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

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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.

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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 2018; Finan, Olken, and Pande 2017). But to what extent are workers motivated by the opportunity to climb the organization's ladder? Despite 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 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 combined and isolated effect of both 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. Similarly, higher pay progression boosts worker productivity, but this result holds only when promotions are meritocratic. Meanwhile, when promotions are non-meritocratic, a higher pay progression *demotivates* workers, 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 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 is 40% lower than the salary of a PS, and they have the opportunity of being promoted to PS whenever a position becomes vacant in their own unit.

Before our experiment, promotion decisions were entirely left to the discretion of the local health authority and were perceived by CHWs as being overwhelmingly 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 strong 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 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 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 units with information about the *true* PS pay, thus affecting their perception of the pay progression. Our 2×2 research design allows us to assess the effect of a more meritocratic promotion regime, steeper (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. 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, a 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), or if they 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 while holding perceptions about pay progression fixed. In line with the theoretical framework, we find that the introduction of a more meritocratic promotion rule increases CHW performance: the total number of visits provided by CHWs increases by 12.5% with no concomitant decrease in the average visit length, and an increase in retention. Importantly, the boost in performance is concentrated among workers who

believe that the pay progression is steep enough at baseline, suggesting that meritocracy and pay progression may complement each other in incentivizing workers. The effect is also driven by workers who rank first or second in terms of performance in their unit, especially those who are not connected to the local health authority at baseline. In contrast, higher meritocracy does not affect the level of effort of lower-ranked workers, who have a low chance of being promoted under a meritocratic regime.

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 regime. Increasing perceived pay progression – by revealing the true PS pay to workers who initially underestimated pay progression – has two contrasting effects depending on the prevailing promotion rule. In the new meritocratic promotion regime, higher (perceived) pay progression raises the number of visits provided by 24%. 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 a potential future higher pay play an important role.

In the old (non-meritocratic) regime, higher (perceived) pay progression instead *decreases* the number of visits by 26%. Two potential mechanisms can explain such a reduction in productivity. First, 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). We provide two pieces of evidence that are consistent with the morale effect but not the lobbying effect. First, the drop in the number of visits provided is not compensated by workers being more likely to spend time talking 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 workers who are unsatisfied with the work of the PS and high-performing workers, 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 show that organizations seeking to in-

crease 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 (Shepherd 2003; World Bank 2016; Sahling, Schuster, and Mikkelsen 2018).[1] This is illustrated in Figures 1 and 2 which use data from the Worldwide Bureaucracy Indicators to show that many bureaucracies of low-income countries combine high pay progression with low meritocracy (Figure 1) and that this combination negatively correlates with government performance (Figure 2).[2] 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). 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),[3] our findings indicate a consequent demotivation of the "unfavored" low-tier workers which may hinder organizational performance.

This paper contributes to and bridges two 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

[1] In a ten-country survey of 23,000 public servants, Sahling, Schuster, and Mikkelsen (2018) find that in 9 countries, promotions rather than pay and dismissals incentivize performance most. Yet, the majority of promotions are politicized and non-meritocratic at every level of the hierarchy (the managerial level, the administrative support and the technical-professional level).

[2] In a regression with country and time fixed effects, governance performance is found to be negatively correlated with pay progression in non-meritocratic regimes and positively correlated with meritocracy when combined with high pay progression (see Figure 2). Pay progression is measured as the ratio of the 90th percentile wage to the 10th percentile wage in the public sector. Meritocracy is measured 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.)

[3] 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 permit to capture the effect on the productivity of higher-tier workers (PSs) or how this, in turn, affects CHW performance. Indeed, we did not change the actual pay progression, and promotions are infrequent in our context.

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; Bertrand et al. 2019; Li 2019; Nieddu and Pandolfi 2020).[4] To the best of our knowledge, ours is the first study to provide causal evidence on the effect of more meritocratic promotion rules and how this interacts with pay progression.

Second, the paper builds on work 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), 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, a steeper pay progression can demotivate workers who are averse to vertical pay inequalities. On the other hand, it can also prompt an increase in effort through career incentives. Understanding which of the two effects prevails is of obvious policy relevance given the recent exponential growth of manager-worker pay ratio (Ashraf and Bandiera 2018). The only paper we are aware of that studies vertical pay inequalities is Cullen and Perez-Truglia (2018). 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 their supervisor's salary are revised upward. Unlike Cullen and Perez-Truglia (2018), we focus on a large public-sector organization in which promotions have only recently started to become more meritocratic and study how the effects of vertical pay inequalities vary with the level of meritocracy. This focus allows to bridge the literature on pay inequalities with that on promotions.

Finally, our study contributes to investigations that explore how to build effective state

[4]Using retrospective panel data on teachers in China, Karachiwalla and Park (2017) show that promotions are associated with better performance in the years leading up to promotion eligibility but reduce performance if workers are repeatedly passed over for promotion. Bertrand et al. (2019) 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 (2019) 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 (2019), we show that such morale effects materialize only when pay progression is large enough. Nieddu and Pandolfi (2020) shows that promotion incentives in academia prompt higher productivity, but this is only the case when the goals set are attainable.

capacity in developing countries. 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 (see Figure 1) – may also constrain the state's ability to provide high-quality public services.[5]

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 highest maternal mortality rate and the fifth-highest child mortality rate (2018 WHO Global Health Observatory). Such elevated mortality rates have been attributed to the slow post-civil war recovery, the 2014 Ebola outbreak, 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 2012. The program is organized around Peripheral Health Units (PHUs), small health posts staffed with doctors (when available), nurses, and midwives. Each PHU has a catchment area of two to 18 villages with one Community Health Worker (CHW) per village and one Peer Supervisor (PS), for a total of approximately 1,500 PSs and 15,000 CHWs 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 (e.g., Darmstadt et al. 2010; Nyqvist et al. 2019; Deserranno, Nansamba, and

[5] See Finan, Olken, and Pande (2017) for a literature review on incentives, monitoring and selection in the public sector. Our paper also relates to recent studies that show that performance-based posting increases the productivity of public sector workers (Khan, Khwaja, and Olken 2019) and that performance-based hiring improves the selection of public sector workers (Xu and Adhvaryu 2020; Colonnelli, Prem, and Teso 2020).

Qian 2020).

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 monitors CHWs through in-person visits and by phone. 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 carry out other daily occupations such as farming, petty trading, or small shopkeeping. In our sample, CHWs and PSs report working an average of 22 and 11 hours per week, 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 PS and CHWs is thus large: CHWs earn 40% less than then PSs even though they report working more hours on average.[7]

As with most public-sector employees, CHWs and PSs are rarely fired. New vacancies typically open up when CHWs or PSs voluntarily decide to quit. When a PS position becomes available, one of the CHWs in that PHU is promoted to take over the position. The District Health Management Teams (DHMTs), which oversee the implementation of the CHW program at the district level, are in charge of these 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. 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 best predictor of promotions.

[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 respectively.

[7] Using the self-reported number of hours as a reference, the hourly wage of PSs is 3.3 times higher than that of CHWs.

While 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 – higher performance as a CHW likely translates into higher performance as a PS. Indeed, both jobs involve conveying information about health (to the CHWs for the PSs and to households for the CHWs) and rely on workers being motivated. In line with this, Table 1 shows that the high-performing PSs in our sample – i.e., those who supervise and motivate their CHWs by regularly calling and visiting them or by frequently accompanying them on household visits – tend to have greater health knowledge as well as provided more visits when they themselves were CHWs (columns 1-4). However, 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). This is not surprising as most of the PS work is independent of the PHU in-charge.

2.2 Research Design

Our experiment took place in 372 PHUs in six of the 14 districts of Sierra Leone, which employ 372 PSs and 2,081 CHWs.[8] These PHUs were cross-randomized into two treatment arms: (1) the "meritocratic promotion treatment," which introduced a 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 Promotion Treatment In November 2018, we collaborated with the DHMTs to transition a random 168 PHUs to a new meritocratic promotion system ($T_{merit} = 1$), while the status quo was left unaltered in the remaining 168 PHUs ($T_{merit} = 0$). In the new promotion regime, the DHMTs agreed to promote CHWs based on objective measures of CHW performance collected by the research team. Performance data were collected by measuring the number and the length of visits through a household survey (which we discuss in Section 2.3) and unannounced spot checks with potential patients. Every time a vacancy became available in a treated PHU

[8] 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). These six districts were chosen to be representative of the diversity of the country in terms of accessibility to health facilities, geography, wealth, and ethnic composition. Out of the existing 823 PHUs across the six districts, we excluded half because no up-to-date and verified list of CHWs was available, and selected 372 PHUs from the remaining eligible PHUs to be part of the experiment. In these 372 PHUs, our data cover all 372 PSs and a subsample of 2,081 CHWs (out of a total of 2,970) who we were able to reach by phone.

($T_{merit} = 1$), we committed to providing the DHMTs with these performance data for all CHWs in the corresponding PHU, and the DHMTs in turn committed to making these the main input in their promotion decisions. No information on performance was shared with DHMTs in the control PHUs ($T_{merit} = 0$).

Two weeks after the new promotion system was introduced, we provided information on the new promotion system to CHWs in the 168 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."*

The script was (purposefully) vague on the performance metric used for promotion decisions, yet CHWs were aware that their performance was being monitored in terms of quantity and quality.[9]

To keep the saliency of promotions constant between the treatment and control group, we also reminded CHWs in the 168 control PHUs about the old 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."*

In Section 3.1, we demonstrate that CHWs in $T_{merit} = 1$ updated their perception of meritocracy upward after receiving the information above while CHWs in $T_{merit} = 0$ did not change their perception (indicating that they were presumably aware of the status quo system).

[9] Consistent with the fact that CHWs believed that both quantity and quality were monitored (and would be used for promotion decisions), we later show that the meritocratic promotion treatment increases the number of visits and the average visit length.

The meritocratic promotion treatment allows us to quantify the effect of meritocracy on CHW performance without the need for promotions *actually* occurring during the study period. Instead, the new promotion model shifted CHWs' perception of meritocracy in *anticipation* of future promotions. 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 promotion treatment. Our study thus assesses whether CHWs work harder when they perceive future promotions as being more meritocratic. However, we do not estimate the effects of more meritocratic promotions on PS performance and on how this, in turn, affects CHW performance. If a more meritocratic system improves the quality of the PS selected (as one would expect), then our results underestimate the long-run effect of meritocratic promotions on CHW performance.

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 reported knowing the exact PS pay. We took advantage of this lack of information to create random variation in *perceived* pay progression. Cross-randomizing by the meritocratic promotion treatment, we informed CHWs in a random selection of 168 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 168 PHUs ($T_{pay} = 0$) about their own pay:

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

As we will show in Section 3.2, 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.

This variation in perceived pay progression will allow us to quantify the effect of a steeper or flatter pay progression on CHW productivity due to shifting perceptions of the pay progression rather than by changing it *per se*. Importantly, we will estimate the effects of steeper or flatter pay progression on CHW productivity, holding PS productivity fixed. Estimating the effects of *actually* increasing 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 done at this level, as well as to limit information spillover between different treatment arms.[10] 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. In Appendix A, we describe the temporary incentives in detail and show that their presence does 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 selection margin.

2.3 Data and Balance Checks

2.3.1 Data Sources

We leverage three sources of data:

CHW and PS surveys – PSs and 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

[10] 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.

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

CHW beliefs surveys – Two weeks before the implementation of the treatments (November 2018) and two weeks after (December 2018), we surveyed 2,081 CHWs 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.

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).[11] Each respondent 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.

2.3.2 Summary Statistics and Balance Checks

Table 1 reports summary statistics and balance checks for the CHW characteristics (Panel A) and PS characteristics (Panel B). Panel A shows that 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 22 hours per week as a CHW. On a health knowledge test with 7 questions, they answered an average of 2.9 questions correctly, indicating low health knowledge. Over half (53%) of the CHWs report having ever talked to the PHU in-charge and 76% report being satisfied with the work of their PS. To perform the balance checks, we regress each baseline CHW characteristic on a dummy for the meritocratic promotion treatment, the pay progression treatment and the

[11] 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 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.

interaction of both, controlling for stratification variables and clustering standard errors at the PHU level. Columns (3) to (8) show CHW characteristics are well balanced across treatments.[12]

Panel B shows that PSs are more likely to be men than the CHWs (92%) and are more likely to have completed secondary school (25%). They are also more knowledgeable about health services (score of 3.5 out of 7) 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 and an average of 1.8 years as a CHW prior to becoming a PS. PS characteristics are balanced across treatments.

Table 2 presents summary statistics at the village level (Panel A) and at the household level, collapsed by village (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.

Importantly, our 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 3.1. 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 than any other potential PS candidate, while only 20% of them ranked highest in terms of predicted performance as a CHW (see Figure 3 for details).[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, social connections do not correlate with CHW performance within the pool of CHWs we interviewed. (The correlation is 0.018 and is not statistically significant.) Promoting based on connections

[12] Out of the 45 pairwise treatment comparisons we performed, only two are statistically significant. "Being satisfied with the PS work" differs relative to the control group in the meritocratic promotion treatment without information about PS pay and the "number of years the CHW has known PHU in-charge for" differs relative to the control group in the pay progression treatment with the status-quo promotion system.

[13] Connections to the PHU in-charge are proxied with the number of years the PS/CHW had known the PHU in-charge for before joining the program. CHW performance is proxied with the total number of visits per household in a six months time frame.

rather than based on performance thus presumably leads to substantially different candidate selection.

3 Belief 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.

3.1 Beliefs about Meritocratic Promotions

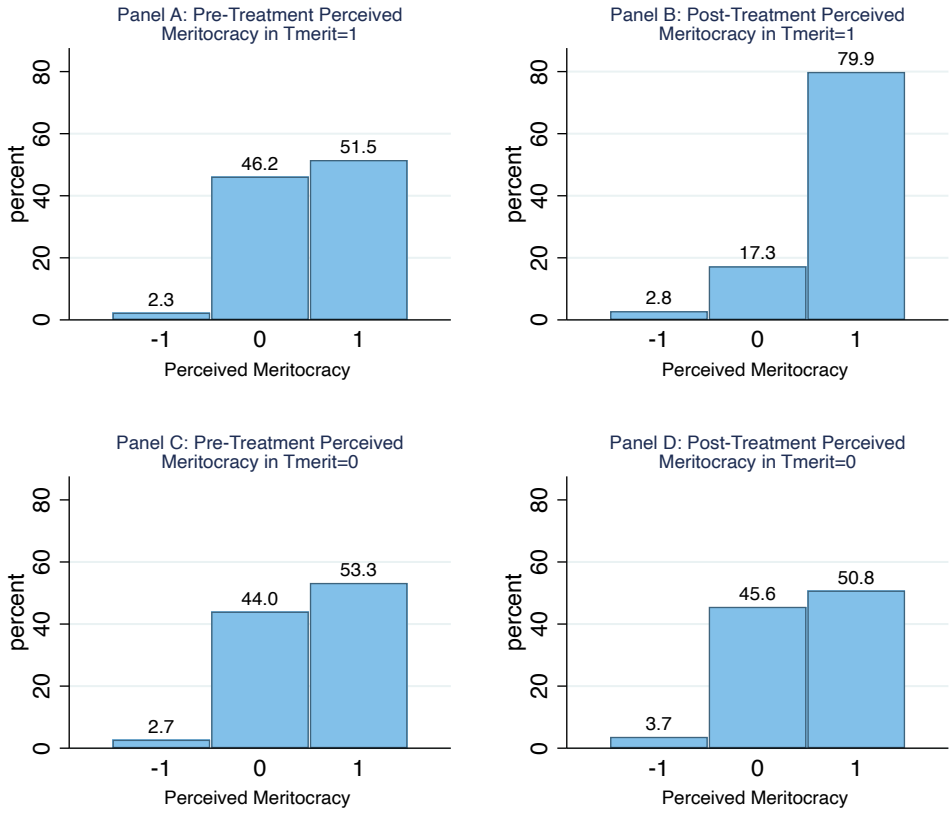
To measure how workers updated their beliefs about meritocracy in the promotion system, we analyze CHWs' perceptions about meritocracy before and after we announced the introduction of the new promotion regime. As indicated in our pre-analysis plan, we measure perceived meritocracy using a set of hypothetical questions in our surveys. 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 $X = \{2, 5, 10\}$.[14] 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 fully meritocratic, i.e., 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 fully non-meritocratic, i.e., 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 intermediary situations, such as when 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 promotion treatment ($T_{merit} = 1$) and the rest ($T_{merit} =$

[14] 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.*"

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). 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 (Panels A vs. B).[15] CHWs in $T_{merit} = 0$ did not significantly update their perceptions (Panels C vs. D).

FIGURE 1: BELIEF UPDATING ABOUT MERITOCRACY



Notes: Perceived meritocracy in the promotion system 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.

[15] 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. Table 3 (columns 1-2) show that workers' priors about meritocracy are unrelated with most of the baseline CHW characteristics, except with "being satisfied about the PS work" and with the "wealth score."

The corresponding regression results are presented in Table 2 (columns 1-5) where we estimate the effect of the meritocratic promotion treatment on perceptions about meritocracy, controlling for the stratification variables and clustering standard errors at the PHU level. Columns (1) and (2) confirm that baseline perceptions are comparable in $T_{merit} = 1$ vs. $T_{merit} = 0$. Column (3) shows that the average perception of meritocracy in $T_{merit} = 1$ is 63% higher than in $T_{merit} = 0$ following treatment. Column (4) shows that the effect of T_{merit} on perceptions about meritocracy is orthogonal to whether the CHW also received information about the pay gap (the coefficient for $T_{merit} \times T_{pay}$ is small and not statistically significant).[16] Finally, column (5) shows that the patterns of belief updating are consistent with Bayesian models: CHWs whose prior is closer to the information provided in $T_{merit} = 1$ (prior of 1) update their beliefs less strongly.

3.2 Beliefs about Pay Progression

Figure 2 plots the difference between perceived and true PS pay (250,000 SLL) 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.[17] 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.

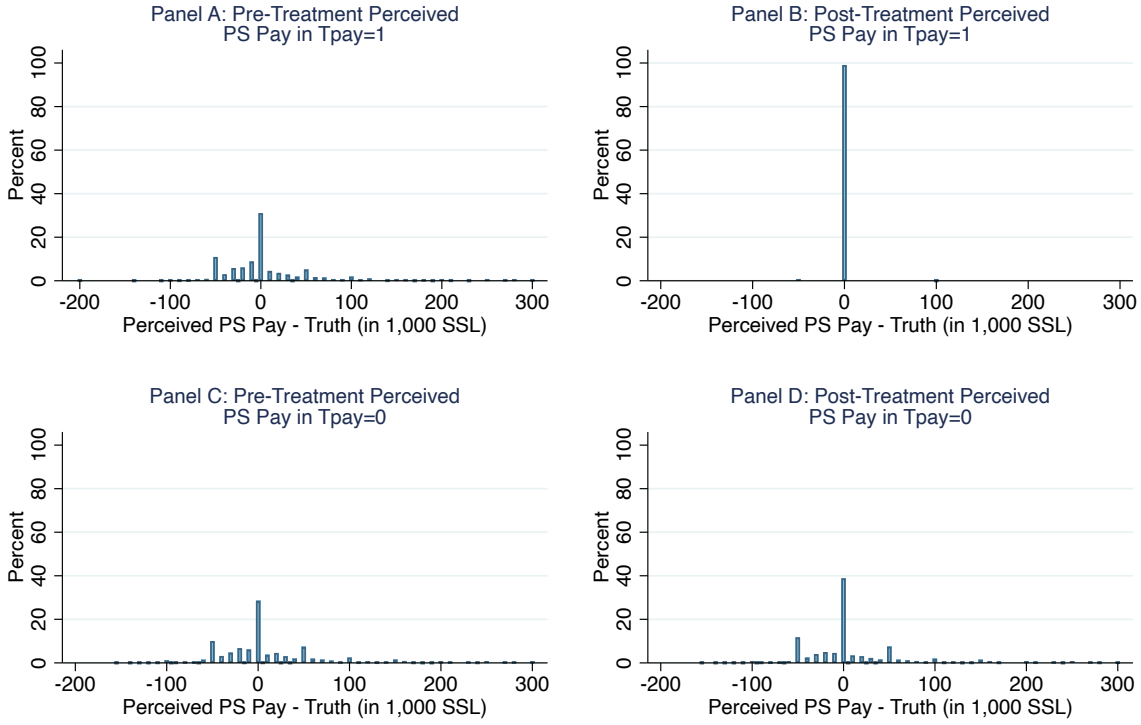
Consistent with the randomization, perceptions of PS pay are comparable in $T_{pay} = 1$ and $T_{pay} = 0$ before the treatment (Panels A vs. C). In both groups, roughly 30% of the CHWs knew that PSs earn 250,000 SLL per month. 37% of the CHWs underestimated PS pay and 33% overestimated it.[18] After receiving information about PS pay, almost all CHWs in $T_{pay} = 1$

[16] For the average worker, T_{pay} reduces perceived meritocracy by 0.065 on a scale -1 to 1 (statistically significant at the 10% level). This effect disappears when we estimate it separately for workers who overestimate and underestimate the PS pay at baseline, as we will for the rest of the analysis.

[17] We offered a reward of 2,000 SSL if the answer is correct. We decided to incentivize the question because in the survey pilot a number of CHWs overstated the pay gap in the non-incentivized question relative to the incentivized version. In order 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.

[18] Large misperceptions about supervisors' pay are common. In Cullen and Perez-Truglia (2018), for example, only 12% of respondents knew their manager salary. In our context, large misperceptions about PS pay exist because this information is not publicized to CHWs. Additionally, discussions between colleagues about each other's pay is not the norm. In Table 3 (columns 3-4), we show that the size of misperceptions does not appear to be correlated with any of the baseline CHW characteristics, except the number of years the CHW has known the PS for.

Figure 2: Belief Updating about Pay Progression



Notes: We plot the difference between perceived 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.

converged to the truth. 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. The absence of significant belief updating in $T_{pay} = 0$ corroborates the lack of information spillover across treatment groups.

The corresponding regression results are presented in Table 2 (columns 6-10), where we estimate the effect of the pay progression treatment on perceptions about PS pay, controlling for the stratification variables and clustering standard errors at the PHU level. Columns (6) and (7) confirm that beliefs are balanced at baseline in $T_{pay} = 1$ and $T_{pay} = 0$. Column (8) shows that the mean absolute difference between perceived PS pay and the truth is 482 SLL in $T_{pay} = 1$ vs. 35,320 SLL in $T_{pay} = 0$. As mentioned earlier, the effect of the pay progression treatment on beliefs concerning PS pay is orthogonal to the meritocratic promotion treatment (column 9). Again, consistent with Bayesian models, a CHW updates her beliefs more strongly the further

her baseline perception about PS pay was from the truth (column 10).

Table 3 digs deeper into the effects of our pay progression treatment on CHWs' beliefs. Column (1) shows that in $T_{pay} = 1$, CHWs who *underestimated* PS pay at baseline revised their perceptions of PS pay *upward* by 29,043 SLL (+13%), while those who *overestimated* perceived PS pay at baseline revised their perceptions *downward* by 59,685 SLL (-19%). The magnitude of the update is smaller for the former group because the level of CHW pay (150,000 SLL) provides a lower bound for perceptions. Workers whose perceptions of PS pay were accurate did not update their views significantly.

In columns (2) and (3) of Table 3, we explore whether changes in CHWs' perceptions of PS pay affected their beliefs about different aspects of the PS's position, namely 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., the PS pay accounting for total working hours and work expenses).[19]

4 Theoretical Framework

Having established that our treatments had significant effects on CHWs' beliefs about meritocracy and pay progression, we now 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.

4.1 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,

[19] Table 4 reports the corresponding results for the meritocratic promotion treatment and shows that the treatment does not affect perceptions of any PS job attribute.

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.

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 $P^b = (P^b_1, P^b_2)$, where $P^b_i(e_1, e_2) = P(b_1 e_1, b_2 e_2)$.[20] 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

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

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.[21] 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 pay progression $\bar{w} - \underline{w}$ and meritocracy b (Section 4.2). 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 4.3). 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 2019). 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 B for a more formal and detailed exposition of the model.

4.2 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

[21] 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.

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 B.2 - B.8 presented in Appendix B.1, we obtain the following predictions for all players:

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

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

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

Prediction 4. *The effort response in Predictions 1, 2 and 3 is stronger for higher-ability workers.*

See Appendix B.1 for details on the propositions and Appendix B.2 for their proofs.[22]

4.3 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 B. 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.[23] 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:

[22] 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 B.1.1 for more details.

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

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

From Propositions B.9 - B.14 presented in Appendix B.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's effort increases as pay progression (resp., meritocracy) increases if $b \leq \bar{b}$.*

Prediction 8. *The effort response in Predictions 5, 6 and 7 is stronger for higher-ability workers.*

See Appendix B.1 for a formal definition of $\bar{b}$ and $\bar{\bar{b}}$ and for details on the propositions, and Appendix B.2 for the proofs.[24]

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). 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.

[24]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 B.1.2 for more details.

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): $l_i \in \mathbb{R}_+$.[25] 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 6.2.

5 The Effect of Meritocratic Promotions on Worker Productivity

In this section, we estimate the causal effect of greater meritocracy in the promotion system on CHW productivity while holding beliefs about PS pay fixed. To do so, we restrict the analysis to the sample of CHWs in the 186 PHUs where no information on the pay gap was provided ($T_{pay} = 0$) and estimate the following regression equation:

$$Y_{ij} = \alpha + \beta T_{merit,j} + Z_j\gamma + \varepsilon_{ij}, \tag{3}$$

where Y_{ij} represents the performance of CHW i in PHU j, $T_{merit,j}$ is a dummy for whether the PHU j is assigned to the meritocratic promotion treatment, Z_j are the stratification variables and ε_{ij} is an error term clustered at the PHU level (level of randomization).

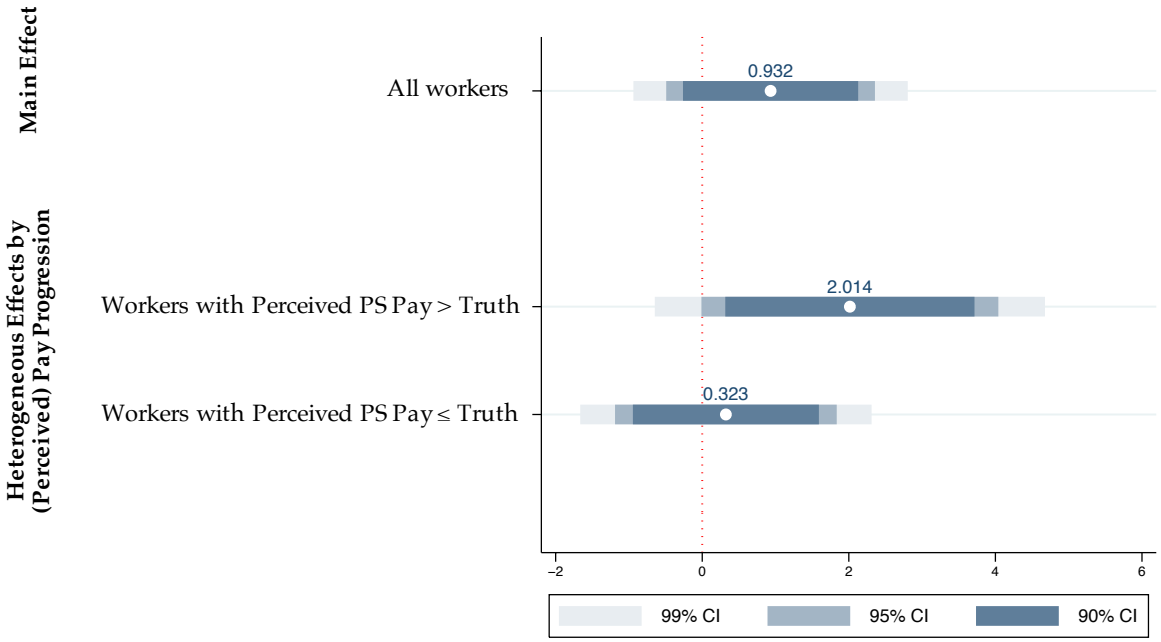
Our main measure of worker performance is the total number of visits that households report having received from the CHW in the six months before the endline survey (mean of 7.9). To obtain this measure, we take the total number of times a household has received a routine visit, ante- or post-natal visit, or has been treated/referred for sickness, and then average these data at the CHW level. We also consider the average visit length (mean of 15 minutes) and use this as a proxy of work quality. Indeed, CHWs are expected to follow a checklist when they visit a household and short visits are an indication that the checklist was not properly followed. Finally, we study retention, i.e., whether the CHW self-reported not having dropped out and provided

[25] 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 $u_i(s_1^\alpha, s_2^\alpha) = \underline{w} + P_i(s_1^\alpha, s_2^\alpha)\,[\bar{w} - \underline{w}] - \min_{e_i, l_i | \alpha e_i + (1-\alpha) l_i = s_i^\alpha} c_i(e_i, l_i)$.

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%.[26]

In line with Predictions 1 and 5 of our theoretical framework, Figure 3 (bar 1) and Table 4 (column 1) show that making the promotion system more performance-based raises the number of visits provided by CHWs by 0.932 (12.5%), although this effect is not statistically significant at conventional levels. Table 5 breaks down the result by type of visit and shows that CHWs treat significantly more patients and provide significantly more post-natal visits in $T_{merit} = 1$, while other type of visits increase, but not significantly.

FIGURE 3: EFFECT OF MERITOCRACY ON THE NUMBER OF VISITS



Notes: The first coefficient plots the effect of Tmerit on the number of visits. The second and third coefficients plot the effect of Tmerit for workers with baseline "Perceived PS Pay > Truth" vs. "Perceived PS Pay ≤ Truth" using a single regression with an interaction term. All regression coefficients correspond to those shown in Table 3 (columns 1-2), in which we control for the stratification variables and cluster standard errors at the PHU level. Sample of CHWs in Tpay=0.

In Table 4, we assess whether CHWs in $T_{merit} = 1$ compensate for the higher number of visits by providing shorter visits. This would be the case if CHWs perceived promotions as being

[26]The 11% of CHWs who became inactive during the experiment were not replaced. Hence, households in their community all received zero visits.

based primarily on the number rather than the quality of the visits. Table 4 (row [i]) shows no evidence of a quantity-quality trade-off. On the contrary, households in the meritocratic promotion treatment report that visits are 1.8 minutes longer than those in $T_{merit} = 0$.[27] Finally, Table 4 shows that higher meritocracy also significantly increases retention by 3.2 percentage points, from 87.8% in $T_{merit} = 0$ to 91% in $T_{merit} = 1$.[28]

The increase in CHWs' performance observed in the meritocratic promotion treatment can be explained by an increase in CHW effort in anticipation of a future promotion, or can result from an increase in the effort of their supervisors. Table 7 rejects the latter by showing that PSs in the meritocratic promotion treatment are not more likely to have visited or called CHWs in the past six months (as reported by the CHWs at endline), or to have accompanied them on a household visit (as reported by households at endline).[29]

We now explore the heterogeneous effects of meritocratic promotions on CHW performance. Following Predictions 3 and 7 of our theoretical framework, we expect the effect of our meritocratic promotion treatment to be concentrated among workers who perceive the prize associated with the promotion to be larger, and who are thus presumably more interested in the promotion.

Figure 3 (bars 2 and 3) and the corresponding Table 4 (column 2) report the coefficients β_1 and β_2 estimated from the model:

$$Y_{ij} = \alpha + \beta_1 T_{merit,j} \times X_{ij} + \beta_2 T_{merit,j} \times (1 - X_{ij}) + \gamma X_{ij} + Z_j \gamma + \varepsilon_{ij}, \tag{4}$$

where X_{ij} is a dummy for whether the worker's prior about PS pay is above the median (above the actual rate of 250,000 SLL). We find that the positive effect of meritocracy on the number of visits is entirely driven by CHWs with a prior of PS pay above the actual value ($\hat{\beta}_1 = 2.014$, a 27% increase), while no effect is detected among workers with a prior below the actual level

[27] A visit length of zero is calculated for households that are never visited by the CHW. Therefore, the reported coefficient captures both the extensive and intensive margin.

[28] Table 6 presents the elasticity of CHW performance with respect to meritocracy by instrumenting CHW post-treatment perceived meritocracy with the meritocratic promotion treatment. We find that a one-unit increase in perceived meritocracy (on a scale of -1 to 1) raises the number of visits by 3.235, the average visit length by 6.476 minutes and retention by 13.5 percentage points (row [i]).

[29] The lack of effects on PS performance is partly explained by the fact that few actual promotions took place between baseline and endline in our study. Moreover, PSs are rarely fired in our context and are therefore not threatened by an increase in CHW performance. In the longer run, the meritocratic promotion treatment is expected to improve the quality of the PS selected which may further increase CHW performance. In this sense, the shorter run effects are expected to be a lower bound of the longer run effects.

($\hat{\beta}_2 = 0.323$, not statistically significant). The difference between $\hat{\beta}_1$ and $\hat{\beta}_2$ is statistically significant at the 10% level (p-value reported at the bottom of Table 4, column 2).[30]

Table 4 (column 8) shows that more meritocracy increases retention of CHWs with a prior of PS pay above the actual value by 7.9 percentage points (row [ii]), while it does not affect retention for the other CHWs (row [iii]). Similar but less precise effects are detected on the average visit length. Finally, Table 4 shows that all results are robust to further controlling in Equation (4) for the entire list of CHW characteristics presented in Table 1 and their interaction with T_{merit}. This demonstrates that the heterogeneity in the treatment effects we attribute to perceived pay progression is not due to variation in other observables.

Next, we analyze the heterogeneous effects of meritocracy by performance ranking. Following Predictions 4 and 8 of our theoretical framework, we expect the effect of meritocracy to be stronger for workers who are highly ranked in terms of performance, as they have a higher chance of being promoted in a meritocratic regime. As explained in Section 2.3, the ranking of each CHW within the PHU was provided by the PS at baseline. Indeed, the PS is the only person in the PHU able to compare and rank CHW performance. In line with this, columns (7) and (8) of Table 3 show that the CHWs who rank first or second according to the PS have greater health knowledge, are more educated, have more years of experience as a CHW, and self-report providing a higher number of visits. Importantly, CHWs who are well-connected to the PS (measured by the number of years they have known the PS) are not more likely to be highly ranked. This confirms that the PS is unlikely to misreport the ranking and that the ranking indeed reflects relative CHW performance. Finally, note that the ranking of a CHW does not correlate with CHWs' baseline perceived pay progression (correlation of 0.098). The two heterogeneous effects presented in this section thus leverage different sources of variation.

Table 5 (column 1) reports the coefficients $\hat{\beta}_1$ and $\hat{\beta}_2$ estimated from Equation (4) with X_{ij} defined as a dummy for whether the worker is ranked first or second in her PHU (henceforth, "high rank" workers). Increasing the meritocracy of the promotion system significantly boosts the number of visits provided by high-ranked workers by 2.189 (29%), but does not affect the

[30] Figure 4 (Panel A) presents the effect of the meritocratic promotion 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 and statistically significant only among workers in the top quintile.

productivity of workers ranked third or lower (coefficient of 0.483, not statistically significant).[31] This can also be seen in Figure 4 (Panel B), which breaks down the results for workers ranked 1-2, 3-4, 5-6, 7-8 or 9-10.

Interestingly, the results are even more pronounced if one considers the effect of meritocracy for highly-ranked workers *who are not well-connected to the PHU in-charge* — i.e., who have known the PHU for fewer years than half of the other CHWs. As shown in Table 5, for these workers, making promotions more performance-based increases the number of visits by 4.682 (statistically significant at the 1% level; column 5, row [v]). In contrast, higher meritocracy has no effect on workers who are highly ranked and well-connected to the PHU in-charge (column 5, row [vi]), presumably because they are not substantially more likely to be promoted in the new, as opposed to old, system. Higher meritocracy similarly does not affect low-ranked workers who are well-connected to the PHU in-charge (column 5, row [viii]).

Overall, we show that the effect of our meritocratic promotion treatment is concentrated among workers who perceive the prize associated with the promotion to be large enough and those who are highly ranked. One may worry that the boost in productivity among these workers may be explained by them revising their perceptions of meritocracy more strongly than other workers, rather than due to a greater interest in the promotion or a higher chance of being promoted (as in the theoretical framework). Table 9 shows that this is not the case: workers with a high prior of PS pay or with a high ranking did not differently revise their meritocracy beliefs (columns 1-2).

6 The Effect of Pay Progression on Worker Productivity

Having established that a meritocratic promotion system boosts productivity among CHWs, and that this effect is entirely driven by workers 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.

We estimate the following equation separately for workers with priors on PS pay below the actual pay level at baseline (who revise their beliefs upward), above the actual pay level (who

[31] Table 8 shows that there is no significant differential effect on retention and visit length by ranking.

revise their beliefs downward) or whose priors are accurate (no revision):

$$Y_{ij} = \alpha + \beta_1 T_{pay,j} \times T_{merit,j} + \beta_2 T_{pay,j} \times (1 - T_{merit,j}) + \gamma T_{merit,j} + Z_j \delta + \varepsilon_{ij}. \quad (5)$$

For workers with perceived PS pay below (above) the truth at baseline, β_1 and β_2 capture the causal effect of *increasing (decreasing)* perceived pay progression on productivity in a high meritocracy regime ($T_{merit} = 1$) and a low meritocracy regime ($T_{merit} = 0$), respectively.

Alternatively, one can estimate a fully interacted version of Equation (5) with triple interactions $T_{pay,j} \times T_{merit,j} \times \mathbf{1}(PerceivedPSpay \lessgtr Truth)_{ij}$. We do not use this model as our preferred one because comparisons across worker types (for example, between workers who underestimate or overestimate PS pay at baseline) are not necessarily causal in our empirical design. Indeed, while these two types of workers are comparable in most observed CHW characteristics (Table 3, columns 5-6), we cannot rule out any differences being due to unobserved CHW characteristics that affect their effort response. We focus 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.[32]

In what follows, we first assess the effect of higher pay progression on worker productivity in the new meritocratic system ($T_{merit} = 1$) and then present the corresponding effects in the old, non-meritocratic system ($T_{merit} = 0$).

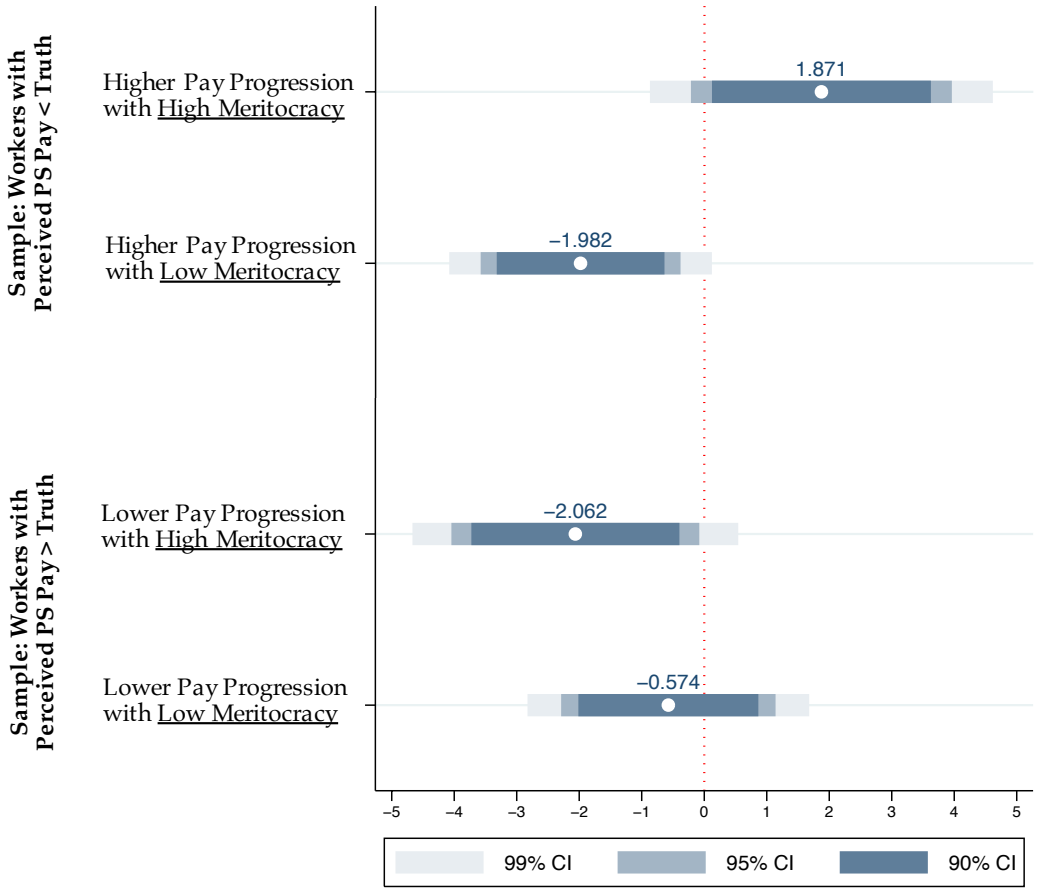
6.1 Pay Progression in Meritocratic Regimes

Predictions 2 and 6 of our theoretical framework say 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, the first and third bars of Figure 4 show that workers who revised their perception of pay progression upward provide 1.871 (24%) more visits, while workers who revised their perception of pay progression downward provide 2.062 (24%) fewer visits.

The same results are reported in row [i] of Table 6, along with other measures of CHW performance. Table 6 shows that pay progression does not significantly impact visit length but

[32] Table 10 shows indeed that CHWs' characteristics are balanced across treatments within a worker type. For completeness, we report the results of the fully interacted model in Table 11.

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 for High Meritocracy (Tmerit=1) vs. Low Meritocracy (Tmerit=0) using a single regression with an interaction term. The sample is restricted to workers with baseline "Perceived PS Pay > Truth" in the top half of the figure and on the sample of workers with baseline "Perceived PS Pay < Truth" in the bottom half of the figure. All regression coefficients correspond to those shown in Table 6 (columns 1 and 4), in which we include stratification variables and cluster standard errors at the PHU level.

it does affect retention. Higher perceived pay progression increases retention by 8.7 percentage points, which corresponds to a 9.8% increase relative to the mean (significant at the 1% level). Lower perceived pay progression instead reduces retention by 4.8 percentage points, albeit not significantly. While these effects on retention are large in magnitude, it is important to remember that the context is one of rural areas, in which CHWs have limited supervision and are rarely fired, and in which they are hard to motivate without promotion incentives. In other settings in which workers can be more easily monitored and fired, the effects of promotion incentives on

retention may be smaller.[33]

For completeness, Table 6 also reports the effect of pay progression on the productivity of workers whose priors were equal to the truth at baseline (and who did not update their beliefs about the pay gap). As expected, these workers did not significantly change their behavior. This is reassuring as it indicates that providing information about true PS pay unlikely affects workers' behavior through channels unrelated to a reassessment of their prior beliefs.

Table 7 shows that the effect of higher pay progression on worker productivity is more pronounced among higher-ranked workers, who have greater chances of being promoted in a meritocratic regime, while the effect is muted for lower-ranked workers (columns 3-6, rows [iii] and [iv]). This is consistent with Prediction 4 of our theoretical framework.

Finally, Table 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 $T_{pay} \times \mathbf{1}(Perceived\ PS\ pay < Truth)$ and $T_{pay} \times \mathbf{1}(Perceived\ PS\ pay > Truth)$.[34] Revising PS pay upward by 10% (25,518 SSL) 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.[35]

Overall, the results in this section indicate 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 a potential future higher pay play an important role.

[33] Table 12 shows that the pay progression treatment does not have any clear effect on PS monitoring behavior: all the coefficients are small and not significant except the one in row [i] of column 2.

[34] Using this approach, the Cragg-Donald F-statistic is around 180. Instead, if we only used T_{pay} as an instrument, we would 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 among CHWs following the treatment (rather than using the extent to which they updated perceptions). The results are shown in Table 13 (columns 2-3) and are discussed later.

[35] 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 (2018). 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 promotion treatment.

6.2 Pay Progression in Non-Meritocratic Regimes

We now turn our attention to the effects of pay progression in a non-meritocratic regime ($T_{merit} = 0$). The second bar of Figure 4 and Table 6 (column 1, row [ii]) show that updating pay progression upward reduces the number of visits provided by CHWs by 1.982 (26%). Retention also appears to have gone down by 6.3 percentage points (7.11%, albeit not statistically significant). Overall, these results suggest that the combination of a steep pay progression and a promotion regime with low meritocracy, commonly seen in the public and private sectors, 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 4.3 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. This would reduce the number of visits provided if the extra time spent on lobbying crowds out time spent on productive tasks (visits).[36]

Two pieces of evidence indicate that the reduction in worker productivity we find in the data is more likely driven by a demotivation caused by morale concerns rather than by workers spending more time lobbying. First, we find no evidence of increased lobbying when pay progression increases. Lobbying is inherently hard to measure, as it can take different forms, but should at the minimum entail CHWs being more likely to talk to 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 55% had done so, this variable did not increase with pay progression (Table 7, column 1), suggesting no increase in lobbying. Moreover, we asked CHWs what fraction of their time as a CHW was dedicated to non-patient-related activities, which include visits to the PHU (mean of 21%). Once again, we document no effect of the pay progression treatment on this variable

[36] This interpretation assumes that lobbying and productive effort are substitutes, i.e., that the cost for CHWs to perform a visit increases as they devote more time to lobbying (and vice versa).

(Table 7, column 2).

Second, we find that the negative effect of pay progression on worker productivity is stronger among the two types of workers who presumably 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. In the latter case, these workers may doubt that the vertical pay gap is justified. Table 7 shows that high-ranked workers and those unsatisfied with the PS react to the increase in perceived pay progression by providing 2.390 and 3.231 fewer visits respectively (columns 3 and 5, row [v]). 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 [vi]). 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 not due to variation in other observables.[37]

Table 13 presents IV results in which post-treatment CHWs' perceptions 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 [iv]) 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 2018).[38] It is however smaller than the demotivational effect created by mass layoffs or pay cuts (Akerlof et al. 2020; Coviello, Deserranno, and Persico 2020).

Finally, the last bar of Figure 4 and Table 6 (column 2, row [ii]) show that a downward update

[37] Table 9 shows that the larger reduction in effort observed among high ranked CHWs or among CHWs who are unsatisfied with their PS is neither explained by these workers updating their beliefs about pay progression more strongly than other workers (columns 5-6), nor with these workers revising their perception of meritocracy downward (columns 8-9).

[38] Cullen and Perez-Truglia (2018) 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.

of beliefs about pay progression has a precisely estimated zero effect on worker productivity and on retention. This may indicate 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 raise worker productivity.

7 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* a large 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 a high enough pay progression, otherwise the effect is muted. A higher pay progression can have contrasting effects depending on whether promotions are decided solely based on performance or not. In meritocratic regimes, a 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, a steeper pay progression demotivates workers through negative morale effects.

Our findings have several important policy implications. In recent years, the manager-worker pay ratio has exponentially 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 demotivating 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.

Overall, the results of this paper highlight the importance of taking into account the interactions between different tools of personnel policy. Non-meritocratic organizations should ideally combine any increase in pay progression with a shift to a more merit-based promotion system for the former to be effective (and not backfire). Whether or not this is achievable ultimately depends on the organization's ability to measure worker performance. In contexts such as that assessed here – in which performance is measured with at least some accuracy and where shirking (worker inactivity) is detectable – shifting the promotion rule to a more meritocratic one is relatively easy to implement. In other settings where worker performance is harder to measure, an organization's ability to introduce a performance-based promotion rule is much more limited. Identifying the optimal design of promotion systems in such contexts is a question for future research.

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Table 1: Summary Statistics and Balance Checks

	(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 (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}	0.083	0.275	0.019	(0.020)	-0.018	(0.019)	-0.001	(0.027)
Wealth 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	21.95	21.77	1.498	(1.650)	1.347	(1.756)	-1.659	(2.443)
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)
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	2.926	4.645	-0.652	(0.479)	-0.825*	(0.491)	0.613	(0.599)
Number of years CHW has known PS for	7.774	8.430	0.038	(0.706)	-0.283	(0.632)	0.843	(0.949)
PS 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}	0.253	0.435	0.022	(0.065)	-0.010	(0.065)	-0.047	(0.091)
Wealth 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)

Notes: We present characteristics of CHWs and PSs in Panel A and B, respectively. 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: Belief Updating about Meritocracy and Pay Progression

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dep. Var.:	Pre-Treatment Perceived Meritocracy = {-1, 0, 1}		Post-Treatment Perceived Meritocracy = {-1, 0, 1}			Pre-Treatment Perceived PS Pay (in 1,000 SLL)		|Post-Treatment Perceived PS Pay - Truth| (in 1,000 SLL)		
Tmerit	-0.017	-0.032	0.296***	0.267***	0.574***		0.352		0.690	
	(0.022)	(0.030)	(0.025)	(0.033)	(0.030)		(3.634)		(2.889)	
Tpay		-0.041		-0.065*		-4.088	-4.474	-34.838***	-33.956***	81.653***
		(0.034)		(0.036)		(2.489)	(3.731)	(1.480)	(2.161)	(11.484)
Tmerit × Tpay		0.030		0.058			0.744		-1.714	
		(0.044)		(0.048)			(5.029)		(2.999)	
Pre-Treatment Perceived Meritocracy					0.739***					
					(0.028)					
Pre-Treatment Perceived Meritocracy × Tmerit					-0.543***					
					(0.039)					
|Pre-Treatment Perceived PS Pay - Truth|										0.452***
										(0.044)
|Pre-Treatment Perceived PS Pay - Truth| × Tpay										-0.441***
										(0.045)
Observations	1,942	1,942	1,982	1,982	1,933	2,009	2,009	2,009	2,009	2,009
Mean Dep. Var.	0.498	0.498	0.626	0.626	0.626	261.693	261.693	17.900	17.900	17.900
Mean Dep. Var. if Tmerit=0	0.505	0.505	0.471	0.471	0.471					
Mean Dep. Var. if Tpay=0						264.0	264.0	35.32	35.32	35.32

Notes: Sample of all CHWs. All regressions control for stratification variables. Standard errors are clustered at the PHU level. The sample size is smaller in columns (1) to (5) because a set of CHWs answered "don't know" and their answer is coded as missing.*** p<0.01, ** p<0.05, * p<0.1

Table 3: Belief Updating about Other PS Job Attributes

	(1)	(2)	(3)
	Post-Treatment Perceptions about PS Job Attributes		
Dep. Var.:	PS Pay (in 1,000 SLL)	PS Number of Hours Worked	PS Work-Related Expenses (in 1,000 SLL)
Tpay × 𝟙(Perceived PS Pay < Truth)	29.043***	0.134	8.052*
	(1.823)	(0.771)	(4.318)
Tpay × 𝟙(Perceived PS Pay > Truth)	-59.685***	0.687	-1.083
	(3.427)	(0.789)	(4.287)
Tpay × 𝟙(Perceived PS Pay = Truth)	0.848	1.864**	6.087
	(0.929)	(0.872)	(4.905)
Observations	2,009	1,940	1,932
Mean Dep. Var.	255.2	14.17	96.70
Mean Dep. Var. if Tpay=0	260.7	13.79	94.30
Mean Dep. Var. if Tpay=0 & 𝟙(Perceived PS Pay < Truth)	220.7	14.05	92.75
Mean Dep. Var. if Tpay=0 & 𝟙(Perceived PS Pay > Truth)	309.7	13.95	95.60

Notes: Sample of all CHWs. All regressions control for stratification variables and two dummy variables: 𝟙(Perceived PS Pay < Truth) and 𝟙(Perceived PS Pay > Truth). Standard errors are clustered at the PHU level. The sample size is smaller in columns (2) and (3) because a set of CHWs answered "don't know" and their answer is coded as missing. "Work-related expenses" include communication and transportation costs. *** p<0.01, ** p<0.05, * p<0.1

Table 4: Meritocracy and Worker Performance

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dep. Var.:	Number of Visits			Visit Length (in Minutes)			Retention = {0, 1}		
Tmerit [i]	0.932			1.797*			0.032*		
	(0.726)			(1.083)			(0.019)		
Tmerit × 𝟙(Perceived PS Pay > Truth) [ii]		2.014*	2.015*		1.998	2.636*		0.079**	0.084***
		(1.033)	(1.033)		(1.522)	(1.549)		(0.031)	(0.032)
Tmerit × 𝟙(Perceived PS Pay ≤ Truth) [iii]		0.323	0.510		1.685	1.437		0.007	0.004
		(0.772)	(0.747)		(1.297)	(1.326)		(0.024)	(0.025)
Observations	995	995	977	995	995	977	1,004	1,004	986
Mean Dep. Var. if Tmerit=0	7.455	7.455	7.455	14.60	14.60	14.602	0.878	0.878	0.878
p-value H_0: [ii] - [iii] = 0		0.099	0.148		0.861	0.516		0.079	0.065
Extra Controls: Tmerit × CHW Charact.	No	No	Yes	No	No	Yes	No	No	Yes

Notes: Sample of CHWs in Tpay=0. All regressions control for the dummy variable "𝟙(Perceived PS Pay > Truth)" and the stratification variables. Columns (3), (6) and (9) also control for all CHW characteristics in Table 1 (Panel A) and their interaction with Tmerit. Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Meritocracy and Worker Performance – Heterogeneous Effects by Ranking and Connections

Dep. Var.:	(1)	(2)	(3)	(4)	(5)	(6)
	Number of Visits					
Tmerit × High Rank [i]	2.189**	1.941*				
	(0.959)	(0.993)				
Tmerit × Low Rank [ii]	0.483	0.784				
	(0.826)	(0.823)				
Tmerit × Not Connected to PHU In-Charge [iii]			1.621*	1.773**		
			(0.862)	(0.897)		
Tmerit × Connected to PHU In-Charge [iv]			0.344	0.436		
			(0.795)	(0.862)		
Tmerit × High Rank & Not Connected to PHU In-Charge [v]					4.682***	4.326***
					(1.447)	(1.457)
Tmerit × High Rank & Connected to PHU In-Charge [vi]					0.445	0.262
					(1.186)	(1.383)
Tmerit × Low Rank & Not Connected to PHU In-Charge [vii]					0.716	1.146
					(0.974)	(1.030)
Tmerit × Low Rank & Connected to PHU In-Charge [viii]					0.296	0.480
					(0.968)	(0.996)
Observations	932	916	995	977	932	916
Mean Dep. Var. if Tmerit=0	7.455	7.455	7.455	7.455	7.455	7.455
p-value H_0: [i] - [ii] = 0	0.090	0.279				
p-value H_0: [iii] - [iv] = 0			0.108	0.210		
p-value H_0: [v] - [vi] = 0					0.018	0.046
p-value H_0: [v] - [vii] = 0					0.011	0.041
p-value H_0: [v] - [viii] = 0					0.004	0.024
Extra Controls: Tmerit × CHW Charact.	No	Yes	No	Yes	No	Yes

Notes: Sample of CHWs in Tpay=0. All regressions control for stratification variables. We also control for the dummy variable "High Rank" in columns (1)-(2), for the dummy variable "Not Connected" in columns (3)-(4), and for three dummy variables in columns (5)-(6): "High Rank & Not Connected", "High Rank & Connected" and "Low Rank & Not Connected". All even columns control for all CHW characteristics in Table 1 (Panel A) and their interaction with Tmerit. Standard errors are clustered at the PHU level.*** p<0.01, ** p<0.05, * p<0.1.

Table 6: Pay Progression and Worker Performance

Dep. Var.:	(1) Number of Visits	(2) Visit Length (in Minutes)	(3) Retention = {0, 1}	(4) Number of Visits	(5) Visit Length (in Minutes)	(6) Retention = {0, 1}	(7) Number of Visits	(8) Visit Length (in Minutes)	(9) Retention = {0, 1}
Sample:	*Perceived PS Pay < Truth* *[Higher Perceived Pay Progression with Tpay=1]*			*Perceived PS Pay > Truth* *[Lower Perceived Pay Progression with Tpay=1]*			*Perceived PS Pay = Truth* *[Same Perceived Pay Progression with Tpay=1]*		
Tpay × High Meritocracy (Tmerit=1) [i]	1.871*	-0.849	0.087***	-2.062**	-2.357	-0.048	-0.251	0.274	-0.010
	(1.065)	(1.698)	(0.030)	(1.012)	(1.429)	(0.030)	(1.016)	(1.661)	(0.032)
Tpay × Low Meritocracy (Tmerit=0) [ii]	-1.982**	-1.136	-0.063	-0.574	-1.333	0.029	-1.010	-0.878	0.040
	(0.816)	(1.590)	(0.040)	(0.875)	(1.653)	(0.039)	(0.827)	(1.850)	(0.034)
Observations	701	701	738	668	668	673	597	597	598
Mean Dep. Var.	7.577	14.910	0.888	7.763	14.950	0.900	7.313	14.977	0.893
Mean Dep. Var. if Tpay=0	7.702	15.620	0.885	8.473	15.929	0.903	7.656	15.117	0.885
p-value H_0: [i] - [ii] = 0	0.005	0.902	0.002	0.269	0.640	0.125	0.555	0.642	0.288

Notes: Sample described in column headings. All regressions control for a dummy variable for "High Meritocracy (Tmerit=1)" and for the stratifications variables. Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1

TABLE 7: PAY PROGRESSION AND WORKER PERFORMANCE – 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			
Definition of **Z**:	-		High Rank		Unsatisfied with the PS	
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) × **Z** [iii]			2.935**	3.578**	4.842***	4.552**
			(1.218)	(1.390)	(1.630)	(1.824)
Tpay × High Meritocracy (Tmerit=1) × **1-Z** [iv]			-2.395	-2.638	1.108	1.353
			(2.025)	(2.185)	(1.191)	(1.362)
Tpay × Low Meritocracy (Tmerit=0) × **Z** [v]			-2.390***	-1.709*	-3.231***	-3.353***
			(0.877)	(0.872)	(1.160)	(1.214)
Tpay × Low Meritocracy (Tmerit=0) × **1-Z** [vi]			-0.694	-1.237	-1.486*	-1.135
			(1.265)	(1.243)	(0.889)	(0.882)
Observations	738	715	660	651	701	690
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				
p-value H_0: [iii] - [iv] = 0			0.019	0.012	0.040	0.126
p-value H_0: [v] - [vi] = 0			0.220	0.728	0.140	0.082
p-value H_0: [iii] - [v] = 0			0.001	0.002	0.000	0.000
p-value H_0: [iv] - [vi] = 0			0.475	0.575	0.082	0.128
Extra Controls	No	No	No	Yes	No	Yes

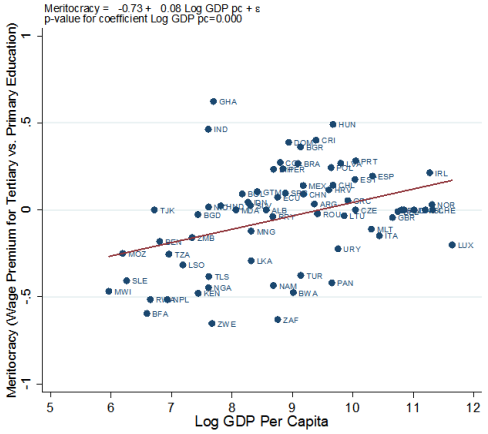
Notes: Sample restricted to workers with "Perceived PS Pay < Truth". All regressions control for stratification variables and for a dummy variable for "High Meritocracy (Tmerit=1)". Columns (3)-(6) control for "Z" and columns (4) and (6) also control for all CHW characteristics in Table 1 (Panel A) and their interactions with Tpay, Tmerit and Tpay × Tmerit. Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1

Online Appendix

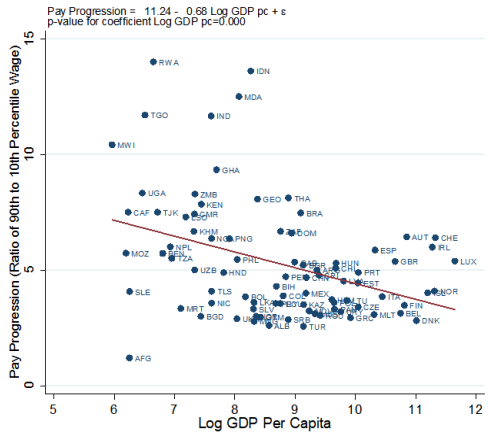
A Appendix Figures and Tables

FIGURE 1: MERITOCRACY, PAY PROGRESSION AND GOVERNMENT PERFORMANCE BY GDP LEVEL – COUNTRY-LEVEL ANALYSIS

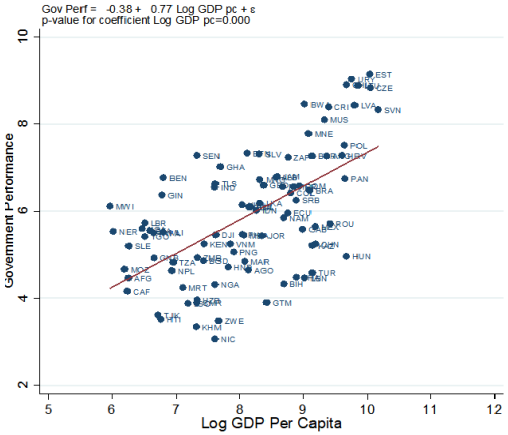
Panel A: Correlation between Meritocracy and GDP per Capita



Panel B: Correlation between Pay Progression and GDP per Capita



Panel C: Correlation between Government Performance and GDP per Capita

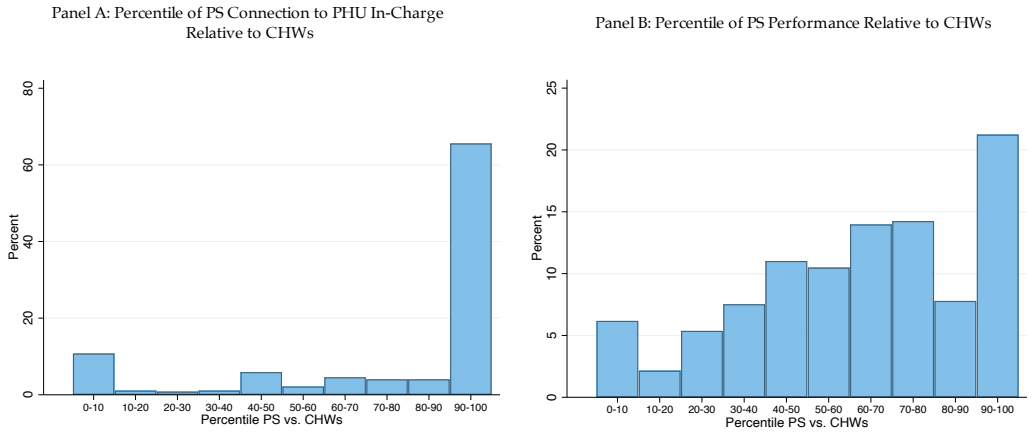


Notes: One observation per country. The red solid line represents the linear regression of meritocracy (Panel A), pay progression (Panel B) and government performance (Panel C) on log GDP per capita, with robust standard errors and no controls. For each country, we use data for the most recent year for 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 in the public sector relative to the private sector for workers with tertiary education vs. 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 2: Association between Meritocracy, Pay Progression and Government Performance – Country-Level Analysis

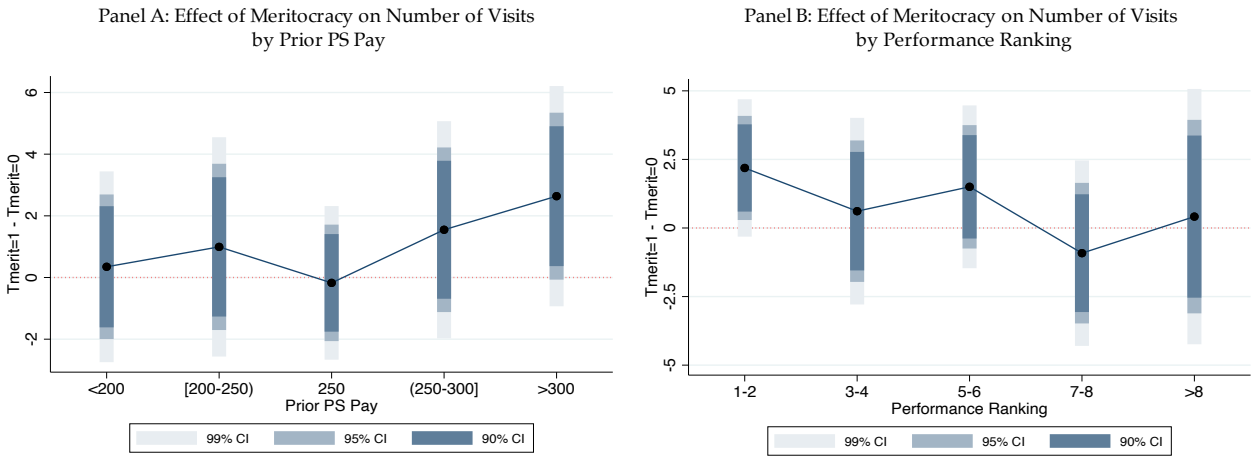
Notes: One observation per country-year. The red solid line represents the linear regression of government performance on pay progression (Panels A-B) or meritocracy (Panels C-D), with country and year fixed effects and with standard errors clustered at the country level. Panels A and B focus on the 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 in the public sector relative to the private sector for workers with tertiary education vs. 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 3: PS vs. CHW Connections and Performance in the Status-Quo Promotion System



Notes: This figure presents the distribution of PS connections to the PHU in-charge (Panel A) and predicted PS performance as a CHW (Panel B). All percentiles shown in the figure are expressed relative to the connectedness of CHWs in the PHU (Panel A) and actual performance of CHWs in the PHU (Panel B). For example, the PS is above the 90th percentile if she has more connections/higher performance than 90% of the CHWs in her PHU. Connections to the PHU in-charge are measured with the number of years the PS/CHW has known the PHU in-charge for before joining the CHW program. CHW performance is measured with the number of visits provided by the CHW to households in the community. Note that we do not observe PS past performance when they were CHWs. Instead, we generate a prediction in two steps. In the sample of all CHWs, we first regress the number of visits provided by a CHW at endline on all observed CHW characteristics (e.g., gender, age, education, wealth score, tenure). 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.

Figure 4: Meritocracy and Worker Performance by Prior PS Pay and Ranking



Notes: This figure plots the effect of Tmerit by quintile of Perceived PS Pay (Panel A) and by performance ranking (Panel B). We plot coefficients from regressing the number of visits on Tmerit, a dummy for each quintile and the interaction of Tmerit with each dummy, controlling for the stratification variables and with standard errors clustered at the PHU level. Sample of CHWs in Tpay=0.

Table 1: Correlations – PS 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 a 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 four regressions, where the measure of PS performance (in each row) is regressed on four different PS characteristic (stated in the columns). 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. Robust standard errors presented in parentheses. *** p<0.01, ** p<0.05, * p<0.1. "Number of times PS visited or called a CHW" is reported by each CHW and aggregated at PS level. "Number of times PS accompanied a CHW to a HH visit" is a variable reported by each household and aggregated at PS level. "Total number of household visits provided by all CHWs supervised by the PS" is reported by each household and aggregated at the PS level. "Predicted number of visits as a CHW" (columns 3-4) is measured in two steps. First, we regressed the average number of visits provided by a CHW at endline on a set of CHW characteristics (gender, age, education, wealth score, and tenure). Second, we calculated the PS predicted number of visits by multiplying the obtained coefficients from the first step by the actual PS characteristics (gender, age, education, wealth score, and tenure) at the moment in which she was promoted.

Table 2: Summary Statistics and Balance Checks— Village and Household Level

	(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. Village characteristics (N=2,009)								
Accessible road to government hospital= {0,	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)
Mobile network available = {0, 1}	0.868	0.338	-0.009	(0.028)	-0.031	(0.030)	0.012	(0.042)
B. Household respondents (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 from home = {0, 1}	0.870	0.273	-0.002	(0.021)	0.002	(0.022)	0.000	(0.028)
Government hospital is localed <30 min from home = {0, 1}	0.389	0.409	0.046	(0.037)	0.031	(0.031)	-0.060	(0.047)

Notes: We present characteristics of villages and sampled households (aggregated at the village level) in Panels A and B, respectively. 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. The last two variables are expressed in walking minutes. *** p<0.01, ** p<0.05, * p<0.1

Table 3: Correlations – CHW Characteristics

Regression:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Perceived Meritocracy = {-1, 0, 1}		Perceived PS Pay - Truth (in 10,000 SLL)		𝟙(Perceived PS Pay > Truth)		High Rank = {0, 1}	
	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.
CHW characteristics (reported by the CHW)								
Male = {0, 1}	-0.027	(0.024)	-0.001	(0.020)	-0.015	(0.027)	0.101***	(0.030)
Age (in years)	-0.941	(0.589)	0.781	(0.608)	1.088	(0.738)	1.276	(0.795)
Completed primary education = {0, 1}	0.018	(0.026)	-0.024	(0.022)	-0.025	(0.031)	0.022	(0.036)
Completed secondary education or above = {0, 1}	0.003	(0.018)	0.006	(0.014)	-0.006	(0.019)	0.104***	(0.025)
Wealth score (0 to 8)	0.118*	(0.061)	0.051	(0.055)	0.059	(0.074)	0.136	(0.084)
Health knowledge score (0 to 7)	-0.014	(0.080)	0.005	(0.068)	0.059	(0.087)	0.221**	(0.102)
Number of years as CHW	0.016	(0.160)	0.139	(0.159)	0.295	(0.197)	0.332*	(0.194)
Number of households CHW is responsible for	-0.798	(4.040)	2.652	(2.862)	3.464	(5.645)	17.548***	(4.939)
Number of hours worked as CHW per week	-0.102	(1.191)	1.048	(0.985)	0.574	(1.355)	1.877	(1.508)
Number of household visits provided per week	0.980	(1.064)	0.670	(0.954)	0.498	(1.587)	4.444***	(1.665)
Satisfied with the PS = {0, 1}	0.049*	(0.027)	0.006	(0.021)	0.032	(0.030)	0.038	(0.027)
Ever talked to the PHU in-charge = {0, 1}	-0.011	(0.028)	-0.007	(0.023)	-0.013	(0.032)	0.037	(0.036)
Number of years CHW has known PHU in-charge for	-0.370	(0.283)	-0.282	(0.229)	-0.482	(0.324)	0.027	(0.364)
Number of years CHW has known PS for	-0.631	(0.477)	0.825**	(0.416)	1.277**	(0.595)	-0.288	(0.552)
PS was best-performing CHW when promoted = {0, 1}	-0.038	(0.024)	-0.002	(0.002)	-0.028	(0.030)	-0.032	(0.027)
CHW characteristics (reported by the PS)								
Performance ranking	-0.253	(0.171)	0.098	(0.163)	0.197	(0.219)	-4.733***	(0.152)

Notes: Each row states the estimates from four regressions, where the CHW characteristic in each row is is regressed on CHW perceived meritocracy (columns 1-2), on the difference between CHW perceived PS pay and the truth (columns 3-4), on a dummy for whether perceived PS pay is above the truth (columns 5-6), and on a dummy for whether the worker is high rank (columns 7-8). All regressions control for stratification variables. Standard errors are clustered at the PHU level. All variables reported in this table are measured at baseline. Sample of CHWs in Tpay=0.
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Belief Updating about Other PS Job Attributes

	(1)	(2)	(3)
	Post-Treatment Perceptions about PS Job Attributes		
Dep. Var.:	PS Pay (in 1,000 SLL)	PS Number of Hours Worked	PS Work-Related Expenses (in 1,000 SLL)
Tmerit	2.848	0.104	1.840
	(1.880)	(0.594)	(3.015)
Observations	2,009	1,940	1,932
Mean Dep. Var.	255.2	14.17	96.70
Mean Dep. Var. if Tmerit=0	253.8	14.14	95.43

Notes: Sample of all CHWs. All regressions control for stratification variables. Standard errors are clustered at the PHU level. The sample size is smaller in columns (2) and (3) because a set of CHWs answered "don't know" and their answer is coded as missing. "Work-related expenses" include communication and transportation costs.
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Meritocracy and Worker Performance, by Type of Visit

Dep. Var.:	(1) Number of Routine Visits	(2) Number of Cases Treated	(3) Number of Cases Referred	(4) Number of Ante-natal Visits	(5) Number of Post-natal Visits	(6) Brought Woman for Child Birth to Hospital
Tmerit	1.325	1.019*	0.213	-0.011	0.045*	-0.014
	(0.909)	(0.574)	(0.160)	(0.177)	(0.027)	(0.024)
Observations	995	995	995	995	995	995
Mean Dep. Var.	4.765	3.373	0.911	0.304	0.042	0.056
Mean Dep. Var. in Tmerit=0	4.038	2.846	0.805	0.312	0.020	0.064

Notes: Sample of CHWs in Tpay=0. All regressions control for stratification variables. Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1

Table 6: Meritocracy and Worker Performance – IV Results

Dep. Var.:	(1) Number of Visits	(2) Number of Visits	(3) Visit Length (in Minutes)	(4) Visit Length (in Minutes)	(5) Retention = {0, 1}	(6) Retention = {0, 1}
Perceived Meritocracy [i]	3.235		6.476		0.135*	
	(2.746)		(4.209)		(0.072)	
Perceived Meritocracy		6.767*		6.803		0.318**
× 𝟙(Perceived PS Pay > Truth) [ii]		(3.923)		(5.759)		(0.127)
Perceived Meritocracy		1.051		6.278		0.027
× 𝟙(Perceived PS Pay ≤ Truth) [iii]		(2.983)		(5.139)		(0.095)
Observations	981	981	981	981	989	989
Mean Dep. Var. in Tmerit=0	7.455	7.455	15.59	15.586	0.891	0.891
F-stat 1st Stage (Cragg Donald Test)	64.94	29.554	64.94	29.554	65.81	30.381
p-value H_0: [ii] - [iii] = 0		0.151		0.939		0.073

Notes: Sample of CHWs in Tpay=0. IV regressions with Tmerit as an IV in odd columns, and two IVs in even columns: Tmerit × 𝟙(Perceived PS Pay > Truth) and Tmerit × 𝟙(Perceived PS Pay ≤ Truth). All regressions control for the dummy variable "𝟙(Perceived PS Pay > Truth)" and the stratification variables. Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1

Table 7: Meritocracy, PS Performance and Additional Outcome Variables

Dep. Var.:	(1) Number of Times PS Visited or Called CHW	(2)	(3) Number of Times PS Accompanied CHW to HH Visit	(4)	(5) CHW Talked to PHU In-Charge = {0,1}	(6)	(7) Fraction of CHW Time on Non-Patient-Related Activities	(8)
Tmerit [i]	0.040		0.020		-0.018		-0.020	
	(0.210)		(0.018)		(0.047)		(0.013)	
Tmerit × 𝟙(Perceived PS Pay > Truth) [ii]		-0.058		0.051*		-0.006		-0.017
		(0.249)		(0.029)		(0.064)		(0.018)
Tmerit × 𝟙(Perceived PS Pay ≤ Truth) [iii]		0.098		0.003		-0.025		-0.022*
		(0.243)		(0.019)		(0.051)		(0.013)
Observations	973	973	1,004	1,004	1,004	1,004	979	979
Mean Dep. Var. in Tmerit=0	2.460	2.460	0.131	0.131	0.561	0.561	0.218	0.218
p-value H_0: [ii] - [iii] = 0		0.55		0.132		0.765		0.744

Notes: Sample of CHWs in Tpay=0. Sample of CHWs in Tpay=0. All regressions control for the dummy variable "𝟙(Perceived PS Pay > Truth)" and the stratification variables. Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Meritocracy and Worker Performance – Additional Heterogeneous Effects

Dep. Var.:	(1) Visit Length (in Minutes)	(2)	(3)	(4) Retention = {0, 1}	(5)	(6)
Tmerit × High Rank [i]	2.447			0.058		
	(1.868)			(0.039)		
Tmerit × Low Rank [ii]	1.496			0.016		
	(1.245)			(0.021)		
Tmerit × Not Connected to PHU In-Charge [iii]		2.137			0.064**	
		(1.383)			(0.029)	
Tmerit × Connected to PHU In-Charge [iv]		1.300			-0.003	
		(1.403)			(0.025)	
Tmerit × High Rank & Not Connected to PHU In-Charge [v]			1.017			0.062
			(2.703)			(0.056)
Tmerit × High Rank & Connected to PHU In-Charge [vi]			3.677			0.061
			(2.466)			(0.054)
Tmerit × Low Rank & Not Connected to PHU In-Charge [vii]			1.451			0.066*
			(1.510)			(0.036)
Tmerit × Low Rank & Connected to PHU In-Charge [viii]			1.605			-0.024
			(1.597)			(0.029)
Observations	932	932	932	940	940	940
Mean Dep. Var. if Tmerit=0	14.602	14.602	14.602	0.878	0.878	0.878
p-value H_0: [i] - [ii] = 0	0.637			0.345		
p-value H_0: [iii] - [iv] = 0		0.608			0.082	
p-value H_0: [v] - [vi] = 0			0.456			0.990
p-value H_0: [v] - [vii] = 0			0.881			0.951
p-value H_0: [v] - [viii] = 0			0.845			0.156

Notes: Sample of CHWs in Tpay=0. All regressions control for stratification variables. We also control for the dummy variable "High Rank" in columns (1) and (4), for the dummy variable "Not Connected" in columns (2) and (5), and for three dummy variables in columns (3) and (6): "High Rank & Not Connected", "High Rank & Connected" and "Low Rank & Not Connected". Standard errors are clustered at the PHU level. Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1

TABLE 9: BELIEF UPDATING ABOUT MERITOCRACY AND PAY PROGRESSION – HETEROGENEOUS EFFECTS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dep. Var.:	Post-Treatment Perceived Meritocracy = {-1, 0, 1}			|Post-Treatment Perceived PS Pay - Truth| (in 1,000 SLL)			Post-Treatment Perceived Meritocracy = {-1, 0, 1}		
Definition of **Z**	𝟙(Pre-Treatment Perceived PS Pay > Truth)	High Rank	Satisfied with the PS	𝟙(Pre-Treatment Perceived PS Pay > Truth)	High Rank	Satisfied with the PS	𝟙(Pre-Treatment Perceived PS Pay > Truth)	High Rank	Satisfied with the PS
Z	-0.033	-0.004	0.089*	44.312***	-5.009	-1.180	0.007	0.076	0.144**
	(0.040)	(0.042)	(0.046)	(3.455)	(3.859)	(3.679)	(0.053)	(0.057)	(0.067)
Tmerit	0.283***	0.307***	0.368***				0.263***	0.295***	0.356***
	(0.029)	(0.030)	(0.052)				(0.040)	(0.038)	(0.076)
Tmerit × **Z**	0.039	-0.025	-0.097				0.012	-0.105	-0.128
	(0.050)	(0.055)	(0.059)				(0.067)	(0.075)	(0.088)
Tpay				-19.206***	-35.868***	-36.063***	-0.037	-0.032	0.008
				(1.106)	(1.797)	(3.114)	(0.042)	(0.046)	(0.079)
Tpay × **Z**				-43.462***	5.004	1.625	-0.089	-0.148*	-0.106
				(3.465)	(3.886)	(3.696)	(0.080)	(0.083)	(0.090)
Tmerit × Tpay							0.040	0.026	0.022
							(0.057)	(0.059)	(0.102)
Tmerit × Tpay × **Z**							0.060	0.149	0.058
							(0.100)	(0.109)	(0.116)
Observations	1,982	1,842	1,982	2,009	1,867	2,009	1,982	1,842	1,982
Mean Dep. Var.	0.626	0.626	0.626	17.900	17.900	17.900	0.626	0.626	0.626

Notes: Sample of all CHWs. All regressions control for stratification variables. Standard errors are clustered at the PHU level. ** p<0.01, ** p<0.05, * p<0.1

Table 10: Summary Statistics and Balance Checks by PS Pay Priors

	(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 for CHWs with Perceived 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)
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)
Number of years CHW has known PS for	7.569	8.383	0.621	(1.077)	1.058	(0.974)	0.963	(1.470)
PS was the best-performing CHW when promoted = {0, 1}	0.434	0.496	-0.056	(0.083)	-0.092	(0.084)	0.136	(0.122)
B. CHW characteristics for CHWs with Perceived 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)
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)
Number of years CHW has known PS for	8.215	8.654	-0.751	(1.048)	-1.454	(0.903)	1.103	(1.411)
PS was the best-performing CHW when promoted = {0, 1}	0.444	0.497	-0.080	(0.090)	-0.006	(0.094)	0.158	(0.128)
C. CHW characteristics for CHWs with Perceived 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)
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)
Number of years CHW has known PS for	7.532	8.225	0.050	(0.943)	-0.581	(0.989)	0.567	(1.328)
PS was the best-performing CHW when promoted = {0, 1}	0.500	0.500	-0.003	(0.100)	0.065	(0.099)	0.024	(0.138)

Notes: We present characteristics of CHWs in three subsample described in panel titles. 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 11: PAY PROGRESSION AND WORKER PERFORMANCE – FULLY INTERACTED MODEL

Dep. Var.:	(1)	(2)	(3)	(4)	(5)	(6)
	Number of Visits		Visit Length (in Minutes)		Retention = {0, 1}	
Higher perceived pay progression with high meritocraticy	1.809*	1.630	-0.823	-1.084	0.083**	0.088***
(Tpay + Tmerit × Tpay) × 𝟙(Perceived PS Pay < Truth)	(1.075)	(1.154)	(1.700)	(1.624)	(0.030)	(0.030)
Higher perceived pay progression with low meritocraticy	-1.952**	-2.020**	-0.807	-1.530	-0.061	-0.071*
Tpay × 𝟙(Perceived PS Pay < Truth)	(0.822)	(0.827)	(1.589)	(1.631)	(0.040)	(0.038)
Lower perceived pay progression with high meritocraticy	-2.045**	-2.362	-2.379*	-3.303**	-0.044	-0.045
(Tpay + Tmerit × Tpay) × 𝟙(Perceived PS Pay > Truth)	(1.023)	(1.006)	(1.431)	(1.440)	(0.030)	(0.032)
Lower perceived pay progression with low meritocraticy	-0.684	-0.798	-1.451	-1.198	0.030	0.034
Tpay × 𝟙(Perceived PS Pay > Truth)	(0.860)	(0.835)	(1.673)	(1.706)	(0.040)	(0.038)
Regression Coefficients:						
Tpay × 𝟙(Perceived PS Pay < Truth)	-1.952**	-2.020**	-0.807	-1.530	-0.061	-0.071*
	(0.822)	(0.827)	(1.589)	(1.631)	(0.040)	(0.038)
Tmerit × 𝟙(Perceived PS Pay < Truth)	0.802	0.914	3.822**	3.315*	-0.004	-0.014
	(0.992)	(1.010)	(1.695)	(1.734)	(0.035)	(0.036)
Tmerit × Tpay × 𝟙(Perceived PS Pay < Truth)	3.761***	3.650**	-0.016	0.446	0.144***	0.159***
	(1.355)	(1.424)	(2.318)	(2.295)	(0.049)	(0.048)
Tpay × 𝟙(Perceived PS Pay > Truth)	-0.684	-0.798	-1.451	-1.198	0.030	0.034
	(0.860)	(0.835)	(1.673)	(1.706)	(0.040)	(0.038)
Tmerit × 𝟙(Perceived PS Pay > Truth)	2.006*	2.053**	1.781	2.483	0.075**	0.082**
	(1.035)	(1.036)	(1.524)	(1.551)	(0.032)	(0.033)
Tmerit × Tpay × 𝟙(Perceived PS Pay > Truth)	-1.361	-1.564	-0.929	-2.105	-0.073	-0.079
	(1.337)	(1.309)	(2.194)	(2.226)	(0.050)	(0.050)
Tpay × 𝟙(Perceived PS Pay = Truth)	-0.968	-0.295	-0.817	-0.813	0.037	0.044
	(0.833)	(0.805)	(1.859)	(1.819)	(0.035)	(0.037)
Tmerit × 𝟙(Perceived PS Pay = Truth)	-0.060	0.196	-0.467	-0.461	0.020	0.029
	(0.976)	(0.968)	(1.863)	(1.926)	(0.030)	(0.031)
Tmerit × Tpay × 𝟙(Perceived PS Pay = Truth)	0.668	-0.040	1.108	0.855	-0.043	-0.060
	(1.300)	(1.313)	(2.497)	(2.492)	(0.048)	(0.049)
Observations	1,966	1,938	1,966	1,938	2,009	1,981
Mean Dep. Var.	7.560	7.560	14.944	14.944	0.893	0.893
Mean Dep. Var. if Tmerit=0 & Tpay=0	7.455	7.455	14.602	14.602	0.878	0.878
Extra Controls	No	Yes	No	Yes	No	Yes

Notes: Sample of all CHWs. All regressions control for the stratification variables and for two dummy variable: 𝟙(Perceived PS Pay < Truth) and 𝟙(Perceived PS Pay > Truth). Even columns also control for all CHW characteristics in Table 1 and their interactions with Tpay, Tmerit and Tpay × Tmerit. Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1

Table 12: Pay Progression and PS Performance

Dep. Var.:	(1) Number of Times PS Visited or Called CHW	(2) Number of Times PS Accompanied CHW to HH Visit	(3) Number of Times PS Visited or Called CHW	(4) Number of Times PS Accompanied CHW to HH Visit	(5) Number of Times PS Visited or Called CHW	(6) Number of Times PS Accompanied CHW to HH Visit
Sample:	*Perceived PS Pay < Truth*		*Perceived PS Pay > Truth*		*Perceived PS Pay = Truth*	
Tpay × High Meritocracy (Tmerit=1) [i]	-0.083	0.046*	0.142	0.027	0.431	-0.023
	(0.307)	(0.025)	(0.277)	(0.033)	(0.324)	(0.032)
Tpay × Low Meritocracy (Tmerit=0) [ii]	0.211	0.025	0.478	0.007	0.491	-0.029
	(0.280)	(0.027)	(0.367)	(0.031)	(0.368)	(0.029)
Observations	706	738	656	673	581	598
Mean Dep. Var.	2.673	0.129	2.520	0.165	2.657	0.139
Mean Dep. Var. if Tpay=0	2.638	0.112	2.375	0.159	2.420	0.152
p-value H_0: [i] - [ii] = 0	0.479	0.553	0.465	0.666	0.903	0.906

Notes: Sample described in column headings. All regressions control for stratification variables and control for a dummy variable for "High Meritocracy (Tmerit=1)". Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1

Table 13: Pay Progression and Worker Performance – IV Results

Dep. Var.:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Number of Visits			Visit Length (in Minutes)			Retention = {0, 1}		
Sample:	*All*	*Perceived PS Pay < Truth*	*Perceived PS Pay > Truth*	*All*	*Perceived PS Pay < Truth*	*Perceived PS Pay > Truth*	*All*	*Perceived PS Pay < Truth*	*Perceived PS Pay > Truth*
Perceived PS Pay Updating × High Meritocracy (Tmerit=1) [i]	0.028***			0.030**			0.001**		
	(0.009)			(0.014)			(0.000)		
Perceived PS Pay Updating × Low Meritocracy (Tmerit=0) [ii]	-0.002			0.006			-0.000		
	(0.008)			(0.016)			(0.000)		
Perceived PS Pay × High Meritocracy (Tmerit=1) [iii]		0.074*	0.033**		-0.033	0.038*		0.003***	0.001
		(0.043)	(0.017)		(0.066)	(0.023)		(0.001)	(0.000)
Perceived PS Pay × Low Meritocracy (Tmerit=0) [iv]		-0.061**	0.010		-0.034	0.023		-0.002	-0.000
		(0.025)	(0.015)		(0.048)	(0.028)		(0.001)	(0.001)
Observations	1,966	701	668	1,966	701	668	2,009	738	673
Mean Dep. Var.	7.560	7.560	7.560	14.944	14.944	14.944	0.893	0.893	0.893
F-stat 1st Stage (Cragg Donald Test)	181.058	89.894	96.240	181.058	89.894	96.240	185.226	100.997	96.999
p-value H_0: [i] - [ii] = 0	0.007			0.195			0.010		
p-value H_0: [iii] - [iv] = 0		0.007	0.300		0.994	0.685		0.001	0.134

Notes: Sample described in column headings. IV regressions with 4 IVs in columns (1), (4) and (7): 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), (3), (5), (6), (8), (9), we use 2 IVs: Tpay × High Meritocracy, Tpay × Low Meritocracy. "Perceived PS Pay Updating" is the difference between post- and pre-treatment perceived PS pay, and is expressed in thousand of SLL. "Perceived PS Pay" is the post- treatment perceived PS pay, expressed in thousand of SLL. 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

Table 14: Incentives and Perceptions

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

Notes: Sample of all CHWs. All regressions include 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 15: Main Results, Interactions with Incentives

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dep. Var.:	Number of Visits		Visit Length (in Minutes)		Retention = {0,1}		Number of Times PS Visited or Called CHW		Number of Times PS Accompanied CHW to HH Visit	
Tmerit	0.998	0.849	1.878	0.773	0.033*	0.028	0.020	0.004	0.039	0.490
	(0.789)	(1.670)	(1.180)	(2.013)	(0.019)	(0.036)	(0.018)	(0.035)	(0.212)	(0.490)
Tpay	-1.297**	-1.761	-1.180	0.621	0.005	0.022	-0.005	0.002	0.439*	-0.171
	(0.637)	(1.474)	(1.176)	(2.415)	(0.022)	(0.039)	(0.018)	(0.035)	(0.252)	(0.369)
Tpay × Tmerit	1.089	1.312	0.208	-0.495	0.007	-0.008	0.015	-0.017	-0.257	0.229
	(0.981)	(2.067)	(1.581)	(3.258)	(0.028)	(0.050)	(0.026)	(0.050)	(0.331)	(0.646)
Tmerit × PS Incentives		2.772		1.511		0.027		0.057		-0.582
		(2.167)		(3.123)		(0.054)		(0.046)		(0.620)
Tpay × PS Incentives		0.378		-4.271		-0.009		0.043		0.743
		(1.786)		(3.315)		(0.061)		(0.048)		(0.541)
Tpay × Tmerit × PS Incentives		-3.235		-0.252		0.050		0.036		-0.474
		(2.675)		(4.455)		(0.077)		(0.073)		(0.868)
Tmerit × CHW Incentives		-1.920		-0.130		-0.021		-0.011		-0.889
		(2.296)		(3.049)		(0.056)		(0.053)		(0.656)
Tpay × CHW Incentives		1.123		0.492		-0.025		-0.028		0.306
		(1.967)		(3.210)		(0.064)		(0.051)		(0.586)
Tpay × Tmerit × CHW Incentives		2.824		2.910		0.050		0.072		-0.172
		(2.869)		(4.365)		(0.077)		(0.074)		(0.877)
Tmerit × No Incentives		-0.755		2.812		0.005		0.016		-0.373
		(1.833)		(2.792)		(0.048)		(0.049)		(0.636)
Tpay × No Incentives		0.546		-2.331		-0.054		-0.006		0.893
		(1.682)		(3.365)		(0.062)		(0.050)		(0.769)
Tpay × Tmerit × No Incentives		-0.527		-1.535		-0.014		0.012		-0.891
		(2.373)		(4.490)		(0.081)		(0.069)		(1.005)
Observations	1,966	1,966	1,966	1,966	2,009	2,009	2,009	2,009	1,943	1,943
Mean Dep. Var.	7.560	7.560	14.944	14.944	0.893	0.893	0.144	0.144	2.617	2.617

Notes: Sample of all CHWs. All regressions icontrol for district fixed effects. Even columns also control for a dummy variable for PS incentives, CHW incentives and no incentives. Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1

A Appendix on Temporary Incentives

The CHWs and PSs in this study were part of a separate evaluation that involved a performance-based incentive scheme paid by an external organization (NestBuilders International) between April 2018 and July 2019. The randomization was done at the PHU level. In the Group Incentives Treatment, CHWs received an incentive of 1,000 SSL for each service performed and the PS received an incentive of 1,000 SSL for each service performed by a CHW under her supervision. In the CHW Incentives Treatment, CHWs received an incentive of 2,000 SSL for each service performed while the PS received no incentives. In the PS Incentive Treatment, the PS received an incentive of 2,000 SSL 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. Notably, these incentives were not publicly announced, but only disclosed to the direct recipients. Moreover, in each treatment, the number of services a CHW provided was measured with an SMS reporting system that played no role in the main experiment of this paper.[39] See Deserranno, Philipp, and León-Ciliotta (2020) for more details on the evaluation.

As mentioned in the body of the paper, the randomization of the meritocracy and pay progression treatments was stratified by the above-mentioned incentives. 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 14, 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 15 shows that the effects of the meritocracy and pay progression treatments on CHW productivity do not interact with the incentives treatments. To be cautious, one should 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.

B Model Appendix

B.1 Main Results

This section formally develops the theoretical framework presented in Section 4.

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* $r_2 = \frac{\bar{w}-\underline{w}}{c_2 g_2(b,\bar{w}-\underline{w})}$.[40]

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 B.2:

[39] Every time a CHW provided a service, she was asked to report the date and type of service and the contact information of the patient by sending an SMS to a toll-free number.

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

Lemma B.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.*

B.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 4.2. The corresponding proofs are presented in Appendix B.2.

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

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

This result implies Prediction 3.

Proposition B.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 B.3 is amplified when player 2 is of higher ability.

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

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

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

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

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

B.1.2 Results with Morale Concerns

This section derives the propositions that underlie the predictions of the model with morale concerns presented in Section 4.3.

We make three assumptions about the morale cost-shift function g_i. (Section 4.3 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 B.2:

Proposition B.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 B.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 B.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 B.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 B.9 is amplified when player 2 is of higher ability.

Proposition B.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 B.10 is amplified when player 2 is of higher ability.

Proposition B.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* $i = 1, 2$,

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

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

B.2 Proofs

Lemma B.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:

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

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:

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

$$\begin{aligned} \bar{e}_2(\bar{w} - \underline{w}, b, c_1, c_2) = \mathbb{E}_{E_2}(e) &= \int_0^{\frac{\bar{w}-\underline{w}}{cg_2(b,\bar{w}-\underline{w})}} \frac{c_1}{\bar{w} - \underline{w}} \frac{e}{b} \quad de \\ &= \frac{c_1}{2b(\bar{w} - \underline{w})} \left(\frac{\bar{w} - \underline{w}}{c_2 g_2(b, \bar{w} - \underline{w})}\right)^2 \\ &= \frac{c_1(\bar{w} - \underline{w})}{2bc_2^2 g_2(b, \bar{w} - \underline{w})^2} \end{aligned}$$

□

B.2.1 Proofs: Model without Morale Concerns

Proposition B.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 B.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 B.4

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

Proposition B.5

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

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

Because $\bar{\bar{w}} - \underline{w} \geq \bar{w} - \underline{w}$, $b \geq 1$, $c_2 > 0$ and $c_1 \geq 0$, it follows that these expressions are strictly greater than zero. Therefore, $\bar{e}_i(\bar{\bar{w}} - \underline{w}, b, c_1, c_2) \geq \bar{e}_i(\bar{w} - \underline{w}, b, c_1, c_2)$, 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 B.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 B.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 B.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 B.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 B.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 B.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 $i=1,2$. □

B.2.2 Proofs: Model with Morale Concerns

Proposition B.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 B.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 $\frac{g_2(\bar{b}_1,\bar{w}-\underline{w})}{\bar{\bar{w}}-\underline{w}}=\frac{g_2(\bar{b}_1,\bar{\bar{w}}-\underline{\underline{w}})}{\bar{\bar{w}}-\underline{\underline{w}}}$. 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 $g_2(\bar{b},\bar{w}-\underline{w})$ 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 $\underline{b}$ 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 $b<\underline{b}$. Conversely, take $\bar{\underline{b}}$ 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 $b>\bar{\underline{b}}$. 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 $b<\underline{b}$. 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 $b<\underline{b}$. 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 $b>\bar{\underline{b}}$, 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 $b>\bar{\underline{b}}$. □

Proposition B.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

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

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 B.12

Proof. From the expressions of average effort we find that

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

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 B.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 B.14

Proof. From Proposition B.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:

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

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

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

For player 2, we have instead:

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

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 $\left(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{c}_2)-\bar{e}_2(\bar{w}-\underline{w},b,c_1,\tilde{c}_2)\right)-\left(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{c}_2)-\bar{e}_2(\bar{w}-\underline{w},b',c_1,\tilde{c}_2)\right)$ and $\left(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{\tilde{c}}_2)-\bar{e}_2(\bar{w}-\underline{w},b,c_1,\tilde{\tilde{c}}_2)\right)-\left(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{\tilde{c}}_2)-\bar{e}_2(\bar{w}-\underline{w},b',c_1,\tilde{\tilde{c}}_2)\right)$. Further, it is positive by proposition B.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 $\left(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{\tilde{c}}_2)-\bar{e}_2(\bar{w}-\underline{w},b,c_1,\tilde{\tilde{c}}_2)\right)-\left(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{\tilde{c}}_2)-\bar{e}_2(\bar{w}-\underline{w},b',c_1,\tilde{\tilde{c}}_2)\right)$ and $\left(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b,c_1,\tilde{c}_2)-\bar{e}_2(\bar{w}-\underline{w},b,c_1,\tilde{c}_2)\right)-\left(\bar{e}_2(\bar{\bar{w}}-\underline{\underline{w}},b',c_1,\tilde{c}_2)-\bar{e}_2(\bar{w}-\underline{w},b',c_1,\tilde{c}_2)\right)$. As $\tilde{\tilde{c}}_2<\tilde{c}_2$, we can conclude that

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

□