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Abstract

We study promotion incentives in the public sector by means of a field experiment with the Ministry of Health in Sierra Leone. The experiment creates exogenous variation in meritocracy by linking promotions to performance and variation in perceived pay progression among the lowest tier of health workers. We find that meritocratic promotions lead to higher productivity, and more so when workers expect a steep pay increase. However, when promotions are not meritocratic, increasing the pay gradient reduces productivity through negative morale effects. The findings highlight the importance of taking into account the interactions between different tools of personnel policy.

JEL Classification: M51, M52, J31, D73

Keywords: promotions, Meritocracy, Pay Progression, Worker productivity

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Promotions and Productivity: The Role of Meritocracy and Pay Progression in the Public Sector*

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June 3, 2022

Abstract

We study promotion incentives in the public sector by means of a field experiment with the Ministry of Health in Sierra Leone. We experimentally establish a new promotion criterion that links promotions to performance for the lowest tier of health workers and introduce variation in perceived pay progression by revealing to them the salary of their supervisors. We find that meritocratic promotions lead to higher worker productivity and that this effect is driven mainly by workers who expect a steep pay progression and those who are highly ranked in terms of performance. When promotions are not meritocratic, increasing the pay gradient instead *reduces* worker productivity through negative morale effects. The findings highlight the importance of taking into account the interactions between different tools of personnel policy.

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1 Introduction

Many organizations face constraints on their ability to dismiss workers or to offer them performance pay, especially in the public sector. As such, they often rely on promotion incentives to motivate their employees (Cullen and Perez-Truglia 2022; Finan, Olken, and Pande 2017). But to what extent are workers motivated by the opportunity to climb the organization's ladder? Despite the long-standing theoretical literature on the effects of promotion incentives on worker productivity (e.g., Lazear and Rosen 1981; Waldman 1984; Gibbons and Waldman 1999b), credible empirical evidence has remained elusive.

The design of promotion incentives involves two distinct but interrelated components. To motivate lower-tier workers to exert extra effort, promotion rules should be predominantly performance-based (*high meritocracy*) and the prize associated with a promotion should be large enough (*steep pay progression*). In this paper, we provide causal estimates of the isolated and combined effect of both of these components by means of a field experiment with a large public sector organization in Sierra Leone.

We show that meritocracy and pay progression complement each other. Raising the extent to which promotions are meritocratic increases the productivity of lower-tier workers, but this is only the case when combined with sufficiently steep pay progression, and especially if the worker ranks high in terms of performance. Similarly, higher pay progression boosts worker productivity but this result holds only when promotions are meritocratic. Meanwhile, when promotions are non-meritocratic, higher pay progression demotivates workers, especially high-ranked ones, causing a reduction in their productivity. These findings highlight the importance of taking into account the interactions between different tools of personnel policy.

The public-sector organization we focus on is the Community Health Worker Program implemented by the Ministry of Health and Sanitation in Sierra Leone. The experiment takes place in 372 health units, each located in a different geographical area and composed of an average of eight Community Health Workers (CHWs), who provide basic health services to households in their community, and one Peer Supervisor (PS), who monitors and trains the CHWs. CHWs receive a fixed pay that equals 60% of the PS salary, and they have the opportunity of being promoted to PS whenever a position becomes vacant in their own health unit.

Before our experiment, promotion decisions were entirely left to the discretion of the local health authority (i.e., the person in charge of the health unit) and were perceived by CHWs

as being non-meritocratic: half of the CHWs in our sample expressed the belief that the best-performing CHW was unlikely to be promoted unless she had a connection with the local health authority. As part of our experiment, we collaborated with the Ministry of Health and Sanitation to transition a random half of the 372 health units to a new meritocratic promotion system that promotes the best-performing CHW based on the quantity and the quality of the health services provided (as measured by the research team). This creates random variation in the *actual* promotion criteria, which we cross-randomize with variation in the *perceived* pay gap between the PS and the CHWs. Leveraging the low initial awareness of pay disparities, we provided CHWs in a random half of the 372 health units with information about the true PS pay, thus affecting their perception of the pay progression. Our research design allows us to study the role of meritocracy in the promotion regime, (perceived) pay progression and the interplay between the two on CHW productivity.

To guide the empirical analysis, we develop a simple theoretical framework in which we model the promotion mechanism as a single prize contest where workers (CHWs) compete for a promotion by exerting effort. Meritocratic contests, in which promotions are based uniquely on worker performance, are predicted to boost worker effort relative to less-meritocratic contests, especially if the pay gap between lower- and upper-tier workers is large enough. Similarly, raising the pay progression is predicted to motivate workers to climb the organization's ladder and to prompt an increase in their effort, but this is true only if the system is meritocratic enough. In a non-meritocratic system, steeper pay progression can instead *reduce* workers' effort if they perceive promotions as being awarded in an unfair or unequal manner (i.e., a negative morale effect). It can also reduce effort if workers divert time away from providing health services into "lobbying" their superiors.

Our empirical analysis proceeds in two steps. We first study the direct causal effect of a more meritocratic promotion regime on CHW performance. We show that a more meritocratic promotion rule increases the number of visits provided by the average worker in our sample by 22.2%. In line with the theoretical framework, we find that the productivity boost is stronger for workers who expect the value of the promotion to be large enough – i.e., those who believe that the pay progression is steep enough at baseline and who are likely to see the PS retire soon. We also find that the effect is stronger for workers who are highly ranked in terms of performance at baseline and who have a better chance of being promoted in a meritocratic regime. Importantly, we show that the increase in the number of visits is not compensated by a reduction in visit

length (leading to lower visit quality) or worse household targeting.

In the second part of the empirical analysis, we study the causal effect of pay progression on CHW performance in the meritocratic promotion regime vis-a-vis the old (non-meritocratic) regime. The direction in which workers who we informed about the true PS pay update their beliefs depends on their priors: workers who underestimated PS pay at baseline revised their perceptions upward, while those who overestimated PS pay revised it downward. Throughout the paper, we will study these two types of workers separately as their predicted effort response to the treatment is expected to move in opposite directions. Specifically, we assess the effect of *higher* (*lower*) pay progression by comparing workers to whom we revealed the true PS pay with workers to whom we did not reveal it within the group of workers who initially underestimated (overestimated) pay progression. We further test whether this effect differs depending on whether the promotion system is meritocratic or not.

The effect of pay progression has two contrasting effects depending on the prevailing promotion rule. In the new meritocratic promotion regime, *higher* (*lower*) pay progression *increases* (*decreases*) the number of visits by nearly 22%, with a particularly pronounced effect for high-ranked workers. This indicates that even for public sector workers – who have been argued to be "intrinsically motivated" (Besley and Ghatak 2005; Bénabou and Tirole 2006) – extrinsic incentives in the form of an expected increase in future pay play an important role.

In the old (non-meritocratic) regime, *higher* pay progression *decreases* the number of visits by 25%, while *lower* pay progression does not affect worker performance. Two potential mechanisms can explain the former result: one possibility is that workers may perceive the large pay gap between the different layers of the organization as being unfair or unequal if the system does not reward highly productive workers, leading to a negative morale effect that decreases their motivation. Alternatively, the larger perceived pay gap may increase workers' interest in a promotion, incentivizing them to substitute productive activities (household visits) for non-productive ones (lobbying) (de Janvry et al. 2021). We provide suggestive evidence that our results are consistent with a morale effect rather than a lobbying effect. First, the drop in the number of visits is not compensated by workers being more likely to interact with the local health authority nor with workers dedicating a larger fraction of their time to non-patient-oriented activities, which we would expect if they were diverting time into lobbying-related activities. Second, the reduction in the number of visits is concentrated among high-ranked workers and workers who are unsatisfied with the work of the PS, both of whom are expected

to view a non-meritocratic regime with a high pay progression as the most unfair.

From a policy perspective, the results of this paper indicate that organizations seeking to increase the productivity of lower-tier workers should simultaneously enforce promotion rules that reward performance *and* ensure that the prize associated with promotions is large enough. This is particularly important as a large number of organizations, both in the public and private sector, adopt only one of the two above components rather than both. In large public organizations in developing countries, for example, pay progression is often steep while promotions are non-meritocratic, largely due to patronage, nepotism, or strict seniority-based rules (Wade 1985; Shepherd 2003; World Bank 2016; Sahling, Schuster, and Mikkelsen 2018; Besley et al. 2022). This is illustrated in Figures A.1 and A.2 which show, respectively, that many bureaucracies of low-income countries combine high pay progression with low meritocracy and that this combination negatively correlates with government performance.[1] Similarly, in the private sector, promotion rates have been shown to be significantly lower for women and minorities across all ranks of firm hierarchies, even after controlling for their performance and especially in firms with steep pay gradients (e.g., Castilla 2008; Kunze and Miller 2017; Cullen and Perez-Truglia 2019; Macchiavello et al. 2020; Benson, Li, and Shue 2021). While raising the pay progression in these "non-meritocratic" organizations may potentially improve the selection of high-tier workers (a mechanism we do not capture in our experiment), our findings indicate a consequent demotivation of the "unfavored" low-tier workers which may hinder organizational performance.[2]

This paper contributes to different strands of the literature. First, it adds to the literature studying the effects of promotion incentives, which has been predominantly theoretical in scope (Lazear and Rosen 1981; Harris and Holmstrom 1982; Waldman 1984; Rosen 1986; Gibbons and Murphy 1992; Gibbons and Waldman 1999a,b; Bose and Lang 2017; Ke, Li, and Powell 2018). A few recent empirical papers have documented the positive effects of increasing upward mobility on the performance of workers for whom a new senior position becomes "attainable", while holding the promotion rule fixed (Karachiwalla and Park 2017; Nieddu and Pandolfi 2022; Bertrand et al. 2020; Li 2020).[3] There is also recent empirical work exploring whether managerial

[1] Pay progression and meritocracy are measured using the Worldwide Bureaucracy Indicators, and government performance is measured using the Gothenburg's Quality of Government Indicators. Refer to the figure notes for more details. In a regression with country and time fixed effects, Figure A.2 shows that government performance is negatively correlated with pay progression in non-meritocratic regimes and positively correlated with meritocracy when combined with high pay progression.

[2] The experiment allows us to assess the effect of pay progression and meritocracy on the productivity of low-tier workers (CHWs), holding the productivity of high-tier workers (PSs) fixed. However, it does not capture the effect on the productivity of high-tier workers (PSs) and how this, in turn, affects CHW performance. Indeed, we did not change the actual pay progression, and promotions are infrequent in our context.

[3] Using retrospective panel data on teachers in China, Karachiwalla and Park (2017) show that promotions

discretion improves or deteriorates the extent to which the promotion system is performance-based (Xu 2018; Aman-Rana 2021; Voth and Xu 2021).[4] In contrast with our paper, these studies do not assess the causal effect of a more meritocratic promotion rule on worker productivity, nor its interaction with pay progression.

Our paper differs from the large literature on non-tournament-based incentives, such as pay-for-performance schemes that do not involve competition across workers (e.g., Lazear 2000; Muralidharan and Sundararaman 2011; Khan, Khwaja, and Olken 2016, among many others). The tournament structure of promotion incentives implies that only the winner is rewarded. As a result, the types of workers who respond the most to promotion incentives may sharply differ from non-tournament-based incentives – e.g., workers who have a high chance of being promoted may respond much more strongly than those with a low chance. Promotion incentives also differ in that their effectiveness is a function of pay progression. Whether promotion incentives are more cost-effective than non-tournament-based schemes is ultimately an empirical question. We discuss this in more detail in the Conclusion.

The second strand of the literature we contribute to is the one on the effects of pay inequality within organizations on worker performance. Most of the existing empirical evidence has focused on *horizontal* pay inequalities (i.e., between workers in the same layer of an organization) while shutting down dynamic incentives, and documents negative morale effects (Card et al. 2012; Cohn et al. 2014; Mas 2017; Breza, Kaur, and Shamdasani 2017). In contrast, we center our attention on *vertical* pay inequalities between supervisors and their subordinates for which the theoretical predictions are less clear. On the one hand, steeper pay progression can demotivate workers who are averse to vertical pay inequalities. On the other hand, it can prompt an increase in effort through career incentives. Understanding which of the two effects prevails is of obvious policy relevance given the recent rapid growth of the manager-worker pay ratio (Ashraf

are associated with better performance in the years leading up to promotion eligibility but reduce performance if workers are repeatedly passed over for promotion. Nieddu and Pandolfi (2022) show that promotion incentives in academia prompt higher productivity, but this is only the case when the goals set are attainable. Bertrand et al. (2020) show that strict seniority-based rules in the Indian public sector prompt an increase in effort among workers for whom the promotion is attainable while demotivating workers who are too young to be promoted in the foreseeable future. Li (2020) shows that exposure to unfair promotions in Chinese high schools adversely affects the productivity of non-favored teachers, a result that echoes our negative morale effects. Unlike Li (2020), we show that such morale effects materialize only when pay progression is large enough.

[4] In the Pakistani public sector, Aman-Rana (2021) shows that discretionary promotions – which are not based on any strict promotion rule – improve meritocracy if the incentives of mid-level bureaucrats (who decide on promotions) are aligned with the organization's objectives. Voth and Xu (2021) show that discretion in promotions in the Royal British Navy improved the selection of captains whenever the admirals had superior information about candidates; while Xu (2018) shows that discretion in promotions in the British Empire promoted governors connected to their superiors (patronage) who subsequently underperformed. Weaver (2021) studies managerial discretion in hiring (rather than in promoting) workers, and shows that letting managers select new hires based on whether they receive a bribe leads to the selection of high-quality workers.

and Bandiera 2018). The only paper we are aware of that studies vertical pay inequalities is Cullen and Perez-Truglia (2022). In the context of a private-sector firm with a relatively meritocratic promotion regime, their study shows that lower-tier workers exert more effort when their perceptions of the supervisor's salary are revised upward. We complement Cullen and Perez-Truglia (2022) by focusing on a large public-sector organization in which promotions have only recently started to become more meritocratic and by studying how the effects of vertical pay inequalities vary with the level of meritocracy. This focus allows us to bridge the literature on pay inequalities with that on promotions.

Finally, our study contributes to investigations that explore how to build effective state capacity in developing countries (Finan, Olken, and Pande 2017; Besley et al. 2022). While the low productivity of frontline public-sector workers has often been attributed to low-powered incentives, low monitoring, or inadequate selection, we argue that the lack of meritocratic promotions combined with steep pay progression – commonly seen in large bureaucracies of developing countries (as shown in Figure A.1) – may also constrain the state's ability to provide high-quality public services. Our study is also related to a few recent papers which study the effect of meritocracy in personnel decisions other than promotions, i.e., transfers and hiring (Khan, Khwaja, and Olken 2019; Xu and Adhvaryu 2020).[5] To the best of our knowledge, this is the first paper exploring the effect of performance-based promotions in the public sector, and its interaction with pay progression.

The paper is structured as follows. Section 2 discusses the context and research design. Section 3 introduces a theoretical framework that models worker effort responses to an increase in meritocracy and pay progression. Section 4 shows how our treatments affect worker perceptions about meritocracy and pay progression. Section 5 presents the effects of higher meritocracy and pay progression on worker productivity. Section 6 concludes. In the Appendix, we discuss further results and key aspects of research ethics (i.e., IRB, study pre-registration).

[5] In the context of property tax inspectors in Pakistan, Khan, Khwaja, and Olken (2019) show that allowing workers to choose their location based on their performance improves their productivity. Xu and Adhvaryu (2020) show that more meritocracy in the recruitment system of bureaucrats in Taiwan incentivizes future potential job applicants to invest in human capital in order to increase their chance of admission, and this may improve the selection of these bureaucrats. Moreira and Pérez (2022) shows that limiting favoritism and making "merit" the main criteria for hiring (through a civil service exam) reduces the representation of workers from poorer backgrounds.

2 Context and Research Design

2.1 The Community Health Worker Program

Sierra Leone is one of the poorest countries in the world, with the third-highest maternal mortality rate and the fourth-highest child mortality rate in 2017 (World Health Organization 2017). Such elevated mortality rates have been attributed to the slow post-civil war recovery, the 2014-15 Ebola epidemic, and the critical shortage of health workers together with limited access to health facilities throughout the country (World Health Organization 2016). In order to strengthen the provision of primary health care, Sierra Leone's Ministry of Health and Sanitation (MoHS) created a national Community Health Worker program in 2017. The program is organized around Peripheral Health Units (PHUs), small health posts staffed with doctors (when available), nurses, and midwives. Each PHU has typically a catchment area of seven to 10 villages with one Community Health Worker (CHW) per village and one Peer Supervisor (PS) per PHU, for a total of approximately 15,000 CHWs and 1,500 PSs nationwide.

The role of the CHWs is to provide a basic and polyvalent package of healthcare services at the community level. They do so by making home visits to households with expecting mothers or young children, during which they provide the following services: (i) health education (e.g., about the benefits of a hospital delivery), (ii) pre- and post-natal check-ups, and (iii) basic medical care and referrals to health clinics. This model of local preventive health service provision has been shown to increase the use of maternal and child health services, improve child health, and reduce child mortality in other poor contexts (e.g., Darmstadt et al. 2010; Nyqvist et al. 2019; Deserranno, Nansamba, and Qian 2021).

CHWs are hired locally and typically have no experience in the health sector prior to joining the program. The role of the PS is to ensure that each CHW acquires the skills and knowledge necessary to provide primary care services. To do so, the PS organizes a monthly one-day training that CHWs are asked to attend, and subsequently advises, trains and monitors CHWs through in-person visits and by accompanying them on household visits. The PS thus has the responsibility of enabling health workers to perform their tasks (Deserranno et al. 2022). Almost all PSs have previous experience as a CHW, and have thus already acquired health knowledge.

Both CHWs and PSs are part-time employees who typically have a secondary occupation such as farming, petty trading, or small shopkeeping. In our sample, CHWs and PSs report dedicating an average of 18 and 11 hours per week to their CHW/PS job, respectively. CHWs

are paid a fixed monthly allowance of 150,000 SLL (17.5 USD) and PSs are paid 250,000 SLL (29.2 USD).[6] The pay gap between PSs and CHWs is thus large: CHWs earn 40% less than the PSs even though they report working more hours on average. Using the self-reported number of hours as a reference, the hourly wage of PSs is 2.7 times higher than that of CHWs.

As with most public-sector employees, CHWs and PSs are almost never fired and new vacancies open up when CHWs or PSs voluntarily decide to quit. PSs usually leave their jobs at the time of retirement (55 years old), and are not pushed out by "upstart" high-performing CHWs.[7] In our study, the age distribution of PSs at baseline implies that at least 10% of the positions are expected to become vacant in the following five years. Consistent with this observation, we see nine of the 372 PS positions in our sample becoming vacant during the ten months of our study, which amounts to a 15% chance of having an opening in a five years span at any given PHU.

When a PS position becomes available, one of the CHWs in that PHU is promoted to take over the position. The competition for a promotion happens within the PHU as CHWs are never promoted in PHUs other than their own. The District Health Management Teams (DHMTs), which oversee the implementation of the CHW program at the district level, are in charge of the promotions. Historically, the DHMTs have always delegated the promotion decision to the head of the PHU (the "PHU in-charge"), who is responsible for all personnel and administrative matters in the PHU. While delegating the promotion decision to a specific person may be optimal if that person has private information on which CHW is best fitted to serve as PS, the system is also subject to patronage and nepotism (Xu 2018; Voth and Xu 2021). As we describe later, our data show that there is a wide perception among CHWs that this system is not meritocratic, and that connections to the PHU in-charge, rather than productivity, is the key predictor of promotions.

The set of skills required for the PS and CHW jobs do not perfectly overlap – e.g., the PS position requires managerial skills that the CHW position does not require. As a result, promoting CHWs based on their current performance (as in the new meritocratic system discussed below) is not necessarily the best possible system to select high-performing PSs.[8] Yet, such a system

[6]We use the January 2019 exchange rate: 1 USD = 8,550 SLL (Sierra Leonean Leones). This payment is formally split between their wage and a transportation and communication allowance. In practice, this distinction only serves as a way to earmark the money. These salaries are in line with earnings from other non-CHW activities: CHWs and PSs report earning 200,000 and 240,000 SLL from other non-CHW activities, to which they dedicate 18 and 19 hours per week respectively.

[7]After they retire at 55 years old, PSs are paid 10% of their wage. See data from "Social Security Programs Throughout the World: Africa" for Sierra Leone.

[8]E.g., see the "Peter Principle" (Peter, Hull et al. 1969; Benson, Li, and Shue 2019). It might be more effective,

is likely more effective than the status-quo system that puts more weight on connections. The PS work is indeed mostly independent of the PHU in-charge and having a connection to PHU in-charge has limited added value in our context, as shown in Table A.1. In contrast, promoting a high-performing CHW presumably implies selecting someone who is highly motivated and with good health knowledge, both of which predict PS performance in our sample of workers (see Table A.1).[9]

2.2 Research Design

Our experiment took place in 372 PHUs in six of the 14 districts of Sierra Leone and covers 372 PSs and 2,009 CHWs.[10] These PHUs were cross-randomized into two treatment arms: (1) the "meritocratic promotions treatment", which introduced a new meritocratic promotion regime (henceforth, T_{merit}), and (2) the "pay progression treatment", which created variation in the *perceived pay progression* (henceforth, T_{pay}). We discuss these two sources of variation in turn.

Meritocratic Promotions Treatment. In November 2018, we collaborated with the MoHS and the DHMTs to transition a random 186 PHUs to a new meritocratic promotion system ($T_{merit} = 1$), while the status quo was left unaltered in the remaining 186 PHUs ($T_{merit} = 0$). In the new promotion regime, the DHMTs promoted CHWs based on objective measures of CHW performance collected by the research team. Performance data were collected in $T_{merit} = 1$ and in $T_{merit} = 0$ by measuring the number of visits and the average visit length of those visits through a household survey and unannounced random spot checks with potential patients. Every time a vacancy became available in a treated PHU ($T_{merit} = 1$), we provided the DHMTs with information on the number and average length of the visits provided by each CHW in the PHU, which is then used to decide on whom to promote. No information on performance was shared with DHMTs in the control PHUs ($T_{merit} = 0$).

for example, to promote CHWs based on their "potential" as a good manager. Such systems are however more subjective and have been shown to lead to more discrimination (Benson, Li, and Shue 2021). Understanding which promotion system leads to selecting the best supervisor is outside the scope of this paper and a good avenue for future research.

[9]Table A.1 shows that the high-performing PSs in our sample – i.e., those who supervise and motivate their CHWs by regularly visiting them or by frequently accompanying them on household visits – tend to have greater health knowledge and are predicted to have provided more visits when they themselves were CHWs (columns 1-4). In contrast, connections to the PHU in-charge, proxied with the number of years the PS has known the PHU in-charge before joining the program, do not predict PS performance (columns 5-6).

[10]One district is located in the south (Bo), one in the east (Kenema), three in the north (Bombali, Tonkolili and Kambia), and one in the west (Western Area Rural). In the 372 PHUs, we were able to reach 372 PSs and 2,081 CHWs by phone. Out of the 2,081 CHWs, 72 refused to be interviewed at baseline and are excluded from the sample. All the staff members interviewed at baseline were then re-interviewed at endline. See Section 2.3.1 for more details on the data.

Two weeks after the new promotion system was introduced, we provided information on the new promotion system to CHWs in the 186 PHUs in which the change was implemented ($T_{merit} = 1$). The information was provided by phone by operators trained to read the following script:

> *"I would like to tell you about a new policy of how promotions from CHW to PS will be done. From now on, the number of services and the quality of services a CHW provides every month will be the key criteria for promotion decisions. The next time a new PS vacancy comes up at a PHU, the best-performing CHW at the PHU will be recommended to the DHMT for promotion to PS."*

To keep the saliency of promotions constant between the treatment and control group, we also reminded CHWs in the 186 control PHUs about the status quo promotion system ($T_{merit} = 0$). The same operator who called workers in the meritocratic promotion group read the following script to workers in the control group:

> *"I would like to tell you about the official policy of how promotions from CHW to PS should be done. The PHU in-charge or the PHU CHW Focal can nominate one of the CHWs as the new PS to the DHMT. This means that the decision whether a CHW gets promoted depends mainly on whether the PHU in-charge thinks highly of the CHW."*

Before reading the script in $T_{merit} = 1$ and $T_{merit} = 0$, the phone operators introduced themselves as belonging to a reputable survey firm, and explicitly mentioned that the information they were conveying was officially approved by the DHMT and the MoHS.

In Section 4.1, we will demonstrate that CHWs in $T_{merit} = 1$ updated their perception of meritocracy upward after receiving the information above, indicating that they trusted and understood the information. In contrast, CHWs in $T_{merit} = 0$ did not change their perception. This variation in perceived meritocracy across treatments allows us to quantify the effect of meritocracy on CHW performance in *anticipation* of future promotions, without the need for promotions to occur during the study period. This is a convenient feature of the design because promotions are rare events in our context: only nine CHWs were promoted to PS during the 10 months of our study, four of whom belonged to the meritocratic promotions treatment. More precisely, our empirical design allows us to assess whether CHWs work harder when they learn that future promotions will be more meritocratic, but the low number of promotions we observe

prevents us from estimating the effects of more meritocratic promotions on PS performance and on how this, in turn, affects CHW performance. Because the new meritocratic system likely improves (i) the quality of the PS selected relative to the status-quo (as discussed in the previous section), and (ii) the quality of the application pool for future CHW positions, our results are likely an underestimate of the long-run effect of meritocratic promotions on CHW performance. We discuss this in more detail in the Conclusion.

Importantly, data from the nine promotions that took place during the span of our experiment confirm that promotions were more meritocratic in $T_{merit} = 1$ than in $T_{merit} = 0$. All four health workers promoted in $T_{merit} = 1$ during our experiment ranked among the top 10% in terms of number of visits, while none of the five health workers promoted in $T_{merit} = 0$ ranked that high. Despite the small sample size, this indicates that the DHMTs in $T_{merit} = 1$ used the information we provided to them.

Pay Progression Treatment. As explained above, PSs and CHWs are paid 250,000 SLL and 150,000 SLL per month, respectively. Importantly, this pay gap was unknown to most CHWs at baseline: only 30% of the CHWs guessed the PS pay correctly, while the remaining 70% either over or underestimated PS pay. We took advantage of this lack of information to create random variation in *perceived* pay progression. Cross-randomizing by the meritocratic promotions treatment, we informed CHWs in a random selection of 186 PHUs of the true pay differential between their own salary and their supervisor's ($T_{pay} = 1$). The information was provided by phone, immediately after informing them about the promotion system:

> *"CHWs are entitled to 150,000 SLL per month. PSs are entitled to 250,000 SLL per month, which is 100,000 SLL more per month than CHWs."*

To keep the saliency of pay constant across all treatment groups, we reminded CHWs in the remaining 186 PHUs ($T_{pay} = 0$) about their own pay:

> *"CHWs are entitled to 150,000 SLL per month."*

In Section 4.2, we will show that CHWs in $T_{pay} = 1$ shifted their perception of the pay gap in different directions depending on their priors: workers who underestimated PS pay at baseline revised their perceptions upward, while those who overestimated PS pay revised downward. Importantly, the empirical design allows us to quantify the effect of pay progression on CHW productivity by shifting *perceptions* of pay progression rather than by changing pay progression

per se. The estimates we will later present will thus capture the effect of changing perceived pay progression on CHW productivity, *holding PS productivity fixed*. Estimating the effects of *actually* changing the PS pay on the selection and the performance of the PS and how this, in turn, affects CHW performance is beyond the scope of this paper.

In sum, the 372 PHUs of this study were randomly divided into four groups of equal size varying in T_{merit} and T_{pay}. The randomization was performed at the PHU level because promotions are decided within PHUs, as well as to limit information spillovers between different treatment arms.[11] We stratified the randomization by district and by the presence of temporary performance-based incentives, which were introduced by an external organization in a sub-sample of the PHUs and which are the focus of Deserranno et al. (2022). In Appendix B, we show that the temporary incentives did not interact with our treatments. Finally, note that all the CHWs in this study were on the job when the experiment started. As a result, our treatment effects do not capture any response on the recruitment margin.

2.3 Data and Balance Checks

2.3.1 Data Sources

We leverage survey data collected from CHWs, PSs and households.

CHW and PS surveys. 372 PSs and 2,009 CHWs in the 372 PHUs were surveyed at baseline (in April-May 2018) and at endline (ten months after the implementation of the treatments, in July-September 2019). CHWs were surveyed on their demographic background (age, gender, education, wealth), their knowledge about health, and their CHW job (number of years of experience as a CHW, number of hours dedicated to the CHW job). The PS interviews contained similar questions, though PSs were also asked to rank the CHWs from 1 to N in terms of performance, where N is the total number of CHWs in that PHU. We will later use this as a baseline measure of relative CHW rankings and show that it correlates with other predictors of CHW performance, like CHW health knowledge and education level.

Two weeks before the implementation of the treatments (November 2018) and two weeks after (December 2018), we surveyed each CHW to assess their perceptions about how meritocratic the promotion system is and about pay progression in the organization. We discuss these measures in detail in the next section.

[11] While CHWs and PSs frequently interact within a PHU, these interactions are minimal across PHUs. As a result, CHWs in $T_{pay} = 0$ are unlikely to learn about the PS pay from CHWs in $T_{pay} = 1$. We provide evidence of this later in the paper.

We also have access to baseline village-level information (i.e., accessible road to government hospital, primary school in the village, and number of water sources in the village) collected from a leaflet that is given to each CHW by the PHU.

Household surveys. A random sample of three eligible households per village were surveyed ten months after the implementation of the treatments (in July-September 2019).[12] This represents roughly 7% of the total number of health workers' potential patients. The respondent was the main female household head. She was asked about the number of visits received by the CHW and the average length of those visits. Given the absence of a baseline household survey, we also asked retrospective questions (e.g., connection with the CHW a year ago, household composition) as well as questions that were unlikely to vary over time (e.g., distance from the CHW house or the PHU, education), which we use in the household balance checks.

All CHWs (both in $T_{merit} = 1$ and $T_{merit} = 0$) were made aware at baseline that we would measure their performance by interviewing households on the visits they received. As explained in the previous section, the CHWs in $T_{merit} = 1$ were also aware that this information would then be used by the DHMTs to decide on promotions. To avoid collusion with the households on misreporting visits, CHWs were not informed about how many households we would interview, which ones, and when. In line with the absence of collusion, we show in Section 5.2 that the share of friends and family members of the CHW who report having received a visit is comparable to the share of non-friends who report having received a visit. While interviewing a sample of households increases the noisiness of the performance data (relative to interviewing the entire village), we will later show that the measure of performance is accurate enough to affect CHW effort in $T_{merit} = 1$.

2.3.2 Summary Statistics and Balance Checks

Table 1 (Panel A) reports summary statistics and balance checks for the CHW characteristics. 73% of the CHWs are male, 71% have completed primary education and 8% have completed secondary school. On average, CHWs are 37 years old, have worked as a CHW for 2.2 years, are responsible for 57 households each, and report working 18 hours per week as a CHW. On

[12] In the absence of a full listing of households in each village, the sampling was done through a random walk starting from the house of the CHW and with pre-specified sampling intervals between households. To cover a random sample of households across the *entire* village (and not only households who live near the CHW), the intervals were calculated based on the total number of households in the community. In order to be eligible for the household survey, the respondent had to be female, be one of the primary caregivers, be between 18 and 49 years old, and have lived in the household for at least 6 months during the study period. We set these eligibility criteria so that sampled households would belong to the group targeted to receive the services of the CHW.

a health knowledge test with 7 questions, they answered an average of 2.9 questions correctly, indicating low health knowledge. To perform the balance checks, we regress each baseline CHW characteristic on a dummy for the meritocratic promotions treatment, the pay progression treatment and the interaction of both, controlling for stratification variables and clustering standard errors at the PHU level. Columns (3) to (8) show that CHW characteristics are well balanced across treatments.

Panel B reports summary statistics on PS characteristics. PSs are 38 years old on average, with 10% being above 50 years old and expecting to retire within five years. Relative to the CHWs, PSs are more likely to be men (92%) and are more likely to have completed secondary school (25%). They are also more knowledgeable about health services and dedicate fewer hours per week to the program (11 hours per week). They are responsible for an average of eight CHWs each, and have worked an average of 3.5 years as a PS. PS characteristics are balanced across treatments.

Panel C presents summary statistics on CHW perceptions about meritocracy and pay progression before the implementation of the treatments. We discuss these in the Section 4.

Table A.2 presents summary statistics at the village level (Panel A) and at the household level, aggregated to the village level (Panel B). Household respondents are less educated than both CHWs and PSs, with only 28% having completed primary school; household members are also less wealthy. Nearly all (97%) of the households knew the CHW at baseline. Most (87%) live within 30 minutes of the CHW's house and 39% live within 30 minutes of a government hospital. The village and household characteristics are balanced across treatments.

Table A.3 presents the balance checks on CHW characteristics within three samples of CHWs, which we will study separately in Section 5.3: i.e., CHWs who overestimate PS pay at baseline, who underestimate it, and who estimate it correctly. Variables are balanced within each sample.

Importantly, the data show that there is a wide perception among CHWs that the status-quo promotion system is not meritocratic. Indeed, only 45% of the CHWs reported that the PS was the best-performing CHW at the time of their promotion (last variable of Table 1, Panel A) and 50% reported perceiving the system as non-meritocratic at baseline, a finding that we revisit in Section 4.1. Moreover, we calculate that, at the time they were promoted, more than 60% of the PSs in our sample were more connected to the PHU in-charge (in term of number of years they had known each other) than any other potential PS candidate, while less than 25% of them ranked highest in terms of (predicted) performance as a CHW (see Figure A.3 for details). Table

A.4 presents a horse race between the different CHW characteristics in predicting promotion, and shows that connections matter twice as much as performance and education, and more than 10 times as much as tenure.[13] We interpret this as evidence that social connections are the key determinant of promotions when these are decided by the PHU in-charge. Interestingly, the correlation between social connections and CHW performance is only 0.018 within the pool of CHWs we interviewed and is not statistically significant. Thus, promoting CHWs based uniquely on connections rather than based on performance presumably leads to substantially different candidate selection.

3 Theoretical Framework

In this section, we set up a simple model of promotion tournaments. The model provides a set of theoretical predictions on how workers respond to meritocratic promotions and pay progression that will guide our empirical analysis. These predictions are distinct from those of models studying non-tournament-based incentives because workers are rewarded based on their relative (rather than absolute) performance.

3.1 The Setup

Players. Several Community Health Workers (CHWs) compete to be promoted to the position of Peer Supervisor (PS). They are risk-neutral and value the promotion in proportion to the pay progression from CHW to PS. The promotion mechanism is modeled as a single-prize contest, in which CHWs compete by exerting effort. In what follows, we study the case of two CHWs competing for the promotion. The case of N CHWs leads to similar predictions under additional mild assumptions.

The Promotion Tournament. We are interested in a promotion tournament in which a principal can observe the effort of both workers, $(e_1, e_2) \in \mathbb{R}^2_+$, and can commit to a promotion rule that maps any effort pair to a promotion decision. Since the promotion contest is characterized by this promotion rule, we start by specifying it.

[13] We follow a two-steps procedure to predict PS past performance when they were CHWs. Refer to the notes of Figure A.3 or Table A.4 for details on the procedure. For each PS in our dataset, we identify the CHWs who competed for the PS position as those who were on-the-job at the time of the promotion and which we interviewed at baseline. In a dataset composed of all competing CHWs and the PS, we regress an indicator for "being promoted" (1 for the PS and 0 for the CHWs) on individual characteristics at the time of the promotion.

We denote a *meritocratic promotion rule* by $P = (P_1, P_2)$ where $P_i : \mathbb{R}^2_+ \to [0,1]$ such that

$$(e_1, e_2) \to P_i(e_1, e_2) = \begin{cases} 0 & \text{if } e_i < e_{-i} \\ p & \text{if } e_i = e_{-i} \\ 1 & \text{if } e_i > e_{-i} \end{cases}$$

where $p \in (0,1)$ and $\sum_{i=1,2} P_i(e_1, e_2) = 1$. This promotion rule is the standard winner-take-all-allocation rule which has been extensively used in the promotion tournament literature (e.g., Lazear and Rosen 1981; Siegel 2010, 2014).

We are also interested in *non-meritocratic promotion rules*. Let $b = (b_1, b_2) \in \mathbb{R}^2$ denote the extent to which a promotion tournament is non-meritocratic. The b-biased contest is a promotion tournament characterized by $P^b = (P_1^b, P_2^b)$, where $P_i^b(e_1, e_2) = P(b_1 e_1, b_2 e_2)$.[14] Therefore, a promotion tournament is meritocratic if $b_1 = b_2$. If $b_1 \neq b_2$, the promotion rule favors one of the workers, and we will say that it is non-meritocratic.

Note that any b-biased contest is strategically equivalent to the $b' = (\frac{b_1}{b_2}, 1)$-biased contest. In what follows, we will use b to refer to contest $(b, 1)$. In this setting, the meritocratic contest is then simply the 1-biased contest. Implicitly, we also assume that any non-meritocratic contest favors player 1, i.e., $b \geq 1$. The case in which the contest favors player 2 ($b < 1$) is similar.

Payoffs. The CHWs decide how much effort to exert. Effort is costly and each worker is characterized by a cost function of effort $c_i : \mathbb{R}_+ \to \mathbb{R}_+$. Workers exert effort in the hope of being promoted, which increases their wage from $\underline{w}$ to $\bar{w}$. We refer to $\bar{w} - \underline{w} > 0$ as the *pay progression* associated with the promotion.

Given a promotion rule P^b and an effort pair (e_1, e_2), player i's payoff is

$$u_i(e_1, e_2) = \underline{w} + P_i^b(e_1, e_2)\,[\bar{w} - \underline{w}] - c_i e_i. \tag{1}$$

The payoff is a function of how meritocratic the promotion rule is (P^b), the pay progression ($\bar{w} - \underline{w}$), and the cost of effort $c_i > 0$ which is assumed to be linear.[15] We define worker i to have higher ability than worker i' if $c_i \leq c_{i'}$.

The model is divided into two parts. We first consider the cost function, c_i, as independent of

[14] All model's results hold if the bias is instead assumed to be additive, i.e., if $\tilde{P}_i^b(e_1, e_2) = P(e_1 + b_1, e_2 + b_2)$.

[15] The assumption of cost linearity is common in the literature on promotion rules (e.g., Nti, 2004; Franke, 2012; Franke et al., 2013) and can be relaxed in the model. Most of the results indeed hold if we assume convex costs and make minimal assumptions on the cost elasticities.

pay progression $\bar{w} - \underline{w}$ and meritocracy b (Section 3.2). We then extend the model by assuming that workers display *morale concerns* and that their costs instead depend on pay progression $\bar{w} - \underline{w}$ and meritocracy b (Section 3.3). This assumption is motivated by recent empirical evidence showing that morale concerns about pay differences and unfair promotions negatively affect effort within the workplace (Card et al. 2012; Cohn et al. 2014; Mas 2017; Breza, Kaur, and Shamdasani 2017; Li 2020). As such, we hypothesize that workers perceive a high pay progression (high $\bar{w} - \underline{w}$) in a non-meritocratic regime (high b) as unfair, leading to higher perceived costs. This is modeled by adding an extra morale cost-shift function $g_i : \mathbb{R}^2_+ \to \mathbb{R}_{++}, (b, \bar{w} - \underline{w}) \mapsto g_i(b, \bar{w} - \underline{w})$ in player i's payoff:

$$u_i(e_1, e_2) = \underline{w} + P_i^b(e_1, e_2)[\bar{w} - \underline{w}] - c_i g_i(b, \bar{w} - \underline{w}) e_i \tag{2}$$

The addition of the morale cost-shift function will only be consequential for a subset of the results, while other results will hold regardless. This will be made clear later in the model.

Throughout, we assume that the participation constraints of both players are satisfied. We are interested in Nash equilibria in which no players play a weakly dominated action with positive probability. See Appendix D for a more formal and detailed exposition of the model.

3.2 Predictions without Morale Concerns

This section studies the b-biased contest ($b \geq 1$) with pay progression $\bar{w} - \underline{w} > 0$ when there are no morale concerns for any player. The morale cost-shift function is thus normalized to 1 for both players, i.e., $g_i(b, \bar{w} - \underline{w}) = 1$ for all $b, \bar{w} - \underline{w}$, and i.

Following Siegel (2010), the b-biased promotion tournament with effort costs (c_1, c_2) has a unique equilibrium in mixed strategies. From Propositions D.2 - D.8 presented in Appendix D.1, we obtain the following predictions for all players:

Prediction 1. *All else equal, more meritocratic promotions (lower b) increase worker effort.*

Prediction 2. *All else equal, higher pay progression (higher $\bar{w} - \underline{w}$) increases worker effort.*

Prediction 3. *The effect of higher meritocracy (resp., pay progression) on worker effort increases as pay progression (resp., meritocracy) increases.*

Prediction 4. *The effort response in Predictions 1 - 3 is stronger for higher-ability workers.*

See Appendix D.1 for details on the propositions and Appendix D.2 for their proofs.

Note that the intensity of the effort response described in the Predictions 1-3 is comparable for players 1 and 2 as long as their costs are symmetric. See Appendix D.1.1 for more details.

3.3 Predictions with Morale Concerns

This section derives the model's results under the assumption that workers display *morale concerns*, which we model by adding an extra morale cost-shift function $g_i : \mathbb{R}^2_+ \to \mathbb{R}_{++}, (b, \bar{w}-\underline{w}) \to g(b, \bar{w} - \underline{w})$ in workers' payoffs.

We make three assumptions about g_i. Each of these are explained intuitively below and formally presented in Appendix D. The first assumption is that the only player who faces morale concerns is the "unfavored" player (2), i.e., $g_1(b, \bar{w} - \underline{w}) = 1$ for all $(b, \bar{w} - \underline{w}) \in \mathbb{R}^2_+$. This assumption is made for simplicity and the results that follow hold if g_1 was instead decreasing in both of its arguments. The second assumption is that a more-biased contest, or a contest with higher pay progression, increases the morale cost-shift function for player 2, and does so in a log-supermodular way.[16] Finally, we assume that for a higher pay progression $\bar{\bar{w}} - \underline{\underline{w}} > \bar{w} - \underline{w}$, $g_2(b, \bar{\bar{w}} - \underline{\underline{w}})$ dominates $g_2(b, \bar{w} - \underline{w})$, and therefore that the morale cost-shifts increase faster in the bias when the pay progression is higher.

Given these assumptions, we can rewrite the players' payoffs as:

$$u_1(e_1, e_2) = \underline{w} + P_1^b(e_1, e_2)[\bar{w} - \underline{w}] - c_1 e_1$$
$$u_2(e_1, e_2) = \underline{w} + P_2^b(e_1, e_2)[\bar{w} - \underline{w}] - c_2 g_2(b, \bar{w} - \underline{w}) e_2$$

From Propositions D.9 - D.14 presented in Appendix D.1.2, we obtain the following predictions for all players:

Prediction 5. *All else equal, more meritocratic promotions (lower b) increase worker effort.*

Prediction 6. *All else equal, higher pay progression (higher $\bar{w} - \underline{w}$) increases worker effort if the promotion rule is meritocratic enough ($b \leq \bar{b}$), while it reduces effort if the promotion rule is non-meritocratic enough ($b \geq \bar{\bar{b}}$).*

Prediction 7. *The effect of higher meritocracy (resp., pay progression) on worker effort increases as pay progression (resp., meritocracy) increases if $b \leq \bar{b}$.*

Prediction 8. *The effort response in Predictions 5 - 7 is stronger for higher-ability workers.*

[16] Log supermodularity implies that the morale cost-shift function becomes less elastic in b as the pay progression increases.

See Appendix D.1 for a formal definition of $\bar{b}$ and $\bar{\bar{b}}$ and for details on the propositions, and Appendix D.2 for the proofs.[17]

The theoretical framework makes clear that the addition of morale concerns does *not* affect the direction of workers' reactions to meritocracy: higher meritocracy in the promotion rule always increases worker effort, regardless of the presence of morale concerns (Predictions 1 and 5). The addition of morale concerns, however, does affect the direction in which workers respond to pay progression. Without morale costs (g_i), greater pay progression always boosts workers' effort regardless of how meritocratic the promotion rule is (Prediction 2). With morale costs (g_i), greater pay progression boosts workers' effort only if the promotion rule is meritocratic enough, while it *reduces* worker effort if the rule is not meritocratic (Prediction 6).[18] We will later show that, empirically, the effect of pay progression is consistent with Prediction 6 rather than Prediction 2, and thus consistent with the presence of morale concerns.

Finally, note that Prediction 6 can be obtained in an alternative multitasking model (without morale concerns) in which workers not only choose how much effort to exert on productive tasks $e_i \in \mathbb{R}_+$ but also choose whether and how much to lobby their principal for the promotion (unproductive task): $l_i \in \mathbb{R}_+$.[19] If productive effort (e_i) and lobbying (l_i) are substitutes, such a model predicts that if the promotion rule is not meritocratic enough, greater pay progression reduces productive effort while increasing lobbying effort. We do not focus on this alternative model since it is proven to be inconsistent with the empirical results in Section 5.3.

4 Beliefs Updating

In this section, we show that our treatments create exogenous variation in workers' perceptions about how meritocratic the promotion system is and about pay progression.

[17] The intensity of the effort response described in Prediction 5 is comparable for players 1 and 2 as long as their costs are symmetric. For Predictions 6 and 7, the relative intensity of the effort response is theoretically ambiguous, and therefore not explored empirically. See Appendix D.1.2 for more details.

[18] Intuitively, morale concerns introduce a tension when assessing the effect of pay progression on productivity. Steeper pay progression raises the effective prize for any given level of effort, which prompts player 2 to exert more effort. At the same time, it leads player 2 to perceive the promotion tournament as more unfair, which increases the effective costs and reduces her effort. Morale concerns instead unambiguously amplify the effect of meritocracy on productivity. A more biased tournament decreases the likelihood that player 2 wins the contest (and therefore reduces the effective prize for any given level of effort), and it increases morale concerns (and therefore increases the cost of effort).

[19] Imagine that the principal promotes the worker who obtains the highest score $s_i^\alpha = \alpha e_i + (1-\alpha) l_i$, where $\alpha \in \mathbb{R}$ captures how efficient lobbying is in getting the promotion, then the CHWs compete by simultaneously and independently choosing a score $s_i^\alpha \in \mathbb{R}_+$. Given the scores (s_1^α, s_2^α), CHW i's payoff becomes $u_i(s_1^\alpha, s_2^\alpha) = \underline{w} + P_i(s_1^\alpha, s_2^\alpha)\,[\bar{w} - \underline{w}] - \min_{e_i, l_i | \alpha e_i + (1-\alpha) l_i = s_i^\alpha} c_i(e_i, l_i)$.

4.1 Beliefs about Meritocratic Promotions

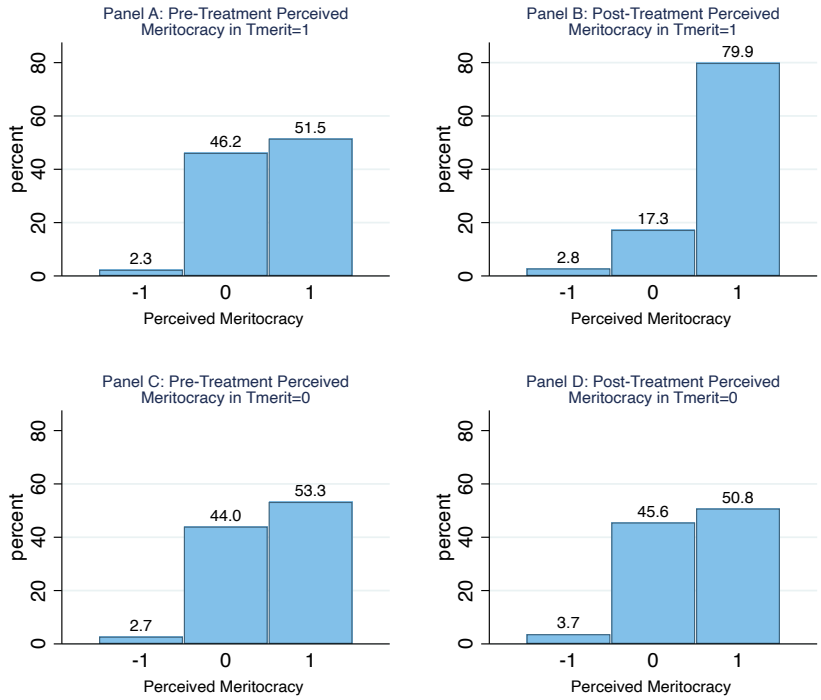
To measure how workers updated their beliefs about meritocracy in the promotion system, we analyze CHWs' perceptions about meritocracy before and after we announced the introduction of the new promotion regime. We measure perceived meritocracy using a set of hypothetical survey questions. We asked each CHW which of the following workers she perceived as having a higher chance of being promoted: a CHW who ranks *first* out of 10 in terms of performance but who does not know the PHU in-charge outside of work vs. another CHW who ranks X out of 10 and who knows the PHU in-charge outside of work, where $X = \{2, 5, 10\}$.[20] Our measure of perceived meritocracy takes a value of -1, 0 or 1. It is coded as 1 if the CHW perceives the system as meritocratic, that is if she believes that the best-performing worker is always more likely to be promoted than the well-connected worker, regardless of whether the connected worker is ranked second, fifth or tenth. It is coded as -1 if the CHW perceives the system as non-meritocratic, that is if she believes that the best-performing worker is never promoted, even when the connected worker is the worst performer (ranked tenth). It is coded as 0 for intermediate situations in which the CHW believes that the best-performing worker is more likely to be promoted only when the well-connected worker has a low enough performance (ranked either fifth or tenth).

Figure 1 presents the distribution of meritocracy perceptions before and after treatment among CHWs in the meritocratic promotions treatment ($T_{merit} = 1$) and the rest ($T_{merit} = 0$). Consistent with randomization, perceptions are comparable in $T_{merit} = 1$ and $T_{merit} = 0$ before treatment (Panels A vs. C) with roughly 50% of CHWs perceiving the promotion system as meritocratic (prior of 1). A formal balance check of the perception variable is presented in Table 1 (Panel C). Table 2 (columns 3-4) shows that workers who perceive the system as meritocratic at baseline are more likely to be satisfied with the work of the PS, and are more wealthy.

After the introduction of the new promotion system, CHWs updated their beliefs upward in $T_{merit} = 1$, with an extra 28.4% of CHWs perceiving the system as meritocratic (Figure 1 Panels A vs. B). Interestingly, the CHWs who updated perception of meritocracy upward are those who had a prior of 0, while the 2.3% of workers with a more extreme prior of -1 did not update upward. In $T_{merit} = 0$, CHWs did not significantly update their perceptions (Panels C vs. D). The corresponding regression results are presented in Table 3 where we estimate the

[20] The exact wording of the questions is: "*A PHU needs a new PS. Whom of the following two CHWs is most likely promoted to PS? (1) Alpha is the best-performing CHW (out of 10). Alpha does not know the PHU in-charge outside of work. (2) Foday is the second-best/ fifth-best/worst-performing CHW (out of 10). Foday is a very good friend of the PHU in-charge.*"

FIGURE 1: BELIEFS UPDATING ABOUT MERITOCRACY



Notes: This figure plots the distribution of perceived meritocracy in the promotion system, which ranges from -1 to 1. Refer to the text for an exact definition. Panels A and B are restricted to Tmerit=1 and Panels C and D to Tmerit=0. Panels A and C (B and D) plot perceptions before (after) the information on meritocracy was provided to the CHWs.

effect of the meritocratic promotions treatment on post-treatment perceptions, controlling for the stratification variables and clustering standard errors at the PHU level. Column (1) shows that the average perception of meritocracy in $T_{merit} = 1$ is 63% higher than in $T_{merit} = 0$ following treatment (statistically significant at the 1% level). Consistent with Bayesian models, CHWs whose prior of meritocracy is the highest in $T_{merit} = 1$ updated their beliefs less strongly (Table A.5, column 1).

Interestingly, T_{merit} did not affect the expected time until the next promotion in the PHU (Table 3, column 2).[21] It also did not affect perceptions about PS pay, PS workload (number of working hours), or PS work-related expenses (transportation and communication): see columns (3) to (5). In sum, the meritocratic promotions treatment appears to have changed perceptions about the promotion criteria (which is perceived as more performance-based), without affecting the perceived prize associated with the promotion and the perceived duration until the next

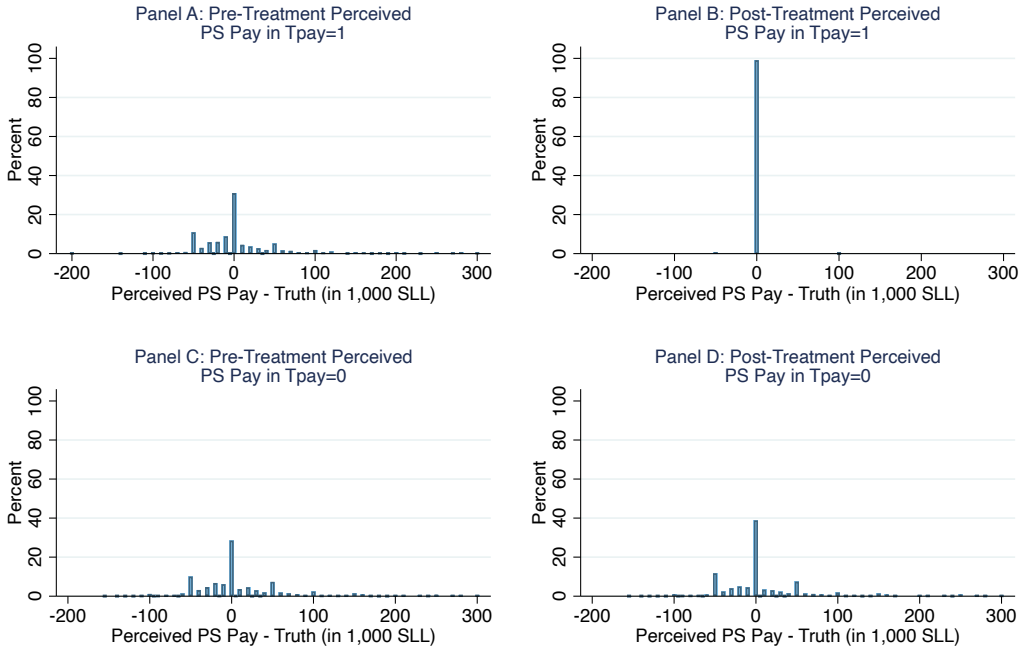
[21] These results should be taken as suggestive because 30% of the CHWs said they were not sure when the next promotion will take place. While this is not surprising – it is often hard to precisely predict a superior's future exiting behavior – this forces us to code the answer of these CHWs as missing, and to effectively run the regression on a potentially endogenous sample of CHWs.

promotion.

4.2 Beliefs about Pay Progression

Figure 2 plots the difference between perceived and true PS pay for CHWs in the pay progression treatment ($T_{pay} = 1$) and those not assigned to that treatment ($T_{pay} = 0$). To measure perceived PS pay, we asked each CHW: "*How much does your PS earn from the government each month?*" and offered a reward conditional on giving the right answer to elicit truthful responses.[22] We did not ask CHWs about perceptions of their own pay as this information was revealed to everyone at baseline, as explained in Section 2.2.

FIGURE 2: BELIEFS UPDATING ABOUT PAY PROGRESSION



Notes: This figure plots the difference between Prior PS Pay and the truth (250,000 SLL). Panels A and B are restricted to Tpay=1 and Panels C and D to Tpay=0. Panels A and C (B and D) plot perceptions before (after) the information on PS pay was provided to the CHWs.

Consistent with the randomization, perceptions of PS pay are comparable in $T_{pay} = 1$ and $T_{pay} = 0$ before the treatment (Panels A vs. C). In both groups, roughly 30% of the CHWs estimated correctly that PSs earn 250,000 SLL per month. 37% of the CHWs underestimated PS pay and 33% overestimated it.[23] Table 2 (columns 5-6) shows that the size of the misperception

[22] We offered a reward of 2,000 SLL if the answer is correct. To avoid revealing the true pay to CHWs who are not in the pay progression treatment, we disbursed the reward only at the end of the study period.

[23] Large misperceptions about supervisors' pay are common in organizations. In Cullen and Perez-Truglia (2022), for example, only 12% of respondents knew their manager's salary. In our context, large misperceptions

about PS pay at baseline is correlated with the number of years of experience as a CHW and with the age of the CHW. Interestingly, the size of the misperception is comparable for CHWs who are connected to the PS or connected to the PHU in-charge relative to unconnected CHWs. Table 2 column (11) compares workers who under vs. overestimate PS pay at baseline, and shows that the former are older, have more tenure and knowledge.

After receiving information about PS pay, almost all CHWs' beliefs in $T_{pay} = 1$ converged to the true PS pay (250,000 SLL): see Figure 2 (Panel B). In contrast, few CHWs updated their beliefs in $T_{pay} = 0$, in which only 38% of the CHWs correctly guessed PS pay in our post-treatment survey (Panel D). The absence of significant belief updating in $T_{pay} = 0$ corroborates the lack of information spillover across treatment groups. The corresponding regression results in Table 4 (column 1) show that the mean absolute difference between perceived PS pay and the truth is 482 SLL in $T_{pay} = 1$ vs. 35,320 SLL in $T_{pay} = 0$. Table A.6 column (1) shows that, consistent with Bayesian models, CHWs update their beliefs more strongly the further their baseline perception about PS pay was from the truth. Column (2) shows that belief updating about PS pay is orthogonal to T_{merit}.

Throughout the paper, we will study the effect of T_{pay} in three separate groups of workers: (i) CHWs who underestimated PS pay at baseline, (ii) those who overestimated PS pay, and (iii) those with accurate beliefs. This is because these workers revised their beliefs in different directions in $T_{pay} = 1$, and are thus expected to respond differently to the treatment: the first group revised their perceptions of PS pay *upward* by 29,043 SLL (+13%), the second group revised them *downward* by 59,685 SLL (-19%), and the third group did not update their views significantly (Table 4, column 6). The magnitude of the update is smaller for the first than the second group because the level of CHW pay (150,000 SLL) provides a lower bound for perceptions about PS pay.

In columns (7) and (8) of Table 4, we explore whether changes in CHWs' perceptions of PS pay were associated with changes in perceived PS workload (number of working hours) and PS work-related expenses (transportation and communication). Workers who revised their perception of PS pay downward did not change their perceptions in either area, while those who revised their perception of PS pay upward increased their estimates of PS work-related expenses slightly, but did not change their perceptions of the PS workload. Overall, this indicates that the pay progression treatment affected *perceptions of gross* PS pay as well as *net* PS pay (i.e.,

about PS pay likely exist because this information is not publicized to CHWs. Additionally, discussions between colleagues about each other's pay is not the norm.

the PS pay accounting for total working hours and work expenses). Finally, columns (9) and (10) show that CHWs who update their beliefs of PS pay upward or downward did not change their perceptions about meritocracy in the promotion system or about the duration until the next promotion.

5 Main Results

In this section, we assess the effect of meritocracy, pay progression and the interplay of the two on worker performance. We first discuss the empirical specifications and then present the results.

5.1 Empirical Specifications

The previous section has established that our treatments have significant effects on CHWs' beliefs about meritocracy and pay progression. Importantly, we have shown that revealing the PS pay to the health workers (T_{pay}) has differential effects on perceived pay progression depending on whether a worker's prior about the PS pay is above, at, or below the truth. Due to this heterogeneous belief updating, the standard specification for analyzing conventional 2×2 experimental designs (i.e., $Y_{ij} = \alpha + \beta T_{merit,j} + \gamma T_{pay,j} + \delta T_{merit,j} \times T_{pay,j} + \eta Z_j + \varepsilon_{ij}$) is not quite as informative in our context. The reason is that the direction in which beliefs about PS pay are updated in the pay progression treatment – and thus also the predicted effect on worker productivity – depends on whether a worker overestimates, underestimates, or correctly estimates pay progression at baseline. Therefore, most of our analysis will rely on a triple-interacted model that interacts T_{merit}, T_{pay}, and $T_{merit} \times T_{pay}$ with indicators for whether workers' priors about PS pay are above, at, or below the truth. We describe the specification in detail below. In the interest of transparency, we report the results using the 2×2 specification in the Appendix but do not discuss them extensively.[24]

For ease of exposition, the empirical analysis in divided two parts. Section 5.2 studies the causal effect of greater meritocracy on worker productivity and how this effect varies for different worker types, and in particular for those with high vs. low baseline perceived pay progression. Section 5.3 studies the causal effect of pay progression on worker productivity in the (new) meritocratic regime vs. the (old) non-meritocratic regime. Together, Sections 5.2 and 5.3 shed light on how pay progression and meritocracy interact with each other. We now lay out the

[24] See Table A.7 and the discussion in footnote 27.

specific empirical strategy for each of the two sections.

Section 5.2 first addresses the question of how greater meritocracy affects the productivity of the average worker by estimating the simple specification $Y_{ij} = \alpha + \beta T_{merit,j} + \eta Z_j + \varepsilon_{ij}$, where Y_{ij} is the productivity of worker i in PHU j, $T_{merit,j}$ is an indicator for the meritocratic promotions treatment, Z_j are the stratification variables, and ε_{ij} are standard errors clustered at the PHU level. The coefficient β captures the average effect of the meritocratic promotions treatment in the entire sample of workers.[25]

From Predictions 3-4 and 7-8 of our theoretical framework and as pre-registered in the AEA registry (see Appendix C), we expect the effect of our meritocratic promotions treatment to be stronger for workers who perceive the prize associated with the promotion to be large enough to be interested in the promotion, i.e., (i) workers with high priors about PS pay and (ii) workers who expect the promotion to materialize soon. We also expect the effect to be stronger for (iii) workers who are highly ranked in terms of performance (i.e., high ability), as they have a higher chance of being promoted in a meritocratic regime.

To assess the effects of the meritocratic promotions treatment by time to promotion and performance ranking, we estimate $Y_{ij} = \alpha + \beta T_{merit,j} \times X_{ij} + \gamma T_{merit,j} \times (1 - X_{ij}) + \delta X_{ij} + \eta Z_j + \varepsilon_{ij}$, where X_{ij} is a dummy for whether a promotion is expected soon or whether a worker is high-ranked. In this model, we expect $\hat{\beta}$ (the effect for workers who expect the promotion soon or who are high ranked) to be larger than $\hat{\gamma}$ (effect for promotion not soon or low ranked). Because we study multiple heterogeneous effects, we correct our p-values for multiple hypothesis testing and show these at the bottom of each table.

To assess the heterogeneous effects of the meritocratic promotions treatment by perceived pay progression, we move on to our core triple interacted model, which explicitly incorporates workers' prior beliefs about PS pay:

[25] This includes workers who received information about the PS pay and those who did not. As such, the magnitude of the coefficient β is specific to the baseline distribution of beliefs about pay progression and the assignment to the pay progression treatment in our sample. As explained below, we will also study the effect of meritocratic promotions for workers with different baseline beliefs.

$$
\begin{aligned}
Y_{ij} = \alpha &+ \beta_{above}[T_{merit,j} \times \mathbb{1}_{Prior>Truth,ij}] + \beta_{at}[T_{merit,j} \times \mathbb{1}_{Prior=Truth,ij}] + \beta_{below}[T_{merit,j} \times \mathbb{1}_{Prior<Truth,ij}] \\
&+\gamma_{below}[T_{pay,j} \times T_{merit,j} \times \mathbb{1}_{Prior<Truth,ij}] + \delta_{below}[T_{pay,j} \times (1 - T_{merit,j}) \times \mathbb{1}_{Prior<Truth,ij}] \\
&+\gamma_{above}[T_{pay,j} \times T_{merit,j} \times \mathbb{1}_{Prior>Truth,ij}] + \delta_{above}[T_{pay,j} \times (1 - T_{merit,j}) \times \mathbb{1}_{Prior>Truth,ij}] \\
&+\gamma_{at}[T_{pay,j} \times T_{merit,j} \times \mathbb{1}_{Prior=Truth,ij}] + \delta_{at}[T_{pay,j} \times (1 - T_{merit,j}) \times \mathbb{1}_{Prior=Truth,ij}] \\
&+\lambda_{below}\mathbb{1}_{Prior<Truth,ij} + \lambda_{above}\mathbb{1}_{Prior>Truth,ij} + \eta Z_j + \varepsilon_{ij}, \qquad (3)
\end{aligned}
$$

where $\mathbb{1}_{Prior>Truth,ij}$, $\mathbb{1}_{Prior=Truth,ij}$ and $\mathbb{1}_{Prior<Truth,ij}$ are indicators for whether workers' prior about PS pay at baseline is above, at, or below the truth (250,000 SLL), and the remaining variables are defined as before. Specifically, we are interested in testing whether $\hat{\beta}_{above} > \hat{\beta}_{at}$ and $\hat{\beta}_{above} > \hat{\beta}_{below}$, i.e., whether the effect of meritocracy is larger for workers who overestimate PS pay at baseline than those who know the true PS pay or those who underestimate it. Note that by focusing on the β coefficients, we limit the comparisons we make to workers in $T_{pay} = 0$, who did not receive information on PS pay. The corresponding comparisons in $T_{pay} = 1$ (i.e., $\hat{\beta}_{above} + \hat{\gamma}_{above}$ vs. $\hat{\beta}_{at} + \hat{\gamma}_{at}$ vs. $\hat{\beta}_{below} + \hat{\gamma}_{below}$) are uninformative about the heterogeneous effect of T_{merit} with respect to beliefs about pay progression. This is because workers' beliefs about PS pay all converge to the truth in $T_{pay} = 1$ and we would be comparing workers with the same *ex-post* beliefs even though their *ex-ante* beliefs were different.

The γ's and δ's coefficients in equation (3) are discussed in Section 5.3, where we assess the differential effect of pay progression on worker productivity by meritocracy and baseline perception of PS pay. By focusing on workers with a prior below (above) the truth, γ_{below} (γ_{above}) capture the causal effect of *increasing* (*reducing*) perceived pay progression on worker productivity in the new meritocratic regime and the old non-meritocratic one, respectively. γ_{at} and δ_{at} are the corresponding effects for workers who did not update their beliefs, which we use as placebos. Across-types comparisons (e.g., γ_{above} vs. γ_{below}) are not causal and are not the focus of this paper.

Finally, the λ's coefficients in equation (3) compare worker productivity across worker types when T_{merit} and T_{pay} are both zero. We do not report these coefficients in the result tables for brevity.

5.2 The Effect of Meritocratic Promotions on Worker Productivity

The goal of this section is to assess how greater meritocracy affects worker performance. Our main measure of worker performance is the total number of visits that households report having received from the CHW in the six months prior to the endline survey (mean of 7.9).[26] To obtain this measure, we take the total number of times a household has received a routine visit, ante- or post-natal visit, or has been treated/referred for sickness, and then average these data at the CHW level. We will later also present results on the length of the visits (mean of 15 minutes) – which we will use as a proxy of work quality – and on retention.

We start by testing Predictions 1 and 5 in the model and assess the effect of T_{merit} on the average worker's productivity, i.e., pooling together workers who did and did not receive information about the PS pay and pooling together workers with different baseline beliefs about pay progression. The first panel of Figure 3 and the corresponding Table 5 column (1) show that making the promotion system more meritocratic raises the number of visits provided by the average CHW by 1.497 (which corresponds to a 22.2% increase relative to the average in $T_{merit} = 0$). The effect is sizable and statistically significant at the 1% level.[27]

Table A.8 breaks down the effect of T_{merit} on the number of visits of the average worker by type of visit and shows that relative to $T_{merit} = 0$, CHWs in $T_{merit} = 1$ do more routine household visits and treat and refer more patients, while the number of ante- and post-natal visits is not significantly affected.

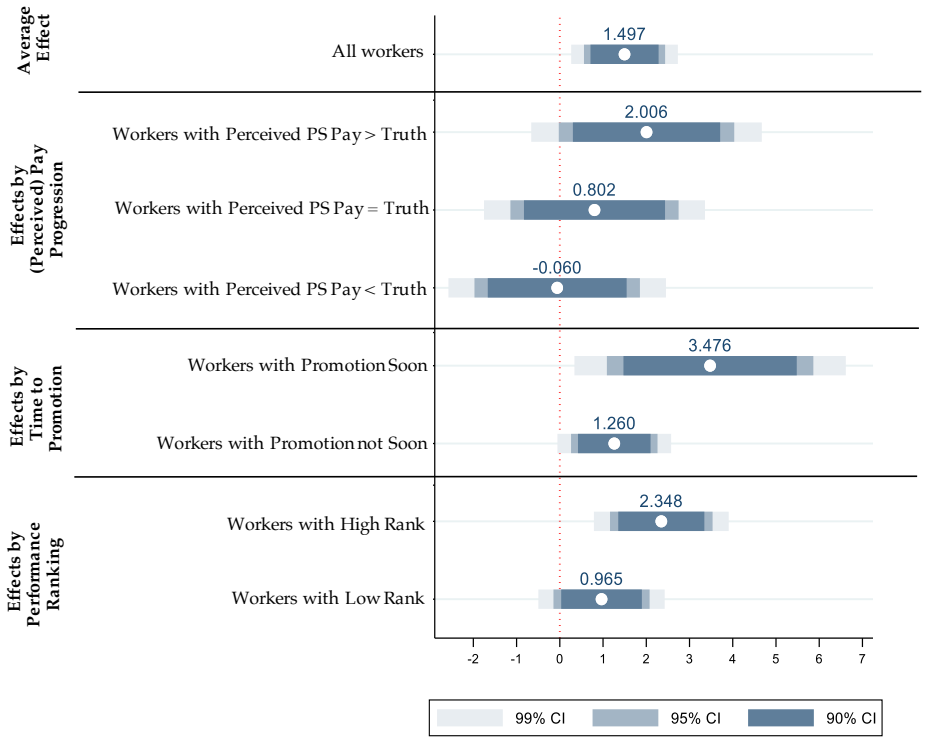
Heterogenous Effect by Perceived Pay Progression. As explained above, we expect the effect of meritocracy to be stronger for workers with high perceived pay progression. We test this by estimating the $\hat{\beta}'s$ coefficient from the fully interacted model in equation (3). Refer to Section 5.1 for more details on the specification.

The second panel of Figure 3 and the corresponding Table 5 (Panel A, column 2) show that the effect of T_{merit} is indeed highest for workers whose prior about pay progression was above the truth ($\hat{\beta}_{above} = 2.006$, a 29.3% increase relative to the average number of visits provided

[26] To minimize recall bias, households were asked about visits received "since the start of the year", which roughly corresponds to the past 6 months.

[27] An earlier version of the paper analyzed the effect of meritocracy only in the sub-sample that did not receive information on the actual PS pay ($T_{pay} = 0$). We now center the analysis on the full sample, which allows us to maximize power. In the interest of transparency, we show the results from the 2×2 specification, which estimates the effect of T_{merit} in $T_{pay} = 0$ and $T_{pay} = 1$, in Table A.7. The table shows that T_{merit} increases the number of visits provided by 0.978 (13%) in $T_{pay} = 0$ and by 2.026 (27%) in $T_{pay} = 1$. The two effects are not statistically different from each other. It is important to mention that it is not clear ex-ante whether the effect of T_{merit} should be higher in either of the two conditions of T_{pay}. A detailed discussion of the interaction between T_{merit} and T_{pay} (and the prior about PS pay) is the subject of Section 5.3.

FIGURE 3: EFFECT OF MERITOCRACY ON THE NUMBER OF VISITS



Notes: The first panel plots the effect of Tmerit on the number of visits for the average worker. The second panel plots the effect of Tmerit by whether the prior about PS pay is above, equal or below the actual salary of SLL 250,000 [i.e. "Prior PS Pay >, = or < Truth"]. These correspond to the estimates for $\boldsymbol{\beta}_{\text{above}}$, $\boldsymbol{\beta}_{\text{equal}}$, $\boldsymbol{\beta}_{\text{below}}$ in equation (3). The third panel plots the effect of Tmerit by whether the supervisor of the CHW is within 5 years of retirement age at baseline ["Promotion Soon"]. The fourth panel plots the effect of Tmerit for "High Rank" workers (ranked first, second or third in terms of performance by the PS at baseline) and for "Low Rank" workers (ranked fourth or more). "Number of visits" is the average number of household visits provided by the CHW (as reported by the households).

by these workers in $T_{merit} = 0$). The effect of T_{merit} is the lowest for workers whose prior was below the truth ($\hat{\beta}_{below} = -0.060$, an insignificant 0.01% decrease in visits) with the estimate for workers with priors at the truth lying in between ($\hat{\beta}_{at} = 0.802$, an 11% increase in visits, but not statistically significant). The difference between $\hat{\beta}_{above}$ and $\hat{\beta}_{below}$ is statistically significant at the 10% level. Figure A.4 (Panel A) presents the effect of the meritocratic promotions treatment on the number of visits by quintiles of prior PS pay. The difference in productivity between $T_{merit} = 1$ and $T_{merit} = 0$ is positive only among workers in the top two quintiles.

Importantly, the variation in priors about the PS pay we leverage in equation (3) is not random. As discussed in Section 4.2, misperceptions about the PS pay are correlated at baseline with age and experience. In column (3) of Table 5, we show that our results are robust – and even become slightly more precise – when we further control for these correlates and their interaction with T_{merit} in equation (3). The results remain nearly identical if we control for the entire

list of CHW-level characteristics presented in Table 1 and their interaction with T_{merit}. The heterogeneity in the effect of T_{merit} we attribute to perceived pay progression is thus unlikely to be explained by correlates of this variable. The goal of Section 5.3 will be to assess the *causal* effect of pay progression by leveraging *random variation* in perceived pay progression.

Heterogenous Effect by Expected Time to Promotion. So far, we have proxied for the perceived prize associated with a promotion with CHWs' prior about pay progression. An alternative strategy is to assess how likely the PS is to leave her position in the near future. Holding perceived pay progression fixed, CHWs who expect a PS to leave her position soon should have a higher present value of the prize associated with the promotion and therefore respond more strongly to the meritocracy treatment.

We proxy worker expectations with an indicator for whether the supervisor is within five years of the standard retirement age (that is, above 50 years old), and present robustness to other cutoffs. Using the 50 years old cutoff, 10% of the CHWs in our sample have a supervisor who is likely to retire soon. The third panel of Figure 3 and the corresponding Table 6 (column 2) show that for these workers making promotions more performance-based increases the number of visits by 3.476 (a 45% increase relative to the average for these workers in $T_{merit} = 0$, statistically significant at the 1% level). The effect for workers who are unlikely to experience a promotion in the next five years remains positive and significant (+1.260 visits, a 19% increase) but is two thirds smaller. The difference in the effect of meritocracy for these two types of workers is statistically significant at the 10% level. Column (3) of Table 6 shows these results are robust to controlling for the correlates of "promotions soon" – i.e., age, health knowledge, number of years the CHW has known the PS – and their interaction with T_{merit}. Note that these estimates pool together workers from $T_{pay} = 0$ and $T_{pay} = 1$. Appendix Table A.9 (columns 4-5) shows that they also hold within $T_{pay} = 0$ only, i.e., for workers who did not revise perceived pay progression.

Figure A.4 (Panel B) shows that, as expected, the results decline when the PS is expected to retire further in the future: the difference in the effects is stronger when we look at workers who expect the PS to retire within 2 years, and disappear when the PS is expected to retire in 10 years. Table A.10 columns (1)-(2) test for heterogeneous effects based on whether the CHW's perception of the duration until the next promotion is above or below the median, and shows that the productivity boost is 70% larger for the latter, but the difference is not statistically significant.

Heterogeneous Effect by Performance Ranking. As predicted by our theoretical model, we expect the effect of meritocracy to be stronger among high-ranked workers, as they have a higher chance of being promoted in a meritocratic regime. Our preferred measure for the ranking of each CHW within the PHU is the one provided by the PS at baseline. The PS has indeed frequent interactions with all CHWs and is in the best position to compare and rank her subordinates. The PS also has no incentive to misreport the ranking because she does not decide on promotions (the PHU in-charge does). Table 2 (columns 12-13) shows that the ranking – as reported by the PS – is correlated with variables that we expect to predict performance: health knowledge, education, years of experience, and number of household visits reported by the CHW. It is also correlated with the number of years the CHW has known the PS, a variable we will later control for, while it does not correlate with connections to the PHU in-charge (the number of years the CHW has known the PHU in-charge) or with the CHWs' perceived PS pay at baseline.

Table 6 (column 4) reports the effect of greater meritocracy for workers who are ranked among the top three of their PHU (henceforth, "high rank" workers) vs. those who are ranked 4 or above (henceforth, "low rank" workers). Increasing the meritocracy of the promotion system boosts the number of visits provided by high-ranked workers by 2.348, a 37.5% increase relative to the average for these workers in $T_{merit} = 0$ (statistically significant at the 1% level). For lower-ranked workers, the effect remains positive but is 60% lower (+0.965 visits which corresponds to an 18% increase) and is only marginally significant. The difference between the effect for high- and low-ranked workers is statistically significant at the 5% level.[28]

Table 6 column (5) shows that the results are robust to further controlling for the variables that are significantly correlated with a worker being high-ranked (top-three) and their interaction with T_{merit}. This indicates that the observed heterogeneous effects are driven by the performance ranking, rather than other observable characteristics. The results are also robust, though less precise, if we measure the ranking of each CHW as reported by other CHWs in the PHU rather than as reported by the PS (Table A.10, columns 3-4).[29]

Figure A.4 (Panel C) presents the effects for the full distribution of worker ranking. The effect

[28]The effect of meritocracy on worker performance is more pronounced for highly-ranked workers who are unconnected to the PHU in-charge than for those who are connected to the PHU in-charge. We discuss this result in more detail in Appendix C.1.

[29]The ranking as reported by other CHWs is positively and significantly correlated with the PS ranking. While CHWs may not be as good as the PS in ranking their colleagues, this indicates that CHWs do have an idea of what the ranking looks like, even in the old promotion regime where effort is not incentivized as much as in the new system. This is not surprising as CHWs know each other and regularly attend trainings together.

of meritocracy is positive and significant for workers ranked 1st-3rd.[30] It converges to a small (non-significant) positive number for rank 4th and above. Note that the effect of meritocracy for low-ranked workers is not negative. This is presumably because these workers had only weak incentives to exert effort in the old non-meritocratic system and have equally weak incentives in the new meritocratic system (as they have no chance of promotion).

Overall, these results show that meritocratic promotions substantially boost the productivity of high-ranked workers – who have a chance of being promoted under the new meritocratic regime – while the effect on the rest of the workforce is more limited. This is consistent with the tournament structure of promotion incentives, which offer larger rewards to top workers only.[31]

Additional Outcomes: Visit Length, Targeting and Worker Retention. We have shown that the effect of our meritocratic promotions treatment raises the number of visits for the average worker and especially for workers who perceive the prize associated with the promotion to be large enough and those who are highly ranked. We now test for the possibility that these CHWs compensate for the higher number of visits by providing shorter visits, i.e., by skipping some of the checklist items they are supposed to follow and thus presumably reducing visit quality.

Table 5 (columns 4-6) shows that a quantity-quality trade-off does not exist in our context. We find indeed that visit length of the average worker increases by 14.6% (statistically significant at the 5% level), and that this is mostly driven by workers with high perceived pay progression (Panel A, columns 5-6). Table 6 (columns 6-10) shows that the positive effect on visit length also holds for workers who expect a promotion soon and those who have a high ranking, though the effect is not precise for the former. These results are consistent with workers being aware that the quality of the visits matters for promotions in $T_{merit} = 1$, as explained in Section 2.2.

The higher number of visits may also potentially be compensated by CHWs targeting only households who live nearby or those who are friends or family members (and who are thus presumably less costly to reach), at the expense of other more deserving households. Tables A.11 and A.12 show that this is not the case: targeting by physical or social distance does not change with T_{merit} on average and there is also no difference in targeting across different worker

[30] Interestingly, the effect is higher for workers ranked 2nd and 3rd than for workers ranked 1st (even though not significantly higher), possibly because workers cannot easily observe other workers' effort response to the change in the promotion system and the 1st-ranked workers may underestimate how hard their competitors try to catch up.

[31] The incentive for the very best workers to exert effort may be weaker in contexts in which the incentives do *not* have a tournament structure, as those analyzed in e.g., Lazear (2000); Muralidharan and Sundararaman (2011); Khan, Khwaja, and Olken (2016).

types.

Table 5 (columns 7-9) presents the effect of meritocracy on worker retention, as measured by whether the CHW self-reports not having dropped out and provided at least one visit to surveyed households in the six months before the endline survey. According to this definition, the retention rate in our sample is 89%. Column (7) shows that higher meritocracy increases retention by 3.9 percentage points (from 87.5% in $T_{merit} = 0$ to 91.4% in $T_{merit} = 1$) and column (8) shows that the effect is nearly entirely concentrated on workers who have higher baseline perceptions about pay progression (Panel A, columns 8-9). Similarly, Table 6 (columns 11-15) shows the same concentration of the effect of higher meritocracy for workers who expect a promotion soon and who are highly ranked.[32]

The positive effect of meritocracy on the retention of both the average worker and workers who have high perceived pay progression or a high ranking raises the question of whether the increase in visits provided by these workers is driven by selection (i.e., meritocracy increasing the retention of the most productive of these workers or decreasing the retention of the least productive ones) or by higher effort of those retained. To separate the two, we perform a bounding exercise. Assuming that the increase in retention in the meritocratic regime comes from workers belonging to the top or bottom decile of the productivity (visits) distribution, and using the estimates identified earlier, we calculate that the direct effect of meritocracy on the number of visits provided by the average worker – net of selection – is between 1.100 and 1.723 (which correspond to a 16.3% and 25.2% increase, respectively).[33] For workers with high perceived pay progression, i.e., workers who overestimate PS pay at baseline, the direct effect is between 1.240 and 2.440 (a 18.4% and 36.2% increase, respectively). For workers who expect a promotion soon, the direct effect is between 2.927 and 4.364 (a 43.4% and 64.7% increase, respectively). Finally, for workers who are highly ranked, the direct effect is between 1.989 and 2.981 (which correspond to a 29.5% and 44.2% increase, respectively). This indicates that the "on-the-job" effort responses of these workers are non-trivial, even in the lower bound scenario.

[32]The latter result might be the case because high-ranked workers have better outside options and become frustrated if they do not see opportunities for career progression in absence of a fully meritocratic promotion system. We discuss this potential mechanism in more detail in Section 5.3.

[33]Assuming that productivity (Y) is a function of both meritocracy (M) and retention (R), which itself is a function of M, the elasticity of worker productivity with respect to meritocracy can be written as: $\frac{dY}{dM} = \frac{\delta Y}{\delta M} + \frac{\delta Y}{\delta R} * \frac{dR}{dM}$, where $\frac{dY}{dM} = 1.497$ and $\frac{dR}{dM} = 0.039$ for the average worker (Table 5 column 1 and column 7, respectively). $\frac{\delta Y}{\delta M}$ is the behavioral response of interest, namely the direct effect of meritocracy due to changes in effort; and $\frac{\delta Y}{\delta R}$ is the change in productivity of the marginal retained worker. We obtain the bounds for $\frac{\delta Y}{\delta M}$ by assuming that the productivity gain from the marginal retained worker corresponds to the difference between the 90^{th} or 10^{th} percentile of the productivity distribution – which correspond to 17.67 or 1.67 visits, respectively – and the average productivity in the control group (7.46 visits).

Alternative Mechanisms. We have shown that meritocratic promotions increase the performance of the average worker. Our model suggests that the increase in worker performance is consistent with workers exerting more effort in anticipation of a future promotion (holding supervisor effort constant). The increase in worker performance could also potentially be explained by an increase in the extent to which the supervisor monitors or advises the CHWs. The last columns of Tables A.11 and A.12 reject this possibility by showing that the likelihood that the PS visited a CHW or accompanied them on a household visit is similar in the meritocratic system relative to the old system.

We have also shown that the performance boost is stronger for two types of workers: (i) those with a high prize associated with the promotion (high perceived pay progression or promotion expected soon), and (ii) those with a high ranking. Our model suggests that this is because workers of type (i) have a greater interest in the promotion, and those of type (ii) have a higher chance of being promoted in the meritocratic system. Another story is that workers of types (i) and (ii) responded more strongly to meritocracy because they revised their perceptions of meritocracy in T_{merit} more strongly than other workers. Table A.5 (columns 2-4) rejects this alternative story.

5.3 The Effect of Pay Progression on Worker Productivity

Having established that a meritocratic promotion system boosts the productivity of CHWs, and that it has an especially strong effect on those who believe that pay progression is large at baseline, we now assess the causal effect of a change in perceived pay progression on CHW productivity in the new meritocratic system ($T_{merit} = 1$) and in the old non-meritocratic system ($T_{merit} = 0$). These correspond to the $\hat{\gamma}$'s and $\hat{\delta}$'s estimates from equation (3), respectively.

Importantly, comparing the treatment effects across workers who underestimate vs. overestimate PS pay at baseline – i.e., the comparison $\hat{\gamma}_{below}$ vs. $\hat{\gamma}_{above}$ or $\hat{\delta}_{below}$ vs. $\hat{\delta}_{above}$ in equation (3) — is not necessarily causal in our context. As discussed in Section 4.2, workers who overestimate PS pay differ from those who underestimate it in experience and age for example, and this may affect their effort response. Our analysis focuses instead on assessing the effect of raising pay progression in meritocratic and non-meritocratic regimes *within a worker type*, for which we can confidently claim that our estimates are causal.[34]

[34] As discussed, CHWs' characteristics are balanced across treatments within a worker type (Table A.3).

Pay Progression in Meritocratic Regimes. We start by assessing the effect of pay progression on worker productivity in the new meritocratic system ($T_{merit} = 1$) by reporting the $\hat{\gamma}$'s coefficients from equation (3).

Prediction 6 of our theoretical framework states that when the promotion system is meritocratic enough ($b < \bar{b}$), raising (reducing) pay progression $\bar{w} - \underline{w}$ should *boost* (*reduce*) worker productivity. In line with this, Figure 4 (first and third bars) and the corresponding Table 5 (Panel B, column 2, row [iv]) show that, within the sample of workers who revise their perception of pay progression upward, the number of visits provided goes up by 1.809. This is significant at the 10% level and corresponds to a 22.7% increase relative to the average number of visits provided by this sample of workers in $T_{pay} = 0$ and $T_{merit} = 1$. Within the sample of workers who revise their perception downward (Panel C, column 2, row [vi]), the number of visits instead goes down by 2.045. This is significant at the 5% level and corresponds to a 21.3% reduction relative to the average number of visits provided by this sample of workers in $T_{pay} = 0$ and $T_{merit} = 1$. Within the sample of workers whose priors were equal to the truth at baseline (and who did not update their beliefs about the pay gap), the number of visits did not change (column 2, row [viii]). This is reassuring as it indicates that providing information about true PS pay does not affect workers' behavior through channels unrelated to a reassessment of their prior beliefs. Finally, the results on visit length and retention go in the same direction as those on the number of visits (Table 5, columns 5 and 8).[35]

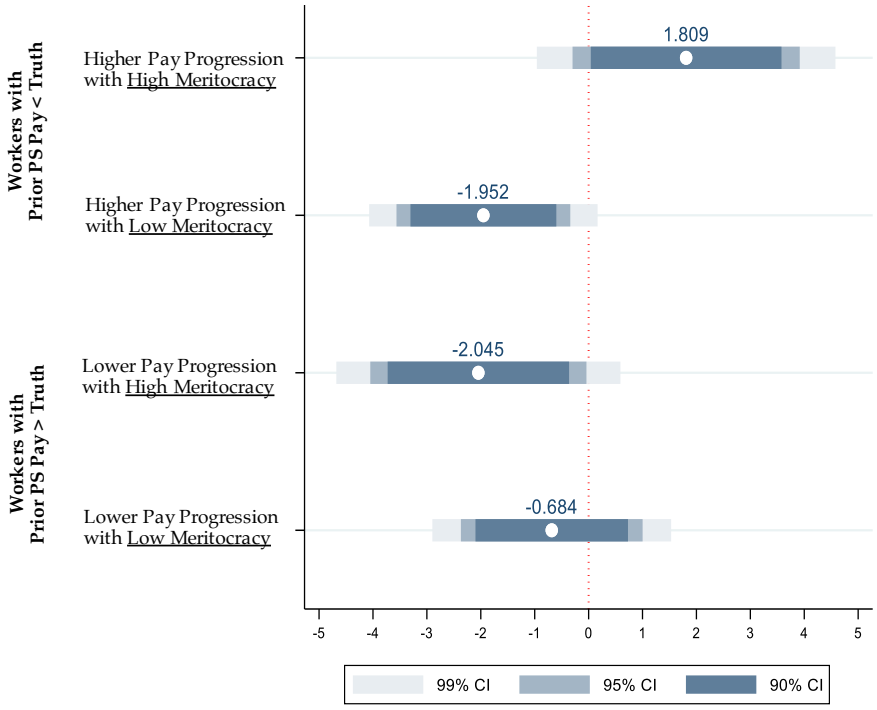
Consistent with Prediction 4 of our theoretical framework, the effect of increasing pay progression on worker productivity is found to be more pronounced for higher-ranked workers, who have greater chances of being promoted in a meritocratic regime. We show this by focusing on the sample of workers whose priors about the PS pay were below the truth at baseline (Table 7, columns 3-4, row [i]). Instead, the effect is negative and not statistically significant for low ranked workers who do not experience a change in their promotion incentives (row [ii]).

Finally, Table A.13 (column 1) computes the elasticity of CHW performance with respect to PS pay. To do so, we use the entire sample of workers and instrument the updating of CHWs' beliefs about PS pay with $T_{pay} \times \mathbb{1}_{Prior<Truth,ij}$ and $T_{pay} \times \mathbb{1}_{Prior>Truth,ij}$.[36] Revising PS pay

[35] Pay progression does not affect household targeting by physical or social distance and does not affect PS effort (Table A.11).

[36] Using this approach, the Cragg-Donald F-statistic is around 180. If we only use T_{pay} as an instrument, we predictably obtain a low first stage, as workers update in opposite directions depending on whether they over- or underestimate PS pay at baseline. Alternatively, we could split the sample by whether the CHW over- or underestimates PS pay at baseline, and use T_{pay} as an instrument for the perceived PS pay following the treatment (rather than using the extent to which they updated perceptions). The results are shown in Table A.13 (columns 2-3) and are discussed later.

FIGURE 4: EFFECT OF PAY PROGRESSION ON THE NUMBER OF VISITS, BY MERITOCRACY



Notes: This figure plots the effects of Tpay on the number of visits in the High Meritocracy regime (Tmerit=1) and in the Low Meritocracy regime (Tmerit=0). The top half of the figure plots $\boldsymbol{\gamma}_{\text{below}}$ and $\boldsymbol{\delta}_{\text{below}}$ estimated from equation (3). The bottom half plots $\boldsymbol{\gamma}_{\text{above}}$ and $\boldsymbol{\delta}_{\text{above}}$ from equation (3). "Number of visits" is the average number of household visits provided by the CHW (as reported by the households).

upward by 10% (25,518 SLL) increases the number of visits provided by the average CHW by 9.4% (0.028*25.518/7.560), giving us a cross-wage elasticity of 0.94.[37]

Overall, the results are consistent with standard theory of career incentives, i.e., worker effort moves in the same direction as the perceived pay gap. The results indicate that extrinsic incentives in the form of a potentially higher future pay play an important role even for public sector workers who have been argued to be more "intrinsically motivated" (Besley and Ghatak 2005; Bénabou and Tirole 2006).

Pay Progression in Non-Meritocratic Regimes. We now turn our attention to the effects of pay progression in a non-meritocratic regime ($T_{merit} = 0$), captured by the $\hat{\delta}$'s coefficients in equation (3).

[37] This is not a trivial elasticity in comparison to the own-wage labor supply elasticity of 1.12-1.25 identified in the experimental literature (Fehr and Goette 2007). The only other estimate of vertical cross-wage elasticity in the literature is provided by Cullen and Perez-Truglia (2022). They document that raising the perceived salary of a manager by 10% increases the number of hours worked by lower-tier employees by 4.31% when these employees are told that the manager position is attainable. Their elasticity might be lower than ours because they use different metrics for performance and (perhaps more importantly) because their promotion system may not be as meritocratic as the system in our meritocratic promotions treatment.

Figure 4 (second bar) and the corresponding Table 5 (Panel B, column 2, row [v]) show that higher pay progression reduces the number of visits provided by CHWs by 1.952. This is significant at the 5% level and corresponds to a 26.4% reduction relative to the average number of visits provided by this sample of workers in $T_{pay} = 0$ and $T_{merit} = 0$. This suggests that the combination of a steep pay progression and a promotion regime with low meritocracy, commonly seen in the public and private sectors,[38] can be detrimental to the productivity of workers at the bottom of the organization.

Two potential channels can explain the observed reduction in worker productivity. The first is the negative morale effect proposed in Section 3.3 of our theoretical framework: workers may become less motivated and provide fewer visits if they perceive a non-meritocratic organization as being unfair or unequal when increasing its pay progression (Prediction 6). The second channel is one of multitasking and lobbying: when pay progression increases, workers may become more interested in a promotion and may start devoting more time to lobbying (e.g., talking with the PHU in-charge) so as to increase their chances of promotion in a non-meritocratic regime. If lobbying and productive effort are substitutes, this behavior would reduce the number of visits because the extra time spent on lobbying would crowd out time spent on productive tasks (visits).[39]

We provide suggestive evidence that the reduction in worker productivity we find in the data is more likely driven by a demotivational effect caused by morale concerns than by workers spending more time lobbying. First, we find limited evidence of increased lobbying when pay progression increases. Lobbying is inherently hard to measure, as it can take different forms, but should presumably entail CHWs being more likely to interact with the PHU in-charge. At endline, we asked CHWs whether they had talked to the PHU in-charge in the past year. While an average of 54% had done so, this variable did not increase with pay progression (Table 7, column 1). Moreover, we asked CHWs what fraction of their time as a CHW was dedicated to non-patient-related activities, which include communications with the PHU in-charge (mean of 21%). Once again, we document no effect of the pay progression treatment on this variable (Table 7, column 2).

Second, we find that the negative effect of pay progression on worker productivity is stronger

[38] Refer to the discussion in the Introduction.

[39] de Janvry et al. 2021 defines this type of lobbying as an "unproductive influence activity." Another type of unproductive influence activity would consist in CHWs bribing the PHU in-charge to get the promotion. This could reduce the number of visits if bribing forces the CHW to devote more time to another secondary job in order to raise the money. This is unlikely in our context because bribes and side-payments across the different layers of the organization are minimal (Deserranno et al. 2022).

among the two types of workers who should perceive the combination of pay progression and non-meritocracy as the most unfair: high-ranked workers, who would be the first to benefit from the steeper pay progression under a meritocratic regime, and workers who are unsatisfied with the work of the PS, who should find a steep vertical pay gap as less justified. Table 7 shows that, in the sample of workers who underestimated PS pay at baseline, high-ranked workers and those unsatisfied with the PS react to the increase in perceived pay progression by providing 2.511 and 3.231 fewer visits respectively (columns 3 and 5, row [iii]). These demotivational effects are instead much smaller (and often not statistically significant anymore) for lower-ranked workers and workers who are satisfied with the work of their PS (row [iv]).[40]

Table A.13 presents IV results in which CHWs' post-treatment perception of PS pay is instrumented by T_{pay}, separately for the subsample of workers who overestimated PS pay at baseline and those who underestimated it. Column 2 (row [ii]) shows that, in the non-meritocratic regime, workers who perceive the level of PS pay as being 10% higher (23,571 SLL higher) provide 19% fewer visits (-0.061*23.571/7.560), leading to an elasticity of -1.9. This level of elasticity of vertical pay inequalities in non-meritocratic regimes is large relative to what the literature has identified as the demotivational effect created by horizontal pay inequality across peers (Breza, Kaur, and Shamdasani 2017; Cullen and Perez-Truglia 2022).[41] It is, however, smaller than the demotivational effect created by mass layoffs or pay cuts (Akerlof et al. 2020; Coviello, Deserranno, and Persico 2022).

Finally, the last bar of Figure 4 and the corresponding Table 5 (Panel C, column 2, row [vii]) show that a downward update of beliefs about pay progression has a small negative effect on worker productivity (-0.684 visits, which corresponds to -0.09%, and is statistically insignificant). In other words, the negative effect of higher pay progression is not mirrored by a positive effect of lower pay progression in the low meritocracy regime. This asymmetric response indicates that a reduction in perceived pay progression in a system that is non-meritocratic does not make workers more likely to perceive the system as fair, or at least does not increase it by enough to

[40] These heterogeneous results are robust to controlling for all observed CHW characteristics and their interaction with the treatment dummies (Table 7, columns 4 and 6). This ensures that the heterogeneity in the treatment effects we are attributing to ranking and satisfaction with the PS is likely not due to variation in other observables. Table A.6 (columns 6 and 7) shows that the larger reduction in effort observed among CHWs who are high ranked or unsatisfied with their PS is not explained by these workers updating their beliefs about pay progression more strongly than other workers.

[41] Cullen and Perez-Truglia 2022 find that a 10% increase in employees' perception of their peers' salaries decrease the number of hours they work by 9.4%, leading to an elasticity of -0.94. Breza, Kaur, and Shamdasani (2017) show that when coworkers' productivity is difficult to observe, horizontal pay inequality reduces output by 0.45 standard deviations and attendance by 18 percentage points.

raise worker productivity.[42]

6 Conclusion

Despite the popular definition of organizations as "pyramids of opportunities" (Alfred P. Sloan) and the wide attention that promotions have received both in the theoretical literature (e.g., Lazear and Rosen 1981; Waldman 1984; Gibbons and Waldman 1999b) and in public policy (e.g., McKinsey 2015; World Bank 2018), empirical evidence on promotion incentives is scarce. This paper fills this gap by providing the first experimental evidence on the causal effect of meritocratic promotions and pay progression on worker productivity.

We collaborated with the Ministry of Health and Sanitation in Sierra Leone to introduce exogenous variation in (i) the extent to which the promotion process from frontline workers (lower-tier) to supervisor (upper-tier) is meritocratic or not, and (ii) the perceived gap between these two positions. Our findings show that promotion systems should have two components to maximize the productivity of frontline workers: promotions based on performance (meritocratic) *and* steep enough pay progression associated with promotions. Crucially, raising the extent to which promotions are meritocratic causes an increase in worker productivity only if combined with high enough pay progression, otherwise the effect is muted. Higher pay progression can have contrasting effects depending on whether promotions are decided solely based on performance or not. In meritocratic regimes, steeper pay progression motivates frontline workers to climb the organization's ladder and prompts an increase in their effort. In non-meritocratic regimes, in contrast, steeper pay progression reduces worker productivity. We provide suggestive evidence that this latter effect is consistent with a negative morale effect.

Our findings have several policy implications. In recent years, the manager-worker pay ratio has rapidly grown around the world. In the United States, it has increased more than tenfold over the past 50 years, from approximately 20 in the 1960s to over 300 in 2015 (Ashraf and Bandiera 2018; Mishel and Wolfe 2019). The salaries of high-level officials in public-sector agencies in developing countries have also substantially increased in recent years, partly motivated by recommendations from the World Bank and other international organizations (Shepherd 2003; World Bank 2014). While raising pay at the top of the organization may improve the quality of managerial staff, the results of this paper show that this can come at the expense of demo-

[42]The asymmetrical response to T_{pay} for workers who over vs. underestimated PS pay at baseline can explain why the effect of more meritocratic promotions on productivity is higher in the sample of workers in $T_{pay} = 1$ compared to workers in $T_{pay} = 0$, as discussed in footnote 27.

tivating workers at the bottom of the organization if the promotion system is not meritocratic enough. When, however, the promotion system is meritocratic, higher pay progression instead unambiguously increases the productivity of bottom-tier workers.

There are also several additional implications from our findings that are less straightforward and require further research. First, the positive effect of promotion incentives identified in this paper may amplify in the longer-run. During the timeframe of our experiment, few promotions took place, and thus most workers reacted to what they believe the future promotion rule will look like. In the longer run, the number of workers up-for-promotion will mechanically increase, and our results indicate that this may intensify their effort response in the years leading up to promotion eligibility. Moreover, the quality of higher-level staff may change as the number of promotions increases. Shifting the promotion system from one that is mostly based on connections to one that rewards performance more prominently may improve the quality of the supervisors selected, and in turn further boost the effort of lower-tier workers. Similarly, establishing a meritocratic promotion system might affect average worker quality in the application pool and generate positive effects over time through the selection margin, which we do not observe in this experiment.

Second, the effectiveness of performance-based promotions (or any other type of performance-based incentives) depends on the organization's ability to accurately measure worker performance. The noisier is the measure of performance, the lower is the worker incentive to exert effort. While our measure of worker performance is not entirely accurate, as it relies on the visits received by a random sample of the potential patients rather than the full population, it is likely more accurate than in the many settings in which it is measured by governments that lack resources to monitor workers closely. The fact that worker performance was measured by outside researchers may also have helped maintain fidelity to the design (Banerjee, Duflo, and Glennerster 2008; De Ree et al. 2018).

Finally, many organizations face the trade-off of whether to incentivize workers through performance-based promotions or, alternatively, through performance-based incentives without a tournament structure. In our context, promotion incentives are shown to be very cost-effective: they prompt the average worker to raise their output (by 22.2%) at the cost of increasing the wage only for the promoted worker (by 50% or 11.7 dollars per month). Only a small share of the productivity gains is thus being passed on to workers in the form of higher wages. Promotion incentives may be even more cost-effective in contexts in which workers have greater

opportunities to rise in the organization, or with steeper pay progression. Even if cost-effective, we have shown that promotion incentives tend to concentrate the increase in productivity among a subset of the workers: those with high perceived pay progression and with a high performance ranking. An organization that aims to achieve a more uniform distribution of effort across workers may thus prefer incentives that do not have a tournament structure. Further research is needed to get a better grasp of these trade-offs.

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Table 1: Summary Statistics and Balance Checks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			Tmerit		Tpay		Tmerit × Tpay	
	Mean	S.D.	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.
A. CHW characteristics (N=2,009)								
Male = {0, 1}	0.726	0.446	-0.017	(0.034)	-0.023	(0.030)	-0.001	(0.048)
Age (in years)	37.03	11.22	0.111	(0.848)	-0.731	(0.780)	1.255	(1.117)
Completed primary education = {0, 1}	0.713	0.453	-0.024	(0.036)	0.018	(0.035)	0.009	(0.050)
Completed secondary education or above = {0, 1} Wealth	0.083	0.275	0.019	(0.020)	-0.018	(0.019)	-0.001	(0.027)
score (0 to 8)	2.496	1.157	0.084	(0.083)	0.008	(0.068)	0.025	(0.116)
Health knowledge score (0 to 7)	2.895	1.425	-0.065	(0.115)	-0.039	(0.110)	0.111	(0.155)
Number of years as CHW	2.212	2.828	0.346	(0.218)	0.083	(0.180)	-0.164	(0.280)
Number of households CHW is responsible for	56.90	73.98	0.944	(6.278)	-1.014	(5.520)	2.109	(8.457)
Number of hours worked as CHW per week	17.78	34.71	-0.070	(3.010)	-2.410	(2.979)	2.824	(3.832)
Number of household visits provided per week	21.47	19.93	0.350	(1.753)	0.775	(1.606)	-1.488	(2.198)
Satisfied with the PS = {0, 1}	0.762	0.426	0.073**	(0.034)	0.058	(0.036)	-0.040	(0.046)
Number of years CHW has known PS for	7.774	8.430	0.038	(0.706)	-0.283	(0.632)	0.843	(0.949)
Ever talked to the PHU in-charge = {0, 1}	0.530	0.499	-0.022	(0.048)	-0.032	(0.048)	-0.040	(0.067)
Number of years CHW has known PHU in-charge for PS	2.926	4.645	-0.652	(0.479)	-0.825*	(0.491)	0.613	(0.599)
was the best-performing CHW when promoted = {0, 1}	0.451	0.498	-0.054	(0.080)	-0.021	(0.081)	0.116	(0.113)
B. PS characteristics (N=372)								
Male = {0, 1}	0.919	0.273	0.043	(0.031)	-0.000	(0.037)	-0.105*	(0.054)
Age (in years)	37.84	8.856	0.433	(1.336)	-1.449	(1.281)	0.715	(1.785)
Completed primary education = {0, 1}	0.739	0.440	-0.001	(0.066)	0.031	(0.065)	0.015	(0.091)
Completed secondary education or above = {0, 1} Wealth	0.253	0.435	0.022	(0.065)	-0.010	(0.065)	-0.047	(0.091)
score (0 to 8)	3.013	1.227	0.128	(0.169)	-0.092	(0.175)	0.117	(0.240)
Health knowledge score (0 to 7)	3.481	1.371	0.045	(0.198)	0.100	(0.202)	-0.119	(0.282)
Number of years as PS	3.529	2.734	-0.139	(0.377)	-0.072	(0.386)	0.122	(0.521)
Number of CHWs PS is responsible for	7.984	2.861	-0.381	(0.405)	-0.441	(0.407)	0.743	(0.575)
Number of hours worked as PS per week	11.16	33.97	-0.420	(5.636)	-5.758	(4.217)	9.114	(7.459)
Number of years as CHW before promotion	1.823	1.978	-0.007	(0.345)	-0.243	(0.338)	-0.284	(0.458)
Ever talked to the PHU in-charge = {0, 1}	1.000	0.000	-	-	-	-	-	-
Number of years PS has known PHU in-charge for	4.073	6.521	1.890	(1.247)	1.038	(1.570)	-1.961	(2.000)
C. CHW pre-treatment perceptions (N=2,009)								
Prior Meritocracy = {-1, 0, 1}	0.498	0.548	-0.032	(0.030)	-0.041	(0.034)	0.030	(0.044)
Prior PS Pay (in 1,000 SLL)	261.7	64.23	0.352	(3.634)	-4.474	(3.731)	0.744	(5.029)

Notes: This table presents summary statistics and balance checks for baseline CHW and PS characteristics in Panel A and B, and for pre-treatment CHW perceptions about meritocracy and PS pay in Panel C. Each row states the sample mean and standard deviation of a variable, as well as the estimates from a regression, where the variable is regressed on an indicator for Tmerit, Tpay and Tmerit × Tpay. All regressions control for stratification variables and cluster standard errors at the PHU level. *** p<0.01, ** p<0.05, * p<0.1

Table 2: Correlates of Perceived Meritocracy and Pay Progression at Baseline

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
			Correlates of Perceived Meritocracy		**Correlates of Misperceptions about Pay Progression**		**Correlates of Overestimating, Underestimating or Correctly Estimating PS Pay** Omitted Group: 𝟙(Prior PS Pay = Truth)					**Correlates of Performance Ranking** (Low Ranking = High Performance)	
	Mean	S.D.	Prior Meritocracy = {-1, 0, 1}		| Prior PS Pay - Truth |		𝟙(Prior PS Pay > Truth) [i]		𝟙(Prior PS Pay < Truth) [ii]		p-value [i] - [ii]	Performance Ranking	
			Coeff	S.E.	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.		Coeff	S.E.
CHW characteristics (N=2,009)													
Male = {0, 1}	0.726	0.446	0.003	(0.018)	-0.023	(0.030)	-0.022	(0.024)	-0.007	(0.024)	0.541	-0.018***	(0.003)
Age (in years)	37.03	11.22	-0.715	(0.438)	-0.731	(0.780)	1.543**	(0.623)	0.136	(0.572)	0.021	-0.066	(0.075)
Completed primary education = {0, 1}	0.713	0.453	0.027	(0.019)	0.018	(0.035)	-0.044	(0.027)	-0.036	(0.026)	0.748	-0.015***	(0.004)
Completed secondary education or above = {0, 1}	0.083	0.275	-0.003	(0.012)	-0.018	(0.019)	-0.024	(0.017)	-0.019	(0.017)	0.721	-0.008***	(0.002)
Wealth score (0 to 8)	2.496	1.157	0.091**	(0.042)	0.008	(0.068)	0.000	(0.056)	0.033	(0.061)	0.580	-0.029***	(0.007)
Health knowledge score (0 to 7)	2.895	1.425	0.025	(0.057)	-0.039	(0.110)	0.017	(0.076)	-0.136*	(0.076)	0.035	-0.035***	(0.011)
Number of years as CHW	2.212	2.828	-0.039	(0.107)	0.083	(0.180)	0.266*	(0.159)	-0.046	(0.140)	0.051	-0.061***	(0.021)
Number of households CHW is responsible for	56.90	73.98	1.856	(2.769)	-1.014	(5.520)	4.446	(4.609)	4.195	(4.102)	0.950	-1.512***	(0.521)
Number of hours worked as CHW per week	17.78	34.71	0.573	(1.029)	-2.410	(2.979)	-0.449	(1.338)	2.220	(1.970)	0.105	-0.214	(0.235)
Number of household visits provided per week	21.47	19.93	0.915	(0.729)	0.775	(1.606)	-1.655	(1.283)	-3.275***	(1.086)	0.126	-0.381***	(0.131)
Satisfied with the PS = {0, 1}	0.762	0.426	0.045**	(0.018)	0.058	(0.036)	0.009	(0.025)	-0.009	(0.025)	0.446	-0.004	(0.003)
Number of years CHW has known PS for	7.774	8.430	-0.575*	(0.341)	-0.283	(0.632)	0.775*	(0.463)	0.433	(0.468)	0.465	-0.124*	(0.067)
Ever talked to the PHU in-charge = {0, 1}	0.530	0.499	-0.007	(0.020)	-0.032	(0.048)	-0.026	(0.029)	-0.020	(0.026)	0.815	-0.006*	(0.004)
Number of years CHW has known PHU in-charge for	2.926	4.645	-0.171	(0.182)	-0.825*	(0.491)	-0.336	(0.240)	-0.063	(0.231)	0.264	-0.010	(0.039)

Notes: All variables reported in this table measure a CHW characteristic at baseline. Each row states the estimates from four regressions, where the CHW characteristic in each row is regressed on the x-variables in each column, controlling for stratification variables and clustering standard errors at the PHU level. In the third regression (columns 7-10), the omitted group is "Perceived PS Pay = Truth" and the coefficients report the difference between "Perceived PS Pay > Truth" and "Perceived PS Pay < Truth" with this omitted group. "Perceived PS Pay > Truth" (resp., "Perceived PS Pay < Truth") equals one if the PS salary perception of the CHW is above (resp., below) the actual salary of SLL 250,000 and 0 otherwise. "Performance Ranking (Low Ranking = High Performance)" is the ranking the PS gives to a CHW at baseline. *** p<0.01, ** p<0.05, * p<0.1

Table 3: Effect of the Meritocracy Treatment on Beliefs Updating

	(1)	(2)	(3)	(4)	(5)
	Post-Treatment Perceptions About Promotions		Post-Treatment Perceptions About PS Pay		
Dep. Var.:	Perceived Meritocracy = {-1, 0, 1}	Number of Months until Next Promotion	PS Pay (in 1,000 SLL)	PS Number of Hours Worked	PS Work-Related Expenses (in 1,000 SLL)
Tmerit	0.296***	0.653	2.848	0.104	1.840
	(0.025)	(5.049)	(1.880)	(0.594)	(3.015)
Observations	1,982	1,387	2,009	1,940	1,932
Mean Dep. Var. if Tmerit=0	0.471	46.35	253.8	14.15	95.43

Notes: All regressions control for stratification variables. "Work-related expenses" include communication and transportation costs. The sample size varies across columns because of CHWs answering "don't know" and their answer being coded as missing. Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1

Table 4: Effect of the Pay Progression Treatment on Beliefs Updating

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Post-Treatment Perceptions About PS Pay			Post-Treatment Perceptions About Promotions		Post-Treatment Perceptions About PS Pay			Post-Treatment Perceptions About Promotions	
Dep. Var.:	|PS Pay - Truth| (in 1,000 SLL)	PS Number of Hours Worked	PS Work-Related Expenses (in 1,000 SLL)	Prior Meritocracy = {-1, 0, 1}	Number of Months until Next Promotion	PS Pay (in 1,000 SLL)	PS Number of Hours Worked	PS Work-Related Expenses (in 1,000 SLL)	Prior Meritocracy = {-1, 0, 1}	Number of Months until Next Promotion
Tpay	-34.838***	0.832	4.499	-0.035	-4.081					
	(1.480)	(0.600)	(2.999)	(0.030)	(5.039)					
Tpay × 𝟙(Prior PS Pay < Truth)						29.043***	0.134	8.052*	0.014	-8.138
						(1.823)	(0.771)	(4.318)	(0.044)	(6.837)
Tpay × 𝟙(Prior PS Pay > Truth)						-59.685***	0.687	-1.083	-0.078	4.160
						(3.427)	(0.789)	(4.287)	(0.048)	-7.198
Tpay × 𝟙(Prior PS Pay = Truth)						0.848	1.864**	6.087	-0.050	-7.174
						(0.929)	(0.872)	(4.905)	(0.044)	(6.820)
Observations	2,009	1,940	1,932	1,982	1,387	2,009	1,940	1,932	1,982	1,387
Mean Dep. Var. if Tpay=0	35.32	13.79	94.30	0.643	49.46	260.7	13.79	94.30	0.643	49.46
… & 𝟙(Prior PS Pay < Truth)	32.71	14.05	92.75	0.598	50.50	220.7	14.05	92.75	0.598	50.50
… & 𝟙(Prior PS Pay > Truth)	63.44	13.95	95.60	0.648	46.56	309.7	13.95	95.60	0.648	46.56

Notes: All regressions control for the stratification variables. Columns (6) to (10) also control for two dummy variables: 𝟙(Prior PS Pay < Truth) and 𝟙(Prior PS Pay > Truth). 𝟙(Prior PS Pay < Truth) [resp., 𝟙(Prior PS Pay > Truth)] equals one if the PS salary pre-treatment perception of the CHW is below (resp., above) the actual salary of SLL 250,000 and 0 otherwise. "Work-related expenses" include communication and transportation costs. The sample size varies across columns because of CHWs answering "don't know" and their answer being coded as missing. Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1

Table 5: Effect of Meritocracy and Pay Progression on Worker Performance

Dep. Var.:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Number of Visits			Visit Length (in Minutes)			Retention = {0, 1}		
Tmerit	1.497***			1.754***			0.039**		
	(0.479)			(0.651)			(0.015)		
A. Effects of Meritocracy by Baseline Prior about PS Pay									
Tmerit × 𝟙(Prior PS Pay > Truth) [i]		2.006*	2.095**		2.829**	2.910**		0.075**	0.074**
		(1.035)	(1.042)		(1.215)	(1.239)		(0.032)	(0.033)
Tmerit × 𝟙(Prior PS Pay = Truth) [ii]		0.802	0.830		1.420	1.352		-0.004	-0.003
		(0.992)	(1.000)		(1.308)	(1.320)		(0.035)	(0.035)
Tmerit × 𝟙(Prior PS Pay < Truth) [iii]		-0.060	-0.132		-0.795	-0.999		0.020	0.018
		(0.976)	(0.989)		(1.618)	(1.618)		(0.030)	(0.030)
B. Effects of Higher Pay Progression by Meritocracy (Tmerit)									
Tpay × High Meritocracy (Tmerit=1) × 𝟙(Prior PS Pay < Truth) [iv]		1.809*	1.655		1.330	1.316		0.083***	0.083***
		(1.075)	(1.080)		(1.291)	(1.276)		(0.030)	(0.030)
Tpay × Low Meritocracy (Tmerit=0) × 𝟙(Prior PS Pay < Truth) [v]		-1.952**	-1.906**		-1.846	-1.846		-0.061	-0.060
		(0.822)	(0.818)		(1.243)	(1.224)		(0.040)	(0.039)
C. Effects of Lower Pay Progression by Meritocracy (Tmerit)									
Tpay × High Meritocracy (Tmerit=1) × 𝟙(Prior PS Pay > Truth) [vi]		-2.045**	-2.272**		-2.186*	-2.602**		-0.044	-0.044
		(1.023)	(1.025)		(1.215)	(1.224)		(0.030)	(0.031)
Tpay × Low Meritocracy (Tmerit=0) × 𝟙(Prior PS Pay > Truth) [vii]		-0.684	-0.677		-0.639	-0.543		0.030	0.036
		(0.860)	(0.849)		(1.316)	(1.334)		(0.040)	(0.040)
D. Effects of Same Pay Progression by Meritocracy (Tmerit)									
Tpay × High Meritocracy (Tmerit=1) × 𝟙(Prior PS Pay = Truth) [viii]		-0.300	-0.186		1.308	1.534		-0.006	-0.005
		(1.018)	(1.049)		(1.460)	(1.469)		(0.032)	(0.033)
Tpay × Low Meritocracy (Tmerit=0) × 𝟙(Prior PS Pay = Truth) [ix]		-0.968	-0.738		-0.008	0.322		0.037	0.046
		(0.833)	(0.827)		(1.615)	(1.614)		(0.035)	(0.035)
Observations	1,966	1,966	1,951	1,868	1,868	1,853	2,009	2,009	1,994
Mean Dep. Var.	7.560	7.560	7.560	12.925	12.925	12.925	0.893	0.893	0.893
Mean Dep. Var. if Tmerit=0	6.749	6.749	6.749	11.990	11.990	11.990	0.875	0.875	0.875
Mean Dep. Var. if Tpay=0	7.965	7.965	7.965	13.191	13.191	13.191	0.891	0.891	0.891
p-value H_0: [i] - [iii] = 0		0.100	0.078		0.043	0.031		0.212	0.208
p-value H_0: [iv] - [v] = 0		0.006	0.009		0.077	0.074		0.004	0.003
p-value H_0: [vi] - [vii] = 0		0.309	0.232		0.385	0.253		0.147	0.112
p-value H_0: [viii] - [ix] = 0		0.608	0.677		0.546	0.579		0.372	0.294
Extra Controls		No	Yes		No	Yes		No	Yes

Notes: All regressions control for the stratification variables. The last two columns of each outcome variable follow the specification in Equation (3) and control for 𝟙(Prior PS Pay < Truth) and 𝟙(Prior PS Pay > Truth). Additionally, the last column of each outcome variable controls for the correlates of priors about PS pay and their interactions with Tpay, Tmerit and Tpay × Tmerit. See text for more details on the correlates. 𝟙(Prior PS Pay < Truth) [resp., 𝟙(Prior PS Pay > Truth)] equals one if the PS salary pre-treatment perception of the CHW is below (resp., above) the actual salary of SLL 250,000 and 0 otherwise. "Number of Visits" is the average number of household visits provided by the CHW (as reported by the households). "Visit Length" is the average visit length as reported by the households. A visit length of zero is inputed to households that are never visited by the CHW. "Retention" equals one if CHW self-reported not having dropped out and visited at least one household, and 0 otherwise. Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Effect of Meritocracy on Worker Performance, by Time to Promotion and Performance Ranking

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Dep. Var.:	Number of Visits					Visit Length (in Minutes)					Retention = {0, 1}				
Tmerit	1.497***					1.754***					0.039**				
	(0.479)					(0.651)					(0.015)				
Tmerit × Promotion Soon [i]		3.476***	3.478***				2.559	2.824				0.087**	0.085*		
		(1.218)	(1.240)				(1.818)	(1.896)				(0.044)	(0.046)		
Tmerit × Promotion not Soon [ii]		1.260**	1.251**				1.669**	1.611**				0.033**	0.031*		
		(0.510)	(0.510)				(0.685)	(0.686)				(0.016)	(0.016)		
Tmerit × High Rank [i]				2.348***	2.329***				1.676*	1.713*				0.062***	0.065***
				(0.605)	(0.602)				(0.880)	(0.903)				(0.024)	(0.025)
Tmerit × Low Rank [ii]				0.965*	0.992*				1.640**	1.642**				0.017	0.017
				(0.567)	(0.563)				(0.790)	(0.796)				(0.019)	(0.019)
Observations	1,966	1,966	1,959	1,830	1,812	1,868	1,868	1,861	1,735	1,717	2,009	2,009	2,002	1,867	1,849
Mean Dep. Var. if Tmerit=0	6.749	6.749	6.749	6.749	6.749	11.990	11.990	11.990	11.990	11.990	0.875	0.875	0.875	0.875	0.875
p-value H_0: [i] - [ii] = 0		0.095	0.100	0.034	0.042		0.644	0.545	0.971	0.945		0.245	0.261	0.118	0.120
p-value MHT correction for [i]		0.008	0.008	0.004	0.004		0.112	0.104	0.044	0.044		0.036	0.048	0.008	0.008
p-value MHT correction for [ii]		0.012	0.012	0.056	0.048		0.012	0.012	0.024	0.028		0.028	0.044	0.255	0.255
Extra Controls		No	Yes	No	Yes		No	Yes	No	Yes		No	Yes	No	Yes

Notes: All regressions control for stratification variables. All columns of each outcome variable (except the first one) control the uninteracted x-variable (Promotion Soon or High Rank depending on the column). The "Extra Controls" include the CHW characteristics that are correlated with the uninteracted x-variable (see text for more details on the correlates) and their interaction with Tmerit. At the bottom of the table, we present p-values adjusted for multiple hypothesis testing across all columns computed using Romano and Wolf [2016] step-down procedure. "Promotions Soon" equals one if the supervisor of the CHW is within 5 years of retirement age at baseline and 0 otherwise. "High Rank" equals one if the CHW is ranked first, second or third in terms of performance by the PS at baseline and 0 otherwise. "Visit Length" is the average visit length as reported by the households. A visit length of zero is inputed to households that are never visited by the CHW. "Retention" equals one if CHW self-reported not having dropped out and visited at least one household, and 0 otherwise. "Number of Visits" is the average number of household visits provided by the CHW (as reported by the households). Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Effect of Pay Progression on Worker Performance with Low Meritocracy – Morale Concerns vs. Lobbying

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Var.:	Talked to PHU In-Charge = {0,1}	Fraction of Time on Non-Patient-Related Activities	Number of Visits			
Effects of Higher Pay Progression by Meritocracy (Tmerit)						
Tpay × High Meritocracy (Tmerit=1) [i]	-0.043	-0.000				
	(0.063)	(0.016)				
Tpay × Low Meritocracy (Tmerit=0) [ii]	-0.038	0.020				
	(0.056)	(0.018)				
Tpay × High Meritocracy (Tmerit=1) × High Rank [i]			3.434***	3.781***		
			(1.292)	(1.433)		
Tpay × High Meritocracy (Tmerit=1) × Low Rank [ii]			-1.915	-1.509		
			(1.829)	(1.938)		
Tpay × Low Meritocracy (Tmerit=0) × High Rank [iii]			-2.511**	-2.112**		
			(1.000)	(0.997)		
Tpay × Low Meritocracy (Tmerit=0) × Low Rank [iv]			-0.997	-1.160		
			(1.007)	(0.985)		
Tpay × High Meritocracy (Tmerit=1) × Unsatisfied with the PS [i]					4.842***	4.655***
					(1.630)	(1.670)
Tpay × High Meritocracy (Tmerit=1) × Satisfied with the PS [ii]					1.108	1.212
					(1.191)	(1.287)
Tpay × Low Meritocracy (Tmerit=0) × Unsatisfied with the PS [iii]					-3.231***	-3.289***
					(1.160)	(1.244)
Tpay × Low Meritocracy (Tmerit=0) × Satisfied with the PS [iv]					-1.486*	-1.227
					(0.889)	(0.829)
Observations	738	715	660	652	701	691
Mean Dep. Var.	0.543	0.212	7.577	7.577	7.577	7.577
Mean Dep. Var. if Tpay=0	0.556	0.210	7.702	7.702	7.702	7.702
p-value H_0: [i] - [ii] = 0	0.954	0.391	0.016	0.019	0.040	0.072
p-value H_0: [iii] - [iv] = 0			0.241	0.474	0.140	0.113
p-value H_0: [i] - [iii] = 0			<0.001	0.001	<0.001	<0.001
p-value H_0: [ii] - [iv] = 0			0.660	0.872	0.082	0.113
Extra Controls	No	No	No	Yes	No	Yes

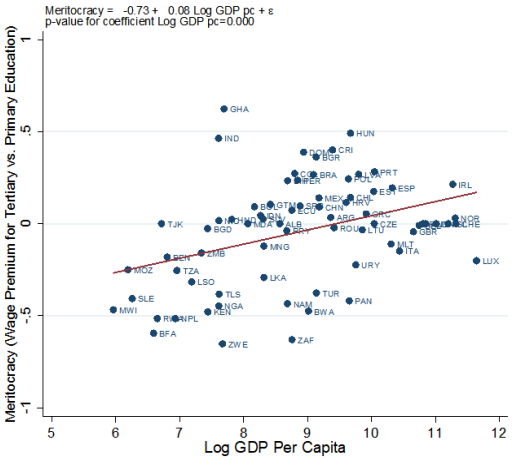
Notes: Sample restricted to workers with "Prior PS Pay < Truth". All regressions control for stratification variables and for a dummy variable for "High Meritocracy (Tmerit=1)". Columns (3)-(6) additionally control for the uninteracted x-variable (High Rank or Unsatisfied with the PS depending on the column). The "Extra Controls" include the CHW characteristics that are correlated with the uninteracted x-variable and their interaction with Tpay, Tmerit and Tpay × Tmerit. "Talked to PHU In-Charge" is self-reported by the CHW at endline. "Non-Patient Related Activities" include administrative tasks and liaising with PHU staff. The time spent on different tasks is self-reported by the CHW at endline. "High Rank" equals 1 if the CHW is ranked first, second or third in terms of performance by the PS at baseline, and 0 otherwise. "Unsatisfied with the PS" equals 1 if the CHW was not happy with the PS at baseline and 0 otherwise. "Number of Visits" is the average number of household visits provided by the CHW (as reported by the households). Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1.

Online Appendix

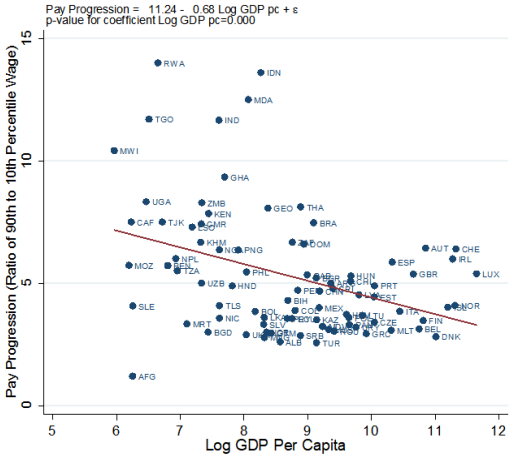
A Appendix Tables and Figures

FIGURE A.1: MERITOCRACY, PAY PROGRESSION AND GOVERNMENT PERFORMANCE BY GDP PER CAPITA: CROSS-COUNTRY ANALYSIS

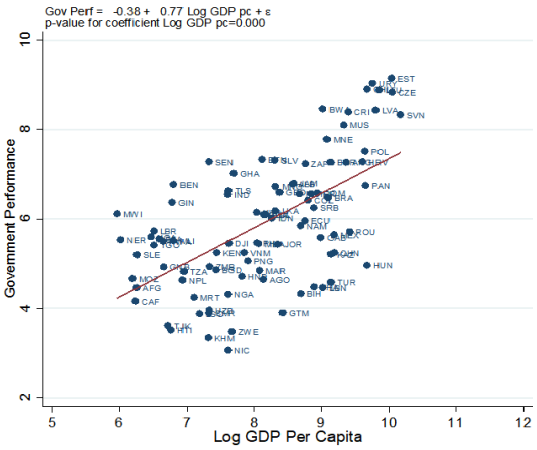
Panel A: Correlation between Meritocracy and GDP per Capita



Panel B: Correlation between Pay Progression and GDP per Capita



Panel C: Correlation between Government Performance and GDP per Capita

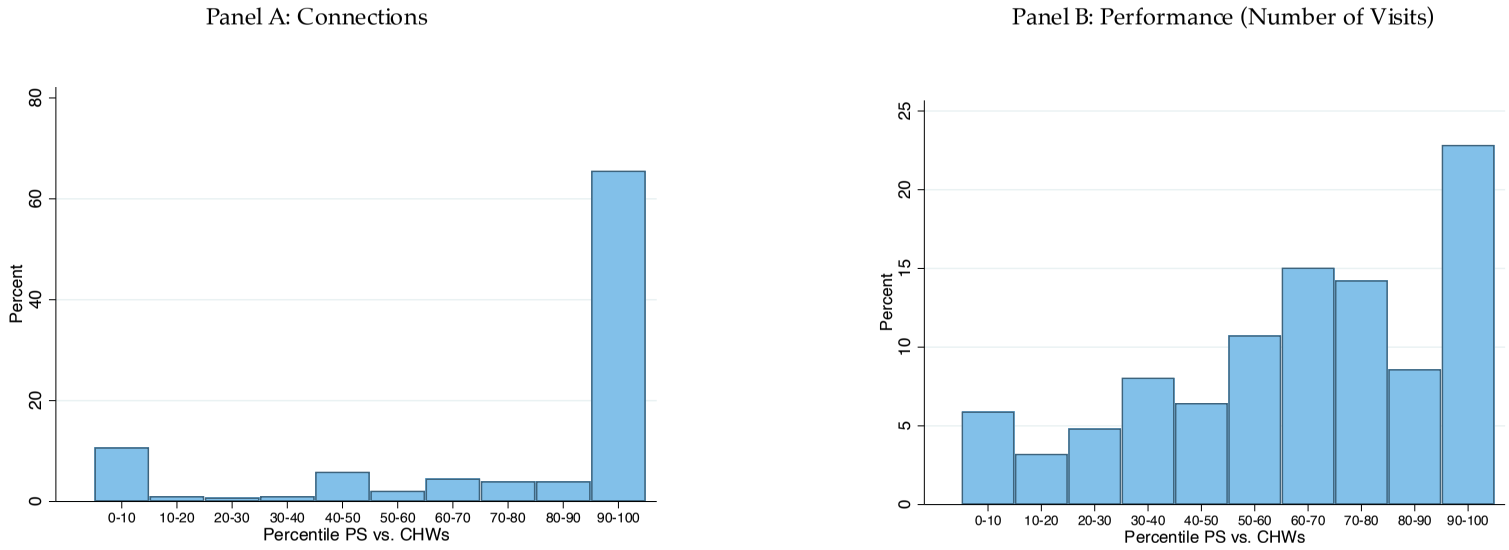


Notes: One observation per country. The red solid line represents the linear regression of meritocracy (Panel A), pay progression (Panel B) and government performance (Panel C) on log GDP per capita, with robust standard errors and no controls. For each country, we use data for the most recent year for which we have information on meritocracy, pay progression, government performance and GDP per capita (2018 or 2017 in most countries). Pay progression is measured by the World Bank's Worldwide Bureaucracy Indicators as the ratio of the 90th percentile wage to the 10th percentile wage in the public sector. Meritocracy is measured by the World Bank's Worldwide Bureaucracy Indicators as the average wage premium for workers with a tertiary education vs. a primary education in the public sector relative to the private sector. (Differences between the public and private sectors are used to hold fixed country-level characteristics such as the fraction of workers with a tertiary or primary education.) Government performance is measured by the Gothenburg's Quality of Government Indicators as an index of 4 government scores (1-10): steering capability, resource efficiency, consensus building, and international cooperation. Log GDP per capita is measured by the World Development Indicators.

FIGURE A.2: ASSOCIATION BETWEEN MERITOCRACY, PAY PROGRESSION AND GOVERNMENT PERFORMANCE: CROSS-COUNTRY ANALYSIS

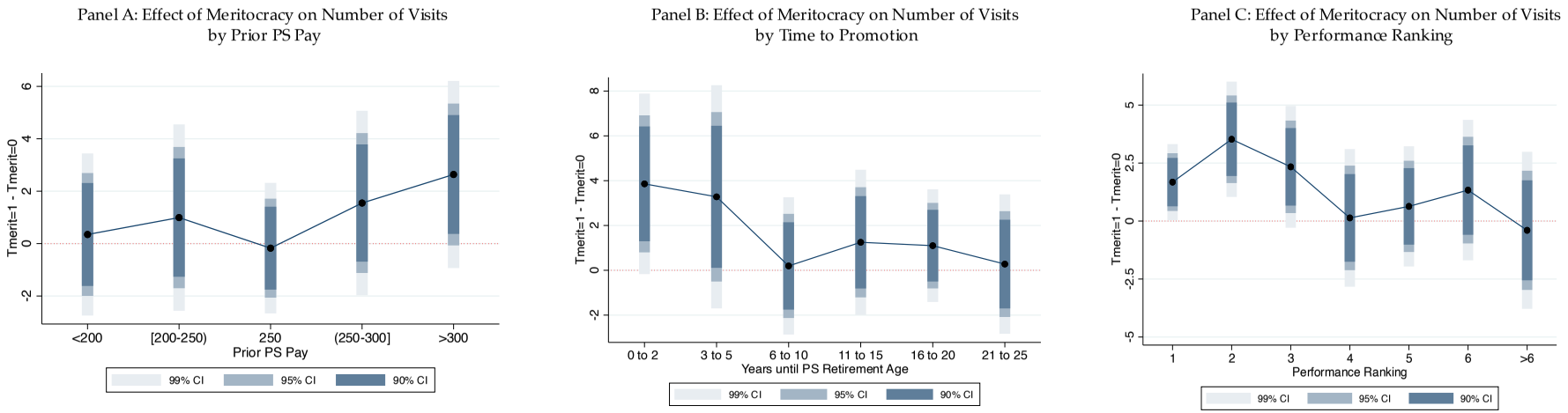
Notes: One observation per country-year. The red solid line represents the linear regression of government performance on pay progression (Panels A-B) or meritocracy (Panels C-D), with country and year fixed effects and with standard errors clustered at the country level. Panels A and B focus on the sample of countries with average meritocracy below and above the sample median, respectively. Panels C and D focus on the sample of countries with average pay progression below and above the sample median, respectively. "Residuals Meritocracy" ("Residuals Pay Progression") are measured as the residuals from a regression of meritocracy (pay progression) on country and year fixed effects. Pay progression is measured by the World Bank's Worldwide Bureaucracy Indicators as the ratio of the 90th percentile wage to the 10th percentile wage in the public sector. Meritocracy is measured by the World Bank's Worldwide Bureaucracy Indicators as the average wage premium for workers with a tertiary education vs. a primary education in the public sector relative to the private sector. (Differences between the public and private sectors are used to hold fixed country-level characteristics such as the fraction of workers with a tertiary or primary education.) Government performance is measured by the Gothenburg's Quality of Government Indicators as an index of 4 government scores (1-10): steering capability, resource efficiency, consensus building, and international cooperation. All variables vary across countries but also within countries over time.

FIGURE A.3: COMPARISON OF SUPERVISOR'S VS. WORKER'S CONNECTIONS AND PERFORMANCE IN THE STATUS-QUO PROMOTION SYSTEM



Notes: Panel A plots the distribution of the number of years the PS had known the PHU in-charge before joining the health program relative to the number of years other CHWs in the PHU (i.e., other candidates for the PS position) had known the PHU in-charge. PS connections is the x^{th} percentile if she had known the PHU in-charge for more years than x% of the CHWs in her PHU. Panel B plots the distribution of PS performance as a CHW relative to the performance of other CHWs in the PHU. PS performance is the x^{th} percentile if she performed better as a CHW than x% of the CHWs in her PHU. Because PS past performance when they were CHWs is not observed, we predict it in two steps. In the sample of all CHWs, we first regress the number of endline visits provided by a CHW within a given PHU on CHW characteristics: gender, age, primary/secondary education, tenure as a CHW. The R-squared of the first-stage is 38%. We then calculate the PS predicted number of visits by multiplying the obtained coefficients from the first step by the actual PS characteristics at the moment in which she was promoted. We do not include health knowledge and the wealth score in our two-step procedure because we do not know their values at the time of the promotion.

Figure A.4: Effect of Meritocracy on the Number of Visits by Prior PS Pay, Time to Promotion and Performance Ranking



Notes: This figure plots the effect of Tmerit by prior about PS pay (Panel A), time to promotion (Panel B) and performance ranking (Panel C). In Panel A, we estimate an extended version of equation (3) -- with 5 different level of priors PS pay -- and we report the estimates of the $\boldsymbol{\beta}$'s coefficients. In Panel B, we plot the coefficients from regressing the number of visits on Tmerit, dummy variables for different times to promotion (see x-axis), and the interaction of Tmerit with each dummy variable, controlling for the stratification variables and with standard errors clustered at the PHU level. In Panel C, we plot the coefficients from regressing the number of visits on Tmerit, dummy variables for a worker's rank (see x-axis) and the interaction of Tmerit with each dummy variable, controlling for the stratification variables and with standard errors clustered at the PHU level. "Number of Visits" is the average number of household visits provided by the CHW (as reported by the households).

Table A.1: Correlates of Supervisor Performance

	(1)	(2)	(3)	(4)	(5)	(6)
	Health knowledge score (0 to 7)		Predicted number of visits as a CHW		Number of years PS has known the PHU in-charge for	
	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.
Number of times the PS visited or called a CHW	0.122**	(0.056)	0.174	(0.217)	0.009	(0.018)
Number of times the PS accompanied a CHW to HH visit	0.010**	(0.005)	0.030**	(0.015)	-0.003*	(0.001)
Total number of HH visits provided by all CHWs supervised by the PS	0.600	(1.393)	9.383**	(4.130)	-0.104	(0.255)

Notes: Each row states the estimates from three regressions, where the variable in each row is regressed on the column variable. The regressions are at the PS level (sample of all 372 PSs). All regressions control for stratification variables, and for the two treatment indicators: Tmerit and Tpay. "Number of times PS visited or called a CHW" is reported by each CHW and aggregated to PS level. "Number of times PS accompanied a CHW to a HH visit" is reported by each household and aggregated to PS level. "Total number of household visits provided by all CHWs supervised by the PS" is reported by each household and aggregated to the PS level. "Predicted number of visits as a CHW" (columns 3-4) is measured in two steps. In the sample of all CHWs, we first regress the number of endline visits provided by a CHW within a given PHU on CHW characteristics: gender, age, primary/secondary education, tenure as a CHW. The R-squared of the first-stage is 38%. We then calculate the PS predicted number of visits by multiplying the obtained coefficients from the first step by the actual PS characteristics at the moment in which she was promoted. Robust standard errors presented in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A.2: Summary Statistics and Balance Checks at Village and Household Level

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			Tmerit		Tpay		Tmerit × Tpay	
	Mean	S.D.	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.
A. Village characteristics (N=2,009)								
Accessible road to government hospital= {0, 1}	0.788	0.409	0.009	(0.039)	0.014	(0.044)	-0.022	(0.058)
Primary school in the village = {0, 1}	0.477	0.500	-0.003	(0.040)	0.024	(0.039)	0.027	(0.056)
Number of water sources in the village	2.742	26.24	2.456	(2.193)	0.980	(0.870)	-2.718	(2.497)
B. Household respondents, aggregated to village level (N=2,009)								
Age (in years)	29.15	4.990	0.115	(0.396)	0.288	(0.364)	-0.829	(0.527)
Completed primary education = {0, 1}	0.284	0.292	0.041*	(0.021)	0.024	(0.023)	-0.028	(0.032)
Number of children under 5	0.731	0.280	0.015	(0.022)	-0.020	(0.023)	-0.017	(0.033)
Wealth score (0 to 8)	-0.220	2.175	0.280	(0.194)	0.225	(0.189)	-0.268	(0.259)
Main occupation is farming = {0, 1}	0.605	0.369	-0.017	(0.027)	-0.045	(0.028)	0.011	(0.041)
Knew the CHW at baseline = {0, 1}	0.971	0.121	-0.005	(0.007)	-0.003	(0.007)	0.001	(0.012)
CHW is localed <30 min = {0, 1}	0.870	0.273	-0.002	(0.021)	0.002	(0.022)	0.000	(0.028)
Government hospital is localed <30 min = {0, 1}	0.389	0.409	0.046	(0.037)	0.031	(0.031)	-0.060	(0.047)

Notes: This table presents summary statistics and balance checks for baseline village characteristics in Panel A and for household characteristics (aggregated to the village level) in Panel B. Each row states the sample mean and standard deviation of a variable, as well as the estimates from a regression where the variable is regressed on an indicator for Tmerit, Tpay and Tmerit × Tpay. All regressions control for stratification variables and cluster standard errors at the PHU level. *** p<0.01, ** p<0.05, * p<0.1

Table A.3: Summary Statistics and Balance Checks by PS Pay Priors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Mean	S.D.	Tmerit		Tpay		Tmerit × Tpay	
			Coeff	S.E.	Coeff	S.E.	Coeff	S.E.
A. CHW characteristics for CHWs with Prior PS Pay > Truth (N=673)								
Male = {0, 1}	0.736	0.441	0.008	(0.048)	-0.023	(0.049)	-0.002	(0.072)
Age (in years)	38.28	11.50	1.052	(1.339)	-0.627	(1.267)	2.042	(1.845)
Completed primary education = {0, 1}	0.689	0.463	0.034	(0.057)	0.054	(0.057)	-0.062	(0.081)
Completed secondary education or above = {0, 1}	0.068	0.253	-0.014	(0.027)	-0.051**	(0.025)	0.048	(0.038)
Wealth score (0 to 8)	2.366	1.064	0.191	(0.121)	-0.010	(0.116)	-0.177	(0.171)
Health knowledge score (0 to 7)	3.007	1.414	0.013	(0.167)	0.050	(0.168)	0.092	(0.231)
Number of years as CHW	2.534	3.041	0.346	(0.374)	0.099	(0.304)	-0.124	(0.512)
Number of households CHW is responsible for	56.39	80.98	6.446	(9.043)	-2.135	(8.216)	0.505	(12.702)
Number of hours worked as CHW per week	23.00	21.58	1.238	(2.496)	2.045	(2.691)	-3.107	(3.611)
Number of household visits provided per week	21.81	21.90	2.667	(2.836)	1.807	(3.120)	-5.510	(3.717)
Satisfied with the PS = {0, 1}	0.761	0.427	0.058	(0.052)	0.022	(0.054)	-0.006	(0.075)
Number of years CHW has known PS for	8.215	8.654	-0.751	(1.048)	-1.454	(0.903)	1.103	(1.411)
Ever talked to the PHU in-charge = {0, 1}	0.508	0.500	-0.024	(0.066)	-0.074	(0.067)	0.031	(0.094)
Number of years CHW has known PHU in-charge for	2.657	4.469	-0.274	(0.615)	-0.330	(0.619)	0.022	(0.802)
B. CHW characteristics for CHWs with Prior PS Pay = Truth (N=598)								
Male = {0, 1}	0.734	0.442	0.024	(0.053)	0.041	(0.048)	-0.122*	(0.070)
Age (in years)	35.54	10.69	0.018	(1.210)	-1.393	(1.118)	0.699	(1.675)
Completed primary education = {0, 1}	0.747	0.435	-0.032	(0.055)	0.066	(0.057)	0.002	(0.077)
Completed secondary education or above = {0, 1}	0.100	0.301	0.027	(0.044)	-0.053	(0.040)	-0.004	(0.054)
Wealth score (0 to 8)	2.599	1.162	-0.019	(0.141)	-0.104	(0.114)	0.182	(0.186)
Health knowledge score (0 to 7)	2.940	1.373	-0.080	(0.161)	-0.027	(0.154)	0.406*	(0.217)
Number of years as CHW	2.110	2.798	0.271	(0.294)	-0.244	(0.276)	0.218	(0.405)
Number of households CHW is responsible for	53.48	70.71	3.405	(10.761)	-8.216	(6.223)	1.765	(12.681)
Number of hours worked as CHW per week	20.92	19.90	-0.550	(2.466)	-2.585	(2.338)	2.485	(3.447)
Number of household visits provided per week	22.97	21.61	-0.517	(3.418)	-1.949	(2.482)	1.070	(4.138)
Satisfied with the PS = {0, 1}	0.766	0.424	0.063	(0.055)	0.082	(0.056)	-0.064	(0.073)
Number of years CHW has known PS for	7.532	8.225	0.050	(0.943)	-0.581	(0.989)	0.567	(1.328)
Ever talked to the PHU in-charge = {0, 1}	0.538	0.499	0.031	(0.066)	0.001	(0.067)	-0.143	(0.091)
Number of years CHW has known PHU in-charge for	2.981	4.524	-0.994	(0.628)	-1.066*	(0.632)	0.810	(0.775)
C. CHW characteristics for CHWs with Prior PS Pay < Truth (N=738)								
Male = {0, 1}	0.710	0.454	-0.085	(0.052)	-0.082	(0.052)	0.105	(0.075)
Age (in years)	37.10	11.25	-0.855	(1.246)	-0.418	(1.232)	1.489	(1.694)
Completed primary education = {0, 1}	0.706	0.456	-0.077	(0.050)	-0.055	(0.051)	0.077	(0.074)
Completed secondary education or above = {0, 1}	0.081	0.273	0.047*	(0.027)	0.042	(0.028)	-0.049	(0.043)
Wealth score (0 to 8)	2.533	1.224	0.061	(0.123)	0.132	(0.119)	0.069	(0.181)
Health knowledge score (0 to 7)	2.757	1.467	-0.097	(0.173)	-0.082	(0.160)	-0.165	(0.235)
Number of years as CHW	2.001	2.622	0.338	(0.291)	0.319	(0.291)	-0.426	(0.393)
Number of households CHW is responsible for	60.14	69.68	-9.165	(8.201)	3.420	(9.200)	7.861	(11.979)
Number of hours worked as CHW per week	21.83	23.32	3.149	(2.255)	3.927	(3.043)	-3.832	(3.928)
Number of household visits provided per week	19.93	16.20	-1.565	(1.688)	2.292	(1.683)	-0.332	(2.415)
Satisfied with the PS = {0, 1}	0.760	0.427	0.090*	(0.050)	0.064	(0.054)	-0.046	(0.068)
Number of years CHW has known PS for	7.569	8.383	0.621	(1.077)	1.058	(0.974)	0.963	(1.470)
Ever talked to the PHU in-charge = {0, 1}	0.543	0.498	-0.072	(0.061)	-0.038	(0.056)	-0.005	(0.085)
Number of years CHW has known PHU in-charge for	3.126	4.888	-0.916	(0.667)	-1.204*	(0.635)	1.113	(0.851)

Notes: This table presents summary statistics of CHW characteristics in the three sub-samples: CHWs who overestimated PS pay at baseline (Panel A), CHWs who guessed PS pay correctly (Panel B), CHWs who underestimated PS pay (Panel C). Each row states the sample mean and standard deviation of a variable, as well as the estimates from a regression, where the variable is regressed on an indicator for Tmerit, Tpay and Tmerit × Tpay. All regressions control for stratification variables and cluster standard errors at the PHU level. All variables reported in this table are measured at baseline. *** p<0.01, ** p<0.05, * p<0.1

Table A.4: Worker Characteristics that Predict Promotions

	(1)	(2)	(3)	(4)	(5)
Dep. Var.:	Promoted to PS = {0, 1}				
Connected to the PHU in-charge = {0, 1}	0.663***			0.555***	0.607***
	(0.047)			(0.045)	(0.050)
High performance (predicted number of visits > median) = {0, 1}		0.460***		0.272***	
		(0.029)		(0.029)	
Male = {0, 1}			0.116***		0.103***
			(0.036)		(0.033)
Age (in years)			0.002		0.002
			(0.002)		(0.001)
Completed primary education = {0, 1}			0.193***		0.078**
			(0.033)		(0.038)
Completed secondary education or above = {0, 1}			0.476***		0.264***
			(0.085)		(0.068)
High tenure (tenure > median) = {0, 1}			0.221***		0.033
			(0.032)		(0.027)
Observations	746	746	743	746	743
Mean Dep. Var.	0.217	0.217	0.217	0.217	0.217
R-squared	0.553	0.381	0.304	0.620	0.586

Notes: The sample is restricted to Tmerit=0. The dependent variable "Promoted to PS" equals one for the PSs in our sample and zero for the CHWs in our sample who were present in the PHU at the time of the promotion. The dependent variable is regressed on characteristics of the potential candidates for the PS position at the time of the promotion, who are assumed to be the current PS and the CHWs who were present in the PHU at the time of the promotion. "Connected to the PHU in-charge" equals one if the number of years the candidate has known the PHU in-charge before joining the program is in the top quartile. "High performance" equals one if the number of visits performed by the candidate is above the median. Because PS past performance when they were CHWs is not observed, we predict it in two steps. In the sample of all CHWs, we first regress the number of endline visits provided by a CHW within a given PHU on CHW characteristics: gender, age, primary/secondary education, tenure as a CHW. We then calculate the PS predicted number of visits by multiplying the obtained coefficients from the first step by the actual PS characteristics at the moment in which she was promoted. "High tenure" equals one if the number of years as a CHW is above the median. All regressions control for PHU fixed effects and cluster standard errors at the PHU level *** p<0.01, ** p<0.05, * p<0.1

Table A.5: Heterogeneous Effects of the Meritocracy Treatment on Beliefs Updating

Dep. Var.:	(1)	(2)	(3)	(4)
	Post-Treatment Perceived Meritocracy = {-1, 0, 1}			
Tmerit	0.574***	0.274***	0.297***	0.322***
	(0.030)	(0.093)	(0.026)	(0.032)
Prior Meritocracy = {-1, 0, 1}	0.739***			
	(0.028)			
Tmerit × Prior Meritocracy	-0.543***			
	(0.039)			
Prior PS Pay		0.002		
		(0.003)		
Tmerit × Prior PS Pay		0.001		
		(0.004)		
Promotion Soon			0.010	
			(0.050)	
Tmerit × Promotion Soon			-0.016	
			(0.074)	
High Rank				0.018
				(0.036)
Tmerit × High Rank				-0.053
				(0.047)
Observations	1,982	1,982	1,982	1,842
Mean Dep. Var.	0.626	0.626	0.626	0.626

Notes: All regressions control for stratification variables. "Prior PS Pay" is expressed in 10,000 SLL. "Promotions Soon" equals 1 if the supervisor of the CHW is within 5 years of retirement age at baseline. "High Rank" equals 1 if the CHW is ranked first, second or third in terms of performance by the PS at baseline and 0 otherwise. Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1

Table A.6: Heterogeneous Effects of the Pay Progression Treatment on Beliefs Updating

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dep. Var.:	|Post-Treatment PS Pay - Truth| (in 1,000 SLL)						
Definition of (pre-treatment) **Z** variable:	|Prior PS Pay - Truth|	Tmerit	High Rank	Satisfied with the PS	Tmerit	High Rank	Satisfied with the PS
Tpay	-3.449**	-36.063***	-35.549***	-36.063***			
	(1.524)	(3.114)	(1.961)	(3.114)			
Z	0.774***	-1.180	-2.582	-1.180	-0.317	0.931	-2.282
	(0.048)	(3.679)	(3.430)	(3.679)	(2.471)	(2.996)	(3.372)
Tpay × **Z**	-0.769***	1.625	2.524	1.625			
	(0.049)	(3.696)	(3.421)	(3.696)			
Tpay × 𝟙(Prior PS Pay < Truth)					-32.552***	-31.862***	-34.274***
					(2.060)	(1.766)	(2.859)
Tpay × 𝟙(Prior PS Pay > Truth)					-62.084***	-62.991***	-65.066***
					(3.678)	(3.689)	(4.519)
Tpay × 𝟙(Prior PS Pay = Truth)					-2.274	-1.474	-3.624
					(1.611)	(1.729)	(2.697)
Tpay × 𝟙(Prior PS Pay < Truth) × **Z**					-0.287	-0.268	2.136
					(2.637)	(3.013)	(3.379)
Tpay × 𝟙(Prior PS Pay > Truth) × **Z**					-1.283	-1.039	3.079
					(2.673)	(3.169)	(3.428)
Tpay × 𝟙(Prior PS Pay = Truth) × **Z**					-0.225	-1.844	1.700
					(2.632)	(3.032)	(3.491)
Observations	2,009	2,009	1,867	2,009	2,009	1,867	2,009
Mean Dep. Var.	17.90	17.90	17.90	17.90	17.90	17.90	17.90

Notes: All regressions control for the stratification variables. Columns (5) and (7) also control for two dummy variables: 𝟙(Prior PS Pay < Truth) and 𝟙(Prior PS Pay > Truth). 𝟙(Prior PS Pay < Truth) [resp., 𝟙(Prior PS Pay > Truth)] equals one if the PS salary pre-treatment perception of the CHW is below (resp., above) the actual salary of SLL 250,000 and 0 otherwise. "High Rank" equals 1 if the CHW is ranked first, second or third in terms of performance by the PS at baseline and 0 otherwise. "Satisfied with the PS" equals 1 if the CHW was "very happy" with the PS at baseline and 0 otherwise. Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1

Table A.7: 2 × 2 Specification

Dep. Var.:	(1) Number of Visits	(2) Visit Length (in Minutes)	(3) Retention = {0, 1}
Tmerit [i]	0.978	1.295	0.031
	(0.745)	(0.944)	(0.019)
Tpay [ii]	-1.227**	-0.847	-0.001
	(0.596)	(0.942)	(0.024)
Tmerit × Tpay [iii]	1.048	0.925	0.015
	(0.929)	(1.301)	(0.030)
Observations	1,966	1,868	2,009
Mean Dep. Var.	7.560	12.925	0.893
Mean Dep. Var. if Tpay=0 & Tmerit=0	7.455	12.479	0.878
p-value H_0: [i] + [iii] = 0	<0.001	0.014	0.046
p-value H_0: [ii] + [iii] = 0	0.803	0.932	0.417

Notes: All regressions control for the stratification variables. "Number of Visits" is the average number of household visits provided by the CHW (as reported by the households). "Visit Length" is the average visit length as reported by the households. A visit length of zero is inputed to households that are never visited by the CHW. "Retention" equals 1 if CHW self-reported not having dropped out and visited at least one household, and 0 otherwise. Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.8: Effect of Meritocracy and Pay Progression on the Number of Each Type of Visit

Dep. Var.:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Number of Routine Visits		Number of Cases Treated		Number of Cases Referred		Number of Ante-natal Visits		Number of Post-natal Visits	
Tmerit	1.084**		0.874***		0.297***		0.040		-0.012	
	(0.522)		(0.333)		(0.101)		(0.092)		(0.022)	
A. Effects of Meritocracy by Baseline Prior about PS Pay										
Tmerit × 𝟙(Prior PS Pay > Truth) [i]		3.252*		2.242**		0.236		0.327		-0.024
		(1.657)		(0.988)		(0.263)		(0.243)		(0.056)
Tmerit × 𝟙(Prior PS Pay = Truth) [ii]		1.482		0.563		0.222		0.057		0.023
		(1.142)		(0.785)		(0.217)		(0.060)		(0.025)
Tmerit × 𝟙(Prior PS Pay < Truth) [iii]		-1.142		0.073		0.197		-0.488		-0.042
		(0.827)		(0.545)		(0.272)		(0.508)		(0.043)
B. Effects of Higher Pay Progression by Meritocracy (Tmerit)										
Tpay × High Meritocracy (Tmerit=1) × 𝟙(Prior PS Pay < Truth) [iv]		0.191		0.101		0.061		0.114		0.021
		(1.226)		(0.797)		(0.260)		(0.104)		(0.041)
Tpay × Low Meritocracy (Tmerit=0) × 𝟙(Prior PS Pay < Truth) [v]		-0.669		-1.061**		-0.365***		-0.006		-0.006
		(0.605)		(0.415)		(0.131)		(0.051)		(0.018)
C. Effects of Lower Pay Progression by Meritocracy (Tmerit)										
Tpay × High Meritocracy (Tmerit=1) × 𝟙(Prior PS Pay > Truth) [vi]		-3.419**		-1.926*		-0.143		-0.330		0.012
		(1.627)		(1.015)		(0.265)		(0.246)		(0.044)
Tpay × Low Meritocracy (Tmerit=0) × 𝟙(Prior PS Pay > Truth) [vii]		0.160		0.307		-0.084		-0.057		-0.050
		(0.633)		(0.549)		(0.199)		(0.075)		(0.055)
D. Effects of Same Pay Progression by Meritocracy (Tmerit)										
Tpay × High Meritocracy (Tmerit=1) × 𝟙(Prior PS Pay = Truth) [viii]		-0.084		-0.123		-0.158		0.009		0.038
		(0.516)		(0.445)		(0.287)		(0.102)		(0.032)
Tpay × Low Meritocracy (Tmerit=0) × 𝟙(Prior PS Pay = Truth) [ix]		-1.446*		-0.321		-0.230		-0.502		0.132
		(0.799)		(0.517)		(0.193)		(0.498)		(0.107)
Observations	1,966	1,966	1,966	1,966	1,966	1,966	1,966	1,966	1,966	1,966
Mean Dep. Var.	4.256	4.256	3.058	3.058	0.832	0.832	0.242	0.242	0.066	0.066
Mean Dep. Var. if Tmerit=0	3.658	3.658	2.573	2.573	0.676	0.676	0.222	0.222	0.073	0.073
Mean Dep. Var. if Tpay=0	4.765	4.765	3.373	3.373	0.911	0.911	0.304	0.304	0.056	0.056
p-value H_0: [i] - [iii] = 0		0.019		0.044		0.914		0.146		0.802
p-value H_0: [iv] - [v] = 0		0.526		0.189		0.146		0.294		0.551
p-value H_0: [vi] - [vii] = 0		0.045		0.059		0.859		0.288		0.382
p-value H_0: [viii] - [ix] = 0		0.146		0.767		0.834		0.324		0.398

Notes: All regressions control for the stratification variables. The last column of each outcome variable follows the specification in Equation (3) and controls for 𝟙(Prior PS Pay < Truth) and 𝟙(Prior PS Pay > Truth). 𝟙(Prior PS Pay < Truth) [resp., 𝟙(Prior PS Pay > Truth)] equals one if the PS salary pre-treatment perception of the CHW is below (resp., above) the actual salary of SLL 250,000 and 0 otherwise. The dependent variable is reported by the households. Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.9: Effect of Meritocracy on Worker Performance in Tpay=0

	(1)	(2)	(3)	(4)	(5)
Dep. Var.:	Number of Visits				
Tmerit	0.932				
	(0.726)				
Tmerit × Promotion Soon [i]		4.894***	5.099***		
		(1.475)	(1.494)		
Tmerit × Promotion not Soon [ii]		0.308	0.342		
		(0.786)	(0.790)		
Tmerit × High Rank [i]				2.251**	2.191**
				(0.907)	(0.873)
Tmerit × Low Rank [ii]				0.066	0.210
				(0.866)	(0.871)
Observations	995	995	989	932	921
Mean Dep. Var. if Tmerit=0	7.455	7.455	7.455	7.455	7.455
p-value H_0: [i] - [ii] = 0		0.007	0.006	0.026	0.041
p-value MHT correction for [i]		0.004	0.004	0.004	0.004
p-value MHT correction for [ii]		0.753	0.709	0.908	0.809
Extra Controls		No	Yes	No	Yes

Notes: The sample is restricted to workers in Tpay=0. All regressions control for stratification variables. All columns (except the first one) control the uninteracted x-variable (Promotion Soon or High Rank depending on the column). The "Extra Controls" include the CHW characteristics that are correlated with the uninteracted x-variable and their interaction with Tmerit. At the bottom of the table, we present p-values adjusted for multiple hypothesis testing across all columns computed using Romano and Wolf [2016] step-down procedure. "Promotions Soon" equals one if the supervisor of the CHW is within 5 years of retirement age at baseline and 0 otherwise. "High Rank" equals one if the CHW is ranked first, second or third in terms of performance by the PS at baseline and 0 otherwise. "Number of Visits" is the average number of household visits provided by the CHW (as reported by the households). Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1.

TABLE A.10: MORE HETEROGENEOUS EFFECTS OF MERITOCRACY ON WORKER PERFORMANCE

Dep. Var.:	(1)	(2)	(3)	(4)
	Number of Visits			
Tmerit × Promotion Soon (self-reported by CHW) [i]	1.777***	1.686***		
	(0.584)	(0.584)		
Tmerit × Promotion not Soon (self-reported by CHW) [ii]	1.044*	1.174**		
	(0.600)	(0.587)		
Tmerit × High Rank (reported by other CHWs) [i]			1.949***	1.931***
			(0.536)	(0.541)
Tmerit × Low Rank (reported by other CHWs) [ii]			0.950	0.985
			(0.722)	(0.689)
Observations	1,966	1,955	1,773	1,749
Mean Dep. Var. if Tmerit=0	6.749	6.749	6.749	6.749
p-value H_0: [i] - [ii] = 0	0.302	0.481	0.200	0.225
Extra Controls	No	Yes	No	Yes

Notes: All regressions control for the stratification variables and for the uninteracted x-variable(s). Columns with even numbers additionally control for CHW characteristics that are correlated with the x-variable(s) and their interaction with Tmerit. Refer to the paper for details on the list of controls. "Promotion Soon (self-reported)" equals one if the perceived duration until the next promotion as reported by the CHW at baseline is below the median. CHWs who answered that they "don't know" when the next promotion will take place are assumed to have a perception above the median. "High Rank (reported by other CHWs)" equals one if the CHW is ranked first, second or third in terms of performance by other CHWs at baseline and 0 otherwise. At baseline, each CHW was asked to assess the rank of other CHWs in the PHU. We define a CHW to be "High Rank" if she is ranked in the top three by pooling together answers from all other CHWs in the PHU. "Number of Visits" is the average number of household visits provided by the CHW (as reported by the households). Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.11: Effect of Meritocracy and Pay Progression on Household Targeting and Supervisor Effort

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Household Targeting						PS Effort	
Dep. Var.:	% Visits to Households Living Within 30 Minutes Walk of the CHW		Median Distance Between the Visited Households and the CHW		% Visits to Friends/Family of the CHW		PS Visited CHW or Accompanied Her to HH Visit = {0, 1}	
Tmerit	-0.002		0.251		0.022		0.001	
	(0.017)		(0.512)		(0.020)		(0.023)	
A. Effects of Meritocracy by Baseline Prior about PS Pay								
		0.046		-0.134		0.028		0.011
Tmerit × 𝟙(Prior PS Pay > Truth) [i]		(0.029)		(0.631)		(0.039)		(0.045)
		0.018		0.668		0.008		0.020
Tmerit × 𝟙(Prior PS Pay = Truth) [ii]		(0.041)		(1.282)		(0.043)		(0.045)
		-0.043		0.125		0.058		-0.039
Tmerit × 𝟙(Prior PS Pay < Truth) [iii]		(0.038)		(0.739)		(0.043)		(0.054)
B. Effects of Higher Pay Progression by Meritocracy (Tmerit)								
Tpay × High Meritocracy (Tmerit=1) × 𝟙(Prior PS Pay < Truth) [iv]		-0.032		-0.059		-0.007		-0.003
		(0.039)		(1.539)		(0.041)		(0.038)
Tpay × Low Meritocracy (Tmerit=0) × 𝟙(Prior PS Pay < Truth) [v]		0.006		1.234		-0.060		0.015
		(0.044)		(0.952)		(0.041)		(0.045)
C. Effects of Lower Pay Progression by Meritocracy (Tmerit)								
Tpay × High Meritocracy (Tmerit=1) × 𝟙(Prior PS Pay > Truth) [vi]		-0.062*		2.401		-0.061		0.018
		(0.032)		(2.392)		(0.045)		(0.041)
Tpay × Low Meritocracy (Tmerit=0) × 𝟙(Prior PS Pay > Truth) [vii]		0.014		0.276		-0.011		0.020
		(0.034)		(0.483)		(0.042)		(0.051)
D. Effects of Same Pay Progression by Meritocracy (Tmerit)								
Tpay × High Meritocracy (Tmerit=1) × 𝟙(Prior PS Pay = Truth) [viii]		0.054		-0.005		-0.051		0.086*
		(0.036)		(0.731)		(0.040)		(0.052)
Tpay × Low Meritocracy (Tmerit=0) × 𝟙(Prior PS Pay = Truth) [ix]		0.009		0.206		0.010		0.052
		(0.044)		(0.683)		(0.047)		(0.044)
Observations	1,868	1,868	1,441	1,441	1,903	1,903	2,009	2,009
Mean Dep. Var.	0.873	0.873	2.234	2.234	0.449	0.449	0.843	0.843
Mean Dep. Var. if Tmerit=0	0.877	0.877	2.069	2.069	0.439	0.439	0.842	0.842
Mean Dep. Var. if Tpay=0	0.877	0.877	1.913	1.913	0.466	0.466	0.829	0.829
p-value H_0: [i] - [iii] = 0		0.064		0.772		0.576		0.391
p-value H_0: [iv] - [v] = 0		0.515		0.490		0.358		0.758
p-value H_0: [vi] - [vii] = 0		0.104		0.384		0.417		0.968
p-value H_0: [viii] - [ix] = 0		0.436		0.835		0.325		0.612

Notes: All regressions control for the stratification variables. The last column of each outcome variable follows the specification in Equation (3) and controls for 𝟙(Prior PS Pay < Truth) and 𝟙(Prior PS Pay > Truth). 𝟙(Prior PS Pay < Truth) [resp., 𝟙(Prior PS Pay > Truth)] equals one if the PS salary pre-treatment perception of the CHW is below (resp., above) the actual salary of SLL 250,000 and 0 otherwise. The first three dependent variables aggregate household-level data to CHW level. "PS Visited CHW or Accompanied Her to HH Visit" equals one if the PS visited or called the CHW at least once or if at least one household reports having received a visit in which the CHW was accompanied by the PS, and 0 otherwise. Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1.

TABLE A.12: EFFECT OF MERITOCRACY ON HOUSEHOLD TARGETING AND SUPERVISOR EFFORT, BY TIME TO PROMOTION AND RANKING

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Household Targeting									PS Effort		
Dep. Var.:	% Visits to Households Living Within 30 Minutes Walk of the CHW			Median Distance Between the Visited Households and the CHW			% Visits to Friends/Family of the CHW			PS Visited CHW or Accompanied Her to HH Visit		
Tmerit	-0.002			0.251			0.022			0.001		
	(0.017)			(0.512)			(0.020)			(0.023)		
Tmerit × Promotion Soon [i]		0.053			-0.855			0.049			0.036	
		(0.046)			(1.034)			(0.036)			(0.050)	
Tmerit × Promotion not Soon [ii]		-0.009			0.389			0.019			-0.003	
		(0.019)			(0.572)			(0.022)			(0.025)	
Tmerit × High Rank [i]			-0.009			0.525			0.011			0.015
			(0.028)			(0.926)			(0.027)			(0.028)
Tmerit × Low Rank [ii]			-0.003			0.201			0.024			-0.013
			(0.020)			(0.652)			(0.025)			(0.028)
Observations	1,868	1,868	1,737	1,441	1,441	1,338	1,903	1,903	1,770	2,009	2,009	1,867
Mean Dep. Var. if Tmerit=0	0.877	0.877	0.877	2.069	2.069	2.069	0.439	0.439	0.439	0.842	0.842	0.842
p-value H_0: [i] - [ii] = 0		0.221	0.850		0.312	0.772		0.473	0.676		0.482	0.395

Notes: All regressions control for stratification variables. All columns of each outcome variable (except the first one) control the uninteracted x-variable (Promotion Soon or High Rank depending on the column). "Promotions Soon" equals one if the supervisor of the CHW is within 5 years of retirement age at baseline and 0 otherwise. "High Rank" equals one if the CHW is ranked first, second or third in terms of performance by the PS at baseline and 0 otherwise. The first three dependent variables aggregate household-level data to CHW level. "PS Visited CHW or Accompanied Her to HH Visit" equals one if the PS visited or called the CHW at least once or if at least one household reports having received a visit in which the CHW was accompanied by the PS, and 0 otherwise. Standard errors are clustered at the PHU level.

Table A.13: Effect of Pay Progression on Worker Performance – IV Results

Dep. Var.:	(1)	(2)	(3)
	Number of Visits		
Sample:	*All*	*Prior PS Pay < Truth*	*Prior PS Pay > Truth*
Post-Treatment Perceived PS Pay Updating × High Meritocracy (Tmerit=1) [i]	0.028***		
	(0.009)		
Post-Treatment Perceived PS Pay Updating × Low Meritocracy (Tmerit=0) [ii]	-0.002		
	(0.008)		
Post-Treatment Perceived PS Pay × High Meritocracy (Tmerit=1) [i]		0.074*	0.033**
		(0.043)	(0.017)
Post-Treatment Perceived PS Pay × Low Meritocracy (Tmerit=0) [ii]		-0.061**	0.010
		(0.025)	(0.015)
Observations	1,966	701	668
Mean Dep. Var.	7.560	7.560	7.560
F-stat 1st Stage (Cragg Donald Test)	181.058	89.894	96.240
p-value H_0: [i] - [ii] = 0	0.007	0.007	0.300

Notes: Sample described in column headings. In column (1), we present an IV regression with four IVs: Tpay × 𝟙(Perceived PS Pay < Truth) × High Meritocracy, Tpay × 𝟙(Perceived PS Pay < Truth) × Low Meritocracy, Tpay × 𝟙(Perceived PS Pay > Truth) × High Meritocracy, Tpay × 𝟙(Perceived PS Pay > Truth) × Low Meritocracy. In columns (2) and (3), we use 2 IVs: Tpay × High Meritocracy, Tpay × Low Meritocracy. "Post-Treatment Perceived PS Pay Updating" is the difference between post- and pre-treatment perceived PS pay, and is expressed in thousand of SLL. "Post-Treatment Perceived PS Pay" is the post-treatment perceived PS pay, expressed in thousand of SLL. "Number of Visits" is the average number of household visits provided by the CHW (as reported by the households). All regressions control for a dummy variable for "High Meritocracy (Tmerit=1)" and for the stratification variables. Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1.

B Performance-based Incentives

The CHWs and PSs in this study were part of a separate evaluation that is the focus of Deserranno et al. (2022) and that involves a temporary performance-based incentive scheme paid by an external organization. The randomization was done at the PHU level. In the Shared Incentives Treatment, CHWs received an incentive of 1,000 SLL for each service performed and the PS received an incentive of 1,000 SLL for each service performed by a CHW under her supervision. In the Worker Incentives Treatment, CHWs received an incentive of 2,000 SLL for each service performed while the PS received no incentives. In the Supervisor Incentives Treatment, the PS received an incentive of 2,000 SLL for each service performed by a CHW under her supervision while the CHWs received no incentives. In the control group, neither the CHWs nor the PS received an incentive. In each treatment, the number of services a CHW provided was measured with an SMS reporting system, which required the CHW to report the date and type of service and the contact information of the patient by sending an SMS to a toll-free number. This reporting system played no role in the main experiment of this paper.

As mentioned in the body of the paper, the randomization of the meritocracy and pay progression treatments was stratified by the above-mentioned incentives treatments. Still, one may be concerned that the main effects shown in the paper are driven by specific interactions between the treatments in the two projects. We address this concern directly in Table A.16, where we first show that the impact of the meritocratic promotion and pay progression treatments on perceptions of meritocracy and pay progression are orthogonal to the presence of these incentives. This is not surprising as these incentives are short-run and are provided by an external organization with no connection with the government, and thus should not affect the perceptions about the promotion criteria or perceptions about the pay PSs receive from the government. Accordingly, Table A.15 shows that the effects of the meritocracy and pay progression treatments on the number of visits do not interact with the incentives treatments (column 2). The effects of the meritocracy treatment by perceived PS pay, promotion expected soon or high rank – which we presented in Section 5.2 – also appear orthogonal to the incentives treatments (columns 3-5).

One may be worried that there may just be too little power to test for these interactions. In that case, one should cautiously interpret the effects of our meritocracy and pay progression treatments as composite treatment effects that include a weighted-average of the interactions with the incentives treatments (Muralidharan, Romero, and Wüthrich 2020). These composite weighted-average treatment effects remain qualitatively informative and policy-relevant.

Table A.14: Incentives and Perceptions

	(1)	(2)	(3)	(4)
Dep.Var.:	Post-Treatment Perceived Meritocracy = {-1, 0, 1}		|Post-Treatment Perceived PS Pay - Truth| (in 1,000 SLL)	
Supv Incentives	0.018	0.043	-1.409	-2.399
	(0.043)	(0.042)	(3.125)	(2.724)
Worker Incentives	0.023	0.042	0.389	3.740
	(0.041)	(0.040)	(3.254)	(2.902)
No Supv/Worker incentives	-0.005	0.027	2.517	4.140
	(0.041)	(0.038)	(3.273)	(2.872)
Tmerit		0.317***		
		(0.044)		
Tmerit × Supv Incentives		-0.007		
		(0.062)		
Tmerit × Worker Incentives		-0.013		
		(0.059)		
Tmerit × No Supv/Worker incentives		-0.035		
		(0.062)		
Tpay				-32.367***
				(2.578)
Tpay × Supv Incentives				2.760
				(3.460)
Tpay × Worker Incentives				-2.899
				(3.500)
Tpay × No Supv/Worker incentives				-2.333
				(3.642)
Observations	1,933	1,933	2,009	2,009
Mean Dep. Var. in Omitted Group	0.615	0.448	18.157	34.405

Notes: All regressions control for district fixed effects and the baseline value of the outcome variable. Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1

Table A.15: Main Results, Interactions with Incentives

	(1)	(2)	(3)	(4)	(5)
Dep. Var.:			Number of Visits		
Definition of Z:	-	-	𝟙(Prior PS Pay > Truth)	Promotion Soon	High Rank
Tmerit	0.968	0.849			
	(0.771)	(1.670)			
Tpay	-1.327**	-1.761			
	(0.621)	(1.474)			
Tpay × Tmerit	1.165	1.312			
	(0.980)	(2.067)			
Tmerit × Supv Incentives		2.772			
		(2.167)			
Tpay × Supv Incentives		0.378			
		(1.786)			
Tpay × Tmerit × Supv Incentives		-3.235			
		(2.675)			
Tmerit × Worker Incentives		-1.920			
		(2.296)			
Tpay × Worker Incentives		1.123			
		(1.967)			
Tpay × Tmerit × Worker Incentives		2.824			
		(2.869)			
Tmerit × No Supv/Worker incentives		-0.755			
		(1.833)			
Tpay × No Supv/Worker incentives		0.546			
		(1.682)			
Tpay × No Supv/Worker incentives		-0.527			
		(2.373)			
Tmerit × Z			1.958	1.127	1.945
			(1.438)	(1.212)	(1.301)
Tmerit × 1-Z			1.021	1.663	0.911
			(1.124)	(1.168)	(1.186)
Tmerit × Z × Supv incentives			1.007	2.309	0.937
			(1.932)	(1.630)	(1.752)
Tmerit × 1-Z × Supv incentives			1.784	0.044	1.909
			(1.510)	(1.803)	(1.599)
Tmerit × Z × Worker incentives			-1.776	0.748	0.329
			(1.849)	(1.778)	(1.647)
Tmerit × 1-Z × Worker incentives			0.622	-1.516	-0.674
			(1.651)	(1.570)	(1.689)
Tmerit × Z × No Supv/Worker incentives			-1.778	-0.671	0.215
			(1.586)	(1.402)	(1.540)
Tmerit × 1-Z × No Supv/Worker incentives			-0.385	-1.130	-0.872
			(1.289)	(1.368)	(1.370)
Observations	1,966	1,966	1,966	1,966	1,830
Mean Dep. Var.	7.560	7.560	7.560	7.560	7.560

Notes: Columns (3) to (5) control for the uninteracted Z variable, defined in the column heading. "Number of Visits" is the average number of household visits provided by the CHW (as reported by the households). Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1.

C Ethics Appendix

Following Asiedu et al. (2021), we detail key aspects of research ethics.

C.1 Pre-Analysis Plan

The study was pre-registered on the AEA RCT Registry with the number 0003993. We follow the pre-analysis closely. The outcomes variables we use in the paper and the heterogeneous treatment effects with respect to perceived pay progression and worker ability were pre-registered.

In the pre-analysis plan, we specified that we would use the number of SMS reports, described in Appendix B, as a secondary measure of worker performance. We ended up not using this variable because the average worker is found to vastly underreport the visits provided: the average reporting rate is 17.7% and is comparable across treatments. This measure is hence uninformative about worker performance. We decided to focus only on the primary measure of worker performance based on households' responses in the household survey.

We also specified that we would study heterogeneous treatment effects by social connections to the PHU in-charge. We did not present these results in the main text due to the lack of a clear theoretical prediction on this heterogeneity. For transparency, we show these results in Table A.16 and describe them here. As column (1) shows, we estimate that T_{merit} leads to an increase of 2.3 visits (35%) for workers not connected to the PHU in-charge (significant at the 1% level) and an increase of 0.8 visits for workers connected to the PHU in-charge, although this estimate is not significant. The difference between the two estimates is statistically significant at the 1% level. Looking at the interaction of connections and worker ranking, column (3) shows that high-ranked, unconnected workers increase the number of visits the most (by 3.3) when promotions become meritocratic. Both low-ranked, unconnected workers and high-ranked, connected workers also significantly increase the number of visits they provide, but to a smaller extent. Finally, we do not find a sizable or significant effect for low-ranked, connected workers. Intuitively, these results can be rationalized when viewing the status quo promotion rule as one in which performance matters for promotions conditional on being sufficiently connected to the PHU in-charge. In that case, unconnected workers have weak career incentives for exerting effort in the status quo which could explain their strong response to the meritocratic promotions treatment. Connected workers also have higher incentives to exert effort in the meritocratic promotions treatment due to an increase in competition from unconnected workers, but only if they are ranked highly and stand a chance to be among the best performers. Note that low-ranked, unconnected workers might respond to the meritocratic promotions treatment because their low ranking in the status quo does not necessarily stem from a lack of ability, but a lack of career incentives. The same is not true for low-ranked, connected workers for whom we do not find an increase in visits.

TABLE A.16: EFFECT OF MERITOCRACY BY CONNECTIONS AND PERFORMANCE RANKING

Dep. Var.:	(1)	(2)	(3)	(4)
	Number of Visits			
Tmerit × Not Connected to PHU In-Charge [i]	2.344***	2.508***		
	(0.571)	(0.618)		
Tmerit × Connected to PHU In-Charge [ii]	0.782	0.595		
	(0.547)	(0.572)		
Tmerit × High Rank & Not Connected to PHU In-Charge [i]			3.263***	3.475***
			(0.727)	(0.781)
Tmerit × High Rank & Connected to PHU In-Charge [ii]			1.557**	1.372*
			(0.740)	(0.771)
Tmerit × Low Rank & Not Connected to PHU In-Charge [iii]			1.824***	2.046***
			(0.689)	(0.717)
Tmerit × Low Rank & Connected to PHU In-Charge [iv]			0.237	0.217
			(0.671)	(0.661)
Observations	1,966	1,956	1,830	1,812
Mean Dep. Var. if Tmerit=0	6.749	6.749	6.749	6.749
p-value H_0: [i] - [ii] = 0	0.007	0.007	0.040	0.034
p-value H_0: [i] - [iii] = 0			0.076	0.086
p-value H_0: [i] - [iv] = 0			0.001	0.001
Extra Controls	No	Yes	No	Yes

Notes: All regressions control for the stratification variables and for the uninteracted x-variable(s). Columns with even numbers additionally control for CHW characteristics that are correlated with the x-variable(s) and their interaction with Tmerit. "Connected to PHU In-Charge" takes value one if the CHW has known the PHU in-charge for more years than half of the other CHWs (i.e., top half in terms of years she has known the PHU in-charge). "High Rank & Not Connected to PHU In-Charge" is a dummy variable for being ranked among the top three in the PHU by the PS at baseline & not being connected to the PHU in-charge at baseline. "Number of Visits" is the average number of household visits provided by the CHW (as reported by the households). Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1.

C.2 IRB and Research Ethics

The project received IRB from the University of Pompeu Fabra (CIREP Approval 107) and from the Sierra Leone Ethics and Scientific Review Committee (no IRB number assigned by this local institution).

We obtained informed consent from all participants prior to the study. The consent form described the participants' risks and rights, confidentiality, and contact information. Research staff and enumerator teams were not subject to additional risks in the data collection process. None of the researchers have financial or reputation conflicts of interest with regard to the research results. No contractual restrictions were imposed on the researchers limiting their ability to report the study findings.

On policy equipoise and scarcity, there was uncertainty regarding the net benefits from our treatments for any worker. The interventions under study did not pose any potential harm to participants and non-participants. The intervention rollout took place according to the evaluation protocol.

On potential harms to participants or nonparticipants, our data collection and research procedures adhered to protocols around privacy, confidentiality, risk-management, and informed consent. Participants were not considered particularly vulnerable (beyond some households residing in poverty). Besides individual consent from study participants, consultations were conducted with local representatives at the district levels. All the enumerators involved in data collection were recruited from the study districts to ensure they were aware about implicit social norms in these communities.

The presentation of the findings from the project to district and national level authorities in Sierra Leone was delayed due to COVID-19 but is planned for 2022. No activity for sharing results to participants in each study village is planned due to resource constraints. We do not foresee risks of the misuse of research findings. Policy briefs have been created based on this project and have been distributed to policymakers through IGC and CEGA.

D Model Appendix

D.1 Main Results

This section formally develops the theoretical framework presented in Section 3.

Throughout we assume that player 2 is willing to participate in the promotion contest but exerts less effort than player 1 such that the costs of effort are equal to the pay progression.

Assumption 1. *The cost functions satisfy* $r_1 > r_2$, *where* $r_1 = bc_1^{-1}(\bar{w} - \underline{w}) = b\frac{\bar{w}-\underline{w}}{c_1}$ *and* $r_2 = \frac{\bar{w}-\underline{w}}{c_2 g_2(b,\bar{w}-\underline{w})}$.[43]

Following Siegel (2010), the b-biased promotion tournament with effort costs (c_1, c_2) has a unique equilibrium in mixed strategies. We derive the following lemma, which we prove in Appendix D.2:

Lemma D.1. *The average effort, as a function of* $\bar{w} - \underline{w}$, c_1, c_2 *and* b, *is given by* $\bar{e}_1(\bar{w} - \underline{w}, b, c_1, , c_2) = \frac{\bar{w}-\underline{w}}{2bc_2 g_2(b,\bar{w}-\underline{w})}$ *and* $\bar{e}_2(\bar{w} - \underline{w}, b, c_1, c_2) = \frac{c_1(\bar{w}-\underline{w})}{2bc_2^2 g_2(b,\bar{w}-\underline{w})^2}$, *for players* 1 *and* 2, *respectively.*

D.1.1 Results without Morale Concerns

This section derives the propositions that underlie the predictions without morale concerns (i.e., $g_i(b, \bar{w} - \underline{w}) = 1$ for $i = 1, 2$) presented in Section 3.2. The corresponding proofs are presented in Appendix D.2.

[43] This assumption does not imply $c_1 < c_2$ or $c_1 > c_2$. In what follows, we do not restrict to either case.

Proposition D.2. *Fix c_1, and suppose that $\tilde{c}_2 > \tilde{\tilde{c}}_2$. Then $\bar{e}_i(\bar{w} - \underline{w}, b, c_1, \tilde{\tilde{c}}_2) > \bar{e}_i(\bar{w} - \underline{w}, b, c_1, \tilde{c}_2)$, for $i = 1, 2$.*

Proposition D.3. *Let $b' > b$, then $\bar{e}_i(\bar{w} - \underline{w}, b, c_1, c_2) > \bar{e}_i(\bar{w} - \underline{w}, b', c_1, c_2)$, for $i = 1, 2$.*

This result implies Prediction 1.

Proposition D.4. *Let $\bar{\bar{w}} - \underline{\underline{w}} > \bar{w} - \underline{w}$. Then $\bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, c_2) > \bar{e}_i(\bar{w} - \underline{w}, b, c_1, c_2)$, for $i = 1, 2$.*

This result implies Prediction 2.

We are also interested in the effect of pay progression on workers' effort at different levels of meritocracy, and the effect of meritocracy at different levels of pay progression. We have that:

Proposition D.5. *Let $\bar{\bar{w}} - \underline{\underline{w}} \geq \bar{w} - \underline{w}$, $b' \geq b$. Then $\bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, c_2) - \bar{e}_i(\bar{w} - \underline{w}, b, c_1, c_2) \geq \bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b', c_1, c_2) - \bar{e}_i(\bar{w} - \underline{w}, b', c_1, c_2)$, for $i = 1, 2$.*

This result implies Prediction 3.

Proposition D.6. *Let $b' > b$. For $\tilde{c}_2 > \tilde{\tilde{c}}_2$, we have that $\bar{e}_i(\bar{w} - \underline{w}, b, c_1, \tilde{\tilde{c}}_2) - \bar{e}_i(\bar{w} - \underline{w}, b', c_1, \tilde{\tilde{c}}_2) > \bar{e}_i(\bar{w} - \underline{w}, b, c_1, \tilde{c}_2) - \bar{e}_i(\bar{w} - \underline{w}, b', c_1, \tilde{c}_2)$, for $i = 1, 2$.*

This entails that the result of Proposition D.3 is amplified when player 2 is of higher ability.

Proposition D.7. *Let $\bar{\bar{w}} - \underline{\underline{w}} > \bar{w} - \underline{w}$. For $\tilde{c}_2 > \tilde{\tilde{c}}_2$ we have that $\bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, \tilde{\tilde{c}}_2) - \bar{e}_i(\bar{w} - \underline{w}, b, c_1, \tilde{\tilde{c}}_2) > \bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, \tilde{c}_2) - \bar{e}_i(\bar{w} - \underline{w}, b, c_1, \tilde{c}_2)$, for $i = 1, 2$.*

This entails that the result of Proposition D.4 is amplified when player 2 is of higher ability.

Proposition D.8. *Let $\bar{\bar{w}} - \underline{\underline{w}} > \bar{w} - \underline{w}$, $b' > b$. For $\tilde{c}_2 > \tilde{\tilde{c}}_2$ and $i = 1, 2$*

$$\left(\bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, \tilde{\tilde{c}}_2) - \bar{e}_i(\bar{w} - \underline{w}, b, c_1, \tilde{\tilde{c}}_2)\right) - \left(\bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b', c_1, \tilde{\tilde{c}}_2) - \bar{e}_i(\bar{w} - \underline{w}, b', c_1, \tilde{\tilde{c}}_2)\right) >$$
$$\left(\bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, \tilde{c}_2) - \bar{e}_i(\bar{w} - \underline{w}, b, c_1, \tilde{c}_2)\right) - \left(\bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b', c_1, \tilde{c}_2) - \bar{e}_i(\bar{w} - \underline{w}, b', c_1, \tilde{c}_2)\right).$$

This tells us that the result of Proposition D.5 is amplified when player 2 is of higher ability. Taken together, Propositions D.6, D.7, and D.8 imply Prediction 4.

D.1.2 Results with Morale Concerns

This section derives the propositions that underlie the predictions of the model with morale concerns presented in Section 3.3.

We make three assumptions about the morale cost-shift function g_i. (Section 3.3 provides the intuition for each of them):

Assumption 2.

1. *$g_1(b, \bar{w} - \underline{w}) = 1$ for all $(b, \bar{w} - \underline{w}) \in \mathbb{R}^2_+$.*
2. *$g_2 : \mathbb{R}^2_+ \to \mathbb{R}_{++}$ is strictly increasing in all of its arguments, log super-modular, and $g_2(1, \bar{w} - \underline{w}) = 1$ $\forall \bar{w} - \underline{w}$.*
3. *Domination of cost-shift for higher pay progression: For $\bar{w} - \underline{w} < \bar{\bar{w}} - \underline{\underline{w}}$, we have that $\lim_{b \to \infty} \frac{g_2(b, \bar{w} - \underline{w})}{g_2(b, \bar{\bar{w}} - \underline{\underline{w}})} = 0$.*

Given these assumptions, we obtain the following propositions, which we prove in Appendix D.2:

Proposition D.9. *Let $b' > b$. Then $\bar{e}_i(\bar{w} - \underline{w}, b', c_1, c_2) \leq \bar{e}_i(\bar{w} - \underline{w}, b, c_1, c_2)$, for $i = 1, 2$.*

This result implies Prediction 5.

Proposition D.10. *Let $\bar{\bar{w}} - \underline{\underline{w}} \geq \bar{w} - \underline{w}$. Then there exists $\bar{b}, \bar{\bar{b}}$ where $\bar{\bar{b}} \geq \bar{b}$, such that:*

1. *If $b \leq \bar{b}$, $\bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, c_2) \geq \bar{e}_i(\bar{w} - \underline{w}, b, c_1, c_2)$, for $i = 1, 2$, and*
2. *If $b \geq \bar{\bar{b}}$, $\bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, c_2) \leq \bar{e}_i(\bar{w} - \underline{w}, b, c_1, c_2)$, for $i = 1, 2$.*

That is, if $b \geq \bar{\bar{b}}$, the equilibrium level of effort decreases as pay progression increases. Instead, if $b \leq \bar{b}$, the equilibrium level of effort increases. From this, we derive Prediction 6.

Proposition D.11. *Let $\bar{\bar{w}} - \underline{\underline{w}} \geq \bar{w} - \underline{w}$, $b' \geq b$ and $\bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, c_2) - \bar{e}_i(\bar{w} - \underline{w}, b, c_1, c_2) \geq 0$, for $i = 1, 2$. Then $\bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, c_2) - \bar{e}_i(\bar{w} - \underline{w}, b, c_1, c_2) \geq \bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b', c_1, c_2) - \bar{e}_i(\bar{w} - \underline{w}, b', c_1, c_2)$, for $i = 1, 2$.*

This implies Prediction 7.

Proposition D.12. *Let $b' > b$. For $\tilde{c}_2 > \tilde{\tilde{c}}_2$ we have $|\bar{e}_i(\bar{w} - \underline{w}, b, c_1, \tilde{\tilde{c}}_2) - \bar{e}_i(\bar{w} - \underline{w}, b', c_1, \tilde{\tilde{c}}_2)| > |\bar{e}_i(\bar{w} - \underline{w}, b, c_1, \tilde{c}_2) - \bar{e}_i(\bar{w} - \underline{w}, b', c_1, \tilde{c}_2)|$, for $i = 1, 2$.*

This implies that the result of Proposition D.9 is amplified when player 2 is of higher ability.

Proposition D.13. *Let $\bar{\bar{w}} - \underline{\underline{w}} > \bar{w} - \underline{w}$. For $\tilde{c}_2 > \tilde{\tilde{c}}_2$ we have $|\bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, \tilde{\tilde{c}}_2) - \bar{e}_i(\bar{w} - \underline{w}, b, c_1, \tilde{\tilde{c}}_2)| > |\bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, \tilde{c}_2) - \bar{e}_i(\bar{w} - \underline{w}, b, c_1, \tilde{c}_2)|$, for $i = 1, 2$.*

This implies that the result of Proposition D.10 is amplified when player 2 is of higher ability.

Proposition D.14. *Let $\bar{\bar{w}} - \underline{\underline{w}} > \bar{w} - \underline{w}$, $b' > b$, $\tilde{c}_2 > \tilde{\tilde{c}}_2$ and $\bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b', c_1, \tilde{c}_2) - \bar{e}_i(\bar{w} - \underline{w}, b', c_1, \tilde{c}_2) \geq 0$, for $i = 1, 2$. Then, for $i = 1, 2$,*

$$\left(\bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, \tilde{\tilde{c}}_2) - \bar{e}_i(\bar{w} - \underline{w}, b, c_1, \tilde{\tilde{c}}_2)\right) - \left(\bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b', c_1, \tilde{\tilde{c}}_2) - \bar{e}_i(\bar{w} - \underline{w}, b', c_1, \tilde{\tilde{c}}_2)\right) >$$
$$\left(\bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, \tilde{c}_2) - \bar{e}_i(\bar{w} - \underline{w}, b, c_1, \tilde{c}_2)\right) - \left(\bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b', c_1, \tilde{c}_2) - \bar{e}_i(\bar{w} - \underline{w}, b', c_1, \tilde{c}_2)\right).$$

We can then say that the result of Proposition D.11 is amplified when player 2 is of higher ability. Taken together, Propositions D.12, D.13, and D.14 imply Prediction 8.

D.2 Proofs

Lemma D.1

Proof. Define the score of player 1 as $s_1 = be_1$ and the score of player 2 as $s_2 = e_2$. The score indicates how effort maps into the probability of winning. We can rewrite the tournament success function under a biased rule as:

$$P_i^b(s_1, s_2) = \begin{cases} 0 & \text{if } s_i < s_{-i} \\ p & \text{if } s_i = s_{-i} \\ 1 & \text{if } s_i > s_{-i} \end{cases}$$

where $p \in [0, 1]$.

Mapping to Siegel (2010), we have that $v_1(s_1) = \bar{w} - \underline{w} - c_1\left(\frac{s_1}{b}\right)$ and $v_2(s_2) = \bar{w} - \underline{w} - g_2(b, \bar{w} - \underline{w})c_2(s_2)$. Given $c_i > 0$ and Assumption 1, Siegel (2010)'s assumptions are satisfied. From Theorem 3 in Siegel (2010), we conclude that the *cdfs* of the score are:

$$E^s{}_1(s) = \begin{cases} \frac{g_2(b, \bar{w} - \underline{w})c_2(s)}{\bar{w} - \underline{w}} & \text{if } y \in [0, r_2) \\ 1 & \text{if } y \geq r_2 \end{cases} \quad \text{and,} \quad E_2^s(s) = \begin{cases} \frac{\bar{w} - \underline{w} - c_1(r_2) + c_1(s)}{\bar{w} - \underline{w}} & \text{if } s \in [0, r_2) \\ 1 & \text{if } s \geq r_2 \end{cases}.$$

We now express the *cdfs* of the score as *cdfs* of each player's effort. For any given score where $s_1 = s_2$, we have that $\frac{e_1}{b} = e_2$ and $be_2 = e_1$. Therefore,

$$E_1(e) = \begin{cases} \frac{g_2(b,\bar{w}-\underline{w})c_2(be)}{\bar{w}-\underline{w}} & \text{if } e \in \left[0, \frac{r_2}{b}\right) \\ 1 & \text{if } e \geq \frac{r_2}{b} \end{cases} \quad \textit{and}, \quad E_2(e) = \begin{cases} \frac{\bar{w}-\underline{w}-c_1(r_2)+c_1\left(\frac{e}{b}\right)}{\bar{w}-\underline{w}} & \text{if } e \in [0, r_2) \\ 1 & \text{if } e \geq r_2 \end{cases}.$$

We can now compute the average effort as a function of $\bar{w} - \underline{w}$ and b:

$$\begin{aligned} \bar{e}_1(\bar{w}-\underline{w}, b, c_1, c_2) = \mathbb{E}_{E_1}(e) &= \int_0^{\frac{1}{b}\frac{\bar{w}-\underline{w}}{c_2 g_2(b,\bar{w}-\underline{w})}} \frac{g_2(b,\bar{w}-\underline{w})bc_2}{\bar{w}-\underline{w}} e \quad de \\ &= \frac{g_2(b,\bar{w}-\underline{w})bc_2}{2(\bar{w}-\underline{w})} \left(\frac{\bar{w}-\underline{w}}{bc_2 g_2(b,\bar{w}-\underline{w})}\right)^2 \\ &= \frac{\bar{w}-\underline{w}}{2bc_2 g_2(b,\bar{w}-\underline{w})} \end{aligned}$$

$$\begin{aligned} \bar{e}_2(\bar{w}-\underline{w}, b, c_1, c_2) = \mathbb{E}_{E_2}(e) &= \int_0^{\frac{\bar{w}-\underline{w}}{c g_2(b,\bar{w}-\underline{w})}} \frac{c_1}{\bar{w}-\underline{w}} \frac{e}{b} \quad de \\ &= \frac{c_1}{2b(\bar{w}-\underline{w})} \left(\frac{\bar{w}-\underline{w}}{c_2 g_2(b,\bar{w}-\underline{w})}\right)^2 \\ &= \frac{c_1(\bar{w}-\underline{w})}{2bc_2^2 g_2(b,\bar{w}-\underline{w})^2} \end{aligned}$$

□

D.2.1 Proofs: Model without Morale Concerns

Proposition D.2

Proof. We have that $g_2(b, \bar{w}-\underline{w}) = 1$ for all $(b, \bar{w}-\underline{w})$. Therefore, $\bar{e}_2(\bar{w}-\underline{w}, b, c_1, \tilde{c}_2) = \frac{c_1(\bar{w}-\underline{w})}{2b\tilde{c}_2^2}$ and $\bar{e}_1(\bar{w}-\underline{w}, b, c_1, \tilde{c}_2) = \frac{(\bar{w}-\underline{w})}{2b\tilde{c}_2}$, while $\bar{e}_2(\bar{w}-\underline{w}, b, c_1, \tilde{\tilde{c}}_2) = \frac{c_1(\bar{w}-\underline{w})}{2b\tilde{\tilde{c}}_2^2}$ and $\bar{e}_1(\bar{w}-\underline{w}, b, c_1, \tilde{\tilde{c}}_2) = \frac{(\bar{w}-\underline{w})}{2b\tilde{\tilde{c}}_2}$. As $\tilde{c}_2 \geq \tilde{\tilde{c}}_2$, it immediately follows that $\bar{e}_2(\bar{w}-\underline{w}, b, c_1, \tilde{c}_2) \leq \bar{e}_2(\bar{w}-\underline{w}, b, c_1, \tilde{\tilde{c}}_2)$ and $\bar{e}_1(\bar{w}-\underline{w}, b, c_1, \tilde{c}_2) \leq \bar{e}_1(\bar{w}-\underline{w}, b, c_1, \tilde{\tilde{c}}_2)$. Without morale concerns, the effort of both players thus decreases as the costs for player 2 increases. □

Proposition D.3

Proof. We have that $\bar{e}_1(\bar{w}-\underline{w}, b, c_1, c_2) = \frac{\bar{w}-\underline{w}}{2bc_2}$ and $\bar{e}_1(\bar{w}-\underline{w}, b', c_1, c_2) = \frac{\bar{w}-\underline{w}}{2b'c_2}$, while $\bar{e}_2(\bar{w}-\underline{w}, b, c_1, c_2) = \frac{c_1(\bar{w}-\underline{w})}{2bc_2^2}$ and $\bar{e}_2(\bar{w}-\underline{w}, b', c_1, c_2) = \frac{c_1(\bar{w}-\underline{w})}{2b'c_2^2}$. As $b' > b$, it follows that the denominator is strictly larger in both $\bar{e}_1(\bar{w}-\underline{w}, b', c_1, c_2)$ and $\bar{e}_2(\bar{w}-\underline{w}, b', c_1, c_2)$ than in $\bar{e}_1(\bar{w}-\underline{w}, b, c_1, c_2)$ and $\bar{e}_2(\bar{w}-\underline{w}, b, c_1, c_2)$, respectively. Since the numerator is the same in both cases, we conclude that $\bar{e}_i(\bar{w}-\underline{w}, b', c_1, c_2) < \bar{e}_i(\bar{w}-\underline{w}, b, c_1, c_2)$, for $i = 1, 2$. □

Proposition D.4

Proof. In the model without morale concerns $g_2(b, \bar{w}-\underline{w}) = 1 = g_2(b, \bar{\bar{w}}-\underline{\underline{w}})$. Moreover, as $\bar{w}-\underline{w} \leq \bar{\bar{w}}-\underline{\underline{w}}$, we have that $\bar{e}_1(\bar{w}-\underline{w}, b, c_1, c_2) = \frac{\bar{w}-\underline{w}}{2bc_2} \leq \frac{\bar{\bar{w}}-\underline{\underline{w}}}{2bc_2} = \bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}}, b, c_1, c_2)$, and $\bar{e}_2(\bar{w}-\underline{w}, b, c_1, c_2) = \frac{c_1(\bar{w}-\underline{w})}{2bc_2^2} \leq \frac{c_1(\bar{\bar{w}}-\underline{\underline{w}})}{2bc_2^2} = \bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}}, b, c_1, c_2)$. If follows that the average effort of both players decreases as pay progression increases. □

Proposition D.5

Proof. Note that $\bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, c_2) \lesseqgtr \bar{e}_i(\bar{w} - \underline{w}, b, c_1, c_2)$ if and only if $\bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, c_2) - \bar{e}_i(\bar{w} - \underline{w}, b, c_1, c_2) \lesseqgtr 0$. As morale cost-shifts are normalized to 1, we focus on the following expressions:

$$\bar{e}_1(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, c_2) - \bar{e}_1(\bar{w} - \underline{w}, b, c_1, c_2) = \frac{1}{2bc_2}\left((\bar{\bar{w}} - \underline{\underline{w}}) - (\bar{w} - \underline{w})\right)$$
$$\bar{e}_2(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, c_2) - \bar{e}_2(\bar{w} - \underline{w}, b, c_1, c_2) = \frac{c_1}{2bc_2^2}\left((\bar{\bar{w}} - \underline{\underline{w}}) - (\bar{w} - \underline{w})\right)$$

Because $\bar{\bar{w}} - \underline{\underline{w}} \geq \bar{w} - \underline{w}$, $b \geq 1$, $c_2 > 0$ and $c_1 \geq 0$, it follows that these expressions are strictly greater than zero. Therefore, $\bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, c_2) \geq \bar{e}_i(\bar{w} - \underline{w}, b, c_1, c_2)$, for $i = 1, 2$. As b is only in the denominator of the multiplicative term for both expressions, we conclude that a decrease in b leads to an increase in average effort for $i = 1, 2$.

Note that the relative magnitude of the change in effort for player 1 and player 2 is ambiguous, and ultimately depends on whether $c_1 < c_2$ or $c_1 > c_2$ (both of which are possible). □

Proposition D.6

Proof. From the expressions of the average effort for each player, we know that:

$$\bar{e}_1(\bar{w} - \underline{w}, b, c_1, \tilde{c}_2) - \bar{e}_1(\bar{w} - \underline{w}, b', c_1, \tilde{c}_2) = \frac{(\bar{w} - \underline{w})}{2\tilde{c}_2}\left(\frac{1}{b} - \frac{1}{b'}\right)$$
$$\bar{e}_2(\bar{w} - \underline{w}, b, c_1, \tilde{c}_2) - \bar{e}_2(\bar{w} - \underline{w}, b', c_1, \tilde{c}_2) = \frac{c_1(\bar{w} - \underline{w})}{2\tilde{c}_2^2}\left(\frac{1}{b} - \frac{1}{b'}\right)$$

$$\bar{e}_1(\bar{w} - \underline{w}, b, c_1, \tilde{\tilde{c}}_2) - \bar{e}_1(\bar{w} - \underline{w}, b', c_1, \tilde{\tilde{c}}_2) = \frac{(\bar{w} - \underline{w})}{2\tilde{\tilde{c}}_2}\left(\frac{1}{b} - \frac{1}{b'}\right)$$
$$\bar{e}_2(\bar{w} - \underline{w}, b, c_1, \tilde{\tilde{c}}_2) - \bar{e}_2(\bar{w} - \underline{w}, b', c_1, \tilde{\tilde{c}}_2) = \frac{c_1(\bar{w} - \underline{w})}{2\tilde{\tilde{c}}_2^2}\left(\frac{1}{b} - \frac{1}{b'}\right)$$

As $\tilde{c}_2$ and $\tilde{\tilde{c}}_2$ only show up in the denominator of each difference in average effort, which is positive by Proposition D.3, for $\tilde{c}_2 > \tilde{\tilde{c}}_2$ we have that $\bar{e}_i(\bar{w} - \underline{w}, b, c_1, \tilde{c}_2) - \bar{e}_i(\bar{w} - \underline{w}, b', c_1, \tilde{c}_2) < \bar{e}_i(\bar{w} - \underline{w}, b, c_1, \tilde{\tilde{c}}_2) - \bar{e}_i(\bar{w} - \underline{w}, b', c_1, \tilde{\tilde{c}}_2)$ for $i = 1, 2$. □

Proposition D.7

Proof. From the expressions of the average effort for each player, we know that:

$$\bar{e}_1(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, \tilde{c}_2) - \bar{e}_1(\bar{w} - \underline{w}, b, c_1, \tilde{c}_2) = \frac{1}{2b\tilde{c}_2}\left((\bar{\bar{w}} - \underline{\underline{w}}) - (\bar{w} - \underline{w})\right)$$
$$\bar{e}_2(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, \tilde{c}_2) - \bar{e}_2(\bar{w} - \underline{w}, b, c_1, \tilde{c}_2) = \frac{c_1}{2b\tilde{c}_2^2}\left((\bar{\bar{w}} - \underline{\underline{w}}) - (\bar{w} - \underline{w})\right)$$

$$\bar{e}_1(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, \tilde{\tilde{c}}_2) - \bar{e}_1(\bar{w} - \underline{w}, b, c_1, \tilde{\tilde{c}}_2) = \frac{1}{2b\tilde{\tilde{c}}_2}\left((\bar{\bar{w}} - \underline{\underline{w}}) - (\bar{w} - \underline{w})\right)$$
$$\bar{e}_2(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, \tilde{\tilde{c}}_2) - \bar{e}_2(\bar{w} - \underline{w}, b, c_1, \tilde{\tilde{c}}_2) = \frac{c_1}{2b\tilde{\tilde{c}}_2^2}\left((\bar{\bar{w}} - \underline{\underline{w}}) - (\bar{w} - \underline{w})\right)$$

As $\tilde{c}_2$ and $\tilde{\tilde{c}}_2$ only show up in the denominator of each difference in average effort, which are positive by Proposition D.4, for $\tilde{c}_2 > \tilde{\tilde{c}}_2$ we have that $\bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, \tilde{c}_2) - \bar{e}_i(\bar{w} - \underline{w}, b, c_1, \tilde{c}_2) < \bar{e}_i(\bar{\bar{w}} - \underline{\underline{w}}, b, c_1, \tilde{\tilde{c}}_2) - \bar{e}_i(\bar{w} - \underline{w}, b, c_1, \tilde{\tilde{c}}_2)$ for $i = 1, 2$. □

Proposition D.8

Proof. From the expressions of the average effort for each player, we know that:

$$\left(\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{\tilde{c}}_2)-\bar{e}_1(\bar{w}-\underline{w},b,c_1,\tilde{\tilde{c}}_2)\right)-\left(\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{\tilde{c}}_2)-\bar{e}_1(\bar{w}-\underline{w},b',c_1,\tilde{\tilde{c}}_2)\right)=$$
$$\frac{1}{\tilde{\tilde{c}}_2}\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})-(\bar{w}-\underline{w})}{2b}-\frac{(\bar{\bar{w}}-\underline{\underline{w}})-(\bar{w}-\underline{w})}{2b'}\right)$$
$$\left(\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{c}_2)-\bar{e}_1(\bar{w}-\underline{w},b,c_1,\tilde{c}_2)\right)-\left(\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{c}_2)-\bar{e}_1(\bar{w}-\underline{w},b',c_1,\tilde{c}_2)\right)=$$
$$\frac{1}{\tilde{c}_2}\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})-(\bar{w}-\underline{w})}{2b}-\frac{(\bar{\bar{w}}-\underline{\underline{w}})-(\bar{w}-\underline{w})}{2b'}\right)$$

$$\left(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{\tilde{c}}_2)-\bar{e}_2(\bar{w}-\underline{w},b,c_1,\tilde{\tilde{c}}_2)\right)-\left(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{\tilde{c}}_2)-\bar{e}_2(\bar{w}-\underline{w},b',c_1,\tilde{\tilde{c}}_2)\right)=$$
$$\frac{c_1}{\tilde{\tilde{c}}_2^2}\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})-(\bar{w}-\underline{w})}{2b}-\frac{(\bar{\bar{w}}-\underline{\underline{w}})-(\bar{w}-\underline{w})}{2b'}\right)$$
$$\left(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{c}_2)-\bar{e}_2(\bar{w}-\underline{w},b,c_1,\tilde{c}_2)\right)-\left(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{c}_2)-\bar{e}_2(\bar{w}-\underline{w},b',c_1,\tilde{c}_2)\right)=$$
$$\frac{c_1}{\tilde{c}_2^2}\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})-(\bar{w}-\underline{w})}{2b}-\frac{(\bar{\bar{w}}-\underline{\underline{w}})-(\bar{w}-\underline{w})}{2b'}\right)$$

The term within the brackets $\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})-(\bar{w}-\underline{w})}{2b}-\frac{(\bar{\bar{w}}-\underline{\underline{w}})-(\bar{w}-\underline{w})}{2b'}\right)$ is the same in each expression. Because $\tilde{c}_2$ and $\tilde{\tilde{c}}_2$ only show up in the denominator of the term outside of the brackets of each of the difference-in-differences of average effort, which are positive from Proposition D.5, for $\tilde{c}_2>\tilde{\tilde{c}}_2$ we have that:

$$\left(\bar{e}_i(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{\tilde{c}}_2)-\bar{e}_i(\bar{w}-\underline{w},b,c_1,\tilde{\tilde{c}}_2)\right)-\left(\bar{e}_i(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{\tilde{c}}_2)-\bar{e}_i(\bar{w}-\underline{w},b',c_1,\tilde{\tilde{c}}_2)\right)>$$
$$\left(\bar{e}_i(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{c}_2)-\bar{e}_i(\bar{w}-\underline{w},b,c_1,\tilde{c}_2)\right)-\left(\bar{e}_i(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{c}_2)-\bar{e}_i(\bar{w}-\underline{w},b',c_1,\tilde{c}_2)\right)$$

for $i=1,2$. □

D.2.2 Proofs: Model with Morale Concerns

Proposition D.9

Proof. We have that $\bar{e}_1(\bar{w}-\underline{w},b',c_1,c_2)=\frac{\bar{w}-\underline{w}}{2b'c_2g_2(b',\bar{w}-\underline{w})}$ and $\bar{e}_1(\bar{w}-\underline{w},b',c_1,c_2)=\frac{\bar{w}-\underline{w}}{2b'c_2g_2(b',\bar{w}-\underline{w})}$, while $\bar{e}_2(\bar{w}-\underline{w},b,c_1,c_2)=\frac{c_1(\bar{w}-\underline{w})}{2bc_2^2g_2(b,\bar{w}-\underline{w})^2}$ and $\bar{e}_2(\bar{w}-\underline{w},b',c_1,c_2)=\frac{c_1(\bar{w}-\underline{w})}{2b'c_2^2g_2(b',\bar{w}-\underline{w})^2}$. By assumption, $b'>b$ implies that $g_2(b',\bar{w}-\underline{w})>g_2(b,\bar{w}-\underline{w})$. It thus follows that the denominator is strictly larger in both $\bar{e}_1(\bar{w}-\underline{w},b',c_1,c_2)$ and $\bar{e}_2(\bar{w}-\underline{w},b',c_1,c_2)$ than in $\bar{e}_1(\bar{w}-\underline{w},b,c_1,c_2)$ and $\bar{e}_2(\bar{w}-\underline{w},b,c_1,c_2)$, respectively. As the numerator is the same in both cases, we conclude that $\bar{e}_i(\bar{w}-\underline{w},b',c_1,c_2)<\bar{e}_i(\bar{w}-\underline{w},b,c_1,c_2)$, for $i=1,2$. □

Proposition D.10

Proof. Note that $\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,c_2)\lesseqgtr\bar{e}_2(\bar{w}-\underline{w},b,c_1,c_2)$ if and only if $\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,c_2)-\bar{e}_2(\bar{w}-\underline{w},b,c_1,c_2)\lesseqgtr 0$.

Hence, we focus on the following expressions

$$\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,c_2)-\bar{e}_1(\bar{w}-\underline{w},b,c_1,c_2)=\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{2bc_2g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}-\frac{(\bar{w}-\underline{w})}{2bc_2g_2(b,\bar{w}-\underline{w})}$$
$$=(\bar{w}-\underline{w})(\bar{\bar{w}}-\underline{\underline{w}})\frac{\frac{g_2(b,\bar{w}-\underline{w})}{\bar{w}-\underline{w}}-\frac{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}{\bar{\bar{w}}-\underline{\underline{w}}}}{2bc_2g_2(b,\bar{\bar{w}}-\underline{\underline{w}})g_2(b,\bar{w}-\underline{w})}$$

$$\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,c_2)-\bar{e}_2(\bar{w}-\underline{w},b,c_1,c_2)=\frac{c_1(\bar{\bar{w}}-\underline{\underline{w}})}{2bc_2^2g_2(b,\bar{\bar{w}}-\underline{\underline{w}})^2}-\frac{c_1(\bar{w}-\underline{w})}{2bc_2^2g_2(b,\bar{w}-\underline{w})^2}$$
$$=c_1(\bar{w}-\underline{w})(\bar{\bar{w}}-\underline{\underline{w}})\frac{\frac{g_2(b,\bar{w}-\underline{w})^2}{\bar{w}-\underline{w}}-\frac{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})^2}{\bar{\bar{w}}-\underline{\underline{w}}}}{2bc_2^2g_2(b,\bar{\bar{w}}-\underline{\underline{w}})^2g_2(b,\bar{w}-\underline{w})^2}$$

We will proceed by showing that there exists a $\bar{b}_2$ such that $\frac{g_2(\bar{b}_2,\bar{w}-\underline{w})^2}{\bar{w}-\underline{w}}=\frac{g_2(\bar{b}_2,\bar{\bar{w}}-\underline{\underline{w}})^2}{\bar{\bar{w}}-\underline{\underline{w}}}$ and a $\bar{b}_1$ such that $\frac{g_2(\bar{b}_1,\bar{w}-\underline{w})}{\bar{w}-\underline{w}}=\frac{g_2(\bar{b}_1,\bar{\bar{w}}-\underline{\underline{w}})}{\bar{\bar{w}}-\underline{\underline{w}}}$. We will equivalently show that $\frac{g_2(\bar{b}_1,\bar{w}-\underline{w})}{g_2(\bar{b}_1,\bar{\bar{w}}-\underline{\underline{w}})}=\frac{\bar{w}-\underline{w}}{\bar{\bar{w}}-\underline{\underline{w}}}$ for some $\bar{b}_1$ and $\frac{g_2(\bar{b}_2,\bar{w}-\underline{w})}{g_2(\bar{b}_2,\bar{\bar{w}}-\underline{\underline{w}})}=\frac{(\bar{w}-\underline{w})^{1/2}}{(\bar{\bar{w}}-\underline{\underline{w}})^{1/2}}$ for some $\bar{b}_2$.

First, note that $g_2(b,\bar{w}-\underline{w})$ and $g_2(b,\bar{\bar{w}}-\underline{\underline{w}})$ are continuous in b and are strictly greater than 1. It follows that $\frac{g_2(b,\bar{w}-\underline{w})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}$ is continuous.

Second, we have that $\frac{g_2(1,\bar{w}-\underline{w})}{g_2(1,\bar{\bar{w}}-\underline{\underline{w}})}=1>\frac{\bar{w}-\underline{w}}{\bar{\bar{w}}-\underline{\underline{w}}}$ and $\frac{g_2(1,\bar{w}-\underline{w})}{g_2(1,\bar{\bar{w}}-\underline{\underline{w}})}=1>\frac{(\bar{w}-\underline{w})^{1/2}}{(\bar{\bar{w}}-\underline{\underline{w}})^{1/2}}$. Thus, there exists some point such that $\frac{g_2(b,\bar{w}-\underline{w})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}$ is above $\frac{(\bar{w}-\underline{w})^{1/2}}{(\bar{\bar{w}}-\underline{\underline{w}})^{1/2}}$ and $\frac{\bar{w}-\underline{w}}{\bar{\bar{w}}-\underline{\underline{w}}}$. From Assumption 2, we know that in the limit $\lim_{b\to\infty}\left(\frac{g_2(1,\bar{w}-\underline{w})}{g_2(1,\bar{\bar{w}}-\underline{\underline{w}})}\right)=0<\frac{\bar{w}-\underline{w}}{\bar{\bar{w}}-\underline{\underline{w}}}$ and $\lim_{b\to\infty}\left(\frac{g_2(1,\bar{w}-\underline{w})}{g_2(1,\bar{\bar{w}}-\underline{\underline{w}})}\right)=0<\frac{(\bar{w}-\underline{w})^{1/2}}{(\bar{\bar{w}}-\underline{\underline{w}})^{1/2}}$. Therefore there exists some point such that $\frac{g_2(b,\bar{w}-\underline{w})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}$ is below $\frac{(\bar{w}-\underline{w})^{1/2}}{(\bar{\bar{w}}-\underline{\underline{w}})^{1/2}}$ and $\frac{\bar{w}-\underline{w}}{\bar{\bar{w}}-\underline{\underline{w}}}$. From the continuity of the function $\frac{g_2(b,\bar{w}-\underline{w})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}$ in b, there exists some $\bar{b}_2$ such that $\frac{g_2(\bar{b}_2,\bar{w}-\underline{w})}{g_2(\bar{b}_2,\bar{\bar{w}}-\underline{\underline{w}})}=\frac{(\bar{w}-\underline{w})^{1/2}}{(\bar{\bar{w}}-\underline{\underline{w}})^{1/2}}$, and therefore $\frac{g_2(\bar{b}_2,\bar{w}-\underline{w})^2}{\bar{w}-\underline{w}}=\frac{g_2(\bar{b}_2,\bar{\bar{w}}-\underline{\underline{w}})^2}{\bar{\bar{w}}-\underline{\underline{w}}}$. There also exists some $\bar{b}_1$ such that $\frac{g_2(\bar{b}_1,\bar{w}-\underline{w})}{g_2(\bar{b}_1,\bar{\bar{w}}-\underline{\underline{w}})}=\frac{\bar{w}-\underline{w}}{\bar{\bar{w}}-\underline{\underline{w}}}$, and therefore $\frac{g_2(\bar{b}_1,\bar{w}-\underline{w})}{\bar{w}-\underline{w}}=\frac{g_2(\bar{b}_1,\bar{\bar{w}}-\underline{\underline{w}})}{\bar{\bar{w}}-\underline{\underline{w}}}$.

Finally, take $\bar{b}$ to be the infimum of all such $\bar{b}_2$, ensuring that $\frac{g_2(b,\bar{w}-\underline{w})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}>\frac{(\bar{w}-\underline{w})^{1/2}}{(\bar{\bar{w}}-\underline{\underline{w}})^{1/2}}>\frac{\bar{w}-\underline{w}}{\bar{\bar{w}}-\underline{\underline{w}}}$ for all $b<\bar{b}$. Conversely, take $\bar{\bar{b}}$ to be the supremum of all such $\bar{b}_1$, ensuring that $\frac{g_2(b,\bar{w}-\underline{w})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}<\frac{\bar{w}-\underline{w}}{\bar{\bar{w}}-\underline{\underline{w}}}<\frac{(\bar{w}-\underline{w})^{1/2}}{(\bar{\bar{w}}-\underline{\underline{w}})^{1/2}}$ for all $b>\bar{\bar{b}}$. This implies that, $\frac{g_2(b,\bar{w}-\underline{w})}{\bar{w}-\underline{w}}>\frac{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}{\bar{\bar{w}}-\underline{\underline{w}}}$ and $\frac{g_2(b,\bar{w}-\underline{w})^2}{\bar{w}-\underline{w}}>\frac{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})^2}{\bar{\bar{w}}-\underline{\underline{w}}}$ for all $b<\bar{b}$. Therefore, $\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,c_2)>\bar{e}_1(\bar{w}-\underline{w},b,c_1,c_2)$ and $\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,c_2)>\bar{e}_2(\bar{w}-\underline{w},b,c_1,c_2)$ for all $b<\bar{b}$. Moreover, we also have that $\frac{g_2(b,\bar{w}-\underline{w})}{\bar{w}-\underline{w}}<\frac{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}{\bar{\bar{w}}-\underline{\underline{w}}}$ and $\frac{g_2(b,\bar{w}-\underline{w})^2}{\bar{w}-\underline{w}}<\frac{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})^2}{\bar{\bar{w}}-\underline{\underline{w}}}$ for all $b>\bar{\bar{b}}$, implying that $\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,c_2)<\bar{e}_1(\bar{w}-\underline{w},b,c_1,c_2)$ and $\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,c_2)<\bar{e}_2(\bar{w}-\underline{w},b,c_1,c_2)$ for all $b>\bar{\bar{b}}$. □

Proposition D.11

Proof. Note that $\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,c_2)\lesseqgtr\bar{e}_2(\bar{w}-\underline{w},b,c_1,c_2)$ if and only if $\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,c_2)-$

$\bar{e}_2(\bar{w}-\underline{w},b,c_1,c_2) \lesseqgtr 0$. We, therefore, focus on the following expressions

$$\begin{aligned}
\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,c_2)-\bar{e}_1(\bar{w}-\underline{w},b,c_1,c_2) &= \frac{(\bar{\bar{w}}-\underline{\underline{w}})}{2bc_2g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}-\frac{(\bar{w}-\underline{w})}{2bc_2g_2(b,\bar{w}-\underline{w})}\\
&= \frac{1}{2bc_2}\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}-\frac{(\bar{w}-\underline{w})}{g_2(b,\bar{w}-\underline{w})}\right)\\
\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,c_2)-\bar{e}_2(\bar{w}-\underline{w},b,c_1,c_2) &= \frac{c_1(\bar{\bar{w}}-\underline{\underline{w}})}{2bc_2^2g_2(b,\bar{\bar{w}}-\underline{\underline{w}})^2}-\frac{c_1(\bar{w}-\underline{w})}{2bc_2^2g_2(b,\bar{w}-\underline{w})^2}\\
&= \frac{c_1}{2bc_2^2}\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})^2}-\frac{(\bar{w}-\underline{w})}{g_2(b,\bar{w}-\underline{w})^2}\right)
\end{aligned}$$

We proceed by showing that whenever the difference of effort is positive, such difference is decreasing in b.

First, note that $\frac{1}{2bc_2}$ and $\frac{c_1}{2bc_2^2}$ are always decreasing in b.

Second, we show that $\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}-\frac{(\bar{w}-\underline{w})}{g_2(b,\bar{w}-\underline{w})}\right)$ and $\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})^2}-\frac{(\bar{w}-\underline{w})}{g_2(b,\bar{w}-\underline{w})^2}\right)$ are decreasing in b. Take any $b'>b$. Given the log super-modularity of g_2, we have that $g_2(b,\bar{w}-\underline{w})g_2(b',\bar{\bar{w}}-\underline{\underline{w}}) \geq g_2(b',\bar{w}-\underline{w})g_2(b,\bar{\bar{w}}-\underline{\underline{w}})$ and therefore $g_2(b',\bar{\bar{w}}-\underline{\underline{w}}) \geq \frac{g_2(b',\bar{w}-\underline{w})g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b,\bar{w}-\underline{w})}$. By substituting this expression into $\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b',\bar{\bar{w}}-\underline{\underline{w}})}-\frac{(\bar{w}-\underline{w})}{g_2(b',\bar{w}-\underline{w})}\right)$ we obtain:

$$\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b',\bar{\bar{w}}-\underline{\underline{w}})}-\frac{(\bar{w}-\underline{w})}{g_2(b',\bar{w}-\underline{w})}\right) \leq \left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{\frac{g_2(b',\bar{w}-\underline{w})g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b,\bar{w}-\underline{w})}}-\frac{(\bar{w}-\underline{w})}{g_2(b',\bar{w}-\underline{w})}\right)= \frac{g_2(b,\bar{w}-\underline{w})}{g_2(b',\bar{w}-\underline{w})}\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}-\frac{(\bar{w}-\underline{w})}{g_2(b,\bar{w}-\underline{w})}\right).$$

As $g_2(b,\bar{w}-\underline{w}) \leq g_2(b',\bar{w}-\underline{w})$ and the difference in effort is positive, i.e., $\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}-\frac{(\bar{w}-\underline{w})}{g_2(b,\bar{w}-\underline{w})}>0$, we have that $\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b',\bar{\bar{w}}-\underline{\underline{w}})}-\frac{(\bar{w}-\underline{w})}{g_2(b',\bar{w}-\underline{w})}\right) \leq \left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}-\frac{(\bar{w}-\underline{w})}{g_2(b,\bar{w}-\underline{w})}\right)$. The same argument holds for $\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,c_2)-\bar{e}_2(\bar{w}-\underline{w},b,c_1,c_2)$. □

Proposition D.12

Proof. From the expressions of average effort we find that

$$\begin{aligned}
|\bar{e}_1(\bar{w}-\underline{w},b,c_1,\tilde{c}_2)-\bar{e}_1(\bar{w}-\underline{w},b',c_1,\tilde{c}_2)| &= \frac{(\bar{w}-\underline{w})}{2\tilde{c}_2}\left|\left(\frac{1}{bg_2(b,\bar{w}-\underline{w})}-\frac{1}{b'g_2(b',\bar{w}-\underline{w})}\right)\right|\\
|\bar{e}_1(\bar{w}-\underline{w},b,c_1,\tilde{\tilde{c}}_2)-\bar{e}_1(\bar{w}-\underline{w},b',c_1,\tilde{\tilde{c}}_2)| &= \frac{(\bar{w}-\underline{w})}{2\tilde{\tilde{c}}_2}\left|\left(\frac{1}{bg_2(b,\bar{w}-\underline{w})}-\frac{1}{b'g_2(b',\bar{w}-\underline{w})}\right)\right|\\
|\bar{e}_2(\bar{w}-\underline{w},b,c_1,\tilde{c}_2)-\bar{e}_2(\bar{w}-\underline{w},b',c_1,\tilde{c}_2)| &= \frac{c_1(\bar{w}-\underline{w})}{2\tilde{c}_2^2}\left|\left(\frac{1}{bg_2(b,\bar{w}-\underline{w})^2}-\frac{1}{b'g_2(b',\bar{w}-\underline{w})^2}\right)\right|\\
|\bar{e}_2(\bar{w}-\underline{w},b,c_1,\tilde{\tilde{c}}_2-\bar{e}_2(\bar{w}-\underline{w},b',c_1,\tilde{\tilde{c}}_2))| &= \frac{c_1(\bar{w}-\underline{w})}{2\tilde{\tilde{c}}_2^2}\left|\left(\frac{1}{bg_2(b,\bar{w}-\underline{w})^2}-\frac{1}{b'g_2(b',\bar{w}-\underline{w})^2}\right)\right|
\end{aligned}$$

As $\tilde{c}_2$ and $\tilde{\tilde{c}}_2$ only shows up in the denominator of each average effort, and the multiplicative term is the same, for $\tilde{c}_2>\tilde{\tilde{c}}_2$ we have that $|\bar{e}_i(\bar{w}-\underline{w},b,c_1,\tilde{c}_2)-\bar{e}_i(\bar{w}-\underline{w},b',c_1,\tilde{c}_2)|<|\bar{e}_i(\bar{w}-\underline{w},b,c_1,\tilde{\tilde{c}}_2)-\bar{e}_i(\bar{w}-\underline{w},b',c_1,\tilde{\tilde{c}}_2)|$ for $i=1,2$. □

Proposition D.13

Proof.

$$\left|\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{c}_2)-\bar{e}_1(\bar{w}-\underline{w},b,c_1,\tilde{c}_2)\right| = \frac{1}{2b\tilde{c}_2}\left|\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}-\frac{(\bar{w}-\underline{w})}{g_2(b,\bar{w}-\underline{w})}\right)\right|$$

$$\left|\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{\tilde{c}}_2)-\bar{e}_1(\bar{w}-\underline{w},b,c_1,\tilde{\tilde{c}}_2)\right| = \frac{1}{2b\tilde{\tilde{c}}_2}\left|\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}-\frac{(\bar{w}-\underline{w})}{g_2(b,\bar{w}-\underline{w})}\right)\right|$$

$$\left|\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{c}_2)-\bar{e}_2(\bar{w}-\underline{w},b,c_1,\tilde{c}_2)\right| = \frac{c_1}{2b\tilde{c}_2^2}\left|\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})^2}-\frac{(\bar{w}-\underline{w})}{g_2(b,\bar{w}-\underline{w})^2}\right)\right|$$

$$\left|\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{\tilde{c}}_2)-\bar{e}_2(\bar{w}-\underline{w},b,c_1,\tilde{\tilde{c}}_2)\right| = \frac{c_1}{2b\tilde{\tilde{c}}_2^2}\left|\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})^2}-\frac{(\bar{w}-\underline{w})}{g_2(b,\bar{w}-\underline{w})^2}\right)\right|$$

Note that $\tilde{c}_2 \geq \tilde{\tilde{c}}_2$ and thus $\frac{1}{2b\tilde{c}_2} \leq \frac{1}{2b\tilde{\tilde{c}}_2}$ and $\frac{c_1}{2b\tilde{c}_2^2} \leq \frac{c_1}{2b\tilde{\tilde{c}}_2^2}$. From here,

$$\left|\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{c}_2)-\bar{e}_1(\bar{w}-\underline{w},b,c_1,\tilde{c}_2)\right| = \frac{1}{2b\tilde{c}_2}\left|\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}-\frac{(\bar{w}-\underline{w})}{g_2(b,\bar{w}-\underline{w})}\right)\right|$$

$$\leq \frac{1}{2b\tilde{\tilde{c}}_2}\left|\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}-\frac{(\bar{w}-\underline{w})}{g_2(b,\bar{w}-\underline{w})}\right)\right| = \left|\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{\tilde{c}}_2)-\bar{e}_1(\bar{w}-\underline{w},b,c_1,\tilde{\tilde{c}}_2)\right|$$

and

$$\left|\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{c}_2)-\bar{e}_2(\bar{w}-\underline{w},b,c_1,\tilde{c}_2)\right| = \frac{c_1}{2b\tilde{c}_2^2}\left|\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})^2}-\frac{(\bar{w}-\underline{w})}{g_2(b,\bar{w}-\underline{w})^2}\right)\right|$$

$$\leq \frac{c_1}{2b\tilde{\tilde{c}}_2^2}\left|\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})^2}-\frac{(\bar{w}-\underline{w})}{g_2(b,\bar{w}-\underline{w})^2}\right)\right| = \left|\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{\tilde{c}}_2)-\bar{e}_2(\bar{w}-\underline{w},b,c_1,\tilde{\tilde{c}}_2)\right|$$

We conclude that $|\bar{e}_i(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{\tilde{c}}_2)-\bar{e}_i(\bar{w}-\underline{w},b,c_1,\tilde{\tilde{c}}_2)| \geq |\bar{e}_i(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{c}_2)-\bar{e}_i(\bar{w}-\underline{w},b,c_1,\tilde{c}_2)|$, for $i=1,2$. That is, the impact of pay progression on effort is amplified when player 2 is of higher ability, regardless the direction of change. □

Proposition D.14

Proof. From Proposition D.11, we know that all the difference-in-differences of average effort are positive for all players in this region. For player 1, we have that:

$$\begin{aligned}
&\left(\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{\tilde{c}}_2)-\bar{e}_1(\bar{w}-\underline{w},b,c_1,\tilde{\tilde{c}}_2)\right)-\left(\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{\tilde{c}}_2)-\bar{e}_1(\bar{w}-\underline{w},b',c_1,\tilde{\tilde{c}}_2)\right) = \\
&\qquad \frac{1}{\tilde{\tilde{c}}_2}\left(\frac{1}{2b}\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}-\frac{(\bar{w}-\underline{w})}{g_2(b,\bar{w}-\underline{w})}\right)-\frac{1}{2b'}\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b',\bar{\bar{w}}-\underline{\underline{w}})}-\frac{(\bar{w}-\underline{w})}{g_2(b',\bar{w}-\underline{w})}\right)\right) \\
&\left(\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{c}_2)-\bar{e}_1(\bar{w}-\underline{w},b,c_1,\tilde{c}_2)\right)-\left(\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{c}_2)-\bar{e}_1(\bar{w}-\underline{w},b',c_1,\tilde{c}_2)\right) = \\
&\qquad \frac{1}{\tilde{c}_2}\left(\frac{1}{2b}\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}-\frac{(\bar{w}-\underline{w})}{g_2(b,\bar{w}-\underline{w})}\right)-\frac{1}{2b'}\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b',\bar{\bar{w}}-\underline{\underline{w}})}-\frac{(\bar{w}-\underline{w})}{g_2(b',\bar{w}-\underline{w})}\right)\right)
\end{aligned}$$

Note that the expression within the brackets, $\left(\frac{1}{2b}\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})}-\frac{(\bar{w}-\underline{w})}{g_2(b,\bar{w}-\underline{w})}\right)-\frac{1}{2b'}\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b',\bar{\bar{w}}-\underline{\underline{w}})}-\frac{(\bar{w}-\underline{w})}{g_2(b',\bar{w}-\underline{w})}\right)\right)$, is the same within both $\left(\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{c}_2)-\bar{e}_1(\bar{w}-\underline{w},b,c_1,\tilde{c}_2)\right)-\left(\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{c}_2)-\bar{e}_1(\bar{w}-\underline{w},b',c_1,\tilde{c}_2)\right)$ and $\left(\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{\tilde{c}}_2)-\bar{e}_1(\bar{w}-\underline{w},b,c_1,\tilde{\tilde{c}}_2)\right)-\left(\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{\tilde{c}}_2)-\bar{e}_1(\bar{w}-\underline{w},b',c_1,\tilde{\tilde{c}}_2)\right)$. Further, it is positive by proposition D.11. The multiplicative term outside of the brackets is given by $\frac{1}{\tilde{\tilde{c}}_2}$ and $\frac{1}{\tilde{c}_2}$ respectively for $\left(\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{\tilde{c}}_2)-\bar{e}_1(\bar{w}-\underline{w},b,c_1,\tilde{\tilde{c}}_2)\right)-\left(\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{\tilde{c}}_2)-\bar{e}_1(\bar{w}-\underline{w},b',c_1,\tilde{\tilde{c}}_2)\right)$

and $\big(\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{c}_2)-\bar{e}_1(\bar{w}-\underline{w},b,c_1,\tilde{c}_2)\big)-\big(\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{c}_2)-\bar{e}_1(\bar{w}-\underline{w},b',c_1,\tilde{c}_2)\big)$. As $\tilde{\tilde{c}}_2<\tilde{c}_2$ we conclude that

$$\big(\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{\tilde{c}}_2)-\bar{e}_1(\bar{w}-\underline{w},b,c_1,\tilde{\tilde{c}}_2)\big)-\big(\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{\tilde{c}}_2)-\bar{e}_1(\bar{w}-\underline{w},b',c_1,\tilde{\tilde{c}}_2)\big)>$$
$$\big(\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{c}_2)-\bar{e}_1(\bar{w}-\underline{w},b,c_1,\tilde{c}_2)\big)-\big(\bar{e}_1(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{c}_2)-\bar{e}_1(\bar{w}-\underline{w},b',c_1,\tilde{c}_2)\big)$$

For player 2, we have instead:

$$\big(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{\tilde{c}}_2)-\bar{e}_2(\bar{w}-\underline{w},b,c_1,\tilde{\tilde{c}}_2)\big)-\big(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{\tilde{c}}_2)-\bar{e}_2(\bar{w}-\underline{w},b',c_1,\tilde{\tilde{c}}_2)\big)=$$
$$\frac{1}{\tilde{\tilde{c}}_2^2}\left(\frac{c_1}{2b}\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})^2}-\frac{(\bar{w}-\underline{w})}{g_2(b,\bar{w}-\underline{w})^2}\right)-\frac{c_1}{2b'}\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b',\bar{\bar{w}}-\underline{\underline{w}})^2}-\frac{(\bar{w}-\underline{w})}{g_2(b',\bar{w}-\underline{w})^2}\right)\right)$$
$$\big(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{c}_2)-\bar{e}_1(\bar{w}-\underline{w},b,c_1,\tilde{c}_2)\big)-\big(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{c}_2)-\bar{e}_2(\bar{w}-\underline{w},b',c_1,\tilde{c}_2)\big)=$$
$$\frac{1}{\tilde{c}_2^2}\left(\frac{c_1}{2b}\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})^2}-\frac{(\bar{w}-\underline{w})}{g_2(b,\bar{w}-\underline{w})^2}\right)-\frac{c_1}{2b'}\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b',\bar{\bar{w}}-\underline{\underline{w}})^2}-\frac{(\bar{w}-\underline{w})}{g_2(b',\bar{w}-\underline{w})^2}\right)\right)$$

Note that the expression within the brackets, $\left(\frac{c_1}{2b}\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b,\bar{\bar{w}}-\underline{\underline{w}})^2}-\frac{(\bar{w}-\underline{w})}{g_2(b,\bar{w}-\underline{w})^2}\right)-\frac{c_1}{2b'}\left(\frac{(\bar{\bar{w}}-\underline{\underline{w}})}{g_2(b',\bar{\bar{w}}-\underline{\underline{w}})^2}-\frac{(\bar{w}-\underline{w})}{g_2(b',\bar{w}-\underline{w})^2}\right)\right)$, is the same within both $\big(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{c}_2)-\bar{e}_2(\bar{w}-\underline{w},b,c_1,\tilde{c}_2)\big)-\big(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{c}_2)-\bar{e}_2(\bar{w}-\underline{w},b',c_1,\tilde{c}_2)\big)$ and $\big(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{\tilde{c}}_2)-\bar{e}_2(\bar{w}-\underline{w},b,c_1,\tilde{\tilde{c}}_2)\big)-\big(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{\tilde{c}}_2)-\bar{e}_2(\bar{w}-\underline{w},b',c_1,\tilde{\tilde{c}}_2)\big)$. Further, it is positive by proposition D.11. The multiplicative term outside of the brackets is given by $\frac{1}{\tilde{\tilde{c}}_2^2}$ and $\frac{1}{\tilde{c}_2^2}$ respectively for $\big(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{\tilde{c}}_2)-\bar{e}_2(\bar{w}-\underline{w},b,c_1,\tilde{\tilde{c}}_2)\big)-\big(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{\tilde{c}}_2)-\bar{e}_2(\bar{w}-\underline{w},b',c_1,\tilde{\tilde{c}}_2)\big)$ and $\big(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{c}_2)-\bar{e}_2(\bar{w}-\underline{w},b,c_1,\tilde{c}_2)\big)-\big(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{c}_2)-\bar{e}_2(\bar{w}-\underline{w},b',c_1,\tilde{c}_2)\big)$. As $\tilde{\tilde{c}}_2<\tilde{c}_2$, we can conclude that

$$\big(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{\tilde{c}}_2)-\bar{e}_2(\bar{w}-\underline{w},b,c_1,\tilde{\tilde{c}}_2)\big)-\big(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{\tilde{c}}_2)-\bar{e}_2(\bar{w}-\underline{w},b',c_1,\tilde{\tilde{c}}_2)\big)>$$
$$\big(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{c}_2)-\bar{e}_2(\bar{w}-\underline{w},b,c_1,\tilde{c}_2)\big)-\big(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{c}_2)-\bar{e}_2(\bar{w}-\underline{w},b',c_1,\tilde{c}_2)\big)$$

□