + V_b + V_p)] - \beta[w^2(V_s + V_b + V_p) + (1-w)^2V_m]$$

We then find the weights a follower puts on his signal by taking the first-order derivative of his expected payoffs.

$$w = \frac{(\alpha+\beta)V_m + \alpha(V_b + V_p)}{(\alpha+\beta)(V_s + V_m + V_b + V_p)}$$

The follower's weight on this signal is largely dependent $(\alpha + \beta)$ on the variance for noise in the communication and also the variance for noise in the leader's ability ($V_b + V_p$ in this extension). The effect of V_m on the follower's assignment of weights is the same as the previous models. In addition to that, the follower has a prejudice against a female leader. Thus $V_b + V_p$ is higher under a female leader than a male leader. If V_p is higher, the follower would follow his signal better. Thus prejudice also decides the follower's weight on his noisy signal. The only way the weights in this extension are different from the ones in the previous extension is that the follower now also accounts for the prejudice they have against the leader's ability when deciding for the weights on their signal.

Using this expression for weights, the follower's optimal action is:

$a_i = ws_i + (1-w)m_b$

$$a_i = \frac{[(\alpha+\beta)V_m + \alpha(V_b + V_p)]s_i + [(\alpha+\beta)V_s + \beta(V_b + V_p)]m_b}{(\alpha+\beta)(V_s + V_m + V_b + V_p)}$$

This expression for follower's action suggests that the follower assigns more weight to his signal if the variance V_m for noise in communication is higher than the variance V_s in follower's understanding of the state of the world. But since V_p would also be higher under a female regime, the follower would assign a higher weight to his noisy signal. Thus, under a female regime, a male follower would assign a higher weight to his signal due to his prejudice against her, imperfect communication with her and her noisy ability. The follower's decision on weights for the two pieces of information, when deciding the optimal action, also depends on being close to the state of the world. Since only under a female regime would a male follower see an increased V_m and V_p, the follower is more likely to assign a higher weight to his noisy signal under a female regime.

In the first stage of the game, the leader's optimal action and message can be found the same way as we had done before in the previous extension but with minor differences (see Appendix A.1). We would account for the leader's imperfect ability and the follower's prejudice against the leader's ability when deriving the leader's optimal action. We find that the leaders optimal action and optimal message as $a_b = \theta = m_s$.

Given these insights we find the expected payoffs of the players:

$E[U_b] = -\beta[w^2 V_s + (1-w)^2(V_m + V_b)]$

$$E[U_b] = \frac{-\beta[(\alpha+\beta)V_m + \alpha(V_b + V_p)]^2 V_s + [(\alpha+\beta)V_s + \beta(V_b + V_p)]^2 (V_m + V_b)}{(\alpha+\beta)^2 (V_s + V_m + V_b + V_p)^2}$$

The leader's expected payoff is seen to be dependent on the weight $-\beta$ he assigns to better communication with the leader. It also depends on the variance for noise in communication, leader's ability and follower's ability. Since the follower's perception of the leader's ability is also prejudiced based on role incongruency, the expected payoffs for the leader also get affected by it. The follower's prejudice against the leader would contribute to the lowered payoff for the female leader. For a male leader with a male follower, the expected payoff would be higher given no prejudice against his abilities and better communication with him. A female leader with female followers would see prejudice against her abilities but the effects can be offset by the perfect communication within the team. However, a female leader with a male follower would experience a lowered payoff given the high variance in communication due to gender incongruency and high prejudice against her abilities due to role incongruency. For the leader to experience a higher payoff it must be that the players communicate perfectly and that the followers have no prejudice or bias against the female leader's abilities to lead the team.

If we take the first-order derivative of the leader's expected utility with respect to V_s, V_m, V_b and V_p we see that the expected utility decreases in all four. It is reasonable to see that the leader's payoffs are dependent on her ability to understand the state of the world. The further away from the truth, she is the lower would be her payoff. Her payoff also depends on the follower's ability to understand the state of the world as the follower is the one who acts in the last stage of the game. The leader's expected utility also decreases when there's noisier communication between her and the follower. This result also coincides with the results we've found in the base model and the extension on the imperfect leader signal.

In this extension, it is key to notice that now the leader's expected utility also decreases in the prejudice a male follower has against her role as his leader. The higher the prejudice he has against her abilities, the lower the payoffs would be for the leader. The follower is less likely to assign a higher weight to a female leader's message than a male leader's message due to the prejudice he has against the female leader. He would assign a higher weight to his noisy signal. This would ultimately contribute to a lowered payoff for a female leader. This inference is crucial to the paper as it not only backs up the hypothesis but also the literature I've presented earlier.

Given the insights we found earlier, we now look into the follower's expected payoff:

$$E[U_i] = \frac{-[(\alpha+\beta)V_s + \beta(V_b + V_p)][(\alpha+\beta)V_m + \alpha(V_b + V_p)]}{(\alpha+\beta)(V_s + V_m + V_b + V_p)}$$

The follower's expected payoff is largely dependent on the weight on being right and the weight on acting similar to the leader $-(\alpha+\beta)$. The follower's expected utility depends on the variance for noise in his understanding and the variance for noise in communication between the players. The effect of V_s and V_m on his expected utility is the same as the previous models. His expected payoff also depends on the variance for noise in the leader's ability and the prejudice he has against the female leader $(V_b + V_p)$. His payoff is reasonably dependent on his ability. If the follower's prejudice against his leader is higher, he experiences a lowered utility. In this case, the male follower would see a lower payoff under a female leader than under a male leader.

Doing a comparative statistical analysis on the follower's expected payoff shows us that the follower's utility also decreases in all these variances. As shown in the previous models, the utility of a follower decreases in the variance for noise in his(V_s) and the variance for communication V_m between the two players. The expected utility also decreases in the variance from the follower's prejudice(V_p) against the leader's ability. This suggests that the follower also suffers from forming a prejudice against a female leader's ability based on her role incongruency. A male follower would see a higher payoff under a male leader as he would have perfect communication with him as well as have no prejudice against his male leader. These results are consistent with the literature we presented and also help solidify our hypothesis for the paper.

In a scenario, where a male and female leader is similarly-abled, a male follower would be less willing to pay attention to the female leader's message about the state of the world based on her gender. Due to this gender bias, both the follower and leader would encounter a lowered utility than under a gender congruent case. For a female leader, it would help her maximize her utility better if she was supervising a female follower as that would allow the players to have better communication and perhaps overcome the effect of prejudices based on role incongruency. This shows us how role incongruency can affect the female leader's and the team's productivity.

Given the premise explained in the last paragraph, it is intuitive to see that a team with more female players would help enhance not only the gender bias in organizations but also the team's productivity as a whole under a female regime. This would enable a female leader to act and perform better without being prejudiced upon by her subordinates for being role incongruent. This idea of more female followers is discussed later on in the last extension of this paper.

Perfect communication

In this extension, there's no noise in communication between the players. So, the players communicate without any misunderstanding. However, under this perfect communication scenario, the leader's ability to understand the state of the world is noisy. The model used in this extension is much the same as the one with where the leader's signal was imperfect with slight changes in the message sent by the leader. She sends a noisy message in the first stage of the game to the follower, and the follower acts based on the message she sends and the signal he gets from the follower.

The message interpreted by the follower would account for the leader's imperfect ability but with no noises in communication i.e. $m_b = m_s = \theta + \tau_b$. The follower then acts in the second stage based on the message he received from the leader and his signal.

We start with the follower's utility function for finding the weights he'd assign to the two pieces of information for when he's deciding the optimal action.

$U_i = -\alpha[a_i - \theta]^2 - \beta[a_i - a_b]^2$

$U_i = -\alpha[w^2\epsilon_i^2 + (1-w)^2\tau_b^2 + 2w\epsilon_i(1-w)\tau_b] - \beta[w^2(\tau_b^2 + \epsilon_i^2 - 2\tau_b\epsilon_i)]$

Using this we find the expected payoff of the leader as follows:

$E[U_i] = -\alpha[w^2V_s + (1-w)^2V_b] - \beta[w^2(V_s + V_b)]$

Deriving the follower's expected utility with respect to w, we get the weights as:

$$w = \frac{\alpha V_b}{(\alpha+\beta)(V_s+V_b)}$$

The follower's weight w on his signal depends on how much the noise in the leader's ability varies. If the leader's ability varies a lot then the follower assigns a higher weight to his noisy signal. If the follower finds the leader's ability to vary less, then the follower would assign a higher weight to the leader's message when deciding his optimal action. We notice here that unlike the previous extensions, the weights in this model do not depend indirectly on the gender of the leader or follower. The weight depends on the leader's ability and the follower's weight α on being right.

We continue by finding out the optimal action of the follower using these insights:

$$a_i = \frac{\alpha V_b s_i + [\alpha V_s + \beta(V_s + V_b)]m_b}{(\alpha + \beta)(V_s + V_b)}$$

This expression indicates that the follower's optimal action depends on the weight he assigns to the two pieces of information he receives when deciding the optimal action. If the weight w is higher than $1-w$, then the follower would value his noisy signal from nature more than the message he received from the leader. If the leader's ability is noisier, the follower would assign a higher weight to his noisy signal. If his signal is noisier and he values being close to the leader, he would assign a higher weight to the leader's message. The leader's ability hence is key for the follower to determine his optimal action. The follower's weight on being right and being close to the leader is also important in determining the optimal action.

In the first stage, the leader's optimal message and ultimately his action in the second stage is derived the same way as before (See Appendix A.1). The optimal action for the leader is to act exactly as the state of the world requires her to. The message she sends to the follower must also remain the same ($a_s = \theta = m_s$). It's interesting to notice that just like in the previous extensions, the optimal action hasn't changed for the leader despite her noisy ability. This is possible since this is a one-time interaction game. The results might differ if we include multiple periods in this game, as the players will then be able to update and learn better about each other's preferences and strategies. In a one time interaction, given this setup, it is ideal for the leader to send a message and act the same way as the state of the world.

Both player's expected payoff would look much the same as from the first extension with imperfect leader ability. If we simplify the expected payoffs from when there's no noise in communication (i.e. V_m as zero), we see that the expressions we get would be what we would get as the player's expected payoff in this case. We get the leader's expected payoff as follows:

$$E[U_b] = \frac{-\beta V_b[\alpha^2 V_s + \beta^2 (V_s + V_b) + 2\alpha\beta V_s]}{(\alpha + \beta)^2 (V_s + V_b)^2}$$

The leader's expected payoff is dependent on the when she has a noisy ability is dependent on the variance for the noise in her ability and the follower's ability. Her payoff also depends on the weight $-\beta$ for being close to the follower. Since there's no noise in communication, the leader's expected payoff depends entirely on how noisy both player's ability is. It is worth noticing that under this scenario, we'd see a male and a female leader experience much the same expected payoff with a male follower. As the payoff isn't dependent on their communication which is hindered by gender incongruency, the leaders experience similar payoffs regardless of their genders.

However, introducing variance for prejudice against a leader's ability to this extension would then greatly affect the female leader with male followers.

A male leader under this case wouldn't see a lowered payoff, while a female leader would. This shows that role incongruency is also an important factor in determining and affecting the leader's payoffs.

If we derive the leader's expected payoff with respect to V_s and V_b, we see that the leader's expected payoff decreases in both.

$$\frac{\partial E[U_b]}{\partial V_s} = \frac{-\beta V_b(2\beta V_b \alpha + V_b \alpha^2)}{(\alpha+\beta)^2(V_s+V_b)^2}$$

$$\frac{\partial E[U_b]}{\partial V_b} = \frac{-\beta(\beta^2 V_s^2 + \alpha^2 V_s^2 + 2\alpha\beta V_s^2 + 2\beta^2 V_b V_s + \beta^2 V_b^2)}{(\alpha+\beta)^2(V_s+V_b)^2}$$

The leader's payoff can be seen to decrease in both V_s and V_b. Her payoff decreases in her imperfect ability as well as the follower's ability. A female leader and a male leader would thus be seeing no difference in their payoffs given this case, as the payoffs are not affected by imperfect communication or follower's prejudice against the leader's ability. The only factors affecting the leader's payoffs are the noises in the two player's abilities which in the context of this paper and as per the literature isn't affected by one's gender.

We've seen earlier that the leader's expected payoff depends on the noise in the follower's ability to understand the state of the world. Her payoff also decreases in the follower's imperfect ability as he takes the action in the last stage of the game. Introducing the variance for prejudice against a leader's ability would show us that for a female leader, the prejudice against her would also reduce her payoff alongside V_s and V_b.

The follower's expected payoff would be:

$$E[U_i] = \frac{-[(\alpha+\beta)V_s + \beta V_b][\alpha V_b]}{(\alpha+\beta)(V_s+V_b)}$$

The follower's expected payoff depends on the weight on being close to the state of the world and the variance in the leader's ability. If the weight on the follower's signal increases, his expected payoff would decrease. For the follower to experience a non-negative payoff it should be that there's nothing wrong in his understanding of the state of the world and also the leader's ability isn't noisy. The male follower, in this case, would see a lowered payoff due to his and the leader's noisy ability. We can infer that the follower would suffer more from having a leader with noisy ability.

If we include the variance in prejudice against the ability of a leader, the follower would possibly see an even lowered utility due to his prejudices based on role incongruency. However, a male leader wouldn't have to face such prejudices as mentioned in the previous extension, the follower would be worse off under a female regime than under a male regime.

If we take the first-order derivative of the follower's expected payoff with respect to V_s and V_b, we see that the follower's utility decreases in both.

$$\frac{\partial E[U_i]}{\partial V_s} = \frac{-\alpha V_s(-2\beta^2 V_b - \beta V_s + \beta V_b - \alpha V_s + \alpha V_b)}{(\alpha+\beta)^2(V_s+V_b)^3}$$

$$\frac{\partial E[U_i]}{\partial V_b} = \frac{-\alpha V_b(2\beta^2 V_b + \beta V_s - \beta V_b + \alpha V_s - \alpha V_b)}{(\alpha+\beta)^2(V_s+V_b)^3}$$

The follower's expected decreases with high variance for the noise in both the leader's and the follower's ability. This result is synonymous to the previous results as well and indicates an obvious intuition that the follower's payoff depends on his ability V_s. Since the follower's action depends on the leader's message, his action ultimately depends on the ability of the leader V_b as well. As the payoff isn't dependent on the communication between the players, which is hindered by gender incongruency, the leader's experience similar payoffs. The follower would possibly develop no preference for one type of leader under this case as the productivity of the team depends on the sheer ability of the players and not their gender.

However, if we include the variance for follower's prejudice against a leader's ability to this extension, this would affect the male follower a lot despite no noise in communication. However, the follower would be better off under a male leader in such a scenario. Hence, this suggests that role incongruency is an important factor in determining and affecting the follower's payoffs.

Three players

In this extension, the addition of a second follower to the base model suggests a need for better communication within the team. This extension is the closest to a real-life setting at a workplace with multiple employees in the game learning information about the state of the world and the leader's instructions and deciding their optimal strategies. Through this extension, I aim to show how the presence of more employees could affect the dynamics of the decision-making within the team and also induce the leader and the follower to devise different strategies than in the base model. I will show further on that the gender of a second employee plays a vital role in inducing the employees to act a certain way or further lower the leader's payoff. In doing so, I intend to show that a mostly male team under a female regime, could lead to lowered payoffs for the team. On the other hand, the presence of more women could work in favour of the female leader. This extension makes use of the base model specifications. This requires us to form new utility functions for the players.

- **Leader's utility function**: The leader's utility function is much the same as in the base model but with an addition of the new term that captures the communication between the two followers. The leader now also wants to ensure that she coordinates well with the second follower.
  $U_b = -\alpha(a_b - \theta)^2 - \beta(a_b - a_i)^2 - \beta(a_i - a_j)^2$

- **First follower's utility function**: The follower's utility function is also the same as the base model but with an addition of the new term that captures the communication between the two followers. Communication with another follower will also be important in determining the utility maximization of the two followers.
  $U_i = -\alpha(a_i - \theta)^2 - \beta(a_b - a_i)^2 - \nu(a_i - a_j)^2$
  Follower i's linear action would be:
  $a_i = w_i s_i + (1 - w_i)m_b^i$ where $m_b^i = m_s + \mu_i$.

- **Second follower's utility function**: The second follower's utility function is the same as the first follower's utility function with the difference in notation. We use j to denote second follower and i to denote the first follower.
  $U_j = -\alpha(a_j - \theta)^2 - \beta(a_b - a_j)^2 - \nu(a_i - a_j)^2$
  Follower j's linear action would be:

$a_j = w_j s_j + (1 - w_j) m_b^j$ where $m_b^j = m_s + \mu_j$. Here, both followers know that in equilibrium $m_s = \theta$.

The two followers are presumed to listen to the public message of the leader and act simultaneously. Their source of information is the leader's public message and the private signals they receive nature about the state of the world. When deciding on their action, the followers account for both the leader's public message and their private signal. They give weights α and β on being close to nature, the leader's action and the other follower's action where ν is the weight of communication between the followers. The weight on communication would be different in this extension from the weights in the base model. The presence of the second follower ('j') should cause the first follower ('i') to put more weight on better communication with the leader.

The leader would also be more dependent on better communication with the two followers for utility maximization. However, this would also depend on gender congruency between the two followers. If the male follower i is under a female regime where the j is also a male, then we would see possibly lower weight on communication with the female leader. While a male follower i in a gender incongruent pairing with the third member would have a higher β as the female j follower would have better communication with the leader.

As we have already shown above in the base model that gender congruent teams show better communication, this would steer the male follower to better coordinate with his leader just as his female colleague does. To avoid suboptimal utility maximization, the male follower attempts to coordinate better with his female leader. The introduction of a second player requires a more detailed look based on the scenarios presented above. This paper would look into two cases separately under this extension: gender congruent followers and gender incongruent followers.

Gender congruent followers:

Due to the simultaneous revelation of the leader's public message, the two gender congruent followers who are otherwise much the same in their skills would be symmetric in their strategies in the equilibrium. The variance V_s in the follower's noise ϵ_i in understanding nature's signal and V_m for noise mu_i in communication is the same for i and j. This means that the two followers are of the same abilities in the equilibrium. The noise in their ability and communication comes from the same normal distribution but $i.i.d.$

Since the two followers are symmetric, they will have the same optimal weight w_e in equilibrium. Player i's weight to their signal ex-ante is w_i and player j's weight on their signal ex-ante is w_j.

We begin with finding the optimal weight for the two followers. For player i, we find the weights as follows:

$U_i = -\alpha(a_i - \theta)^2 - \beta(a_b - a_i)^2 - \nu(a_i - a_j)^2$

In equilibrium, follower i knows that the leader would play θ, we substitute a_b with θ.

$U_i = -(\alpha + \beta)(a_i - \theta)^2 - \nu(a_i - a_j)^2$

$U_i = -(\alpha + \beta)[w_i^2\epsilon_i^2 + (1 - w_i)^2\mu_i^2 + 2w_i\epsilon_i(1 - w_i)\mu_i] - \nu[w_i^2\epsilon_i^2 + (1 - w_i)^2\mu_i^2 + 2w_i\epsilon_i(1-w_i)\mu_i + w_j^2\epsilon_j^2 + (1-w_j)^2\mu_j^2 + 2w_j\epsilon_j(1-w_j)\mu_j - 2(w_i\epsilon_i + (1-w_i)\mu_i)(w_j\epsilon_j + (1 - w_j)\mu_j)]$

which gives us the follower's expected payoff as:

$E[U_i] = -(\alpha + \beta)[w_i^2V_s + (1 - w_i)^2V_m] - \nu[w_i^2V_s + (1 - w_i)^2V_m - 2w_iw_jV_s -$

$2(1-w_i)(1-w_j)V_m]$

Similarly, for player j:

$E[U_j] = -(\alpha+\beta)[w_j^2 V_s + (1-w_j)^2 V_m] - \nu[w_j^2 V_s + (1-w_j)^2 V_m - 2w_i w_j V_s - 2(1-w_i)(1-w_j)V_m]$

In equilibrium, the two players have symmetric strategies, therefore they also have the same weights. Taking that into consideration, we take the first-order derivative of follower i's expected payoff function with respect to w_i. $(w_i = w_j = w_e)$

$$w_e = \frac{V_m}{V_s + V_m}$$

The weights, in this case, are similar to the ones we found in the base model. This result shows that despite the number of followers, gender congruent followers would assign the same weights to their signals and the leader's message. If both the followers are male, they'd assign more weight to their signal if the weight w_e is higher than $1 - w_e$. While two female followers are more likely to assign a higher weight to the female leader's message since they'd coordinate better with a gender congruent leader. In the context of this paper, two male followers would simultaneously assign a higher weight to their noisy signal than the leader's message. Hence, in such a situation, it becomes very important for the female leader to ensure that the followers assign a higher weight to her message to avoid suboptimal payoffs for the entire team. It is noteworthy that this extension assumes that the leader's ability isn't noisy.

With this, we find the optimal actions of the two followers:

$$a_i = \frac{V_m s_i + V_s m_b^i}{V_s + V_m}$$

and,

$$a_j = \frac{V_m s_j + V_s m_b^j}{V_s + V_m}$$

This indicates that the followers are assigning the same weights to their signal and the leader's message when they are gender congruent. In this case, the two males would assign a higher weight to their noisy signal than the leader's perfect message if the communication between the two followers and female leader is very noisy. Two female followers, on the other hand, would have less noisy communication with the leader and thus assign a higher weight to the leader's perfect message than their noisy signal.

Now we look into the first stage of the game to find out the leader's optimal message and optimal strategy.

$U_b = -\alpha(a_i - \theta)^2 - \beta(a_b - a_i)^2 - \beta(a_b - a_j)^2$

$U_b = -\alpha(a_i - \theta)^2 - \beta(2a_b^2 + a_i^2 + a_j^2 - 2a_b(a_i + a_j))$

$U_b = -\alpha(a_i - \theta)^2 - \beta(2a_b^2 + (w_i(\theta + \epsilon_i) + (1 - w_i)(m_s + \mu_i))^2 + (w_j(\theta + \epsilon_j) + (1 - w_j)(m_s + \mu_j))^2 - 2a_b(w_i(\theta + \epsilon_i) + (1 - w_i)(m_s + \mu_i) + w_j(\theta + \epsilon_j) + (1 - w_j)(m_s + \mu_j)))$

Using this we find the optimal message by finding the expected payoff of the leader and then derive it with respect to m_s ($w_i = w_j = w_e$). We know that in equilibrium, the two followers would have symmetric actions. I find that $a_b = \theta$ which makes the optimal message m_s also equal to θ (see Appendix A.1 for detailed derivation process). The results haven't changed from the results from the base model, despite an increase in the number of followers thus showing that the leader's message and action are indeed optimal when equal to θ given the state of the world θ and this setup.

Using these insights, we find the expected payoff for the two followers and the leader. The leader's expected payoff is as follows:

$$E[U_b] = -2\beta[w^2V_s + (1-w)^2V_m]$$

$$E[U_b] = \frac{-2\beta V_s V_m}{V_s + V_m}$$

The leader's expected payoff depends on the weights -2β on better communication with the two followers. This shows that the presence of a second male follower can be detrimental to the leader's utility. The results are thus slightly different from the ones in the base model. Her expected payoff also depends on variance V_s for noise in the follower's understanding of the state of the world and the variance V_m for the noise in communication.

However, we know that the male followers would be less likely to communicate perfectly under the female leader and instead assign a higher weight to their noisy signal. The leader would thus be two times worse off than the base model if the two male followers have noisy communication with her and have an imperfect signal from nature. For the leader to experience a higher payoff, it must be that both followers are of perfect ability and that the communication with both of them is perfect instead of just one. This further strengthens our results and tells us that the leader is worse off with imperfect communication and followers' imperfect signals. Comparative statistical analysis on the leader's payoff indicates that the leader's expected payoff decreases in both V_s and V_m as was the case in the base model.

This result is also a crucial one for the paper as it shows that in a mostly male team, a female leader would be more likely to be worse off than in a more gender-balanced team. Gender incongruency and gender imbalance in an organization prevent the leader from experiencing a much higher payoff than in a team with more women.

These results clubbed with the results from the extension on prejudiced belief shed a different light on gender discrimination that perpetuates from within the teams which are led by female leaders. Followers that form prejudiced beliefs and practice poor communication with their female leaders, cause the leader to realize a significantly lower payoff than in the base model.

We now look into the follower i's expected payoff:

$$E[U_i] = -(\alpha + \beta)[w^2 V_s + (1 - w)^2 V_m]$$

$$E[U_i] = \frac{-(\alpha + \beta)V_s V_m}{V_s + V_m}$$

Similarly, for symmetric follower j's expected payoff we see:

$$E[U_j] = \frac{-(\alpha + \beta)V_s V_m}{V_s + V_m}$$

The two followers i and j have similar expressions for expected payoff as the ones found in the base model for one follower. The followers are symmetric and are gender congruent, therefore they act the same way and hence experience the same payoffs as the other follower. Their payoffs depend on the weights α and β and variances V_m and V_s. It is worth noticing that they're better off than in the base model. This is because the followers have similar strategies and similar noise distributions. Their payoff doesn't improve due to the presence of another male follower as the overall noise in communication within the team would be higher in this case.

For the followers to enjoy a non-negative payoff, the signals that they receive must be perfect and they must communication perfectly with the leader. However, we've mentioned earlier in the model that the followers would have noisy communication with the leader and they receive an imperfect signal from nature as they're of lower ability than the leader. This causes them both to experience a lower payoff than otherwise. If we derive the follower's expected payoff with respect to V_s and V_m to see the relationship between these factors and their payoffs, we see that the followers' expected payoff decreases in both much like the base model.

We now look into a situation where the followers are gender incongruent and how it affects their payoffs.

Gender incongruent followers:

As the name suggests, this extension deals with a situation where the followers are of different genders i.e. one of them is male and the other female. Due to gender incongruency, the two gender incongruent followers would have asymmetric strategies in the equilibrium despite the simultaneous revelation of the leader's public message. Player i's weight to their signal is w_i and player j's weight on their signal is assumed to be w_j. Their weights remain the same in ex-ante and ex-post. The variance V_s in the follower's noise ϵ_i in understanding nature's signal is the same for i and j. This means that the two followers are of the same abilities. The noise in their ability and communication comes from the same normal distribution but *i.i.d.*

For this part of the extension, i is the female follower while j is a male. So, player i is gender congruent with the leader while player j isn't. In this case, the followers are no longer symmetric as their variance in communication is different. We assume that i is gender congruent with the female leader while j is non-congruent. While the noise in their abilities is still the same as the last case (same variance V_s for noise in their ability), the variance and noise term in communication are different. i's noise in communication is μ_i, where $\mu_i \approx N(0, V_m^C)$ and j's noise in communication is μ_j, where $\mu_j \approx N(0, V_m^N)$.

However, the variance for noise in communication would differ for each follower. The follower who is gender congruent with the female leader i.e. the female follower would have lower variance in communication. We will denote this by V_m^C, where C stands for gender congruent communication. While the male follower would have a higher variance in communication denoted by V_m^N, where N denotes gender non-congruent communication. The noise μ_i and μ_j are taken from two different distributions since the followers are of two different genders. The way a female follower would interact with a female leader would see different noises than when a male follower interacts with a female leader. We begin with finding the optimal weight for the two followers. For player i, we find the weights as follows:

$U_i = -\alpha(a_i - \theta)^2 - beta(a_b - a_i)^2 - \nu(a_i - a_j)^2$

Since the followers know that $a_b = \theta$ in equilibrium, we solve for w with the same.

$U_i = -(\alpha+\beta)[w_i^2\epsilon_i^2 + (1-w_i)^2\mu_i^2 + 2w_i\epsilon_i(1-w_i)\mu_i] - \nu[w_i^2\epsilon_i^2 + (1-w_i)^2\mu_i^2 + 2w_i\epsilon_i(1-w_i)\mu_i + w_j^2\epsilon_j^2 + (1-w_j)^2\mu_j^2 + 2w_j\epsilon_j(1-w_j)\mu_j - 2(w_i\epsilon_i + (1-w_i)\mu_i)(w_j\epsilon_j + (1-w_j)\mu_j)]$

Similarly,

$U_j = -(\alpha+\beta)[w_j^2\epsilon_j^2 + (1-w_j)^2\mu_j^2 + 2w_j\epsilon_j(1-w_j)\mu_j] - \nu[w_j^2\epsilon_j^2 + (1-w_j)^2\mu_j^2 + 2w_j\epsilon_j(1-w_j)\mu_j + w_i^2\epsilon_i^2 + (1-w_i)^2\mu_i^2 + 2w_i\epsilon_i(1-w_i)\mu_i - 2(w_j\epsilon_j + (1 -$

$w_j)\mu_j)(w_i\epsilon_i + (1-w_i)\mu_i)]$

We find the expected payoff for follower i as:

$E[U_i] = -(\alpha+\beta)[w_i^2 V_s + (1-w_i)V_m^C] - \nu[w_i^2 V_s + (1-w_i)V_m^C + w_j^2 V_s + (1-w_j)V_m^N - 2w_i w_j V_s]$

Similarly, for follower j we find:

$E[U_j] = -(\alpha+\beta)[w_j^2 V_s + (1-w_j)V_m^N] - \nu[w_j^2 V_s + (1-w_j)V_m^N + w_i^2 V_s + (1-w_i)V_m^C - 2w_i w_j V_s]$

Deriving the respective expected payoffs for each follower with w_i and w_j, we find the values for both weights by substitution.

$$w_i = \frac{(\alpha+\beta+\nu)V_m^C + \nu w_j V_s}{(\alpha+\beta+\nu)(V_s+V_m^C)}$$

and,

$$w_j = \frac{(\alpha+\beta+\nu)V_m^N + \nu w_i V_s}{(\alpha+\beta+\nu)(V_s+V_m^N)}$$

From further simplification, we get w_i and w_j as:

$$w_i = \frac{(\alpha+\beta+\nu)^2 V_m^C(V_s+V_m^N) + (\alpha+\beta+\nu)V_m^N V_s}{(\alpha+\beta+\nu)^2(V_s+V_m^N)(V_s+V_m^C) - \nu^2 V_s^2}$$

and,

$$w_j = \frac{(\alpha+\beta+\nu)^2 V_m^N(V_s+V_m^C) + (\alpha+\beta+\nu)V_m^C V_s}{(\alpha+\beta+\nu)^2(V_s+V_m^N)(V_s+V_m^C) - \nu^2 V_s^2}$$

Follower i's and j's weight on their signal is determined by weights on being close to nature's signal, being close to the leader and the second follower's action $(\alpha + \beta + \nu)$. It is also dependent on both player's variance for communication with the leader and the variance in the follower's ability to understand the state of the world. The optimal action for both would follow the same linear strategy in this case but with the respective weights given previously. In our case, the weight on player $j's$ signal is dependent on the variance in communication for the gender congruent follower (V_m). Thus this could induce j to follow the leader, despite his noisy communication.

It can be shown that if the communication isn't very noisy then the follower would assign a higher weight to the leader's signal than to her signal. We know from our assumptions that the gender congruent i would be assigning a lower weight on her signal and more on her female leader's message. A lower V_m^C induces the other player j to also lower the weights on his noisy signal and assign higher weights on his female leader's signal.

Now we look into the first stage of the game to find out the leader's optimal message and optimal strategy.

$U_b = -\alpha(a_i - \theta)^2 - \beta(a_b - a_i)^2 - \beta(a_b - a_j)^2$

$U_b = -\alpha(a_i - \theta)^2 - \beta(2a_b^2 + a_i^2 + a_j^2 - 2a_b(a_i + a_j))$

$U_b = -\alpha(a_i - \theta)^2 - \beta[2a_b^2 + (w_i(\theta + \epsilon_i) + (1 - w_i)(m_s + \mu_i))^2 + (w_j(\theta + \epsilon_j) + (1 - w_j)(m_s + \mu_j))^2 - 2a_b(w_i(\theta + \epsilon_i) + (1 - w_i)(m_s + \mu_i) + w_j(\theta + \epsilon_j) + (1 - w_j)(m_s + \mu_j))]$

Using this we find the optimal message by finding the expected payoff for the leader and then deriving it with respect to m_s. We find the message sent by the leader to the two followers as follows:

$$m_s = \frac{(1 - w_i)(a_b - w_i\theta) + (1 - w_j)(a_b - w_j\theta)}{(1 - w_i)^2 + (1 - w_j)^2}$$

We see that the message is dependent on the weights that the follower's put on the leader's message. This is an intuitive result, as the leader will now account for both the congruent and incongruent follower's noisy communication when sending the message. Given the difficult expression we have derived in this extension, we will use *proof by contraposition* to show that it is indeed optimal for the leader to act θ. For a_b higher than θ, the expression for m_s would result in $m_s > \theta$. This scenario is impossible since the leader cannot send a message above the requirement of nature, as she would find it suboptimal to do so in a one-time interaction game. Doing so might result in a cheap talk equilibrium. Similarly, for a_b lower than θ, the expression for m_s would result in $m_s < \theta$. This scenario is also suboptimal as the state of the world requires her to send a message which is θ. Sending a message below θ would result in less than needed results and hence suboptimal. Therefore $a_b = m_s = \theta$ is the only optimal strategy in this scenario.[6]

To summarize this part of the extension, it can be easily shown with the help of the expression for weights derived for both players that the presence of second female follower can help induce the male follower to assign higher weights to the leader's perfect signal. This would help the team realize higher payoffs than with two male followers. The female leader and the team benefits from the presence of a female follower. Not only does it contribute to a well-balanced team but also helps perfect the communication within the team thus leaving room for further improvement. In contrast with the previous extension on gender congruent players, the followers in this extension are better off because of the weight the follower's put on the leader's perfect

[6]The expected payoffs are likely to show similar results. However, given the complex expressions in this extension, I haven't derived them. But the previous results can be extrapolated to this extension as well.

signal. It can be easily extrapolated that the gender of the second follower can thus act as a make or break factor for the performance of the team and the leader. Another male follower puts more pressure on the leader's payoff, while another female follower induces the team to perform better.

One can argue that given these results, having an all-female team would help establish better performance in female-run teams. But in the real world, it comes at the cost of finding and replacing the men working in such teams. It would also reflect poorly on the team's gender balance and knowledge pool. Hence it ideal for a well-balanced team for optimal performances. These results are vital for the research question and can be generalized to the real world. In the real world, there are situations where the leader's signals could be imperfect or the followers would have biased beliefs about the leader's ability. In such a case, having more women or fewer women wouldn't help reduce the prejudice against the leader's ability. But having more female followers in the team could offset the negative effect of prejudice with better communication and help improve the team's performance.

Discussion

In most models explored above, a player's payoff depends on his/her action. The noisier their ability is the lower their payoff is. However, given the nature of their interaction, the follower's action also depends on the leader's ability which affects his payoff ultimately. The leader's payoff also depends on the follower's ability as the follower is the one taking action in the last stage of the game.

The results derived in these extensions are consistent with the literature mentioned above. As shown in Delfgaauw et al. (2013), more gender congruent teams perform better as they can communicate better in general. Thus in this context, gender congruency helps establish better communication within the team and improve the team's overall performance. It is optimal for a team to communicate their information as accurately as possible to enjoy optimal payoffs in the equilibrium. Given the difference in variance for communication between the two genders, the gender incongruent players are worse off due to the noisy communication. An all-male team would be better off and perform better under such circumstances as the male players would have less noisy communication amongst themselves. Female leaders are thus worse off working with only male followers. Thus for female leaders, having more female followers on a team can thus benefit the team and the leader.

In the extension of prejudice, the results indicate that the female leaders and followers enjoy a lowered utility due to the prejudice he has against her abilities. This result is also consistent with the results of Eagly et al. (2002). A mostly male team who has a strong preference for a male leader, backed up by their prejudice against a female leader, would perform better under a male leader. In my extension on prejudiced belief, the follower and team were worse off due to noisy communication and prejudice against a leader's ability. Given this prejudice and his choice of acting right, a male follower prefers paying more attention to his signal rather than the leader's more accurate one. Following his noisy signal more costs him and the leader a lowered payoff. This could act as a self-fulfilling prophecy against the leader's skills. A male employee might hold the female leader responsible for a lowered expected payoff causing him to further establish a stronger prejudice against her abilities. For a female leader, having more female followers could help offset some of the losses bore due to prejudices beliefs in a one-time interaction game. Female followers would have lower noise in communication with their leader causing them to follow their leader better. If the female followers assigned more weight to their female leader, their male colleagues would be induced into assigning a higher weight to their female leader as well.

Thus, introducing female players can induce male followers to assign a higher weight to the leader's signal. It shows that having more women on a female-run team can improve communication within the team in general and thus the player's expected payoff increases. So introducing more female players would cause the players to align their actions more to the leader's more accurate message. In a real-life scenario, a team would be better off if the team players listened to the boss and communicated better with each other. Poor communication can cause the employees to act differently than instructed thus lower the team's performance. Introducing more women to the team could also boost the morale of a female leader. To summarize the key takeaway, more women on the team would help offset the prejudice against the leader's ability with better communication and help improve the team's performance. Needless to say, seeing more women as successful leaders can influence women on lower strata into aiming for the same in future. This can lead to a cascading effect for ambitious women in firms and improve the firm's productivity.

In a scenario where the communication between gender congruent teams is noisier, firms can find ways to organize simple yet immersive team activities for employees to slowly eradicate the prejudice followers have against their team leaders. Firms can even encourage outside-firm activities amongst the team members where the employees and the leaders get to see each other in a different light and perhaps improve their relationship. Furthermore, firms can hold compulsory workshops and seminars for better HR practices in the team. By the very nature of it, repeated interactions with female leaders can also act a catalyst in improving the follower's overview of her abilities.

Conclusion

I proposed a base model which intends to capture the basic idea of a corporate culture where the leader instructs the follower to work a certain way and the follower decides to act based on the information combined. Their expected payoffs ex-ante decreases in players' noisy communication and the follower's imperfect ability. In the extensions, I show that their expected payoffs also decrease in leader's ability and the gender-based bias a follower has against a female leader's ability. I also show that the number of followers and their gender can affect the way both players experience their expected utility. Another female follower causes the male to align his actions closer to the leader while another male follower causes the female leader to suffer a further lowered payoffs. With more players in the team, the followers would want to be aligned with each other's action. Their gender would matter in such a case as well.

Given that this is a one-time interaction game, the results cannot be directly extrapolated to a real-life setup with multiple interactions and scope of updating prior beliefs. It is likely that the players develop and update their beliefs about each other's strategies, payoffs and abilities and accordingly act in a repeated game structure. A female leader may realize that she is being discriminated upon and would thus resort to sending messages which are not the same as her signal in an attempt to make up for the miscommunication and prejudice. This might lead to a cheap talk equilibrium where the follower and the leader are continuing with less credible information and sub-optimal strategies and payoffs. The followers could update their beliefs about the leader's abilities which would reduce their prejudices against the leader's abilities. Thus, this approach can be further explored with more players in a repeated game structure where the players can update their beliefs.

Furthermore, introducing factors such as reputation, altruism and many more can help us come closer to a more realistic answer to my research question. Followers who are more concerned with their reputation would prefer conforming than not conforming regardless of their beliefs or noise in communication. Similarly, altruistic followers would be motivated to help a female leader and attempt to either better communicate with her or improve their relationship with her thus inducing others to follow suit. An interplay of many such factors can lead to altered results and perhaps even opposing results, though beyond the scope of this topic. Future studies in this topic can try to include such factors and see how well the team performs under those circumstances.

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A Appendix

A.1 Leader's optimal strategies

To find the leader's action in all extensions, we must find the message he sends to the follower i.e. m_s. The leader's optimal action may differ from the message she sends due to the follower's belief about the accuracy of the leader's message and action being the same as the message. For a detailed explanation I focus on the base model. I start by finding out the expanded expression for leader's utility function:
$U_b = -\alpha(a_b - \theta)^2 - \beta(a_b - a_i)^2$
$U_b = -\alpha(a_b - \theta)^2 - \beta[a_b^2 + (w(\theta + \epsilon_i) + (1 - w)(m_s + \mu_i))^2 - 2a_b(w(\theta + \epsilon_i)(1 - w)(m_s + \mu_i))]$

Deriving the expected utility from the leader's utility function, we get:
$E[U_b] = -\alpha(a_b - \theta)^2 - \beta[a_b^2 + w^2\theta^2 + w^2V_s + m_s^2 - 2wm_s^2 + w^2m_s^2 + V_m - 2wV_m + w^2V_m + 2w\theta m_s(1 - w) - 2a_b w\theta - 2a_b(1 - w)m_b]$
$E[U_b] = -\alpha(a_b - \theta)^2 - \beta[a_b - (w\theta + (1 - w)m_b]^2 - \beta[w^2V_s + (1 - w)^2V_m]$

Taking a first-order condition of the expected utility with respect to m_s, we get the leader's message m_s as,

$$m_s = \frac{a_b - w\theta}{1 - w}$$

The leader's message depends on the weight w the follower puts on his signal, their action a_b and the state of the world θ. Substituting this result for m_s into the leader's utility function (U_b) and taking the first-order condition of the leader's expected utility function ($E[U_b]$) with respect to a_b, we get the leader's optimal action a_b as,

$$a_b = \theta.$$

Plugging this into the expression for m_s, we get $m_s = \theta = a_b$. The optimal action for the leader is to act exactly as per the state of the world. This means that it's optimal for the leader to act as required by the state of the world. Any action lower or higher than that would lead to a suboptimal utility level. Intuitively, this suggests that the leader's optimal action, when the follower puts no weight on his noisy signal and all his weight $1-w$ on the leader's accurate message, is the same as the state of the world. Regardless of the gender of the leader, the optimal message to the follower should be the same as their action, which is also equal to the state of the world. This enables them to maximize their utility given their one-time interaction with the follower.

In the extensions after the base model(with an exception of the Gender incongruent followers in the Three players extension), we see that the leader's ability isn't the same as in the base model, which would ultimately affect the message sent to the follower. However, the optimal message isn't the same the message sent by the leader. The leader's optimal strategies are more to indicate the ideal situation for the team to arrive at the highest payoffs in the given setup. In other extensions, I introduce the respective errors and their variances in the objective function as well as the expected payoffs. The process is much the same after deriving the expected payoffs with the corresponding errors and variances accounted for.