Merit Pay and Wage Compression with Productivity Differences and Uncertainty *

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Abstract

This paper experimentally investigates wage setting and effort choices in a multi-worker setting when there is heterogeneity in worker productivity and managers' perception of this productivity is imperfect. Worker ability is assigned via an aptitude test and, in an innovative design, manager uncertainty concerning this ability is related to the manager's own test performance. We propose a merit-pay hypothesis, that higher-ability workers will reduce their effort if they are not paid more than coworkers with lower ability, but not vice versa. Based on a simple model, we also predict that the higher the uncertainty about employee ability levels, the more managers compress wages between perceived high- and low-ability workers. We find strong experimental support for both hypotheses.
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1 Introduction

Wage inequality within countries and within firms is increasing and is at historically high

levels. For example, the average ratio between the highest and lowest salary in firms is

much higher today than fifty years ago. Structural changes such as skill-biased technological change, see for instance Bekman, Bound, and Machin (1998), or capital-skill complementarity as proposed by Krusell, Ohanian, Ros-Rull, and Violante (2000), could lead to higher wage inequality through performance pay (Lemieux, MacLeod, and Parent, 2009). We are interested in the question of how wage inequality within a firm affects employees' motivation and their work effort and how this can in turn affect wage inequality.

When firms attempt to optimally set wages, they must take into account the incentive effects of these wages on employee work effort. Campbell III and Kamlani (1997, p.780) survey firms and find that: "Overall, firms appear to believe that wages have a strong effect on effort by affecting workers' attitudes toward their employer." There are reasons to believe that not only absolute wages matter, but also that the relative remuneration in comparison to one's coworkers matters, as argued by Akerlof and Yellen (1990). We wish to assess whether the relative wage of a worker matters for choosing effort when productivities are different.

Our paper makes three main contributions. To the best of our knowledge, we are the first to investigate the effect of relative pay on worker performance when productivity is assigned on the basis of test performance and the firm only receives a signal concerning the productivity of each worker.[1] Previous work has found little or no effect of relative pay on worker performance, but we find that this changes in our richer environment. Second, we develop a novel mechanism for generating uncertainty about a worker's productivity, with more-able managers receiving a more precise signal in this regard. The mechanism reflects the fact that managers differ in their ability to assess worker skill and performance. Third, we use this mechanism to investigate the effect of uncertainty about productivity on whether managers choose to compress wages. While previous work has found evidence of wage compression when differences in worker productivity are clear, we feel that there is

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[1]In fact, there are very few studies that do not simply assign productivity to workers randomly. Rivas (2009) and Bolton and Werner (2012) do assign productivity to workers according to a test, but the productivity levels are common information.

considerable uncertainty about such differences in the field environment, and so our setting may have more external validity.

We hypothesize that many people believe that merit should be rewarded and therefore more-able workers should receive higher remuneration. At the end of the experiment, we asked participants to fill out a questionnaire, which included the question: "Do you think the higher-ability worker deserves to be paid more than the lower-ability worker?" Fifty-two out of 66 assigned workers (79 percent) answered this question positively. For this subsample, more capable workers would thus expect higher compensation, and we therefore postulate our merit-pay hypothesis: *Ceteris paribus*, more productive workers who believe in merit pay will reduce their effort when not receiving a higher wage than their less productive coworkers, while less productive workers will not react much to relative wages.[2]

To investigate this hypothesis, we needed to address three important issues, which are reflected in the contributions listed above. First, an arbitrary assignment of productivity may not give high-productivity workers a sense of entitlement, so we instead assign ability in the experiment according to the results of an aptitude test at the beginning of the experiment.[3] Second, the manager is very unlikely to intentionally pay a higher wage to the lower-ability worker, and so we would not observe very many violations of merit pay. We therefore create a mechanism that induces an endogenous degree of uncertainty into the managers' perception of worker ability, resulting in higher-ability workers receiving a lower wage in 26% of the cases.[4] Third, wage assignments should still be attributable to the competence of the managers, as otherwise workers are not likely to punish the manager for a wage they perceive as unfair (Ku and Salmon, 2012). In our mechanism, the precision with which the manager

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[2]This is in line with what Cappelen, Sørensen, and Tungodden (2010) call meritocracism. Our hypothesis also holds when we define merit pay as receiving at least as much as less-productive coworkers (instead of strictly more).

[3]For instance, Charness and Kuhn (2007) find no statistically or economically significant effect of coworker wages on effort, even when controlling for ability (which was randomly assigned). However, if workers "earned" their productivity by their own doing, then they are more likely to expect merit pay. Similarly, random wage assignments in Bartling and von Siemens (2011) do not seem to affect effort in a team production environment.

[4]Bolton and Werner (2012) report this in 4.9% of the cases and Charness and Kuhn (2007) observe shares of 6.5% and 8.1% in two treatments; neither have manager uncertainty of worker ability.

can distinguish between higher and lower ability workers depends on her performance in the aptitude test. This reflects the fact that there is heterogeneity in the field regarding managerial competence with respect to differentiating the productivity of different workers – whether at hiring, when deciding on bonuses and wage increases, or for promotion.[5]

If workers care about equality, then higher wage dispersion could result in lower worker effort (Milgrom and Roberts, 1992). However, if workers differ in their productivity, a higher wage dispersion is cost-effective for inducing more effort from higher-productivity workers (Adams, 1966; Lazear and Rosen, 1981). Bewley (1999) shows the importance of fairness in determining effort in response to wages. But what constitutes a fair wage? Are fair wages the same across coworkers, or do they depend on each worker's effort, or on each worker's output? Cappelen, Hole, Sørensen, and Tungodden (2007) find that a person's effort and productivity strongly influence perceptions of a fair wage, whereas impersonal market features such as prices do not.[6]

A related issue is that of wage compression. Frank (1984) reports that firms compress wages relative to productivity. Charness and Kuhn (2005) find that, even with no uncertainty about productivity, managers did compress wages significantly more when wages are public than when they are not. When there is uncertainty, firms have an incentive to compress wages so as to guard themselves against the possibility of being wrong in their assessment of worker ability.[7]

Our experimental results lend strong support to the merit hypothesis and there is a significant resulting decrease in effort when high-ability workers are paid less than low-

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[5]Every organization has its share of incompetent managers, and one of the greatest sources of employee frustration are "idiot" bosses, reports USA Today (Kay, 2013). The Financial Post (Deveau, 2013) reports that 69% of employers complain that bad hires lowered company productivity and affected morale. Wourio (2011) at Microsoft Business argues that "many businesses approach the concept of job promotions with something less than a studied eye" and that "the consequences of an ill-advised promotion can be nothing short of cataclysmic."

[6]In a similar vein, Gantner, Güth, and Konigstein (2001) provide some evidence that a person's input contributions, including productivity, are correlated with one's demands in a bargaining game.

[7]Specifically, they worry that high-ability workers will not provide effort when they receive a low wage – even when workers do not respond to relative wages. We show this in a simple theoretical model. The idea is related to the dynamic learning model in Harris and Holmstrom (1982) on the true level of productivity of a worker.

ability workers in an environment where workers "earn" their own productivity by their own doing. We also find strong experimental evidence that wage compression due to uncertainty about true ability is indeed taking place, beyond possible concerns about equality.

In the next section, we discuss the related literature. In section 3 we explain the experimental setup, then present the data, and explore in section 5 the merit-pay hypothesis. Section 6 deals with wage compression and the final section concludes.

2 Related Literature

A common theme in the work on social preferences is that people not only pursue their own self-interest but also care about the well-being of others, whether this sense of fairness is strictly payoff-driven (Bolton and Ockenfels, 2000; Fehr and Schmidt, 1999) or also intention-driven (Charness and Rabin, 2002; Rabin, 1993). Experimental evidence supports the idea that information about the behavior and treatment of others systematically influences an individual's behavior in various settings. In the ultimatum game, responders turn down offers with positive probability, especially if the offer is low (Knez and Camerer, 1995). In public goods experiments, even with strong incentives to free-ride and contribute nothing, people regularly contribute non-zero amounts, and this is particularly true when it is possible to punish non-contributors (Bardsley and Sausgruber, 2005; Carpenter, 2004).

Within organizational management, the issue of equality versus inequality is of central importance. On the one hand, wage inequality is thought to negatively affect worker effort, leading to morale problems and diminished teamwork (Milgrom and Roberts, 1992). In their "fair wage-effort hypothesis," Akerlof and Yellen (1990) note that within a labor-wage setting where effort is not perfectly contractible, workers' effort is affected by the perceived fairness of their salary, and workers withhold effort if their actual wage is less than their fair wage. People make social comparisons with their coworkers as their reference point for a fair wage (Clark and Senik, 2010; Falk and Knell, 2004; Frank, 1984), and if social comparisons

are important for teamwork and morale, internal wage equity is critical for worker effort and firm productivity (Agell and Bennmarker, 2007; Campbell III and Kamlani, 1997; Clark and Oswald, 1996; Loewenstein, Thompson, and Bazerman, 1989; Pfeffer and Langton, 1993).

On the other hand, unequal wages could positively affect worker effort. Holmstrom (1982) points out that equal wages do not account for heterogeneity in agent's ability and performance, and when payment is not linked to an individual's marginal product, this allows for free-riding behavior. According to equity theory, inequality reflects the unequal human capital or productive capabilities of different workers (Adams, 1966; Konow, 2000). Under the premise that wages are commensurate with their contributions to the firm, then fairness considerations should not adversely affect effort from workers (Brown, 2001; Goerg, Kube, and Zultan, 2010). Incentive arguments in tournament models claim a greater wage inequality stimulates effort as workers aspire to superior positions (Lazear and Rosen, 1981). Gill and Stone (2010) consider notions of fairness and desert in their model of providing effort in tournaments. Furthermore, a theoretical model by Winter (2004) suggests that it might even be preferable to pay workers of equal ability unequally, depending on the shape of the production function, especially if a worker's effort induces a positive externality on the effectiveness of other workers' efforts.

Empirical research exploring the relationship between wage inequality and performance has produced mixed results, both in field studies (Bandiera, Barankay, and Rasul, 2005; Carpenter and Seki, 2006; Cowherd and Levine, 1992; Eriksson, 1999; Hibbs Jr and Locking, 2000; Leonard, 1989; Main, O'Reilly III, and Wade, 1993; Martins, 2008; Winter-Ebmer and Zweimüller, 1999) and in laboratory experiments. For example, Mas (2006) shows how pay raises for policemen below a fair wage reference point reduce job performance. Winter-Ebmer and Zweimüller (1999), however, find results in line with incentive considerations, using panel data of blue- and white-collar workers in Austrian firms. Card, Mas, Moretti, and Saez (2012) observe an asymmetric response to wage inequality: employees who are paid less than the average tend to be less satisfied with their job and their pay when aware

of their coworkers' salaries, while those who are paid more than the average do not react noticeably. These field studies of wage dispersion and firm performance were conducted in vastly different contexts, doing comparisons within and across groups of lower-level employees and upper management, between firms, operating under a number of unobservable real world forces such as social pressure, learning, knowledge spillovers, intrinsic motivation, etc. In consequence, researchers have turned to laboratory experiments in an attempt to isolate a pure, information-based wage comparison effect.

Much of the seminal experimental research into efficiency wages is based on vertical inequality, in the form of bilateral gift-exchange games (GEG) between a manager and a single agent (Fehr, Kirchler, Weichbold, and Gächter, 1998; Fehr, Kirchsteiger, and Riedl, 1993). Gift-exchange games have been argued to be well-suited to detect equity-motivated effort effects because there are no other influences on worker behavior besides fairness considerations and because it is costless to punish firms for unfair wages, see Charness and Kuhn (2007). Dufwenberg and Kirchsteiger (2004) provide a theory of reciprocity in sequential games. In reality though, labor settings are often complex social systems, with multiple workers, social information, and varying ability levels. Maximiano, Sloof, and Sonnemans (2007) extend the bilateral gift exchange game to a situation where a firm has multiple workers, each earning the same wage, and find that the reciprocity relationship is not affected by the number of workers per firm.

More recently, attention has focused on horizontal wage comparisons within the workforce and the effect of social information on possibly unequal wages amongst workers. In Bartling and von Siemens (2011), wages are assigned exogenously with no managers in the experiment, and the authors do not find any effect of wage inequality on effort choices. Nosenzo (2010) compares public versus secret wage treatments and finds effort choices decrease when wages are public (in a three-person GEG with one manager and two equal-ability workers). Goerg, Kube, and Zultan (2010) are interested in the question when to pay unequal wages to workers of the same ability. Their focus is less on effort levels and more on coordination issues between

workers in a repeated game, which allows for incomplete contracts and reputation-building. Gächter and Thöni (2010) use a three person GEG to explore whether wage comparison effects are due to intentional wage discrimination or due to mere payoff differences. Gächter and Sefton (2012) include sequential effort decisions, with the second worker having the benefit of additional information on the first worker's effort choice. In this paper, we do not allow for information on coworker effort because introducing public effort comparisons on top of public wage comparisons could confound the interpretation of the results. Abeler, Altmann, Kube, and Wibral (2010) invert the traditional GEG order, first having the workers provide effort and then, upon observing their efforts, the manager pays them a wage. They find that forcing firms to pay workers equal wages reduces worker effort and argue that this effect is due to fairness/merit considerations. In contrast to our study, their merit criterion is based on effort, not on ability.

None of the aforementioned horizontal wage comparison papers take into account possible differences in worker ability. Some papers explicitly do so: Güth, Königstein, Kovács, and Zala-Mezõ (2001) investigate fairness within a game with one principal and two agents and find that public wage contracts lead to wage compression, similar to Charness and Kuhn (2005); this wage compression is not due to uncertainty about worker ability as in our study, though. Güth, Königstein, Kovács, and Zala-Mezõ (2001) also investigate the impact of relative wages on effort provision. In contrast to our study, worker remuneration includes a performance component and most of their subjects do not exhibit any significant deviations from materialistically optimal behavior, making it difficult to measure the impact of fairness (violations of merit pay do not occur at all in their data).[8] Charness and Kuhn (2007) study a pure gift exchange setup where a firm offers various wages to two workers whose productivities differ, finding workers' effort choices do not depend on coworkers' wages. In Rivas (2009), productivity is assigned via an aptitude test. However, higher ability workers

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[8]The authors show a preliminary result that agents favored by fairness provide higher effort, but concede that further data collection is required: the statistical analysis for this result suffers from potential endogeneity, does not control for individual fixed effects and overall "generosity" of the contract, considers only one-sided t-tests, and results are not consistent across trials or for low- and high-productivity workers.

can never receive a lower wage in her experimental setting. She finds that the more unequal wage assignments result in lower average effort, but it is not clear if her results are driven by non-linear responses to own wages – in some wage regimes the highest wage is 30 times as high as the lowest. In our study, we find evidence of non-linear effects of own wages on effort, even though the ratios and differences between wage levels are much lower. Bolton and Werner (2012) also assign productivity via a test and find that unequal wage assignments do not lead to a reduction in effort. They find very few instances of higher wages for lower-ability workers, though, and do not examine our merit-pay hypothesis.

To sum up how this paper fits into the literature, we would like to emphasize the commonalities and differences with the literature. We use a standard two-worker gift-exchange game, in which heterogeneous ability is assigned non-randomly through a test, as in other studies. The novelty of our experimental design lies in the mechanism that injects uncertainty about the true ability of a worker. It endogenously creates instances where managers mistakenly, but through their own fault, assign lower wages to higher-ability workers than to the lower-ability co-workers. It allows us to consider the merit-pay hypothesis and wage compression due to uncertainty.[9]

3   Experimental Design

As in many other experimental studies, the labor market is represented by a gift-exchange game between managers and workers. In preparation, we designate a third of the participants to be managers and two-thirds to be workers by random drawings. After this, all participants take a twenty question aptitude test which consists of quantitative and verbal

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[9]While the design in Abeler, Altmann, Kube, and Wibral (2010) is simpler than ours, their results regarding merit pay are perfectly in line with standard economic reasoning (without any behavioral fairness considerations) that agents reduce their effort when their remuneration depends not only on their own effort, but also their coworker's (similar to public good contributions). Wage compression has been studied, for instance by Güth, Königstein, Kovács, and Zala-Mezõ (2001) and Charness and Kuhn (2005), but is due to prevent workers from responding negatively to relative wages in these studies.

test questions.[10] For the workers, the top 50% are classified as high ability and the lower 50% are classified as low ability. We privately tell workers their type, which remains constant throughout the experiment. Managers are not told their aptitude test results. All information concerning the rules of this game is common to all participants.

The game consists of ten periods. In each period, a three-person firm is formed by randomly and anonymously matching a manager with one actual high-ability worker and one actual low-ability worker. The composition of firms changes every period. Each worker, because he knows his own ability level, automatically knows the ability of his coworker. They also know the actual high-ability worker generates twice as much money for the manager as the actual-low ability worker for the same effort.

However the manager is uncertain who the *actual* high-ability worker is. He assigns wages to the *perceived* high- and low-ability workers, and the perceived high-ability worker is the one with the higher signaling score (details are in the next section and the appendix). The higher the manager scored on the aptitude test, the better the chances his perception is accurate.

In addition, we exogenously vary the manager information level in each period. We label them as perfect, good, normal, poor, and no information; we also refer to them as levels 1 to 5 respectively. Out of the ten time periods in each game, we had two periods for each information level, which we would publicly announce at the beginning of the period. There are thus two identical cycles in every experiment, both consisting of each of the five different information levels.

With a perfect information level, the manager knows exactly who the high-ability worker is. In the good (poor) information level, we increase the accuracy of managers' perception of worker ability (details are in the following section). With no information, the manager is given a random guess. Due to the different combinations of workers and managers, as well as the different information treatments, the perception of which person is the high-ability

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[10]The exact instructions, the aptitude test questions, and a detailed description of the experimental procedure can be found in the appendix.

worker may change.

Each period, the manager has seven lab dollars total to spend on wages of both workers. The minimum wage is one lab dollar, and the manager keeps money not assigned to workers.

Once workers in each firm learn their own wages as well as their coworker's wages, they choose how much effort to provide on a scale from one to six, at the cost shown in table 1.

Table 1: Worker Effort Cost Function

Effort Level	1	2	3	4	5	6
Cost	$0.10	$0.30	$0.60	$1.00	$1.50	$2.10

Finally, the firm generates revenue (shown in table 2) depending on the actual ability level of the workers (not the levels perceived by the manager) as well as their efforts provided. Managers are not informed of the worker effort choices at the end of each period nor of their own payoffs, so they cannot infer anything about how well they did on the aptitude test.

Table 2: Firm Revenue Produced by Worker Type

Effort Level	1	2	3	4	5	6
Higher Ability Worker Output	$3.00	$6.00	$9.00	$12.00	$15.00	$18.00
Lower Ability Worker Output	$1.50	$3.00	$4.50	$6.00	$7.50	$9.00

Earnings accumulate over the course of the session. Workers are paid 1 dollar for every 2 lab-dollars, and managers are paid 1 dollar for every 5 lab-dollars of cumulative firm profits. Firm profit is simply firm revenue plus any potential left-overs from the wage assignment.[11] All of this is common information.

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[11] The exchange rate from lab-dollars into actual earnings is the same for all workers, but differs from the managers' exchange rate. This difference should not affect wage comparisons *across* workers, though, which is what matters for our purposes.

3.1 Design Rationale and Mechanism Details

This experimental design relies on the well-established three-person gift-exchange game as the foundation onto which we will build more realistic characteristics of manager uncertainty. By the nature of the GEG design, the variation of wages is not exogenously or randomly imposed by the experimenters but is instead determined endogenously by managers who anticipate effort decisions by workers. This feature is important because unless the wage offers come from a real person with a personal financial stake, it is not clear that workers would respond reciprocally. It has been observed that wage responses are very sensitive to the source and intention of the wage assignment (Charness, 2004; Charness and Levine, 2007; Ku and Salmon, 2012).

In studying the effect of endogenous wages on effort, with wages being endogenously determined, there is a possibility that the wages assigned might be influenced by unobserved characteristics, such as worker reputation, that also affect effort. Charness and Kuhn (2007) convincingly argue that random and anonymous assignment each period, as well as controlling for worker fixed effects, addresses these potential endogeneity concerns.[12]

Moreover, as mentioned in the Introduction, we had three main goals in creating an experimental mechanism:

1. Workers have to internalize their role as a higher/lower ability worker.

2. Managers should not have perfect information about worker types.

3. The information about worker types should be related to the manager's competence.

To achieve these goals, we needed to develop a new mechanism for assigning relative productivity to each worker. The keys to this mechanism are that worker productivity is determined by performance on a quiz and that the manager only receives a signal about the worker's productivity. The novelty of the design is that the strength of the signal is

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[12]We have purposefully set the effort decision orthogonal to the ability test, even though this makes the experiment somewhat less natural. It is in order to avoid confounding the merit-pay hypothesis with possible other systematic interactions between type and effort choices.

determined by the manager's own ability on the same quiz. The signal is always informative unless the manager somehow believes that the number of her correct answers is lower than what would be expected by random guessing.

We had each participant take an aptitude test at the beginning of the experiment, in order to gauge the competence of both workers and managers. A worker who scored in the top (bottom) half of all workers was assigned higher (lower) productivity. We think this serves as a reasonable proxy for workers' perception of real ability (especially as compared to randomly assigning ability) and addresses the first point.

Managers know they are paired in each round with one higher-ability and one lower-ability worker.[13] However, instead of telling managers who is who, we send them an imprecise (except in the perfect-information treatment) signal about worker ability. This addresses the second point.

The accuracy of the signal depends on the manager's performance on the aptitude test, with precision increasing with performance. *Importantly, the manager does not know how well he scored on the test.* This implies that even though a manager might perform very poorly on the test (even worse than with random guesses), he is not aware of it at any time during the experiment. From the manager's perspective, having some kind of information is therefore always associated, in expectation, with a *better* performance than if he guesses randomly.[14] We matched the answers given by the paired workers and manager. The manager received a signal concerning which worker had high productivity, with this signal based on which worker matched more of the manager's answers.[15] This signal does relate to the

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[13]While the assumption of perfect knowledge of type and productivity among workers might not be the most realistic, it allows us to focus on the merit-pay hypothesis.

[14]Since our test has binary answers, assigning a probability $p > 1/2$ to one answer being right increases the expected signal score compared to a random guess; assigning a probability $p < 1/2$ to one answer being right is equivalent to assigning a probability of $1 - p > 1/2$ for the other answer to be right, which is again better than a random guess. Therefore, from an ex-ante perspective (that is without knowing the test results) one cannot do worse than guessing. We discuss the possibility of purposefully answering questions incorrectly below.

[15]In the perfect-information treatment, we converted all of the manager's answers into correct ones. In the good- (poor-) information treatment, we converted three of the manager's incorrect (correct) answers into the opposite. In the no-information treatment, we assigned a correct/incorrect answer to each question with a probability of one half each.

manager's competence. We offer some examples and intuition below; for more details see appendix B.

Intuitively, the probability of a correct signal is increasing in the number of questions to which the manager knows the correct answer. Consider first a manager who knows that he has answered every question correctly. His signal will always be correct, since the higher-ability worker has answered more questions correctly than the lower-ability worker. Now consider an ignorant manager who randomly guesses the answer to each question; from his perspective the signal is (almost) completely random. However, the probability that the signal is correct is actually slightly higher than 1/2 (since in the case of a tie, the true type is revealed). Therefore, even in this (worst) case the probability that the signal is correct is greater than 50%. Thus, a worker who matches more of the manager's answers should always be evaluated as having higher productivity. The mechanism thus addresses the third point.[16]

Is it possible to game the mechanism? If a manager knew he had performed poorly on the test, then he should invert the signal ex-post; but since managers never find out about the test score, the worst ex-ante expected signaling is still slightly better than random. Similarly, one obviously needs to know the correct answer in order to purposefully give the incorrect answer. It is thus not possible to improve the signal quality by trying to minimize the score by reversing the signal.[17]

Overall we are confident that subjects understood the mechanism, based on their behavior outlined in the next section and our conversations with participants after the experiment. We also had a manager comprehension quiz at the beginning of the experiment, which all managers were able to answer correctly.

It is possible that some workers react to violations of the merit-pay norm only if they

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[16]Presuming that one's random guesses are worse than expected must mean one is feeling unlucky. Of course, a manager never learns her test score.

[17]Even if some managers do reverse the signal, this should not affect how a worker reacts to the wages for herself and her co-workers. It should not affect wage-compression either, as the accuracy of the signal decreases in the lower-information levels, independently of how one reads the signal.

perceive them as the intention of the manager. In our experiment, we expect that not paying high-ability workers more than their co-workers should be more attributable to the competence of managers than to intentions. But if manager intentions mattered for our merit-pay hypothesis, the more a worker believes that the manager can identify the actual high-ability worker, the more likely that the worker should punish a violation of merit pay.[18] This is one reason we included the exogenous variation in information levels; another is that it allows us to study wage compression due to uncertainty about worker productivity (which relies on a comparison of the dispersion of wages across information levels).

4   Data

In this section, we report descriptive statistics of our data. We conducted six sessions at the University of California, Santa Barbara, with three sessions of 18 students and three sessions of 15 students, for a total of 99 participants. Participants were recruited through an email to the general university population. No one could participate in more than one session. The average payout was $19 per person, with a maximum of $30 and a minimum of $12. All sessions lasted less than 90 minutes.

We begin by examining the frequency of the combinations of wage offers to the two workers in each firm. Without uncertainty and given a concave worker-effort function and a linear revenue function, it is optimal for the manager to pay the high-ability worker a strictly higher wage. Table 3 shows manager wage assignments to the perceived high- and low-ability workers (Table 5 shows the wages received by the actual high- and low-ability workers); it excludes the no-information environment, since the designation of the perceived high-ability worker is arbitrary in this case.

In the perfect-, good-, and normal-information environments, it is always optimal for the manager to follow the guidance of the signal, even with uncertainty (as pointed out above). In fact, in 196 of the 258 wage-offer combinations (76%), managers offered the perceived high

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[18]However, we do not find any evidence for this, see section 5.4.

Table 3: Frequency of wage-offer combinations for *perceived* high and low ability workers

		Wage Perc. Low Ability						
		$ 1	$ 2	$ 3	$ 4	$ 5	$ 6	Total
Wage Perc. High Ability	$ 1	2	2	0	0	0	1	5
	$ 2	4	11	3	2	1	0	21
	$ 3	6	18	26	14	0	0	64
	$ 4	11	29	51	0	0	0	91
	$ 5	4	43	0	0	0	0	47
	$ 6	30	0	0	0	0	0	30
	Total	57	103	80	16	1	1	258

ability worker a higher wage, while in 23 cases (8.9%), managers assign a higher wage to the perceived lower-ability worker (we exclude the no-information treatment); thus, managers are more than eight times more likely to assign a higher wage to the high-ability worker than vice versa. Possible reasons for non-optimal wage assignments include having an arbitrary "hunch" concerning which worker actually has higher ability or due to some form of equity or fairness considerations. It could also be a mistake or a misunderstanding. For example, the two instances in the perfect-information treatment where the lower-ability worker was assigned a higher wage both happened in the first period, where such mistakes would be most common.

Whatever the reason, these cases are both infrequent and clearly related to the amount of uncertainty in the information environment. Table 4 shows in the first row the number of instances in which the manager assigned to the perceived low-ability worker a wage (w_L) that is higher than the wage assigned to the perceived high-ability worker (w_H) for each information environment. In the second row, we also observe that the frequency with which managers pay equal wages increases with uncertainty, which gives us an indication of wage compression. The third row indicates how often managers assign a higher wage to higher-ability workers.[19]

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[19]The observations in the perfect information environment only add up to 60 (66 for the other information levels). We had to eliminate six observations due to a small initial glitch in the computer program that led to a false signal in the perfect information environment for one manager in sessions 1, 2, and 4.

Table 4: Frequency of "non-merit" wages for perceived ability by information environment

	Perfect	Good	Normal	Poor	Random
$w_H < w_L$	0	5	6	12	8
$w_H = w_L$	2	3	11	23	29
$w_H > w_L$	58	58	49	31	29

While non-optimal wage assignments (based on perception) in Table 3 are rare, Table 5 shows that this (i.e., $w_H < w_L$) happens much more often for wage assignments in terms of the actual productivity rather than the perceived productivity: 26% of the time for all information environments, 27% excluding no information, and 31% excluding perfect information (the corresponding numbers for $w_H \leq w_L$ are 47%, 42%, and 56%, respectively). This is due to our uncertainty mechanism, which creates cases of an inept manager mistakenly assigning the high ability worker a lower wage, which is exactly what we would like to observe in order to statistically identify our merit-pay hypothesis.

Table 5: Frequency of wage-offer combinations for *actual* high- and low-ability workers

		Wage Act. Low Ability						
		$ 1	$ 2	$ 3	$ 4	$ 5	$ 6	Total
Wage Act. High Ability	$ 1	2	3	4	3	1	4	17
	$ 2	3	11	5	12	5	0	36
	$ 3	2	16	26	21	0	0	65
	$ 4	8	19	44	0	0	0	71
	$ 5	3	39	0	0	0	0	42
	$ 6	27	0	0	0	0	0	27
	Total	45	88	79	36	6	4	258

We see a decline in average wages as information decreases, from 3.26 in the perfect information environment, over 3.21 with good information, 3.11 with normal information, 2.81 with less information, to 2.83 with no information. Average wages do not decrease from the first to the second cycle (we had two cycles with the five different information environments), averages are 3.02 in the first cycle and 3.06 in the second. Average effort on

the other hand decreased slightly from 2.64 to 2.43.[20]

As table 6 shows, high-ability workers are paid more on average per period than are low-ability workers, 3.44 compared to 2.64. Average effort is also higher for high-ability than for low-ability workers, at 2.78 vs. 2.29. This does seem to track wages, as an inspection of the table below indicates. Indeed, in the regression analysis we do not find evidence to suggest that higher- and lower-ability workers respond differently to the same wages.

Table 6: Average Wage and Effort by Worker Type and Information

Information Level	1	2	3	4	5	Overall
Higher Ability Worker Mean Wage	4.75	3.83	3.17	2.70	2.88	3.44
Std. Err.	0.14	0.16	0.14	0.14	0.13	0.08
Higher Ability Worker Mean Effort	4.02	3.00	2.48	2.15	2.35	2.78
Std. Err.	0.16	0.19	0.17	0.17	0.19	0.09
Lower Ability Worker Mean Wage	1.77	2.59	3.05	2.92	2.77	2.64
Std. Err.	0.10	0.15	0.12	0.13	0.15	0.06
Lower Ability Worker Mean Effort	1.88	2.35	2.53	2.44	2.21	2.29
Std. Err.	0.16	0.21	0.20	0.19	0.17	0.09

Information level 1 is the perfect, 2 is the good, 3 is the normal, 4 is the poor, and 5 is the no-information environment.

Given the heterogeneity observed for effort across workers (e.g., five out of 66 workers provided the minimum effort in every period while one worker provided average effort that was more than 90% of the maximum possible), we generally include worker-fixed effects in our regression analysis below.

5 Merit-Pay Hypothesis

In this section, we test our merit-pay hypothesis, formalized below:

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[20]A simple regression of wages on information indeed confirms that there is a statistically significant decrease in wages with information. A t-test shows no significant difference in wages across cycles, whereas average effort is significantly lower in the second cycle, at 10% with a two-sided and 5% with a one-sided test.

Hypothesis 1 *High-ability workers who believe in merit pay will ceteris paribus provide a lower level of effort when paid no more than low-ability workers. Low-ability workers, when paid no more than high-ability workers, will ceteris paribus not change their effort level.*

Since one would not expect workers who do not believe in merit pay to have their effort levels affected by relative wages (and indeed they do not), we restrict the hypothesis to this subset of workers. Nevertheless, section 5.3 shows that this hypothesis holds for the full population of high-ability workers; similarly, we also show that it holds for people who believe in merit pay when a high-ability worker is paid strictly less than the paired low-ability worker.

5.1   Baseline Result

We regress effort on wages (linearly in regression 1, and with a dummy for every wage level in regressions 2, 3, and 4) and the dummy variable *Ifless*High*Merit* (which is one if the person received a wage lower than or equal to the coworker's, has high ability, and answered the merit-pay question positively), controlling for individual fixed effects.[21] In regressions 3 and 4, we add the dummy variable *Ifless*Low* (which is one if the person received a wage lower than or equal to the coworker's and has low ability); in regression 4, we add the dummy variable *Ifless*High*NMerit* (which is one if the person received a wage lower than or equal to that of the coworker, is high ability, and answered the merit-pay question negatively).

As has been found in many other experimental studies, there is a strong and significant effect of workers' wages on the effort they supply. The coefficient for *Ifess*High*Merit* is highly significant in all four regressions and large: violating merit pay reduces effort by 0.59 to 0.79 points, while the average effort was 2.53 and the minimum possible is 1. Alternatively, according to regression (1) a violation of merit pay is equivalent to reducing the wage by 1.46, which is quite substantial, given that the mean wage was 3.04 and the minimum is 1.

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[21]This implies that the characteristics "High" and "Merit" are redundant, since they are included in the individual fixed effects. All our regressions also include a constant, which we do not report.

Table 7: Merit pay and effort

	Regression 1	Regression 2	Regression 3	Regression 4
Linear Wage	0.54***			
	0.04			
Wage = 2		0.26*	0.26*	0.28**
		0.14	0.14	0.14
Wage = 3		1.02***	1.02***	1.03***
		0.13	0.14	0.14
Wage = 4		1.64***	1.66***	1.78***
		0.17	0.20	0.21
Wage = 5		2.33***	2.34***	2.46***
		0.23	0.25	0.25
Wage = 6		2.32***	2.34***	2.45***
		0.25	0.27	0.28
Ifless*High*Merit	-0.79***	-0.70***	-0.68***	-0.59***
	0.15	0.16	0.17	0.18
Ifless*Low			0.02	0.11
			0.19	0.20
Ifless*High*Nmerit				0.37
				0.28
R^2	0.66	0.67	0.67	0.67

The dependent variable is worker effort. Robust standard errors below the estimates. The asterisks (1, 2, or 3) refer to results significant at the 10%, 5%, and 1% level, respectively. There are 648 observations. All regressions include dummy variables for each individual and a constant.

At the same time, the coefficient for *Ifess*Low* is not significantly different from zero.[22]

We focus on high-ability workers who answered the merit-pay question positively, since if one does not believe that higher-ability workers deserve a higher wage, then there is no reason why one should react to not receiving a higher wage than the lower-ability co-

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[22]One might think that social identity considerations are driving these results instead of (or jointly with) our merit-pay hypothesis. There could evolve an ingroup/outgroup thinking stemming from our mechanism which signals the higher-ability worker as the one who has the most answers in common with the manager. We believe this explanation does not hold water in our experiment for the following reasons: First, managers pay higher wages to actual than perceived high-ability workers, as shown by wage compression across information levels in section 6. If social-identity considerations were driving the results, we would have to observe the highest wage-differences in the normal-information environment, then decreasing towards more and less information. Second, and maybe more importantly, the workers have no information whatsoever on what basis managers assign wages and whether they are in the ingroup or outgroup.

worker. Indeed, as apparent from regression (4), the coefficient for *Ifless*High*Nmerit* is not significantly different from zero. Moreover, as we show below in section 5.3, the merit-pay hypothesis still holds for all high-ability workers grouped together.

5.2 Robustness Checks

We have conducted several robustness checks which are summarized in table 8.[23] In regression (i) we use a different definition of a violation of merit-pay, which is when the high-ability worker receives strictly less than the co-worker (i.e., here we use $w_H < w_L$ instead of $w_H \leq w_L$). Formally, our definition of *Ifless* is now a strictly negative relative wage and also applies to *Ifless*Low*. The coefficient on *Ifless*High*Merit* is somewhat smaller than before, but still significant at the 1%-level. The coefficient for *Ifless*Low* is tiny and insignificant. In regression (ii) we employ a different definition of effort, in terms of cost rather than the effort level. Since costs are lower than the effort levels, the coefficient for *Ifless*High*Merit* is of course correspondingly smaller but remains highly significant.

Including time-period dummies in regression (iii) or information and cycle dummies in regression (iv) leaves results virtually unchanged as compared to the baseline. We have also used robust clustered errors in regression (v)-(vii), since not only the means, but also the error terms might be correlated for each worker.[24] We have also combined robust clustered errors and time-period dummies in regression (vi) or information and cycle dummies in regression (vii); the coefficient for *Ifless*High*Merit* retains about the same magnitude and remains always significant at least at the 5% level, whereas the coefficient for *Ifless*Low* remains insignificant.

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[23]All results in the table are from regressions with wage dummies, which are not reported, but remain roughly the same as in table 7. We have also used linear wages, which reinforced results in every specification, but do not report them here. Moreover, leaving out the dummy variable *Ifless*High*Nmerit* does not change results much.

[24]The number of clusters should not be too low, as Angrist and Pischke (2008) point out. They refer – only somewhat in jest – to 42 as the minimum number of clusters, which is why we do not cluster errors around sessions, time periods, or information treatments.

Table 8: Robustness checks

Regression	Ifless*High*Merit	Ifless*Low
(i) Strictly less	-0.40***	0.01
	0.15	0.13
(ii) Effort definition	-0.22***	-0.02
	0.06	0.07
(iii) Period dummies	-0.60***	-0.08
	0.18	0.19
(iv) Info & cycle dummies	-0.60***	-0.09
	0.17	0.19
(v) Clustered errors	-0.68***	0.02
	0.24	0.24
(vi) Clusters and period	-0.60**	-0.08
	0.25	0.24
(vii) Clusters and info & cycle	-0.60**	-0.09
	0.24	0.24

The dependent variable is worker effort. Robust standard errors below the estimates; where applicable, clustered around 66 individuals. The asterisks (1, 2, or 3) refer to results significant at the 10%, 5%, and 1% level, respectively. There are 648 observations. All regressions include wage dummies and dummy variables for each individual.

5.3 Size of Effects

One might wonder, even if high-ability workers who believe in merit pay reduce their effort when merit-pay is violated, does it matter for the overall provision of effort? We note that 25 out of 33 high-ability workers answered the merit-pay question positively.[25] Moreover, when we estimate the effect of a violation of merit pay on the entire population of high-ability workers, we still find a strong and significant (albeit smaller) effect. We regress effort on wages – linearly in regressions (I) and (III) and with dummies in regressions (II) and (IV) – and the dummy variable *Ifless*High*, controlling for individual fixed effects. In regressions (III) and (IV) we also include the dummy *Ifless*Low*. The results are shown in table 9.

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[25]It is interesting to note that this was also the case for 25 of the 33 low-ability workers. This suggests that responses were unaffected by the results during the gift-exchange game. We preferred to ask this question at the end of the experiment rather than at the beginning in order to avoid affecting behavior during the experiment.

Table 9: Effects of merit-pay violations for all workers

Regression	Ifless*High	Ifless*Low
(I) Linear wages, Ifless*High only	-0.55***	
	0.14	
(II) Wage dummies, Ifless*High only	-0.45***	
	0.15	
(III) Linear wages, both Ifless*High & Ifless*Low	-0.59***	-0.11
	0.14	0.18
(IV) Wage dummies, both Ifless*High & Ifless*Low	-0.40**	0.09
	0.17	0.20

The dependent variable is worker effort. Robust standard errors below the estimates. The asterisks (1, 2, or 3) refer to results significant at the 10%, 5%, and 1% level, respectively. There are 648 observations. All regressions include dummy variables for each individual.

5.4 Manager Intentions and Responses to Merit Pay Violations

Finally, we wish to address the question of whether we can link responses to violations of merit pay to the intentions of the manager. We test whether violations of merit pay are "punished" differently depending on the information the manager had. If managers' intentions matter, then the reduction in effort should be strongest when the manager has the most information. In Table 10, we report the results of regressions of effort on wages - linearly in regression (a) and with dummies in regression (b) - and the dummy variables *Ifless*High*Merit*Info* for each (non-perfect) level of information, controlling for individual fixed effects.[26] The coefficients are large and negative and have roughly the same magnitude for each of the information levels. We fail to reject the hypothesis that all the coefficients are equal to each other (the corresponding joint F-tests in regressions (a) and (b) have p-values of 0.995 and 0.989 respectively). This suggests that the degree to which high-ability workers reduce effort as a consequence of the violation of merit pay does not vary across information conditions.

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[26]We exclude the perfect-information treatment (*Info1*) from the regression, as there were only two observations of violations of merit pay, both in the first period of a session. Given the very limited data, the corresponding coefficient is naturally not significantly different from zero.

Table 10: Manager intentions and punishment of merit-pay violations

	Regression (a) linear wages	Regression (b) wage dummies
Ifless*High*Merit*Info2	-0.80***	-0.71***
	0.27	0.26
Ifless*High*Merit*Info3	-0.79***	-0.68***
	0.19	0.20
Ifless*High*Merit*Info4	-0.84***	-0.75***
	0.19	0.20
Ifless*High*Merit*Info5	-0.80***	-0.70***
	0.23	0.24

The dependent variable is worker effort. Robust standard errors below the estimates. The asterisks (1, 2, or 3) refer to results significant at the 10%, 5%, and 1% level, respectively. There are 648 observations. All regressions include dummy variables for each individual. Information level 2 is the good, 3 is the normal, 4 is the poor, and 5 is the no-information environment.

6 Wage Compression

In this section, we first present a simple model of wage compression due to uncertainty about worker ability, independently of fairness considerations. We then test whether the degree of uncertainty does indeed result in wage compression.

6.1 A Simple Model

Our formal hypothesis regarding wage compression is:

Hypothesis 2 *The higher the degree of uncertainty about worker ability, the higher the wage compression, i.e. the lower will be the difference between the wages assigned to the two workers in a firm.*

We can derive this hypothesis by using a simple model in which managers aim to maximize expected profits, given some beliefs about how workers respond to wage payments with effort. We assume that these beliefs are of the following nature: the effort function $e(w)$ is increasing and strictly concave in wages w, and the derivative tends to infinity as w tends to zero. The concavity assumption seems to be in line with results reported in previous

studies on workers providing effort and the fact that managers assign wages to both the more and less productive workers. With a linear production function, only strictly concave effort functions give a reason to pay both workers. The assumption of $\lim_{w \to 0} e(w)' = \infty$ simply assures an interior solution. Uncertainty about worker types provides an incentive for wage compression. The reason is that managers assign with a certain probability the higher wage to the less-skilled worker. The expected productivity of the perceived high (low) ability worker is thus lower (higher) when uncertainty is higher, so managers compress wages compared to the full-information benchmark.

We exclude the possibility of wage compression due to fairness concerns of workers or due to merit-pay considerations for two reasons. First, in our empirical analysis we can isolate wage compression from fairness motives by managers or workers. Second, merit-pay considerations by themselves are not enough to result in wage compression; only in combination with uncertainty about true worker ability do they affect wage compression. If we included a term that the high-ability worker is providing less effort for which she receives a lower wage than her lower-ability colleague, then it strengthens results in this simple model.

Assuming risk-neutrality for managers (risk-aversion would reinforce the effect), the expected payoff is:

$$\mathbb{E}\pi = p\{\theta_H e(w_H) + \theta_L e(w_L)\} + (1-p)\{\theta_H e(w_L) + \theta_L e(w_H)\} - w_L - w_H \tag{1}$$

where $p > 0.5$ is the probability the manager perceives correctly who the more productive worker is and θ_i is the productivity of a worker of type $i \in \{L, H\}$. w_H is the wage assigned to the perceived high-ability worker and w_L is the wage assigned to the perceived low-ability worker. Taking derivatives with respect to these wages yields:

$$p\theta_H e'(w_H) + (1-p)\theta_L e'(w_H) = 1 \tag{2}$$

$$p\theta_L e'(w_L) + (1-p)\theta_H e'(w_L) = 1. \tag{3}$$

This has two implications. First, wages assigned to more productive workers are higher than for their less productive colleagues, $w_H > w_L$.[27] Second, the difference between w_H and w_L is strictly decreasing in uncertainty about the true type of the worker (this simply follows by Jensen's inequality). When there is complete uncertainty, i.e. $p = 1 - p$, the wage assignments are completely random guesses and $w_H = w_L$. To show wage compression, we take the total derivative of the first-order conditions and rearrange (this obviously only holds for $p > 0.5$):[28]

$$\frac{dw_H}{dp} = \frac{(\theta_H - \theta_L)e'(w_H)}{-e''(w_H)(p\theta_H + (1-p)\theta_L)} > 0 \tag{4}$$

$$\frac{dw_L}{dp} = \frac{(\theta_L - \theta_H)e'(w_L)}{-e''(w_L)(p\theta_L + (1-p)\theta_H)} < 0. \tag{5}$$

The numerator is positive in the first case and negative in the second case, since $e'(w) > 0$ and $\theta_H > \theta_L$. The denominator is positive in both cases, as $e''(w) < 0$ by concavity. The difference between w_H and w_L is thus a monotonically-increasing function of p which is zero when $p = 1 - p = 0.5$.

6.2 Empirical Test of Wage Compression

We can identify this hypothesis independently of equity motives, since such considerations should be separate from the information condition. Thus, if we can observe a higher degree of wage compression in periods with less information compared to those with more information, then the wage compression due to equity considerations should be differenced out. As a measure of wage disparity we use the absolute value of the difference between the two wages the manager assigned. We regress this on a linear term for information in regression 1M and a dummy for each information environment in regressions 2M to 4M. We also include either some control variables (in regressions 1M to 3M) or fixed effects for the manager (in

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[27]We get this result by combining equations (2) and (3), and seeing that $e'(w_L) > e'(w_H)$ for a concave effort function.

[28]Any $p < 0.5$ is of course equivalent to assigning the higher wage to the worker who appears to be of lower skill – we can simply redefine the probability of getting it right then as $\hat{p} = 1 - p$.

regression 4M).

In Table 11 we observe that there is a strong wage-compression effect. In regression 1M the linear information term is negative, large, and highly significant. In regressions 2M to 4M the dummies for each information environment compared to the first with perfect information are also negative, large, and highly significant; moreover, the estimated coefficients become larger in absolute terms with increased uncertainty.[29] Including manager fixed effects in regression 4M does not change the magnitude or significance of the estimates much (the goodness of fit increases, of course).

For the control variables in regressions 1M to 3M, we thought that the wage disparity should positively depend on the confidence a manager has in his ability to discern the high- and low-ability workers. At the end of the aptitude test in the beginning of the experiment, we asked participants how many questions they think they answered correctly. This is the variable Pre-estimate. Our prior is confirmed in the sense that the estimate for it is positive and significant.[30] We have also included the actual test scores of the managers (which were not known to them); we did not have any prior on this and the coefficient is insignificant.[31]

The variable *Rel. wage matters* takes a value of 0, 1, or 2, depending on what the managers answered to the following question in the questionnaire at the end of the experiment: "Do you think that workers respond to their co-workers wages?" The answer no corresponds

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[29] In regression 2M, the hypotheses that coefficients for information levels 1 and 2, and 2 and 3 are equal to each other are both rejected at the 1% level; for information levels 3 and 4, the hypothesis is rejected at the 10% level, while we fail to reject the hypothesis that the coefficients for information levels 4 and 5 are equal.

[30] A potential problem is that the pre-estimate could be correlated with other factors that would lead the manager to pay more unequal wages, rather than simply reflecting the perceived ability to better discern high- and low-ability workers.

[31] However, when we run regressions on how well the test score predicts mistakenly assigning the "wrong" wage (i.e. that the wage assigned to the perceived high-ability work does not correspond to the wage received by the actual high-ability worker), then the coefficient is negative, large, and highly significant at the 1% level. It holds for a linear probability model, a probit, and logit, including controls for the information level and obviously leaving out the perfect information setting. Moreover, while the testscore coefficient was positive in a regression on managers' profits, it was not statistically significant; but when we regressed manager profits on test scores interacting with the information level (plus controls for the information level), the interaction term for test scores in the normal information environment was positive, large, and highly significant at the 1% level, while being insignificant at the other information levels. Both results seem to confirm our idea of inept managers.

Table 11: Wage compression under uncertainty of worker ability

	Regression 1M	Regression 2M	Regression 3M	Regression 4M
Information	-0.51***			
	0.06			
Good Information		-0.70***	-0.68**	-0.74***
		0.26	0.27	0.23
Normal Information		-1.49***	-1.45***	-1.53***
		0.25	0.28	0.22
Poor Information		-1.84***	-1.78***	-1.88***
		0.26	0.34	0.25
No Information		-1.99***	-1.91***	-2.03***
		0.27	0.35	0.25
Preestimate	0.08***	0.08***	0.08***	
	0.02	0.02	0.02	
Test score	-0.05	-0.05	-0.05	
	0.03	0.03	0.03	
Rel. wage matters (linear)	0.02			
	0.13			
Rel. wage matters (dummy)		0.05	0.16	
		0.16	0.40	
Rel. wage matters*Info			-0.04	
			0.12	
Fixed Effects	No	No	No	Yes
R^2	0.24	0.26	0.26	0.43

The dependent variable is the absolute value of the wage difference. 324 observations, robust standard errors below the estimates. The asterisks (1, 2, or 3) refer to results significant at the 10%, 5%, and 1% level, respectively.

to a 0, a little is 1, and a lot is 2; there were 1, 13, and 19 observations in these respective categories. While we had anticipated a negative coefficient, it turns out to be insignificant. In regression 1M we use this regressor linearly, while regressions 2M and 3M contain a dummy for whether or not the response was 2 (matters a lot).[32] In regression 3M we have also included an interaction term of this dummy with the information environment, *Rel. wage matters*Info*, since equality concerns could be dependent on the managers' intentions and thus the information available. This term is also insignificant. It thus appears that concerns about relative wages did not matter for wage compression, whereas the ability to correctly identify the high-ability worker does matter: this lends support to the notion that wage compression is not driven by equality concerns in our experiment.[33]

7 Conclusion

We explore wage setting and effort choices in a multi-worker setting when there is heterogeneity in worker productivity and managers' perception of this productivity is imperfect. Worker ability is assigned via an aptitude test and, in an innovative design, manager uncertainty concerning this ability is related to the manager's own test performance.

We consider asymmetric effects of wage comparisons on worker effort. Our merit-pay hypothesis asserts that a worker's ability level (and the corresponding productivity difference) is critical in anticipating an effort response to coworker wages: A high-ability worker who believes in merit pay will be disgruntled if paid a lower wage and will punish the manager who assigned her the wage by withholding effort, whereas low-ability workers who are paid a lower wage will not respond negatively. In previous experiments where the high-ability

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[32]We have thus combined the answers 0 (that it does not matter) and 1 (that it matters a little). Including a separate dummy for the one manager who answered 0 does not change the results.

[33]As further robustness checks for all specifications, we have also used errors clustered on managers, which were virtually the same as robust errors. When we include manager fixed effects, we cannot identify the clusters correctly, though. Including a dummy variable for the cycle did not change the results either. The variable *Q: Merit* takes the value 1 when the manager positively answered the question if only high-ability workers respond negatively when paid less than their co-workers, and 0 otherwise. Adding this and any subset of control variables did not change the main coefficients of interest in any substantial way: All of the numerous specifications that we ran yielded approximately the same result for wage compression.

worker is almost always paid more than the low-ability worker, it is difficult to test for this effect.

We create a novel mechanism that induces an endogenous degree of uncertainty towards the true ability level of workers, thereby generating a relatively large number of observations that violate merit pay. The degree of uncertainty changes from period to period, allowing us to explore a related issue: If relative wages do not matter, as the previous results of the experimental literature suggest, then why should firms engage in wage compression? We expected (and find) that managers would assign more equal wages with increased uncertainty about workers' true ability.

The merit hypothesis is strongly supported by our experimental data. Since the proportion of high-ability workers who believe in merit pay was high and the effect so strong, violations of merit pay were still significant even for the entire group of high-ability workers. Numerous robustness checks confirm the validity of our result. The managers' intentions did not seem to play a role for the responses to violations of merit pay.

To the best of our knowledge, we are the first to find experimental evidence of optimal wage compression due to uncertainty. The higher the uncertainty concerning workers' true ability, the more equal the wages that managers assign on average to their high- and low-ability workers. In addition, we find that the more questions the manager thinks he answered correctly, the higher the inequality of wages he assigns. This is consistent with our hypothesis, since answering more questions correctly reduces the uncertainty regarding the true type of a worker. Moreover, managers' evaluations of whether relative pay mattered for the provision of workers effort was insignificant for wage compression, lending credence to our assumption that this wage compression is independent of concerns for inequality.

We view uncertainty about worker ability as a realistic and important part of management's leadership role. Who should be paid how much and who should be promoted? It is often the case that it is difficult for a superior to precisely assess the ability and productivity of a worker. Does our experiment shed light on this real-world problem? We believe that

the basic mechanism of hedging bets against paying unidentified high-performers a low wage should be the same. Indeed, if students are able to consistently recognize the problem and assign wages accordingly, then actual managers should do so *a forteriori*.

Our paper establishes that: 1) when higher productivity is the result of ability rather than random assignment, a high-productivity worker typically reduces her output when she receives a lower wage than a less productive worker, and 2) that wage compression is more common with increasing uncertainty concerning which is the more productive worker. While these are new results, we have barely scratched the surface and invite other researchers to join us in exploring this important area.

References

ABELER, J., S. ALTMANN, S. KUBE, AND M. WIBRAL (2010): "Gift Exchange and Workers' Fairness Concerns: When Equality is Unfair," *Journal of the European Economic Association*, 8, 12991324.

ADAMS, J. (1966): "Inequity in social exchange," *Advances in experimental social psychology*, 2, 267–299.

AGELL, J., AND H. BENNMARKER (2007): "Wage incentives and wage rigidity: A representative view from within," *Labour Economics*, 14(3), 347–369.

AKERLOF, G., AND J. YELLEN (1990): "The fair wage-effort hypothesis and unemployment," *The Quarterly Journal of Economics*, 105(2), 255–283.

ANGRIST, J. D., AND J.-S. PISCHKE (2008): *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton University Press.

BANDIERA, O., I. BARANKAY, AND I. RASUL (2005): "Social preferences and the response to incentives: Evidence from personnel data," *The Quarterly Journal of Economics*, 120(3), 917–962.

BARDSLEY, N., AND R. SAUSGRUBER (2005): "Conformity and reciprocity in public good provision," *Journal of Economic Psychology*, 26(5), 664–681.

BARTLING, B., AND F. VON SIEMENS (2011): "Wage inequality and team production: An experimental analysis," *Journal of Economic Psychology*, 32(1), 1–16.

BEKMAN, E., J. BOUND, AND S. MACHIN (1998): "Implications of Skill-Biased Technological Change: International Evidence," *The Quarterly Journal of Economics*, 113(4), 1245–1279.

BEWLEY, T. F. (1999): *Why Wages Dont Fall During a Recession*. Harvard University Press.

BOLTON, G., AND A. OCKENFELS (2000): "ERC: A theory of equity, reciprocity, and competition," *American Economic Review*, pp. 166–193.

BOLTON, G., AND P. WERNER (2012): "Are efficiency wages equality wages? Exogenously induced fairness norms in working environments," Working Paper Series in Economics 56, University of Cologne, Department of Economics.

BROWN, C. (2001): "Review of" Meritocracy and Economic Inequality," Edited by Kenneth Arrow, Samuel Bowles, and Steven Durlaf," *Journal of Economic Literature*, 39(1), 93–104.

CAMPBELL III, C., AND K. KAMLANI (1997): "The reasons for wage rigidity: Evidence from a survey of firms," *The Quarterly Journal of Economics*, 112(3), 759–789.

CAPPELEN, A. W., A. D. HOLE, E. Ø. SØRENSEN, AND B. TUNGODDEN (2007): "The Pluralism of Fairness Ideals: An Experimental Approach," *American Economic Review*, 97(3), 818–827.

CAPPELEN, A. W., E. Ø. SØRENSEN, AND B. TUNGODDEN (2010): "Responsibility for what? Fairness and individual responsibility," *European Economic Review*, 54(3), 429 – 441.

CARD, D., A. MAS, E. MORETTI, AND E. SAEZ (2012): "Inequality at Work: The Effect of Peer Salaries on Job Satisfaction," *American Economic Review*, 102(6), 2981–3003.

CARPENTER, J. (2004): "When in Rome: Conformity and the provision of public goods," *Journal of Socio-Economics*, 33(4), 395–408.

CARPENTER, J., AND E. SEKI (2006): "Competitive Work Environments and Social Preferences: Field Experimental Evidence from a Japanese Fishing Community," *The BE Journal of Economic Analysis & Policy*, 5(2), 2.

CHARNESS, G. (2004): "Attribution and reciprocity in an experimental labor market," *Journal of Labor Economics*, 22(3), 665–688.

CHARNESS, G., AND P. KUHN (2005): "Pay Inequality, Pay Secrecy, and Effort: Theory and Evidence," NBER Working Papers 11786, National Bureau of Economic Research, Inc.

CHARNESS, G., AND P. KUHN (2007): "Does pay inequality affect worker effort? Experimental evidence," *Journal of Labor Economics*, 25(4), 693–723.

CHARNESS, G., AND D. LEVINE (2007): "Intention and stochastic outcomes: An experimental study," *The Economic Journal*, 117(522), 1051–1072.

CHARNESS, G., AND M. RABIN (2002): "Understanding social preferences with simple tests," *The Quarterly Journal of Economics*, 117(3), 817–869.

CLARK, A., AND A. OSWALD (1996): "Satisfaction and comparison income," *Journal of Public Economics*, 61(3), 359–381.

CLARK, A., AND C. SENIK (2010): "Who compares to whom? The anatomy of income comparisons in europe," *The Economic Journal*, 120(544), 573–594.

COWHERD, D., AND D. LEVINE (1992): "Product quality and pay equity between lower-level employees and top management: An investigation of distributive justice theory," *Administrative Science Quarterly*, pp. 302–320.

DEVEAU, D. (2013): "Wage gaps destroy employee morale, productivity," Financial Post, accessed 09/01/2014.

DUFWENBERG, M., AND G. KIRCHSTEIGER (2004): "A theory of sequential reciprocity," *Games and Economic Behavior*, 47(2), 268–298.

ERIKSSON, T. (1999): "Executive Compensation and Tournament Theory: Empirical Tests on Danish Data," *Journal of Labor Economics*, 17(2), 262–80.

FALK, A., AND M. KNELL (2004): "Choosing the Joneses: Endogenous goals and reference standards," *The Scandinavian Journal of Economics*, 106(3), 417–435.

FEHR, E., E. KIRCHLER, A. WEICHBOLD, AND S. GÄCHTER (1998): "When social norms overpower competition: Gift exchange in experimental labor markets," *Journal of Labor Economics*, 16(2), 324.

FEHR, E., G. KIRCHSTEIGER, AND A. RIEDL (1993): "Does fairness prevent market clearing? An experimental investigation," *The Quarterly Journal of Economics*, 108(2), 437–459.

FEHR, E., AND K. SCHMIDT (1999): "A theory of fairness, competition, and cooperation," *The Quarterly Journal of Economics*, 114(3), 817–868.

FRANK, R. (1984): "Are workers paid their marginal products?," *The American Economic Review*, 74(4), 549–571.

GÄCHTER, S., N.-D., AND M. SEFTON (2012): "The Impact of Social Comparisons on Reciprocity," *The Scandinavian Journal of Economics*, 114, 13461367.

GÄCHTER, S., AND C. THÖNI (2010): "Social comparison and performance: Experimental evidence on the fair wage-effort hypothesis," *Journal of Economic Behavior & Organization*, 76(3), 531–543.

GANTNER, A., W. GÜTH, AND M. KONIGSTEIN (2001): "Equitable choices in bargaining games with joint production," *Journal of Economic Behavior & Organization*, 46(2), 209–225.

GILL, D., AND R. STONE (2010): "Fairness and desert in tournaments," *Games and Economic Behavior*, 69(2), 346–364.

GOERG, S. J., S. KUBE, AND R. ZULTAN (2010): "Treating Equals Unequally: Incentives in Teams, Workers' Motivation, and Production Technology," *Journal of Labor Economics*, 28(4), 747–772.

GÜTH, W., M. KÖNIGSTEIN, J. KOVÁCS, AND E. ZALA-MEZÕ (2001): "Fairness within firms: The case of one principal and multiple agents," *Schmalenbach Business Review*, 53(2), 82–101.

HARRIS, M., AND B. HOLMSTROM (1982): "A theory of wage dynamics," *The Review of Economic Studies*, 49(3), 315–333.

HIBBS JR, D., AND H. LOCKING (2000): "Wage dispersion and productive efficiency: Evidence for Sweden," *Journal of Labor Economics*, 18(4), 755–782.

HOLMSTROM, B. (1982): "Moral hazard in teams," *The Bell Journal of Economics*, pp. 324–340.

KAY, A. (2013): "At Work: Employees' biggest frustration? 'Idiot' bosses," USA Today, accessed 09/01/2014.

KNEZ, M., AND C. CAMERER (1995): "Outside options and social comparison in three-player ultimatum game experiments," *Games and Economic Behavior*, 10(1), 65–94.

KONOW, J. (2000): "Fair shares: Accountability and cognitive dissonance in allocation decisions," *The American Economic Review*, 90(4), 1072–1091.

KRUSELL, P., L. E. OHANIAN, J.-V. ROS-RULL, AND G. L. VIOLANTE (2000): "Capital-Skill Complementarity and Inequality: A Macroeconomic Analysis," *Econometrica*, 68(5), 1029–1054.

KU, H., AND T. SALMON (2012): "Procedural Fairness and the Tolerance for Income Inequality," Discussion paper, Florida State University.

LAZEAR, E., AND S. ROSEN (1981): "Rank-Order Tournaments as Optimum Labor Contracts," *The Journal of Political Economy*, 89(5), 841–864.

LEMIEUX, T., W. B. MACLEOD, AND D. PARENT (2009): "Performance Pay and Wage Inequality," *The Quarterly Journal of Economics*, 124(1), 1–49.

LEONARD, J. (1989): "Executive pay and firm performance," *Indus. & Lab. Rel. Rev. 13-S*, 43.

LOEWENSTEIN, G., L. THOMPSON, AND M. BAZERMAN (1989): "Social utility and decision making in interpersonal contexts.," *Journal of Personality and Social psychology*, 57(3), 426.

MAIN, B., C. O'REILLY III, AND J. WADE (1993): "Top executive pay: Tournament or teamwork?," *Journal of Labor Economics*, pp. 606–628.

MARTINS, P. (2008): "Dispersion in wage premiums and firm performance," *Economics Letters*, 101(1), 63–65.

MAS, A. (2006): "Pay, Reference Points, and Police Performance," *The Quarterly Journal of Economics*, 121(3), 783–821.

MAXIMIANO, S., R. SLOOF, AND J. SONNEMANS (2007): "Gift Exchange in a Multi-Worker Firm," *The Economic Journal*, 117(522), 1025–1050.

MILGROM, P., AND J. ROBERTS (1992): *Economics, Organization and Management*, vol. 7. Prentice-Hall Englewood Cliffs, NJ.

NOSENZO, D. (2010): "The impact of pay comparisons on effort behavior," Discussion paper, The Centre for Decision Research and Experimental Economics, School of Economics, University of Nottingham.

PFEFFER, J., AND N. LANGTON (1993): "The effect of wage dispersion on satisfaction, productivity, and working collaboratively: Evidence from college and university faculty," *Administrative Science Quarterly*, pp. 382–407.

RABIN, M. (1993): "Incorporating fairness into game theory and economics," *The American Economic Review*, pp. 1281–1302.

RIVAS, F. (2009): "Wage dispersion and workers effort," *Economics Bulletin*, 29(2), 788–794.

WINTER, E. (2004): "Incentives and discrimination," *The American Economic Review*, 94(3), 764–773.

WINTER-EBMER, R., AND J. ZWEIMÜLLER (1999): "Intra-firm wage dispersion and firm performance," *Kyklos*, 52(4), 555–572.

WOURIO, J. (2011): "Promoting employees: how to get it right," Microsoft Business, accessed 09/01/2014.

A   Experimental Instructions, Aptitude Test, and Procedure

A.1   Instructions for all participants

Preparation

I) Designating Managers and Workers: 1/3 of the participants will be Managers and 2/3 will be Workers, by random drawings. Your position will be the same for the rest of the experiment.

II) Aptitude Test: Everyone takes a 20 question Aptitude Test, which will affect your earnings. For the Workers, the top 50 percent will be classified as "Higher Ability" and the lower 50 percent will be classified as "Lower Ability." You will see your type and this will not change throughout the experiment. Managers are not told their results.

Managers' Comprehension Quiz: To make sure you understand the instructions fully, please read the Manager Instructions Review and answer the questions.

The game will consist of 10 rounds. This is the procedure for each round:

1. Form a 3-person Firm:
A Manager is randomly matched with one actual Higher Ability Worker and one actual Lower Ability Worker. The actual Higher Ability Worker generates twice as much money for the manager as the actual Lower Ability worker for the same effort. The composition of firms changes every round. Pairings are anonymous and random.

2. Manager assigns wages:
   The Manager is uncertain who the actual Higher and Lower Ability Worker is. Each round, the manager assigns wages to the perceived Higher and Lower Ability Worker. The perceived Higher-Ability Worker is the one who has more answers in common with the Manager.

   The better the Manager scores on his Aptitude test, better the chances his perceived matches his actual Higher Ability worker. In addition, from round to round, we will change the accuracy of all Managers' guesses by adjusting their scores either up by 3 points or down by 3 points. There will also be rounds with perfect accuracy, where managers know exactly who the Higher-Ability Worker is, and no information, where managers are given random guesses.

   Each round, the manager has seven lab dollars TOTAL to spend on wages of both workers. The minimum wage is one lab dollar. The manager keeps money not assigned to workers.

3. Workers choose their effort:
   Workers each learn their assigned wages, their own as well their coworker's. Then they choose how much effort to provide, on a scale from one to six, at these costs:

Effort Level	1	2	3	4	5	6
Cost	$0.10	$0.30	$0.60	$1.00	$1.50	$2.10

   Whatever effort level any Worker chooses, the Manager will not be able to learn about Workers' actual ability levels.

4. Managers paid based on workers' effort:
   The firm generates revenues according to ability and effort. Each unit of effort from the actual Higher Ability Worker generates twice as much revenue as effort from the Lower Ability Worker. To reiterate: the payoff depends on the actual Ability level of the Worker and not on the level perceived by the Manager.

Effort Level	1	2	3	4	5	6
Higher Ability Worker Output	$3.00	$6.00	$9.00	$12.00	$15.00	$18.00
Lower Ability Worker Output	$1.50	$3.00	$4.50	$6.00	$7.50	$9.00

Earnings accumulate over the course of the session. You will be paid privately and in cash with payments rounded to the next dollar. Workers are paid one dollar for every two lab-dollars. Managers are paid 1 dollar for every 5 lab-dollars. This is in addition to the five dollars you receive as a show-up fee.

   Also, PLEASE DO NOT TALK DURING THE EXPERIMENT.

A.2 Manager Instructions Review

To create a firm, each Manager is randomly matched with a Higher Ability Worker and a Lower Ability Worker. The composition of firms changes each period.

Workers know each other's actual ability type. The Manager is uncertain of the actual ability of each worker. The Manager will only be told the perceived higher and lower ability worker. This perception depends on his answers to the aptitude test. The worker who had more answers in common with the Manager will be the perceived high ability worker.

To understand it, here are some examples:

Example1: Here are the answers to 3 questions:

Worker1 (High Ability) Answers: T, T, F

Worker2 (Low Ability) Answers: T, F, T

Manager Answers : F, T, F

Question1: Which answers did worker 2 have in common with the Manager?

Question2: How many answers did worker 1 share with the Manager?

Question3: Who is the perceived high-ability worker?

Example2:

Worker1 (High Ability) Answers: T, T, T

Worker2 (Low Ability) Answers: T, F, T

Manager Answers: F, F, T

Question4: Which Worker shares more answers with the Manager?

Question5: Who is the perceived and the actual high ability worker?

Answers to questions on examples:

Question1: Worker 2 had no answers in common with the Manager.

Question2: Worker 1 shared 2 answers with the Manager.

Question3: Worker 1 is thus the perceived high-ability worker.

Question4: Worker 1 had one answer in common with the Manager and Worker 2 had 2 in common with the Manager. Worker 2 thus shares more answers with the Manager.

Question5: Worker 1 is the actual high-ability worker and Worker 2 is the perceived high-ability worker.

Notice, the worker with the most matches with the manager does NOT have to be the high ability worker. However, the perceived high ability worker is on average more likely to be the actual high ability worker.

A.3 Aptitude Test

You have 10 minutes to complete the test. You must answer all questions true/false.

1. This group of four words, "triangle, glove, clock, bicycle," corresponds to this group of numbers "3, 5, 12, 2."

2. The odd numbers in this group add up to an even number: 155, 32, 5, 13, 82, 77, 921.

3. A pie can be cut into more than twelve pieces by making five diameter cuts.

4. If a car travels at an average speed of 60 mph and has a fuel efficiency of 40 mpg, then a 6 hour drive to Las Vegas consumes less than ten gallons.

5. If three Euros are worth five dollars and three dollars are worth 27 Yen, then one Euro is fifteen Yen.

6. The following sentence is grammatically correct: Delighted by the reported earnings for the first quarter of the fiscal year, a raise was given to the staff by the company manager.

7. A round wall clock that has been rotated 270 degrees clockwise will have a minute hand that points to your right when it is two forty-four.

8. If the word, "TON," is written under the word, "SIS," and the word, "TAT," is written above "TON," but below "SIS," then the word, "SAT," is formed diagonally.

9. The words, "hand, every, ever, how," can form common compound words using, "one, ever, finger, more."

10. Unguent is the antonym of irritant.

11. If Monday is the first day of the month, the last Saturday of that month is the twenty-seventh day of the month.

12. The following sentence is grammatically correct: Carbon-14 dating reveals that the megalithic monuments in Brittany are nearly 2,000 years older than any of their supposed Mediterranean predecessors.

13. Fred will be four blocks from his starting place if he travels three blocks north, then three blocks east, then two blocks south and finally one block west.

14. Cur is to base as villain is to evil.

15. The following words are the opposites of words that begin with the letter R: unreal, grasp, tense, wrong.

16. If each of seven persons in a group shakes hands with each of the other six persons, then a total of forty-two handshakes occurs.

17. A square whose sides each measure ten centimeters can completely fit inside of a regular hexagon whose sides each measure ten centimeters.

18. The number 120 is the next logical number in the following sequence: 0, 1, 4, 11, 26, 57...

19. The sum of all the odd numbers from zero to 242 is an even number.

20. Sedulity is the antonym of hurriedness.

A.4   Procedure

The draws of the position as manager and worker were done through paper slips in a bag. Afterwards we read the instructions. Before the experiment, we had created gmail accounts for all subjects and a master account; the aptitude test was taken online as a google documents form, so the results were directly relayed to the master account. We then copied and pasted them into a Matlab program specifically written for this purpose. The program then graded all the tests and randomly assigned the pairings of managers and workers. It also automatically computed whether the manager's perception of the actual high ability worker was correct or not, depending on the information setting.[34] We informed the workers of their ability levels by handing them corresponding paper slips. Meanwhile, managers were asked to answer a manager comprehension review.

At the beginning of each round, we informed the participants about the information level for the current period (perfect, good, normal, poor, and no information). We then asked

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[34]In case two or more workers were tied for being the high ability worker with the lowest score, the lowest experimental ID number was assigned to be of high ability. In case the manager shared the same number of correct answers with both the high and low ability worker, the signal was correct.

managers to assign wages to the perceived high and low ability worker by filling out an online form in their google account. Again, the results were directly relayed to the master account. Inserting this information into the Matlab program, we could determine what the wages for the actual high and low ability workers were. We filled out paper slips and informed workers about their wage assignments. After this, we asked workers to think about how much effort to provide given their own and their coworker's wages which were assigned to them by the managers. Workers then had to fill out an online form in their google account, deciding on their effort for this round. Their decisions were recorded and stored in Matlab.

At the end of the experiment, we asked the participants to fill out a questionnaire, also as an online form in their google account. In the meantime, we computed the total earnings from each round through our Matlab program. The total amount was added to the $ 5 show-up bonus. Finally, we paid each participant privately and in cash.

B   Manager Signal Uncertainty

In this section, we establish two results: (i) the perceived high-ability worker is more likely to be the actual high-ability worker than not; and (ii) the more questions the manager knows how to answer (or at least has an educated guess about), the more accurate the signal.[35] We assume the probability of obtaining the correct answer by guessing on a true/false test is 0.5. We also assume that there are no underlying types of people who would answer a question in a specific way, i.e. guesses are uncorrelated across people and also for each question. We consider first the normal information environment.

We start out with the worst case, where the manager does not know the answer to any question, so he takes random guesses.[36] The probability P for any single question i that the high-ability worker gives the same answer but not the lower-ability worker $P(M_i = H_i \,\&\, M_i \neq L_i)$ is thus the same as for the opposite $P(M_i \neq H_i \,\&\, M_i = L_i)$. The probability that the perceived and actual ability coincide would thus be exactly 50%, if it were not for the case where the number of overlapping questions is exactly the same for the high- and low-ability worker. When such a tie occurs, the manager's signal is correct. Since this is a non-zero probability event, the probability that the perceived equals the actual ability is strictly higher than 50%.

Consider the extreme case where the high-ability worker answered every question correctly and the lower-ability worker answered every question incorrectly. Since the probability of answering a question correctly by pure guessing is exactly $1/2$, it is no more likely to have more answers in common with the high-ability worker than with the low-ability worker or vice versa. All random guesses are independent, so for each question, the probability of

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[35]We focus here on the case where the actual high-ability worker answers strictly more questions correctly than his lower-ability colleague. In the case where both have the same number of correct answers, the probability that the perceived equals the actual ability is still strictly higher than 50% and answering all questions correctly always leads to the correct identification of the high-ability worker – due to the fact that a tie is always resolved in favor of the manager.

[36]As mentioned in section 3.1, it is crucial that managers never know their test score. It implies that from the relevant ex-ante perspective (without knowing the result), the lowest probability a manager can assign to his answer being correct is 50% (if it were lower than 50%, then he could just choose the other answering option which is by necessity then greater than 50%).

getting it right or wrong is 1/2 each, implying that guessing does not favor towards either correct or wrong answers – and therefore not towards a profile with more or less correct answers.

Now consider the case where the manager knows the answer to one question and guesses the rest (the same logic also applies to an educated guess, where the probability of answering correctly is higher than 50% but smaller than one). For our argument, the order of the questions does not matter, so we can rearrange them in the following way: first the ones that both workers answered correctly or incorrectly, then the ones that the high-ability worker answered right but the low-ability worker answered it wrong, and finally the ones the low-ability worker answered correctly and the high-ability worker answered incorrectly.

If both workers have the same answer (be it wrong or right), the manager cannot gain any information about the actual type. Only the questions where the answers differ contain information. If the manager knows how to answer a question, then it is more likely that it is a question that was answered correctly by the high-ability worker and not the low-ability worker than the other way around. The reason is that to be defined as high- and low-ability, the former must have answered more questions correctly than the latter.

The more questions the manager thus knows how to answer correctly, the higher is the probability that these questions coincide with those that contain information. In the case where the manager knows all answers, the overlap with each worker is precisely the number of correct answers that each gave, so the manager knows with certainty who the actual high-ability worker is. If the manager knows all but one question, the actual and perceived ability do not coincide only if three conditions are met: (i) the manager guesses the one question he does not know the answer to wrongly, (ii) this question was answered correctly by the high-ability worker and incorrectly by the low-ability worker, (iii) and the score of the high- and low-ability worker differ by at most one.[37]

The probability of identifying the high-ability worker thus depends not only on the number of correct answers the manager has given, but also on the degree of how much the scores of the high- and low-ability worker differ.

In the perfect information environment, managers know with certainty each worker's type. With good information, up to three of the manager's wrong answers are randomly chosen and turned correct. The probability that the perceived high-ability worker coincides with the actual high-ability worker is thus greater than 50%. In the poor information environment, up to three of the manager's correct answers are randomly chosen and turned wrong. The probability that the signal is correct is then greater than 50% if the manager knew how to correctly answer at least six questions. In this case, the manager will in expectation have at least as many questions answered correctly as incorrectly.

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[37]If it differed by two, for example, then the overlap with the high-ability worker for the other correctly answered questions would be one higher for the high-ability worker. The total overlap is hence identical for both workers, implying that the manager perceives the right signal.