Circumstances, Effort Choice and Redistribution*

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Abstract

This paper investigates theoretically and experimentally how difference in individual circumstances affects effort choice and attitudes towards redistribution. I introduce a model in which a worker's production depends on effort, exogenous circumstances, and luck. I show that when workers aim to reach a target production, those who succeed on average are endowed with better circumstances and exert less effort. A third party who is informed only of the worker's outcome - success or failure - believe that workers who succeed on average exert less effort than workers who fail. I test the theory using a real-effort experiment in which circumstances, effort and the distribution of luck determines the likelihood of success. The experimental results suggest that effort choice responds to circumstances. Workers with better circumstances exert less effort yet succeed more. Eighty-seven percent of workers who provide no effort start with circumstances below the median. Third parties make the right inference about the role that circumstances plays in determining success or failure. Earnings redistribution within pairs of workers with asymmetric outcomes is higher when third parties are informed of worker's circumstances. The higher level of redistribution is suggestive of meritocratic behavior.

Keywords: Inequality; circumstances; opportunity; preference for fairness; redistribution; experiments

JEL Codes: C91, D83, D91

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1 Introduction

"For faction is everywhere due to inequality, ... for some consider themselves wholly equal if they are equal in a certain respect, whereas others claim to merit an unequal share of everything if they are unequal in a certain respect." Aristotle, *Politics*

Many authors have documented the rise in income inequality in the past fifty years in the United States, and in particular since the 1980s (Atkinson, 2015). In the 2021 General Social Survey, 73% of respondents considered that differences in income were too large in the United States.[1] Whether income inequalities are deemed fair or unfair has implications for which inequalities are accepted, and which policies citizens prefer: the level of income taxation, redistribution through social transfers in the form of unemployment benefits, health insurance, and so forth. The sources of income inequality critically affect how people redistribute income (Cappelen, Hole, Sørensen, & Tungodden, 2007). Income inequality may be caused by factors that agents cannot control such as a physical disability, and factors that agents are responsible for, typically the choice of how hard to work.

The majority of people tend to redistribute earnings when inequalities are due to factors beyond agents' control (Cappelen, Konow, Sørensen, & Tungodden, 2013; Mollerstrom, Reme, & Sørensen, 2015), but are more inclined to tolerate income inequalities if they are caused by differences in effort (Cappelen, Mollerstrom, Reme, & Tungodden, 2022). This type of fairness preference is called meritocratic. However, uncertainty about the source of income inequality is common in real life: did a person succeed because they were hard-working or did they just got lucky?

A crucial point is that personal circumstances affect individual's effort choice. When people know their circumstances and how likely they are to succeed, they will take this into account to determine how much effort to exert.[2] Consider the case of a high-school student who wishes obtain a score of 1500 on the SAT. They may attend a good private school which offers a rich curriculum, or they may grow up in a disadvantaged neighborhood whose public school only gives a basic educational program. Knowing their circumstances, the student who attend the private school can choose to study hard

[1] Specifically, the question was: Do you agree or disagree? Differences in income in America are too large. See https://gssdataexplorer.norc.org/variables/4295/vshow. The General Social Survey is a project of the independent research organization NORC at the University of Chicago, with principal funding from the National Science Foundation.

[2] The same observation is made by Andre (2025) who note that "*the choice to work hard is often shaped by circumstances*".

to maximize their chance of getting 1500, or reduce their effort and rely their acquired knowledge. The public-school student may study hard knowing that they start with unfavorable circumstances, or feel discouraged by the magnitude of the work required to reach the cutoff score.

I build a theoretical model in which production is generated by a combination of costly effort, exogenous circumstances, and luck. The worker's production is compared to a fixed and exogenous production target. If the production reaches or exceeds the target, the worker succeeds and earns a fixed payoff. If the production is lower than the target production, they fail and receive nothing. Hence, the outcome is binary: success or failure. In the model, *circumstances* are observed by the worker before they choose their effort level. *Luck* is a multiplier of effort and, unlike *circumstances*, is unknown to the worker before they choose how much effort to exert. Success is uncertain even if the worker makes infinite effort.[3] Thus, the worker faces a trade-off between their cost of effort and their chance of success. Exerting more effort is costlier, but it increases their chance of reaching the target. A third party who observes the worker's outcome but not their effort, circumstances, or luck, is always uncertain about their respective contribution to the worker's production.

The model has two main results. First, I show that the worker's optimal effort is decreasing in circumstances. Intuitively, being endowed with favorable circumstances increases the worker's chance of success, which in turn decreases effort. Turning to inferences, I show that the expected circumstances conditional on success is higher than conditional on failure. Therefore, if a third party observes only the worker's outcome, they expect those who succeed to have received, on average, better circumstances than those who fail. Because effort is decreasing in circumstances, it follows that the expected effort of those who succeed is lower than those who fail. This is a counterintuitive result which has implications for redistribution. A third party with meritocrat preference might be tempted to reward success as it is normally associated with higher effort. However, in this environment success is a signal of lower effort. I run a real-effort experiment to replicate the theoretical set up with the goal of answering three main questions:
(i) How do workers adjust their level of effort to various circumstances?
(ii) Are third parties able to draw the right inferences about why people succeed or fail? Do third parties attribute success to better circumstances or hard work? Conversely, do they attribute failure to worse circumstances or lack of effort?

[3] The worker's circumstances can never be greater than the target production, and because there is always a chance to receive a luck of zero, applying infinite effort does not guarantee success.

(iii) How do those inferences and heterogeneity in circumstances affect the inclination of third parties to redistribute income?

In the experiment, participants complete multiple rounds of a modified version of the slider task introduced by Gill & Prowse (2012, 2019).[4] In each round, before doing the task, participants are told their circumstances value and the distribution of luck. Then, they perform the slider task. When they decide to stop working on the task, they learn their luck draw and their total production is computed as follows: we multiply their effort - the number of sliders correctly positioned - by their luck, then we add their circumstances. If their production is greater than a target production, they succeed and earn \$1. Otherwise, they earn nothing. In the baseline *Identical-Low* treatment, all participants start with the same circumstances and have the same expected luck. The *Identical-High* treatment is similar to the baseline treatment, expect that the expected luck twice higher than in the baseline. In those two treatments, participants have the same ex-ante chance of success.[5] The main treatment of interest is the *Heterogeneous* treatment, in which I vary the circumstances that people start with (the expected luck is equal to that of the baseline). In total, participants perform four rounds of the *Heterogeneous* treatment, one round of *Identical-Low* and one round of *Identical-High* treatment, in random order. Hence, each participant is exposed to potentially five different circumstances values. For each treatment, I elicit their expectations conditional on the outcome. After the real-effort tasks, pairs comprised of one successful and one unsuccessful member are randomly formed. A bonus of \$1 is given by default to the successful member. Participants then act as a third party and are allowed to redistribute the bonus within the pair. The main results of the experiment can be summarized as follows.

Effort - The experiment is successful at making effort endogenous. *Within subject*, people adjust their effort level to the circumstances they receive. We rule out that effort changes are driven by time constraints or exhaustion. In the *Heterogeneous* treatment, the success rate is increasing in circumstances. Only 10% of people in the lowest decile of the circumstances distribution reach the target, whereas 96% of people in the top decile do. As predicted by the theory, people who have circumstances values near the top of the distribution exert on average less effort, yet succeed more. However, I also observe lower levels of effort when people have unfavorable circumstances. A significant fraction

[4] In the original slider task, people can do a maximum of 60 tasks in 2 minutes. In the experiment, I use a longer version in which people can do up to 300 tasks in essentially as much time as they wish.

[5] Some participants of course end up being luckier if they draw a higher luck. But in each of those treatments participants face the same decision problem since they have the same circumstances and only learn their luck after the effort task.

of subject choose to provide no effort when they have unfavorable circumstances, which I call the *demotivation effect*. Eighty-seven percent of people who provide zero effort have circumstances below the median.

Inferences - Participants understand that differences in circumstances, effort and luck matter in determining outcomes. Within each treatment, they properly infer that workers who succeed, on average, exert more effort and are luckier than those who fail. In the *Heterogeneous* treatment, 91% of people believe that the average circumstance of workers who succeed is higher than those who fail. This is the rational inference predicted by the model. But, 70% of people also believe that workers who succeed on average exert more effort than those who fail. This is what our data indeed shows, but it is different from what the model predicts in case where all workers optimal effort is positive. In the two treatments with identical circumstances, participants believe that workers who succeed are luckier (i.e., draw higher luck) in *Identical-High* than in *Identical-Low* treatment, but that they exert more effort in the latter. Again, this prediction is in line with our data.

Redistribution - When third parties observe only the outcome and not effort or luck directly, beliefs seem to have very little effect on redistribution. We do not find that third parties redistribute earnings within pairs differently across treatments. However, giving information about the workers' circumstances in addition to the outcome changes redistribution in an important way. First, third parties care about difference in circumstances. The larger the circumstances difference between the workers in the pair, the higher the level of redistribution. Second, the share of third parties who do not redistribute increases to 38% when the successful worker in the pair is disadvantaged and starts with worse circumstances. In this case, third parties think that the successful worker provides significantly more effort than the other member in the pair. This behavior, which compensates for luck and rewards effort, is consistent with meritocratic preferences.

1.1 Related Literature

This paper relates to the literature on fairness preference and redistribution. Cappelen et al. (2007) distinguish three types of fairness preferences. Libertarians never redistribute income so that they consider any income difference as fair. Egalitarians always redistribute income equally and therefore view any income inequality as unfair. Finally, meritocrats care about the source of income inequality. When income inequality is due to luck, meritocrats tend to redistribute earnings (Cappelen et al., 2013; Mollerstrom et al., 2015). They tolerate more income inequality - hence, redistribute less - if it is caused by differences in performance (Cappelen et al., 2022). In studies, people who hold meritocratic fairness views are often the most prevalent group. Almås, Cappelen, & Tungodden (2020) estimate their share at around 38% in the United States and 43% in Norway.[6] In most experimental and field studies, redistributive behavior has been investigated when the outcome is either due to effort or luck, and the cause of inequality is known by participants. This work has been essential to construct a typology of fairness preferences, and understand how these preferences relate to the sources of inequality.

The effect of uncertainty on redistribution has only been recently considered in the literature. Cappelen et al. (2022) use an experiment to investigate how people redistribute earnings when income inequality is caused by effort *or* luck, in varying proportions. Cappelen, Moene, Skjelbred, & Tungodden (2023) study an environment where both luck and performance determine earnings, but in proportions that are fixed and known by those who redistribute.[7] In practice, determining the relative contribution of effort and luck to someone's outcome is complicated as luck and effort are often intertwined, and people may define effort and luck differently.[8] Throughout this paper, we retain the distinction made in the literature and call effort all the factors that the agent is responsible for, and luck all the factors that are beyond the agent's control. Beliefs and inferences about the source of income inequality will affect how meritocrats redistribute earnings. A meritocrat who is convinced that someone's earnings are solely due to effort may oppose redistribution. In contrast, another meritocrat who believe that the earnings are entirely due to luck might support equalizing ex-post earnings.[9] Because people with meritocratic preferences represent the largest share in Western societies, one of the goals of this paper is to understand which inferences people make about the sources of

[6] Almås et al. (2020) estimate that the US population is made of 29% of libertarians and 15% of egalitarians. The term "meritocrat preference" encompasses a wide range of behaviors. Some meritocrats may fully compensate for inequalities caused by luck, while others would only do so partially. Some may not redistribute a cent if inequalities are due to performance, while others would redistribute partially.

[7] For example, in one treatment 10% of earnings were allocated by luck and the 90% remaining by effort. In another treatment, it was the other way around with 10% of earnings determined by effort and the rest by luck. By contrast, in Cappelen et al. (2022) design, earnings are determined by a coin flip with p% chance, or by performance with $(1 - p)$% chance.

[8] A similar point is made in Alesina & Giuliano (2011) who note that *"What is luck and what is effort is, in practice, an issue on which people may strongly disagree. Is being born smart purely luck? If so, how do I disentangle success in life that results from some combination of effort and intelligence? Being born in a wealthy family is luck, but what if the wealth accumulated by our parents (...) is the result of great effort?"*

[9] In the first case, the meritocrat will behave like a libertarian, whereas in the second case they will behave like an egalitarian. As this example shows, meritocrats do not necessarily favor more redistribution. An unequal income distribution is considered fair if it is caused only by difference in effort levels. Beliefs about source of inequality are irrelevant for other fairness views. Any income inequality is deemed fair for libertarians and unfair for egalitarians, regardless of the cause.

income inequality in an uncertain environment, and how their beliefs affect the way they redistribute income.

The experimental methodology is well suited to circumvent two issues. In real life, the relative contributions of effort and luck to someone's outcome is uncertain and unobserved. In addition, the effort choice is shaped by individual circumstances, which are mainly fixed and time-invariant. Consider a person who grows up in a wealthy family; we cannot observe the choices they would have made if they had been exposed to different circumstances, such as being born into a less affluent environment.[10] Using experiments, we can quantify precisely the contribution of effort and luck to someone's success or failure, and the beliefs that people have about those factors. Measuring those beliefs is important because they affect meritocrat redistribution. In our experiment, we control how much luck affects the outcome: equalizing circumstances reduces the role of luck since everyone starts with the same chance of success, while making circumstances more unequal means some will be more likely to succeed. Next, experiments also allow us to examine how effort responds to circumstances, by exposing people to different levels of circumstances. The closer set up to mine is found in Preuss, Reyes, Somerville, & Wu (2022). They introduce differences in opportunities by using effort multipliers only. In their experiment, altering the multiplier values neither affects the effort exerted by workers nor changes the third parties' effort expectations. The study by Andreoni, Aydin, Barton, Bernheim, & Naecker (2020) is also related to this work, and shows that many people favor equalizing the both ex-ante chance of success and ex-post outcomes.

This paper also contributes to the literature on inequality of ex-ante opportunity, endogenous effort, and real-effort experiments.

2 Set-up

2.1 Model

A worker i generates production P_i which is a function of effort, luck and circumstances.

$$P_i = \underbrace{\kappa_i}_{circumstances} + \underbrace{\lambda_i e_i}_{luck*effort}$$

Circumstances κ_i are drawn from a uniform distribution with support $[\kappa - \delta, \kappa + \delta]$,

[10] Vice versa, we cannot observe the choice a child born in a poor family would make if they were born wealthy.

and are known to the worker before they choose how much effort e_i to exert. Unlike circumstances, the worker does not observe their luck, but they know the distribution of luck, which is uniformly drawn from 0 to $\overline{\lambda}$.[11] The worker's outcome is binary. If the worker's production is greater than or equal to an exogenous target T, the worker succeeds and earns a fixed reward x. If $P_i < T$ the worker earns nothing.[12] In the rest of the paper, I normalize the target to one. Circumstances can never be greater than the target production $\kappa + \delta < T$. The lower bound of the luck distribution is chosen to be 0, so that the worker is never certain to reach the target even if they exert infinite effort.[13] It is possible to interpret luck as a worker's talent or ability. Increasing $\overline{\lambda}$ increases the variance in abilities among workers.

If a worker has unfavorable circumstances with a low k_i, they start far away from the target production. On the other hand, a worker who has favorable circumstances starts closer to the target. Circumstances capture all the factors that can either give an advantage (if good) or make it harder (if bad) for the worker to reach the target: family background, parent's wealth or education, social connection, inherited wealth, discrimination faced etc.[14] The higher the δ, the higher the heterogeneity in circumstances. If $\delta = 0$, everyone has identical circumstances κ. The mean of the distribution κ can be shifted up or down to adjust the expected distance to the target in the population.

2.2 Redistribution and Third Party Preference

A group consists of two workers i and j, and one third party. Each worker who reaches the target earns a fixed amount x. The third party observes both workers' outcome but not their effort, luck, or circumstances. If the workers' outcomes differ (one of them succeeds and the other fails), the third party chooses how to redistribute the total earnings between the workers. Let s_i be the share given to the worker i who succeeds in the pair. The worker j who fails then receives the share $1 - s_i$. If no worker succeeds,

[11] The assumption that people are unaware of their own ability is found in other strands of the literature such as models of career concerns (see for example Dewatripont, Jewitt, & Tirole (1999)).

[12] The fixed reward can be interpreted as the labor market return received by an agent for entering a prestigious university or obtaining a certification.

[13] By modifying the support of the luck distribution such that $\lambda_i \sim \mathcal{U}\left[\underline{\lambda}, \overline{\lambda}\right]$ with $\underline{\lambda} > 0$, effort might become deterministic if the worker is sure to reach the target at $\underline{\lambda}$.

[14] Some people may be born with favorable social or economic circumstances which makes them more likely to attain a higher level of income. Corak (2013) shows for example that the elasticity between a father and son's earning is around .5 in the US. Intergenerational earnings mobility measures gives the flavor that circumstances outside of the child's control - his father's earnings - is positively correlated with their actual earnings.

there are no earnings to redistribute. If both workers succeed, there is no redistribution and each worker keeps their earnings x. Notice that worker j may fail but still receives a payoff if the other worker in the pair reaches the target, and the third party decides that $s_i \neq 1$.[15] Hence, worker i's payoff after redistribution is:

$$\pi_i = x\,\mathbb{1}_{\{P_i \geq 1 \times P_j \geq 1\}} + s_i\,x\,\mathbb{1}_{\{P_i \geq 1 \times P_j < 1\}} + (1 - s_i)\,x\,\mathbb{1}_{\{P_i < 1 \times P_j \geq 1\}}$$

I follow the literature, e.g. Cappelen et al. (2022), and assume that the third party considers it fair that the worker i who succeeds (the high earner) receives a share f_i of the earnings after redistribution. The third party chooses to allocate the share s_i of earnings to the worker who succeed. It is costly for the third party to deviate from what they consider to be the fair share f_i of the worker who succeeds:

$$U(s_i, f_i) = -(s_i - f_i)^2$$

The third party is only informed whether each worker reaches the target, not their level of effort. In other words, the third party cannot condition his choice of s_i on the observed effort, but only on the worker's outcome. Following the literature, we distinguish three types of fairness preference. A third party with *egalitarian* fairness preference thinks that $f_i = .5$ and splits earnings equally. Hence, they choose $s_i = .5$. With *libertarian* preference, a third party believes that it is fair that the player who succeeds keeps their earnings $f_i = 1$. Therefore, they do not redistribute and choose $s_i = 1$. The redistribution in the previous two cases is outcome based. It does not require the third party to draw inferences about the worker's effort and luck based on their outcome.

With *meritocrat* preference, the third party redistribution is a function of their belief about the worker's effort, circumstances, and luck. Given that meritocrats reward effort, the conjecture is that s_i is an increasing function of the expected effort conditional on success $\mathbb{E}[e_i|P_i \geq 1]$. Meritocrats also offset the effect of factors that are not in the worker's control. Hence, a meritocrat third party is more likely to redistribute earnings if they believe that the worker who fails (low earner) has unfavorable circumstances. That is, s_i is decreasing in $\mathbb{E}[\kappa_i|P_i < 1]$.

[15] We do not allow the third party to destroy earnings. Fehr (2018) conducts an experiment in which subjects are allowed to burn income to reduce inequality.

2.3 Optimal Effort

Effort is costly for the worker. I assume that the cost of effort is increasing convex in e_i, so that $c'(e_i) > 0$, and $c''(e_i) > 0$. In the rest of the paper, I assume that $c(e_i) = b\frac{e_i^2}{2}$. This functional form is used in DellaVigna & Pope (2018) to estimate individual preferences and cost of effort using data from a real-effort experiment.[16] Let p be the probability that worker i succeeds and q the probability that the worker j succeeds.[17] The worker i maximizes his expected payoff:

$$\max_{e_i \geq 0} \; x\,pq + s_i\,x\,p(1-q) + (1-s_i)\,x\,(1-p)q - c(e_i) \tag{1}$$

Proposition 1 *The optimal effort e_i^* is equal to*

$$e_i^* = \begin{cases} \left(\frac{x\,(1-\kappa_i)\,s_i}{b\,\overline{\lambda}}\right)^{\frac{1}{3}} & \text{if} \quad \kappa_i > 1 - \overline{\lambda}\left(\frac{x\,s_i}{b}\right)^{\frac{1}{2}} \\ 0 & \text{otherwise} \end{cases} \tag{2}$$

Proof. See Appendix A1.

The worker trades off costly effort for an increase in probability of success. If, given the effort prescribed by solving problem (1), it is impossible for the worker to succeed even if they draw the highest possible luck $\overline{\lambda}$, then they are better off exerting no effort. I characterize the lower bound on the worker's circumstances for which the worker exerts positive effort, which is given by:

$$\kappa_i > 1 - \overline{\lambda}\left(\frac{x\,s_i}{b}\right)^{\frac{1}{2}} \tag{3}$$

If (3) does not hold, the worker's circumstance is too low and they can never reach the target given the optimal effort induced by $c(e_i)$. Hence, they choose $e_i^* = 0$. This occurs for instance when workers have a high effort cost b which decreases the optimal

[16] DellaVigna & Pope (2018) use a power cost function $c(e_i) = \frac{b\,e_i^{1+\gamma}}{1+\gamma}$ to estimate their model. In this paper, I add the assumption that $\gamma = 1$. The authors also consider an exponential cost function $c(e_i) = \frac{b\,exp(\gamma e_i)}{\gamma}$.

[17] $p(e_i, \kappa_i) = p(\lambda_i \geq \frac{1-\kappa_i}{e_i}) = \frac{e_i\overline{\lambda}+\kappa_i-1}{e_i\overline{\lambda}}$

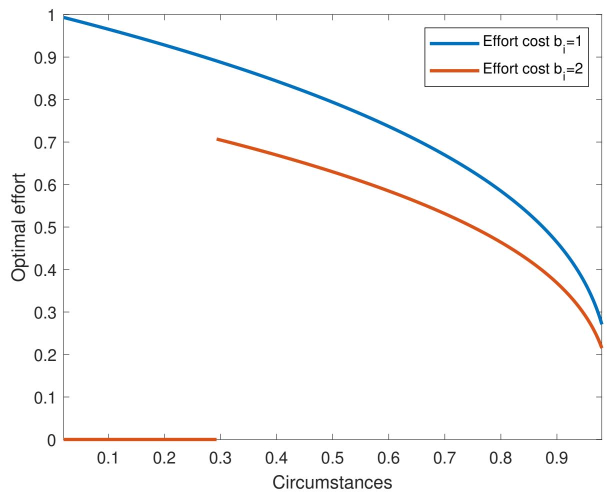

Figure 1: Optimal effort e_i^*

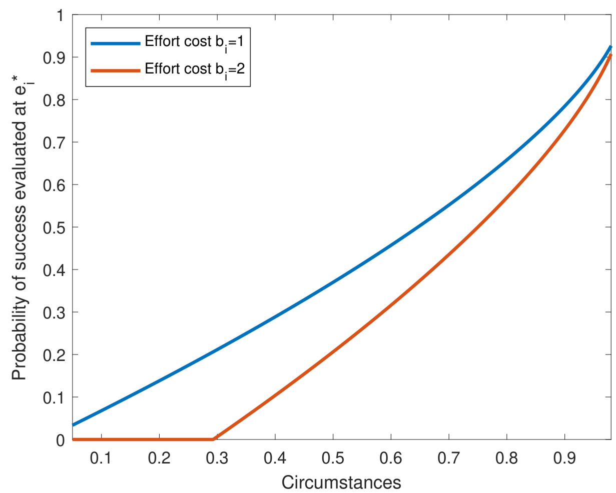

Figure 2: Probability of success given e_i^*

effort. Figure 1 displays the optimal effort using two different effort cost ($b = 1$ and $b = 2$), and the following parameters: $\kappa = .5, \delta = .49, \overline{\lambda} = x = s_i = 1$. Figure 2 plots the probability of success evaluated at the optimal effort for the same parameters. The red curve for $b = 2$ illustrates the corner solution. The workers are better off exerting no effort if they have circumstances below .29. A discontinuous jump in optimal effort occurs above those circumstances.[18]

Proposition 2 *When effort is positive, effort is increasing in x and s_i, and decreasing in b, κ_i and $\overline{\lambda}$.*

Proof. See Appendix A2.

Proposition 2 summarizes the comparative statics when effort is positive. Increasing the benefit in case of success affects effort positively. The larger the reward x or the share given when workers succeed s_i, the higher is the effort. On the other hand, increasing the worker's cost of effort b reduces their effort. Finally, being endowed with favorable circumstances κ_i or higher expected luck $\overline{\lambda}$ increase a worker's chance of success, which in turn decreases the optimal effort.

The worker's effort also depends on how much they expect to receive from the redistribution, and so depends on the third party's fairness preference. If the third party

[18] One has to be careful with the interpretation of figure 2. The probability of success is evaluated at e_i^*. For circumstances below .29, the probability of success is zero because the optimal effort is zero. But the e_i^* is zero because the worker's initial effort (possibly positive) resulting from the maximization problem gives them 0% chance to succeed.

has egalitarian fairness preferences, they choose $s_i = .5$. If the worker knows this, or expects the third party to have such preference, the optimal effort is:

$$e_i^* = \left(\frac{1}{2}\frac{x\,(1-\kappa_i)}{b\,\overline{\lambda}}\right)^{\frac{1}{3}}$$

A libertarian third party chooses $s_i = 1$. If the worker knows this, the optimal effort is:

$$e_i^* = \left(\frac{x\,(1-\kappa_i)}{b\,\overline{\lambda}}\right)^{\frac{1}{3}}$$

Hence, the optimal effort induced by the libertarian rule is always strictly greater than under an egalitarian rule.

Observation 1 *The optimal effort is higher if workers expect a libertarian third party.*

The intuition is that under the egalitarian rule, the worker receives a lower share if he succeeds alone, and a higher share if he fails alone. So, the incentive to work is lower in both cases.

2.4 Third Party's Conditional Beliefs

The only information available to the third party is the workers' outcome, not their circumstances. Conditional on observing the outcome, the third party forms a belief about the worker's circumstances. When doing so, the third party estimate the probability of success (or failure) for each level of circumstances assuming that worker exert the optimal effort $e_i^*(\kappa_i)$.[19] Finally, the expected (optimal) effort conditional on the outcome is just found by plugging the expected circumstances in the optimal effort function.

Proposition 3 *The expected circumstances conditional on success and failure are respectively given by:*

$$\mathbb{E}[\kappa_i|P_i \geq 1] = \int_{\kappa-\delta}^{\kappa+\delta} \kappa_i \, \frac{p(P_i \geq 1|\kappa_i, e_i^*)\; p(\kappa_i)}{\int_{\kappa-\delta}^{\kappa+\delta} p(P_i \geq 1|\kappa_i, e_i^*)\; p(\kappa_i)\; dk}\; dk \tag{4}$$

[19] For example, the third party forms his circumstances expectation conditional on success using: $p(P_i \geq 1|\kappa_i, e_i^*) = \frac{e_i^*\overline{\lambda}+\kappa_i-1}{e_i^*\,\overline{\lambda}}$.

$$\mathbb{E}[\kappa_i|P_i < 1] = \int_{\kappa-\delta}^{\kappa+\delta} \kappa_i \, \frac{p(P_i < 1|\kappa_i, e_i^*) \, p(\kappa_i)}{\int_{\kappa-\delta}^{\kappa+\delta} p(P_i < 1|\kappa_i, e_i^*) \, p(\kappa_i) \, dk} \, dk \tag{5}$$

Proposition 4 *The expected effort conditional on success and failure are respectively given by:*

$$\mathbb{E}[e_i|P_i \geq 1] = \left(\frac{x\,(1 - \mathbb{E}[\kappa_i|P_i \geq 1])\, s_i}{b\,\overline{\lambda}}\right)^{\frac{1}{3}} \tag{6}$$

$$\mathbb{E}[e_i|P_i < 1] = \left(\frac{x\,(1 - \mathbb{E}[\kappa_i|P_i < 1])\, s_i}{b\,\overline{\lambda}}\right)^{\frac{1}{3}} \tag{7}$$

Proofs. See Appendix A3.

I simulate the model with the following parameters: $\lambda_i \sim \mathcal{U}\,[0,1]$; $\kappa = .5$; $\delta \in (0, .45)$; $s_i = 1$ and $b = 1$. Because $s_i = 1$, this simulates the case where the third party is libertarian and the workers know this. Figure 3 below presents the result of the simulation. When there is heterogeneity in circumstances ($\delta > 0$), the expected circumstances conditional on success is lower than conditional on failure, which implies that - since optimal effort is decreasing in circumstances - the expected effort conditional on success is lower than conditional on failure. This is an interesting and counterintuitive result of our model. A third-party with meritocratic preferences might be tempted to reward success, at it is usually associated with higher effort. This is not the case in our model: success is a signal of better circumstances and hence, lower effort.

In addition, the difference between the expected effort conditional on success and the expected effort conditional on failure increases as the heterogeneity in circumstances (2δ) grows.[20]

[20]In Appendix A3, I also discuss how third party's inference are influenced by changes in the individual cost of effort b and the distribution of luck.

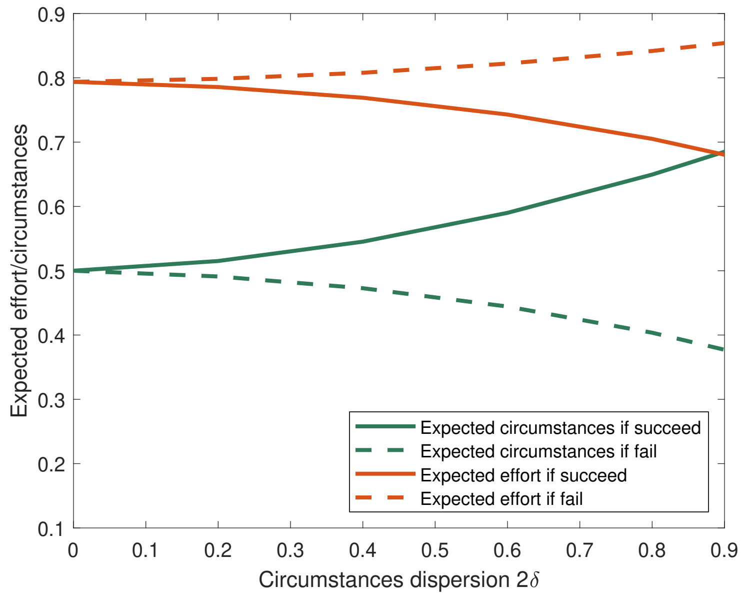

Figure 3: Expected circumstances and effort conditional on outcome

3 Experimental Design

3.1 The Slider Task

The slider task by Gill & Prowse (2012) involves a screen with many sliders (see figure 4). Each slider is initially positioned randomly, and participants have to use the computer mouse to move each slider. Their performance is determined by the number of sliders that are positioned exactly in the middle when they decide to stop working on the task. In the original Gill & Prowse (2012) task, subjects have two minutes to position as many sliders as they can out of a maximum possible of 60. I extend this to allow participants to work for as long as they want on a task and position up to 300 sliders. We chose the slider task because it requires costly effort while limiting the effect of factors that can influence production such as ability, learning the task or exhaustion. Therefore, the observed differences in production that are not due to variations in circumstances should only be caused by differences in effort.[21] As I describe in the result section, I find limited evidence of ability, learning or exhaustion affecting effort in the data.

[21] Hearing many participants sigh while performing the task during the experiment confirmed our prior belief that the task was costly enough.

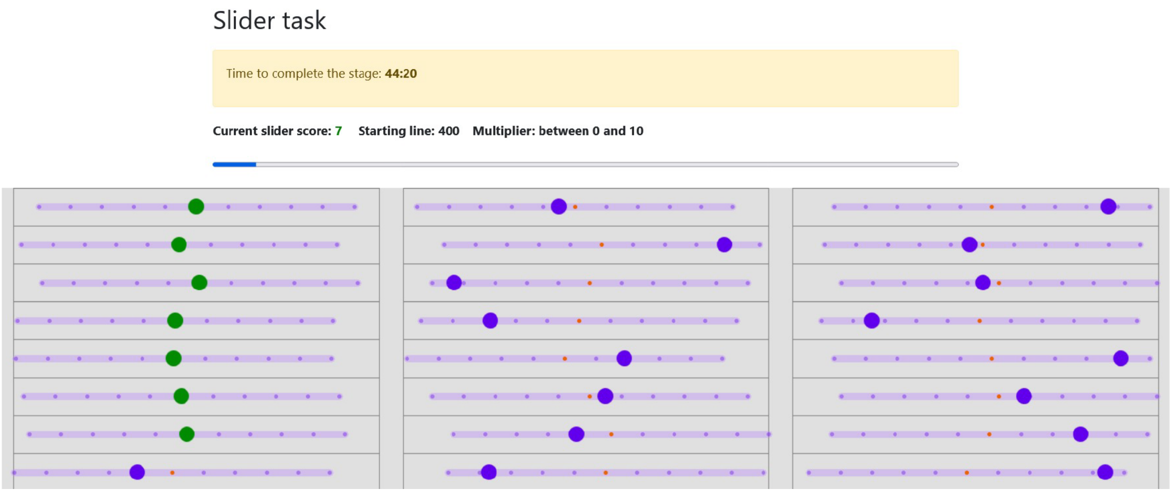

Figure 4: The Slider Task. Participants work for as long as they want on the task and may position properly up to three hundreds sliders. The sliders are displayed on three columns, with one hundred sliders per column (the figure only show the top eight sliders of each column). The green dot indicates that the seven sliders on the top-left have been positioned correctly. Participants use their mouse to scroll through the rest of the screen, or use the scrolling bar on the right-side. Once they decide to stop working on the task, participants click on a button "Next" located at the bottom of the page to move to the following page, where they learn their luck draw and are told wether they reach the target for this round.

3.2 Treatments

There are two treatment variables: circumstances and luck. First, I vary whether people start with the same or different circumstances (Identical vs Heterogeneous circumstances). Next, I vary the extent to which luck plays a role (Low vs High luck). Recall that a worker only knows the distribution of luck and not their luck draw before performing the task. Otherwise, effort is deterministic and, provided that their optimal effort is positive, workers exert the minimum effort required to reach the target, and no more.

Table 1: Experimental treatments

		Expected luck	
		Low $\overline{\lambda}$	High $\overline{\lambda}$
Circumstances	Identical ($\delta = 0$)	*IL*	*IH*
	Heterogeneous ($\delta > 0$)	*Heterogeneous*	-

The Identical-Low (*IL*) treatment is our baseline treatment. All participants receive the same circumstances, and have the same expected luck. This treatment has little variance in luck, so that effort matters more to reach the target. The Identical-High (*IH*) treatment is similar to the *IL* treatment, except that the expected luck is twice as high as in *IL*. In that case, the luck variance is larger and the luck draw matters more to determine which workers succeed. In both treatments with identical circumstances, participants face the same decision problem because they do not know their luck draw before performing the task. Hence, any difference in effort between participants can be attributed to difference in individual cost of effort. Therefore, those treatments are good benchmarks to estimate individual effort costs. The *Heterogeneous* treatment is our main treatment of interest. In this treatment, participants start with different circumstances (the expected luck is the same as in *IL*). A participant with favorable circumstances starts closer to the target, while a participant who receives unfavorable circumstances may find himself very far from the target, with little chance to succeed even when doing the maximum effort. Each participant perform three rounds of the *Heterogeneous* treatment, so that we can observe the within-subject change in effort level when a participant is endowed with different circumstances.

3.3 Hypotheses

I summarize here the hypotheses based on the model prediction. I make three broad categories of hypotheses. They are about the worker's effort level, the rational belief of a third party observing only the outcome, and the redistribution behavior. The first three hypotheses are about the chance of success and the optimal effort.

HYPOTHESIS 0: *The probability of success is increasing in circumstances.*

HYPOTHESIS 1: *Effort is decreasing in circumstances.*

HYPOTHESIS 2: *Effort is decreasing in expected luck.*

Hypotheses 1 and 2 follow from the fact that better circumstances or expecting higher luck increase the probability of success. Both hypotheses should hold within and between subjects. The next three hypotheses are about third party's beliefs about what causes success or failure when they observe only the workers' outcome.

HYPOTHESIS 3: *Comparing between the identical treatments, third parties expect workers who succeed to exert on average more effort in the Identical-Low than in the Identical-High treatment. Third parties expect workers who succeed to have on average higher luck in the Identical-High than in the Identical-Low treatment.*

$$\mathbb{E}[e_i|P_i \geq 1]^{IL} \ > \ \mathbb{E}[e_i|P_i \geq 1]^{IH} \ \text{ and } \ \mathbb{E}[\lambda_i|P_i \geq 1]^{IL} \ < \ \mathbb{E}[\lambda_i|P_i \geq 1]^{IH}$$

In addition, *within treatment*, third party expects workers who succeed to have on average higher luck than workers who fail.

$$\mathbb{E}[\lambda_i|P_i \geq 1] \ > \ \mathbb{E}[\lambda_i|P_i < 1] \quad \text{in both } IL \text{ and } IH \text{ treatments}$$

Note that within each treatment, I do not make any prediction about difference in effort conditional on the outcome. The reason is simple: participants have the same circumstances and so face the same decision problem. Thus, they should choose the same effort level, assuming identical cost of effort.

HYPOTHESIS 4: *In the Heterogeneous treatment, third parties expect workers who succeed to have on average better circumstances than workers who fail.*

$$\mathbb{E}[\kappa_i|P_i \geq 1]^H > \mathbb{E}[\kappa_i|P_i < 1]^H$$

Hence, hypothesis 4 implies:

HYPOTHESIS 5: *In the Heterogeneous treatment, third parties expect workers who succeed to exert on average lower effort than workers who fail.*[22]

$$\mathbb{E}[e_i|P_i \geq 1]^H < \mathbb{E}[e_i|P_i < 1]^H$$

The last hypothesis is about the redistribution behavior of third-party who have meritocrat preferences. Libertarians and egalitarian's beliefs about the source of inequality do not affect their redistribution.[23]

HYPOTHESIS 6: *Third parties with meritocrat preferences redistribute more when they at-*

[22] Assuming that people choose effort rationally.

[23] Libertarians never redistribute (s_i = 0), while egalitarians divide earnings equally (s_i = .5).

tribute success to circumstances or luck, and redistribute less when they attribute success to effort.

3.4 Procedure

The experiment has three stages. In stage 1, participants act as workers and have up to 45 minutes to complete five rounds of the slider task.[24] Each worker performs three rounds of *Heterogeneous*, one round of *IL* and one round of *IH*, in random order determined at the individual level. In each round, a new circumstances and a new luck are drawn for each worker. Before doing the slider task, workers are told their circumstances, and the distribution of luck. Once they decide to stop working on the task, their production is computed as follows: the number of sliders they have correctly positioned is multiplied by their luck, to which we add their circumstances.[25] A worker receives $1 if they reach a fixed production target, and nothing otherwise. Therefore, the first stage replicates the case in which workers face a libertarian third party who never redistribute income. The within-subject design has two advantages. It exposes each worker to different circumstances, so I can observe how effort respond within subject to changes in circumstances. In addition, the design allows me to control for heterogeneity in effort cost across the circumstances distribution.

Table 2: Experiment Parameters

		Parameters				
		κ	δ	Luck distribution	Target	Possible effort range*
Treatments	Identical-Low	1250	0	$\mathcal{U}[0,10]$	2500	0-300
	Identical-High	1250	0	$\mathcal{U}[0,20]$	2500	0-300
	Heterogeneous	1250	1250	$\mathcal{U}[0,10]$	2500	0-300

*The level of effort is participant's choice variable, within the range.

The parameters chosen for each treatment are presented in table 2. In the identical treatments, each worker circumstances is fixed at 1250 ($\kappa = 1250$, $\delta = 0$). In the het-

[24] Forty-five minutes give participants ample time to exert as much effort as they want in each round, so that time is not binding in the experiment. If they finish early, they can use their phone while others finish the stage.

[25] Subjects are explicitly told that they are not expected to correctly position all the 300 sliders in each round. They are shown multiple examples of how the production is computed. Before starting the first stage, they also have to answer a comprehension question asking them to compute a production. The details of the instructions is available in Appendix C.

erogeneous treatment, the circumstances are randomly draw from a discrete uniform distribution between 0 and 2500 (κ = 1250, δ = 1250).[26] The parameters are calibrated so that no matter the circumstances, workers always have some chance to reach the target if they exert the maximal effort. The first time they complete each treatment, I elicit participant's belief about the average effort, luck and circumstances of workers who succeed and fail in their session. People are paid for their guesses using a quadratic scoring rule.[27]

Stage 2 involves hypothetical redistribution decisions. First, I elicit participants' fairness preference in case the source of inequality is known to be either effort or luck. Participants can redistribute income within a pair of workers. In the *luck only* scenario, a bonus of $1 is randomly allocated by the computer to one worker in the pair. In the *effort only* scenario, the bonus is given to the worker in the pair who exerted more effort. Those scenarios are commonly used in the literature for example in Almås et al. (2020) or Cappelen et al. (2022). Next, using the results from stage 1, I form for each treatment "one-winner" pairs in which one worker reaches the target and the other does not. A bonus of $1 is by default awarded to the worker who succeeds. In those cases, there is uncertainty about what causes income inequality: a worker's success is due to a combination of effort, luck, and - in the *Heterogeneous* treatment - circumstances. Participants are reminded of their conditional beliefs from the first stage and can redistribute the bonus within the pair. People are told that their choices are hypothetical but that they should try to answer as if they had real consequences. Hypothetical questions are used because workers are not informed in stage 1 that a subsequent redistribution phase will occur. So, implementing the redistribution decisions would be deceiving.[28] Hence,

[26]In order not to confuse participants more than necessary, I chose a round number for the upper bound of the circumstances distribution (2500 and not 2499), so it equals the target in my experiment. In practice, this has little consequence because drawing a circumstances of 2500 and hence succeeding without providing effort occurs with only 0.04% chance (1/2501). In fact, no worker received a circumstances of 2500 in all our experimental sessions.

[27]I only elicit participant's belief about the average circumstances for the *Heterogeneous* treatment since in the other two treatments participants start with the same circumstances. For example, subjects are asked: "*Think of participants who reach the target in this round, excluding yourself: what do you think is their average effort?*". Participants answer the same questions, considering those who miss the target: "*Think of participants who miss the target in this round ...*". I ask people to consider everyone but themselves to avoid biasing their reports. A participant who exerts the maximal effort but fail because of a luck draw of 0 may overestimate the effort level of people who fail. In addition, this prevents people from strategically choosing their effort to maximize their gains from the belief elicitation, e.g. by choosing to exert no effort and hoping to be the only worker who fail for that treatment.

[28]In stage 1, I am interested in how workers' effort respond to changes in circumstances and the distribution of luck. Telling workers that they will be paired ex-post based on their performance and that a third party will redistribute earnings introduces a new potential confound: worker's effort level might

hypothetical decisions seem to offer a good compromise in this specific case.[29]

In stage 3, I combine effort and redistribution. In this stage, each participant has two distinct roles: that of a worker and a third party. As workers, participants have 10 minutes to perform one round of the *Heterogeneous* treatment. As third party, they redistribute earnings between pairs of workers. Before the task, workers are told that "one-winner" pairs will be formed as in stage 2, and that a third party in their session will be told each worker's starting circumstances and may redistribute the bonus within the pair. Each third party makes a redistribution decision for two pairs of workers, and their choice directly affect other participants earnings.[30] Finally, I conclude the experiment with a survey which includes demographic questions (gender, socioeconomic class), opinion about income inequalities, fairness views, social mobility and political identification. Questions are borrowed from Hvidberg, Kreiner, & Stantcheva (2020) and the General Social Survey.

4 Results

A total of 87 subjects participated in the experiment which was conducted at the Missouri Social Science Experimental Laboratory at Washington University in St. Louis.[31] I ran five sessions of the experiment in March and April 2023. The experiment was coded using oTree (Chen, Schonger, & Wickens, 2016). Each session lasted approximately 90 minutes. The average earnings including a $5 show-up fee was $21.82, which was paid in cash at the end of the experiment.

change depending on how much they expect to receive from the redistribution.

[29]To be clear, incentivized decisions are key to experimental economics. In some specific domains such as time preference, studies compared hypothetical to incentivized decisions and showed that they did not differ significantly from each other (see for example Brañas-Garza, Jorrat, Espín, & Sánchez (2023)). Fairness preferences or more generally other-regarding preferences might be domains in which people's hypothetical decision may not significantly differ from real ones.

[30]Everything is anonymous: workers do not know who is the other worker in their pair or the identity of the third party who makes the redistribution decision for their pair. Third parties do not know the identity of the workers in the pair when they redistribute. If a worker's pair is shown to more than one third party, one of the decisions made for the pair is randomly selected to determine the amount earned by the worker. See the experiment instructions in Appendix C for more details.

[31]A participant asked and was granted the permission to leave the experiment after realizing in the first round that they could not perform the slider task due to a medical condition. I excluded this participant from all the analyses.

4.1 Effort distribution

In all the analysis that follows, my measure of effort is the number of sliders that are correctly positioned in a given round.[32] Across all treatments, workers correctly position 194 sliders on average. The effort distribution is slightly right censored, as shown in figure 5. Workers correctly position more than 290 sliders in 19.4% of the observations, and exert the maximum effort of positioning 300 sliders in 16.7% of the observations across all treatments. The right censoring is partly driven by the first round, in which 36.8% of workers exert the maximum effort. Excluding round one, as shown by the red histogram, only 12.6% of workers exert the maximum effort across all treatments, and 15.3% place correctly more than 290 sliders. Presumably participants are learning about the task during the first round and solving all the sliders might be the natural choice for workers who are still unsure of how the production is calculated. After each round, workers learn their production and whether they reach the target or not, so the task should be well understood after the first-round feedback. Finally, workers chose to provide zero effort in 7.1% of the observations. Figure 6 displays the effort distribution for each treatment in our experiment. Comparing between treatments, we also observe that a higher share of participants exerts the maximum effort if the baseline *Identical-Low* treatment. In this treatment, 25.3% of workers correctly place 300 sliders (29.9% correctly place more than 290 sliders), whereas 14.9% do so in the other two treatments.[33]

As mentioned in section 3.1, difference in production should reflect differences in effort and not between subject difference in abilities. Next, within subject, effort should not be affected by exhaustion or time constraints, so that any effort variation can be attributed to changes in the experiment parameters i.e., circumstances and luck. In appendix B.1, I provide evidence that none of these factors affect worker's effort level in a significant way. In particular, worker's productivity do not decrease over time, and around 93% of participants enter round 5 with more than four minutes left to complete the round.[34]

[32] In practice we can define effort in different ways. It can be the total time spent by people in a given round, or worker's efficiency: how many seconds a worker needs to make one unit of effort, i.e., properly position one slider.

[33] Since the order of the treatments is randomized, the higher level of effort in the baseline treatment is not due to the learning effect of round 1. That is, there is as many participants who start with the *Identical-Low* treatment as participants who start with the *Identical-High* treatment. And since participants have to complete three rounds of *Heterogeneous*, they are actually more likely to face it in the first round.

[34] The average number of sliders solved per round does not decreases over time, and workers do not spent more time per slider as the rounds progress.

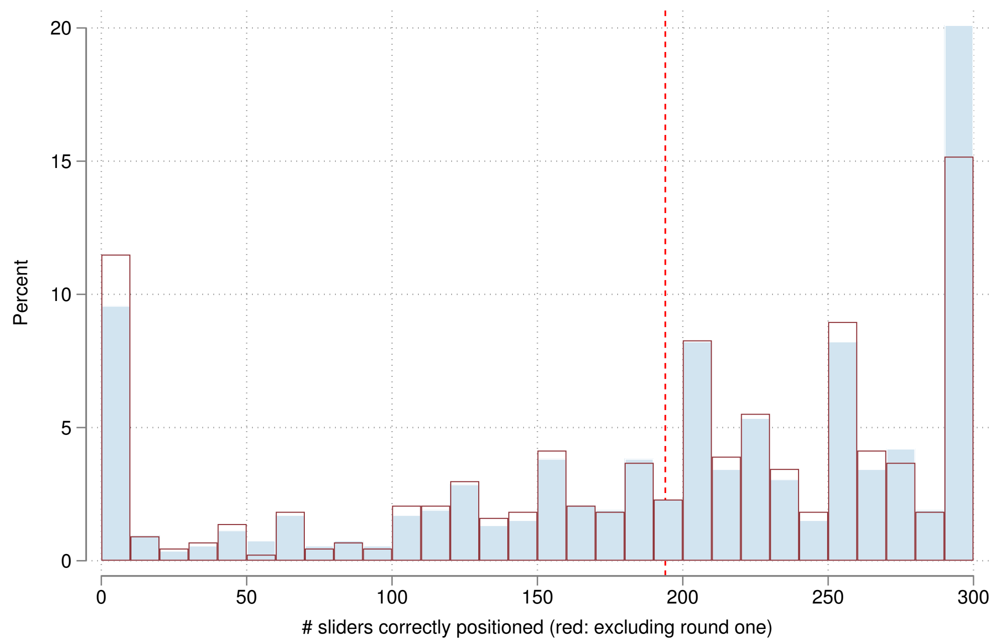

Figure 5: Effort distribution with bins width of 10

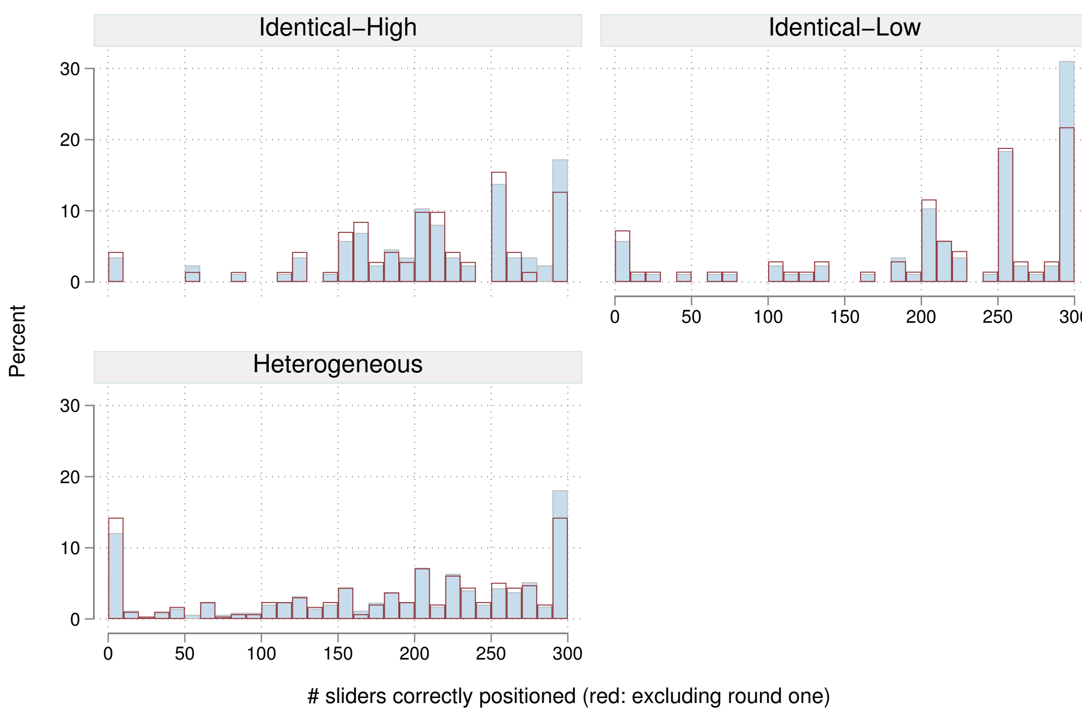

Figure 6: Effort distribution by treatment with bins width of 10

4.2 Effort Choices

In this section I focus on how changes in circumstances and distribution of luck affect individual effort choice.

4.2.1 Effect of Circumstances on Effort

Figure 7 show the success rate and the average effort level conditional on participant's circumstances, for the *Heterogeneous* treatment. Because each subject performs the heterogeneous treatment four times, they receive four different circumstances. Hence, a participant may have circumstances at the bottom of the distribution in a given round, and in the next round be at the top of the distribution. This enables to control for individual difference in effort cost. With our 87 participants, I have a total of 348 observations for the *Heterogeneous* treatment, around 35 for each decile. The average success rate is 46.8%. The success rate is almost monotonically increasing in circumstances: while only 10.3% of people who have circumstances in the lowest decile of the distribution (that is, less than 251 out of possible 2500) reach the production target, 95.8% of those who have circumstances in the top decile (above 2250) reach the target.[35] So, people who have better circumstances are more likely to succeed.

We now turn to how effort responds to changes in circumstances. The orange line in figure 7 displays the average effort by decile with the 90% confidence interval bounds. Within subject, participants adjust their effort level to the circumstances they receive. The effort level looks like an inverted U-shape. On average, lower effort levels are observed in the tails. People who have circumstances in the top 10% of the distribution on average properly position 108 sliders, those in the bottom 10% position 133 sliders. The highest average effort levels (221 and 230) are observed when people have circumstances between 1250 and 1750. There is a negative correlation between circumstances and effort above the median of the circumstances distribution ($\rho = -0.43, p < .01$), which is even stronger in the top 20% ($\rho = -0.58$). Our experiment succeeds in making effort endogenous, as participants *choose* to exert different effort levels depending on the circumstances. At the top, the conjecture is that receiving a favorable circumstances makes success very likely and hence reduce the need for effort. Consider the following case of a worker who has circumstances of 2300. The expected luck is 5 in the *Heterogeneous*

[35] Success depends on people's effort choice, circumstances and luck. Upon closer inspection of the data, one explanation for the fact that the success rate is not monotonically increasing is because participants in the third decile of my experiment were unlucky compared to those of the fourth decile: they receive on average a luck of 4.7 out of 10, whereas the average luck draw of the fourth decile is 5.3.

treatment is 5. Hence, by placing properly 50 sliders the expected production is 2550 which is higher than the production target. If the worker places properly 100 sliders, the only way for them to miss the target is if they are unlucky and draw a luck of 0 or 1, which occurs with around 18% probability.

RESULT 1: *In the heterogeneous treatment, the success rate is increasing in circumstances. The levels of effort are lower when workers have circumstances in the bottom or the top decile of the circumstances distribution. In the top decile, workers exert less effort yet succeed more. Effort is negatively correlated with circumstances in the top half of the distribution* ($\rho = -.43$, $p < .01$).

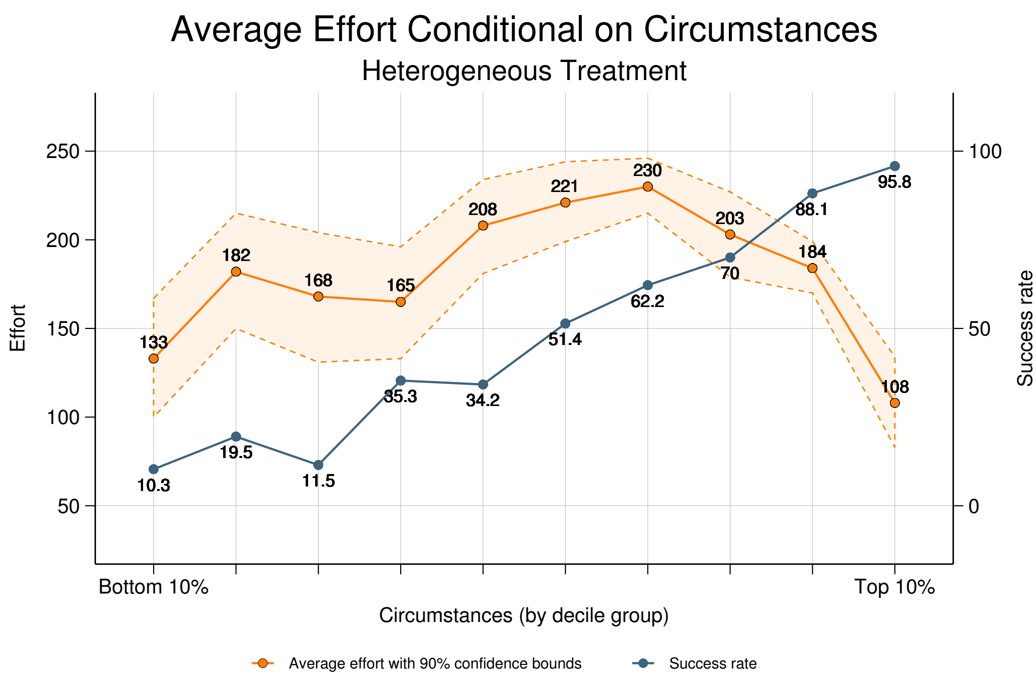

Figure 7: Success rate and average effort conditional on circumstances in the heterogeneous treatment.

What explains the lower effort levels at the bottom of the distribution? In the experiment, worker can choose to provide no effort in a round. The behavior of exerting zero effort is much more common when participants have unfavorable circumstances. We call this the *demotivation effect*. The gray line in figure 8 display the average effort level by decile when workers who provide zero effort are excluded. Removing them boost the average effort in the bottom half of the circumstances distribution. Among people who exert zero effort, 87% have circumstances below the median. Twenty-eight percent of participants who have circumstances in the lowest decile choose to provide zero effort. In addition, workers provide zero effort more frequently in the *Heterogeneous* treatment (in 8.4% of the observations) than in the other two treatments (in 2.3% of the observations). All this suggests that thedemotivation effect is driven by unfavorable circumstances.[36]

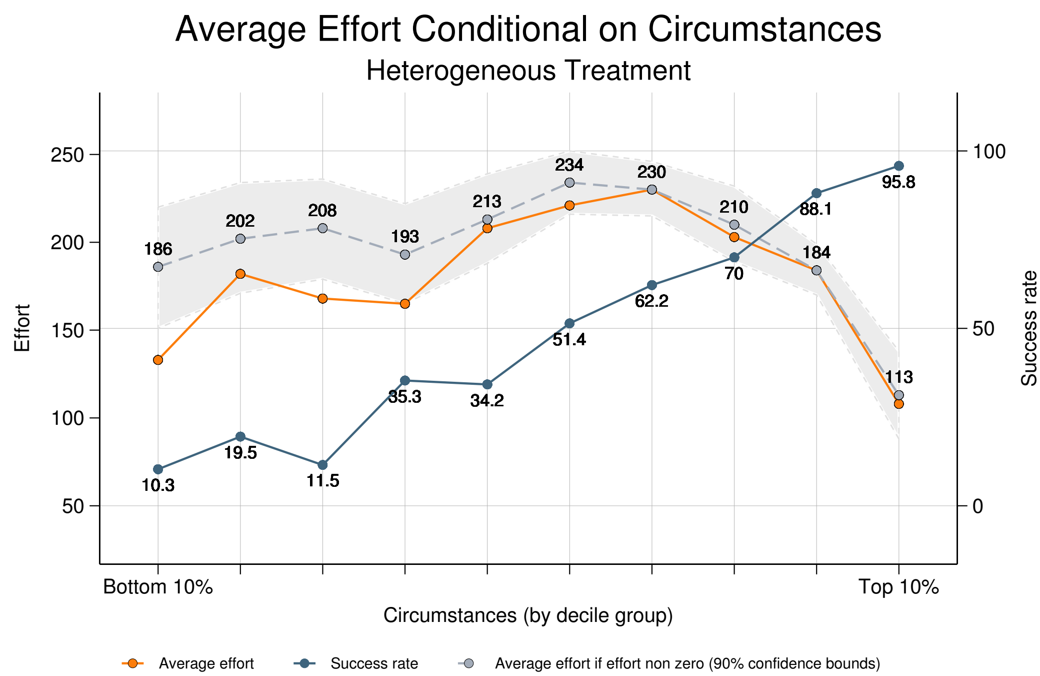

Figure 8: Average effort conditional on circumstances in the heterogeneous treatment when effort is non zero

There are several possible explanations for why workers choose to exert no effort.[37]

1. *High cost of effort:* when workers have high effort cost, it is rational to exert no effort if the optimal effort given their circumstances is too low to give them a positive chance of success. This is the corner case described in section 2.3. I estimate each participant's effort cost $\hat{b}_i$ based on the effort level they provide in the baseline treatment.[38] Using $\hat{b}_i$, I then estimate worker's optimal effort $\hat{e}_i{}^*(\hat{b}_i, \kappa_i)$ given the

[36] This excludes the four people who provide zero effort in the last round of stage 1 because they run out of time before.

[37] Recall that running out of time is not one of those explanation because time is rarely binding, as discussed in 4.1. In addition, out of the four participants who run out of time before the last round of stage 1, only one of them should have performed the *Heterogeneous* treatment.

[38] There are two participants who should have performed the baseline *Identical-Low* treatment in round 5 but who reach the time limit before entering the round. For those participants, I estimate the effort cost based on the effort level in the *Identical-High* treatment.

circumstances that they receive for all the *Heterogeneous* rounds. Finally, I compute the probability of success given this estimated optimal effort. If the estimated probability of success is not positive, then it is rational for the worker to exert zero effort. Using this methodology, providing no effort is rational for only 2 out of the 30 observations in which I observe zero effort. In other words, the demotivation effect does not seem to be due to high effort costs.[39]

2. *Hedging:* workers may be hedging between rounds. When they have unfavorable circumstances, they decide to exert no effort and instead save their energy for future rounds in which they hope to have better circumstances. If this is the case, I should observe no demotivation effect in worker's last round. In the last round of stage 3, 8% of participants exert zero effort, even though they know this is the last effort task. This confirms the result of the regression in table 3, which showed no round effect.

3. *Previous round failure:* people may be more likely to provide no effort if they fail in the previous round and end up being disappointed by their previous outcome. Overall, the failure rate in the *Heterogeneous* treatment is 48.3%. Among people who provide zero effort, 58.6% of people fail in the previous round. Therefore, this effect appears limited.

I confirm these with logit regression (see table 3) where the choice to exert zero effort, i.e., being demotivated, is the dependent variable. Moving up in the circumstances distribution by one decile reduces probability of being demotivated by 2.8%. Apart from the circumstances, no other variable significantly affect the probability of exerting zero effort. In particular there is no effect of the round number, no treatment effect and no effect of the previous round outcome. The overall picture that emerges from this analysis is that the demotivation effect is a behavioral phenomenon. Only in rare cases it is a rational response, in particular to high effort costs.

RESULT 2: *In the heterogeneous treatment, the lower effort levels at the bottom of the circumstances distribution are partly caused by workers exerting no effort (demotivation effect). Workers' circumstances is below the median in 87% of the observations in which the demotivation*

[39] I perform the same analysis using the *IH* treatment as benchmark to estimate effort costs and arrive at the same conclusion. In this case, in only 1 out of the 30 observations doing no effort is rational as workers have no positive probability of success given their effort cost.

Table 3: Logit With Dependent Variable: Choose No Effort (Demotivated)

	(1)
Circumstances (decile)	-0.431***
	(0.104)
Treatment: Identical-Low	0.218
	(.808)
Treatment: Heterogeneous	0.633
	(.689)
Fail in round n-1	-0.465
	(.394)
Constant	-1.214
	(0.873)
Round controls	Yes
Subject FE	Yes
Observations	435

Standard errors in parentheses, clustered at participant level
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

effect occurs. Moving up in the circumstances distribution by one decile reduces probability of exerting no effort by 2.8%. The demotivation effect does not seem to be caused by high effort cost.

4.2.2 Effort Choice and Rationality

Some workers may fail to realize that given their circumstances and the luck distribution, they choose an effort level that is too low to ever reach the target. For instance, in the baseline treatment a worker with circumstances of 500 who chooses an effort level of 100 is sure to fail, because even if they draw the highest possible luck of 10, their production can at most be 1500, which is below the target production. The worker should choose an effort level of at least 200 sliders to have a small chance to succeed (in that case, the probability of reaching the target is 1/11%, as this happens only if the worker draws a luck of 10). Across all treatments, workers choose a positive effort level that yields no chance of success in 14.4% of the observations. This occurs very rarely in the *IH* treatment (2.4% of the observations) because with a maximal luck draw of 20, even low levels of effort bring some probability of success. Non rational effort levels occurs more frequently (18.6% of the observations) in the *Heterogeneous* treatment due to unfavorable circumstances.[40]

I documented two types of irrational behavior. First, with the exception of a few rare cases, workers providing zero effort (i.e., the demotivation effect) can not be explained by high effort costs. The second type of irrational behavior is workers who exert a level of effort which, given their circumstances, is not enough to have a positive probability of success. Figure 9 displays the average effort and success rate by decile of the circumstances distribution for the observations in which workers behave rationally.[41] This represents 75% of the observations in the *Heterogeneous* treatment. When we consider only those observations, the average effort is more in line with the theory prediction of a monotonic decrease in effort as circumstances increase. So, do workers who succeed exert more or less effort in the experiment? In the *Heterogeneous* treatment, workers who succeed have better circumstances (1649 vs 842, $p < 0.01$) and exert more effort (216 vs 154, $p < 0.01$). But in observations for which effort is rational, workers who succeed have better circumstances (1649 vs 1081, $p < 0.01$) and exert less effort (216 vs 234, $p < 0.05$). In the Identical treatments, workers who succeed have better circumstances and exert more effort. This is also true in observations with rational effort, even though the difference in effort between the two groups is no longer significant.

4.2.3 Effect of Luck on Effort

In the *IL* and the *IH* treatment, every worker starts with the same circumstances. The only difference is the expected luck, which is 5 in *IL* and 10 in *IH*. Workers on average correctly position 220 sliders in *IL* and 212 in *IH*.[42] The difference is not significant, which indicates that, contrary to hypothesis 2, workers do not exert less effort when the expected luck increases. Participants may be inattentive and fail to notice that the distribution of luck in the *IH* treatment differ from the other treatments.[43] Another possible reason is that, even if workers observe that the expected luck is higher and

[40]Irrational effort levels may be either one-time mistakes, or the result of dynamic inconsistency. In the latter case, workers start a round planning to exert a predetermined effort level, but fail to carry out this plan. Before doing the task they might underestimate their effort cost which leads them to overestimate their optimal effort. In the data, 62.5% of workers choose an irrational effort level once, and 37.5% of workers choose an irrational effort more than once (the vast majority twice). So, the data seems to point in the direction of the single mistake explanation.

[41]This includes the observations in which workers rationally exert no effort because they have high effort costs, and the observations in which workers run out of time.

[42]The average success rate is 75.9% in *IH* and 43.7% in *IL*.

[43]To prevent this, participants are told in the instructions to pay close attention to the distribution of luck which is revealed to them at the beginning of each round.

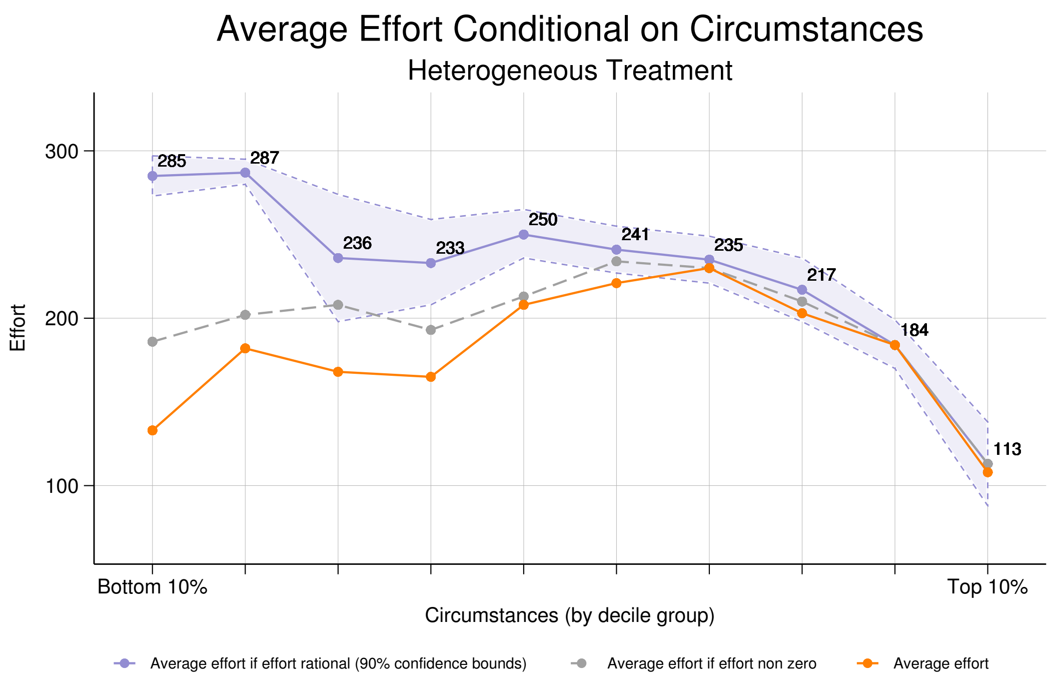

Figure 9: Average rational effort conditional on circumstances in the heterogeneous treatment

understand that this increases their chance of reaching the target, they may not reduce their effort level due to anticipation of regret in case they receive a high luck draw and miss the target because of their lower effort.[44]

4.3 Beliefs Conditional on the Outcome

In this section we turn to participant's beliefs conditional on success or failure in reaching the target. After the first instance of each treatment, we ask participants their belief about the average effort, luck, and circumstances (when applicable) of workers who succeed and fail in their session.

4.3.1 Identical Circumstances Treatments

As shown in table 4, the expected effort conditional on success is higher in the baseline *IL* treatment compared to the *IH* treatment: 215 vs 197 ($p < 0.05$). The average effort of

[44]It is also possible that workers do not anticipate that a higher expected luck increases their likelihood of success, so that *ceteris paribus* less effort is required to succeed. However, we show in section 4.3.1 that participants believe that workers who succeed in the *IH* treatment receive higher luck draws than in *IL*.

workers who succeed is 259 in *IL* and 228 in *IH* ($p < 0.01$). So, participants underestimate the effort of workers who succeed in both treatments, but still properly infer that workers who succeed in the baseline exert more effort than in *IH*.

Table 4: Beliefs Conditional on Success (Identical Circumstances Treatments)

		Treatment		
		Identical-Low	Identical-High	Difference
Average effort if success	Truth	259	228	31^{***}
	Belief	215	197	18^{**}
	Δ Belief - Truth	-44	-31	
Average luck if success	Truth	7.4	12.5	5.1^{***}
	Belief	6.8	11.9	5.1^{***}
	Δ Belief - Truth	-0.6	-0.6	

Two-sample t-test: $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Turning to luck, participants estimate that the average luck draw of workers who succeed in the *IH* treatment is 11.9 vs 6.8 in *IL* ($p < 0.01$). Beliefs about the average luck of workers who succeed are accurate in both treatments, even if a small underestimation is again observed. Workers who succeed receive on average a higher luck draw in the *IH* treatment compared to those who succeed in *IL*: 12.5 vs 7.4 ($p < 0.01$).

RESULT 3: *Participants believe that the average effort of workers who succeed is higher in the baseline treatment compared to IH. Compared to the baseline, participants believe that the average luck draw of workers who succeed is higher in IH.*

Appendix B provide the table of the beliefs conditional on failure. Within each treatment, participants always believe that workers who succeed on average exert more effort and have a higher luck draw than those who fail. [45]

4.3.2 Heterogeneous Circumstances Treatment

According to the hypotheses, in the *heterogeneous* treatment the expected circumstances conditional on success should be higher than conditional on failure (H4), which im-

[45]For example, in the *IH* treatment participants believe that on average those who fail exert 151 effort while those who succeed exert 197 effort. The difference between the beliefs conditional on the outcome within treatment is always highly significant ($p < 0.01$).

plies that the expected effort conditional on success should be lower than conditional on failure (H5).[46]

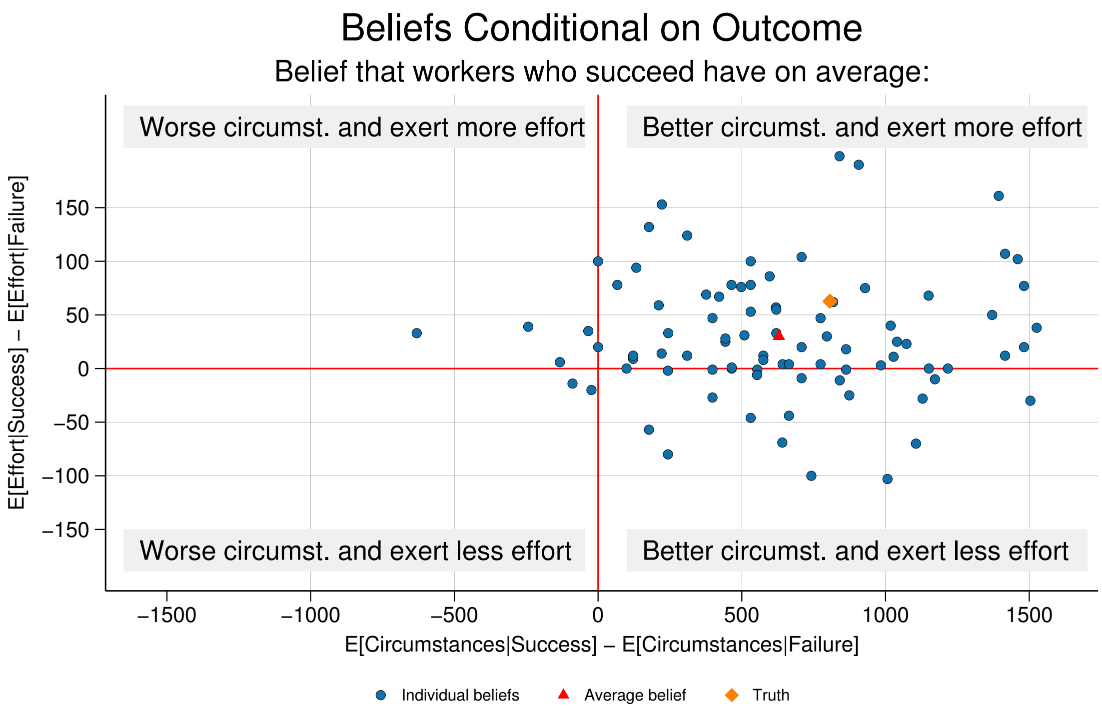

Figure 10: Beliefs in heterogeneous circumstances treatment

In figure 10, I plot for each participant the difference between the expected effort of workers who succeed and the expected effort of workers who fail (y-axis). One blue dot represents the belief of one participant in the experiment. Above (Below) the horizontal red line, participants believe that workers who succeed in the *Heterogeneous* treatment exert more (less) effort than those who fail. The higher the point, the stronger is the belief that those who succeed exert more effort than those who fail. On the x-axis, I do the same for the beliefs about circumstances. Hence, on the right (left) of vertical red line, participants believe that workers who reach the target on average have better (worse) circumstances than those who miss. The more to the right, the more a participant believe that on average those who succeed have better circumstances than those who fail. Ninety-one percent of participants believe that workers who succeed in the *Heterogeneous* treatment have better circumstances than those who fail.[47] This provides support for

[46]Recall that this holds if all workers exert positive effort, and that the implication holds because effort is monotonically decreasing in circumstances.
[47]Visually, 91% of the blue points are on the right side of the vertical red line.

H4. On average, they think that those who reach the target have circumstances of 1497 whereas those who miss have circumstances of 868, a difference of 629. In truth, those who reach the target in the *Heterogeneous* treatment have on average a circumstances of 1649 while those who miss have circumstances of 843. Again, subject's beliefs are very accurate.

Among participants who believe that workers who succeed have better circumstances, 70% believe that they also did more effort. This, on the other hand, contradicts H5. In our data, workers who succeed in *Heterogeneous* correctly position 216 sliders, and those who fail correctly position 154 of them. Participants believe that that those who succeed on average correctly position 205 sliders while those who fail correctly position 175.[48]. So, most participant (63%) believe at the same time that those who succeed on average have better circumstances and exert more effort than those who fail: they appear in the top right quadrant on figure 10. Roughly a quarter of our participants (in the bottom right quadrant) believe that those who reach the target on average have a better circumstances and exert less effort than those who fail, which is what the model would predict.[49]

Our theoretical model predicts that when circumstances are heterogeneous and all workers exert positive effort, conditional on observing only the outcome, third parties expect those who succeed to have better circumstances and exert less effort than those who fail. When we elicit beliefs in our experiment, third parties instead guess that those who succeed on average have both better circumstances and exert more effort than those who fail, which is what our data shows. In other words, third parties predict where the model fail. The failure of the model is due to the irrational effort choice documented in section 4.2.2, which decreases the average effort of workers who fail. Restricting to rounds in which participants exert rational effort, the average effort of workers who fail is higher than those who succeed (234.1 vs 216.3, $p < 0.05$) even though their circumstances are worse on average (1081 vs 1649, $p < 0.01$). [50]

[48]The difference between the circumstances and effort conditional on the outcome are both significant at 1% level (pairwise t-test). The difference between the belief about effort and belief about circumstances conditional on the outcome are also both significant at 1% level (paired t-test)

[49]The exact count of how many participants hold each belief is presented in appendix B.2. The average belief is rather close to the truth (pink dot) in our experiment, even if participant slightly underestimate the role of effort and circumstances in success.

[50]Looking only at the tails of the circumstances distribution, the average effort made by workers who succeed in the top decile (113, n=23) is slightly lower than the average effort made by those *who fail* from the lowest decile (114.8, n=35). Excluding the demotivated, the average effort of participants who miss the target in the lowest decile is 167.5 (n=24), which is much higher than the one of those who succeed from the top.

RESULT 4: *In line with our data and the theory, 91% of third parties believe that workers who succeed in the heterogeneous treatment come from better circumstances. In line with our data but not the theory, 70% of third parties believe that workers who succeed exert more effort than those who fail. Overall two-thirds of third parties believe that workers who succeed on average have better circumstances and exert more effort than those who fail.*

4.4 Redistribution

4.4.1 Redistribution Conditional on the Outcome

In the second stage, participants act as third parties and decide how to redistribute a bonus of $1 within a pair of workers. In the benchmark decisions, there is no uncertainty about the source of income inequality before third party redistribute. The bonus is allocated by default to one worker in the pair, either randomly (*luck only*) or given to the worker who exerted more effort (*effort only*). Table 5 presents the main descriptive statistics for the redistribution behavior in stage 2. In the benchmark cases, when the winner is determined by luck, 64.3% of third parties decide to split the bonus equally between participant, and only 6.9% do not redistribute. When the winner is determined by performance, a lower number of third parties redistribute earnings, as 25.3% of third parties choose not to redistribute. In this case, two-thirds of participants choose a transfer that ultimately leaves the best performer with more income than the worst performer.[51] Conditional on redistributing, there is no significant differences in the average amount transferred between the benchmark cases: average redistributed share is 47.1% in *luck only* and 45.7% in *effort only*. Using third parties answer, I classify third parties as libertarians if they do not redistribute income in *luck only*, and as egalitarian is they split equally the bonus in *effort only* and *luck only*. Finally, I classify as meritocrats third parties who give more to the best performer in *effort only* and equalize earnings in *luck only*. Using this classification, I find 7% of libertarians, 13% of egalitarians and 44% of meritocrats in my sample. [52]

Third parties also have to make one redistribution decision for a randomly selected pair of workers in each treatment, in which the bonus is by default allocated to the

[51]This includes the people who do not redistribute. The exact distribution of behaviors in those benchmark cases is shown in appendix B.5.

[52]My sample has slightly more meritocrats, less libertarians and about the same share of egalitarians than in Almås et al. (2020).

Table 5: Redistribution Descriptive Statistics

	Source of Income Inequality					
	Luck only	Effort only	Treatments with uncertainty			
			All	IH	IL	Heter.
Mean redistributed share	0.439	0.341	0.351	0.339	0.349	0.361
	(0.177)	(0.303)	(0.240)	(0.233)	(0.253)	(0.236)
Median redistributed share	0.5	0.3	0.35	0.35	0.35	0.4
Share split 50-50	**0.643**	0.172	0.230	0.230	0.195	0.264
Share do not redistribute	0.069	**0.253**	0.161	0.149	0.172	0.161
Observations	87	87	261	87	87	87

worker who succeeds. Third parties only know the worker's outcome, not their effort, luck or circumstances (in *Heterogeneous*).[53]. The redistribution pattern when there is uncertainty about what causes income inequality is closer to the *effort only* benchmark when it comes to the number of third-party who choose an equal split. The level of 50-50 split is 41 percentage points lower than in the *luck only* case. Across our three treatments, 16.1% choose not to redistribute.

A regression with the redistributed share as dependent variable and treatment dummy confirm that there is no difference in how third parties redistribute between treatment (table 6). Both third parties preferences and beliefs affect redistribution. The more third party redistribute when they know the causes of income inequality (i.e., in the two benchmark questions), the more they redistribute when there is uncertainty about it. Next, beliefs about the characteristics of the worker who succeed also seem to play a role. The higher the expected *effort of the worker who reach*, the less is transferred ($p < 0.05$).[54] Third parties seem to care about the causes of the winner's success, and they redistribute less when the worker who succeeds exert more effort. This has the flavor of a meritocratic behavior. Unlike effort and luck, beliefs about worker's circumstances have no effect on redistribution in this stage.[55] Finally, I also consider whether

[53]Pairs that are formed are always comprised of who worker who succeed and one who fail. Participants are reminded of their beliefs conditional on the outcome

[54]The higher the expected luck of the worker who reach in the pair, the more is transferred, although this is only significant at 10% level.

[55]Looking at each treatment separately, I confirm that beliefs about worker's circumstances do not affect redistribution in the *Heterogeneous* treatment. See Appendix B.6, where I look into more details at the determinants of redistribution behavior for each treatment separately.

the magnitude of difference in third-party's conditional expectations affect redistribution, for instance how much additional effort a third party expect workers who succeed to exert compared to those who fail (see column 2 in table 6). The larger the gap between the expected effort of the worker who succeeds and the worker who fail, the less third party redistribute.

RESULT 5: *When third parties only observe worker's outcome, fairness preferences influences redistribution more than beliefs about worker's effort, luck, and circumstances. Third parties redistribute less when the difference between the expected effort of the worker who succeeds and the worker who fails increases.*

4.4.2 Redistribution With Known Circumstances

In stage 3, third parties redistribute income for two "one-winner" pairs. This time they are told each worker's circumstances in addition to their outcome. Before redistribution, we show third parties a table indicating the probability of success in the *Heterogeneous* treatment given different combinations of circumstances and effort.[56].

Third parties redistribute much less when the worker who succeeds has lower circumstances, as shown in table 7. Around thirty-eight percent of third parties decide *not* to redistribute in that case, which is the modal behavior, and only 10.3% split the bonus equally. By contrast, the most prevalent behavior (33.8%) among third parties is to split earnings equally between workers when the worker who succeeds has better circumstances. On average, third parties redistribute 40.3% of the earnings to the worker who fail when the worker who succeeds has better circumstances, but redistribute only 26.7% of earnings when the winner has worse circumstances. The difference in average redistribution level is significant at 1% level (two-sample t-test).[57] For pairs in which the winner has lower circumstances, the lower levels of redistribution seems to be driven by the belief that the disadvantaged worker who succeeds did about 30% more effort than the one who fail (254 vs 192, $p < 0.01$). This is suggestive of meritocratic behavior, where people want to reward hard work. Third parties may consider that workers who

[56]For example, third parties learn that correctly placing 200 sliders with a circumstances of 1000 gives 25% chance of reaching the target, and 50% chance if the circumstances is 1500. Third parties are told explicitly that "if two workers exert the same effort, the one who has better circumstances has a greater chance of reaching the target."

[57]When pairs are randomly formed, the case in which the worker who succeeds in the pair has lower circumstances while the one who fail has better circumstances occurs naturally much less often. Hence, forming a pair in which the winner started with worse circumstances is less likely.

Table 6: Redistributed Share

	(1)	(2)
Belief average effort if succeed	-0.056**	
	(0.028)	
Belief average effort if fail	0.033	
	(0.021)	
Belief average luck if succeed	0.935*	
	(0.551)	
Belief average luck if fail	-0.557	
	(0.565)	
Belief average circumstances if succeed	-0.084	
	(0.528)	
Belief average circumstances if fail	0.380	
	(0.629)	
Belief difference in effort		-0.040**
		(0.019)
Belief difference in luck		0.677
		(0.416)
Belief difference in circumstances		-0.214
		(0.458)
Effort only redistribution	0.166**	0.165**
	(0.079)	(0.078)
Luck only redistribution	0.353***	0.350***
	(0.136)	(0.134)
Treatment dummy	Yes	Yes
Subject FE	Yes	Yes
Groups	87	87
Observations	261	261

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. OLS with subject Fixed Effects

Notes: To improve readability of the coefficients, the belief about circumstances are in hundreds. The "Belief difference in effort" independent variable is the difference between the expected effort of workers who succeeds and the expected effort of workers who fail. The same goes for the "Belief difference in luck" and "Belief difference in circumstances" beliefs: they are the difference in beliefs conditional on the outcome. "*Luck only* redistribution" refers to the amount transferred from the lucky to the unlucky worker in the *luck only* benchmark case. "*Effort only* redistribution" refers to the amount transferred from the best to the worst performer in the *effort only* benchmark case.

succeed despite having worse circumstances had to work harder and are entitled to their earnings.[58]

Table 7: Redistribution With Known Circumstances

			Member who succeeds in pair has	
		All	better circumstances	worse circumstances
Mean redistributed share		0.380	0.403	**0.267**
		(0.257)	(0.236)	(0.328)
Median redistributed share		0.425	0.45	0.15
Share split 50-50		0.299	**0.338**	0.103
Share do not redistribute		0.149	0.103	**0.379**
Average circumstances	if succeed	1525	1698	663
	if fail	761	655	1290
Mean belief about effort (Truth)	if succeed	214 (245)	**206** (242)	**254** (261)
	if fail	187 (198)	186 (189)	192 (241)
Observations		174	145	29

A regression with the redistributed share has dependant variable confirm that third parties take circumstances into account. When workers' circumstances are known, the difference between the observed circumstances seems to be good predictor of redistribution behavior, as shown in the table 8. The larger is the difference in circumstances between the workers in the pair, the more third parties redistribute income.

RESULT 6: *When third parties know worker's circumstances, the larger is the difference in circumstances between the workers in the pair, the more they redistribute income. However, third parties redistribute less if the worker who succeed in the pair starts with worse circumstances: 38% of third parties do not redistribute in that case. This is suggestive of meritocratic behavior.*

[58] In the case where the successful member of the pair has better circumstances, third parties believe that they also work more than those who fail on average (206 vs 186, $p < 0.05$). When the disadvantaged worker succeeds, third parties infer (properly in our data) that the winner exerted more effort.

Table 8: Redistributed Share

	(1)
Difference in circumstances	0.481***
	(0.167)
Belief difference in effort	-0.016
	(0.016)
Belief difference in luck	0.044
	(0.698)
Third party's outcome	-6.574*
	(3.724)
Effort only redistribution	0.328**
	(0.065)
Luck only redistribution	0.421***
	(0.107)
Subject FE	Yes
Groups	87
Observations	174

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. OLS with Subject Fixed Effects.

Notes: To improve readability of the coefficients, the difference in circumstances is in hundreds. It is the difference between the circumstances of the worker who succeeds and the circumstances of the worker who fails. The third party's outcome is a dummy variable equal to 1 if the third party succeed in the effort task as a worker in stage 3. The belief difference in effort (luck) is the difference between the expected effort (luck) of the worker who succeeds and the worker who fails.

5 Conclusion

In this paper, I show that individual circumstances have important effects on effort, people's beliefs about what causes success or failure, and therefore redistribution. I introduce a theoretical model in which the worker's production depends on effort, circumstances and luck. In real life, we tend to believe that success is positively correlated with effort. When I introduce circumstances, success is instead negatively correlated with effort. In my environment, I show that the optimal effort is decreasing in circumstances. Workers with better circumstances are more likely to succeed, which reduces the optimal effort. Hence, the rational belief is that average effort of those who succeed is lower than those who fail. Provided that third parties are able to make the right inference, this should affect the redistribution of people with meritocratic preferences.

I run a real-effort experiment using the slider task introduced by Gill & Prowse (2019) to see how workers adjust their level of effort to various circumstances, and if third parties are able to draw the right inferences about why people succeed or fail. Finally, I look at the way those inferences affect third parties' propensity to redistribute income. Workers in the experiment adjust their effort level to the circumstances they receive. There is a negative correlation between effort and circumstances in the top half of the circumstances distribution. Workers who have circumstances values in the top decile of the distribution exert on average less effort, yet succeed more. I also observe lower levels of effort when workers have unfavorable circumstances. This is partly driven by a significant fraction of subject who choose to provide no effort when they have unfavorable circumstances, which I call the *demotivation effect*.

Circumstances also complicate inferences about what causes inequality. When there is heterogeneity in circumstances, two-thirds of participants believe that workers who succeed on average have better circumstances and exert more effort than those who fail. When third parties observe only the outcome and not effort or luck directly, beliefs have little effect on redistribution. However, when third parties observe differences in circumstances, they take them into account when they redistribute income. The larger the circumstances difference between workers, the higher the level of redistribution. But if the successful worker started with lower circumstances, 38% of third parties do not redistribute income. This behavior, which compensates for luck and rewards effort, is consistent with meritocratic preferences.

By modifying the parameters $\overline{\lambda}$ and δ, the model offers the flexibility to adjust which factor affect the worker's outcome, and generates income inequality. For instance, with identical circumstances and little variance in luck, the workers need to exert high effort to succeed. With high heterogeneity in circumstances and low variance in luck, the workers more likely to succeed are those who have better circumstances. With identical circumstances and high luck variance, the workers more likely to succeed are those with higher luck draws, though some effort is still a necessary condition for success. Each of these configurations may have affect worker's effort, third parties inference, and therefore redistribution.[59]

This paper stresses a crucial point: whether people believe that they live in a society in which there are equal or unequal circumstances will affect their beliefs about what causes inequality. Two people with the same fairness preferences may make very different inferences about what causes income inequality, if one believe that everyone starts with equal chance to succeed whereas the other thinks circumstances are heterogeneous. Related to circumstances, perceptions of social mobility will interact with the beliefs about the source of inequality to affect redistribution (Alesina, Stantcheva, & Teso, 2018; Alesina & Angeletos, 2005). Those who think that social mobility is high believe that everyone has a chance to succeed, even if they start with different circumstances. Mobility is for Benabou & Ok (2001a) *"an equalizer of opportunities"*.[60] Children of poor families can become rich through hard work (upward mobility), children of rich families can become poor if they do not work hard enough (downward mobility), therefore less redistribution is needed (Benabou & Ok, 2001b). Our model can also be used to incorporate social mobility by making success feasible only to workers who receive favorable circumstances.[61] This can provide a fruitful avenue for future theoretical and experimental research.

[59]Case (1) looks like a meritocratic society in which success is more likely for worker's who exert higher effort, while case (2) resemble a oligarchic society with low mobility, where success depends on individual's exogenous circumstances.

[60]They note that mobility matters especially since "*it helps attenuates the effects of disparities in initial endowments, or social origins, on future income prospects*"

[61]This can be done by weighting the circumstances by a factor greater than one, or by increasing both the target production and the heterogeneity in circumstances

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A Appendix A: Omitted Proofs

A.1 Proof of Proposition 1: Optimal Effort

Proposition 1 *The optimal effort e_i^* is equal to*

$$\begin{cases} \left(\frac{x\,(1-\kappa_i)\,s_i}{b\,\overline{\lambda}}\right)^{\frac{1}{3}} & \text{if} \quad \kappa_i > 1-\overline{\lambda}\left(\frac{x\,s_i}{b}\right)^{\frac{1}{2}} \\ 0 & \text{otherwise} \end{cases} \tag{8}$$

Proof:

The workers succeeds when $P_i \geq 1$, that is, if $\lambda_i \geq \frac{1-\kappa_i}{e_i}$. Recall that since $s \sim \mathcal{U}\left[0, \overline{\lambda}\right]$, the probability p that worker i succeeds is given by: [62]

$$p = p(\lambda_i \geq \frac{1-\kappa_i}{e_i}) = \frac{e_i\overline{\lambda} + \kappa_i - 1}{e_i\overline{\lambda}} \tag{9}$$

The probability q that the other worker j in the group reaches the target is:[63]

$$q = p\left(\lambda_j \geq \frac{1-\mathbb{E}[k_j]}{e_j}\right) = \frac{e_j\overline{\lambda} + \kappa - 1}{e_j\,\overline{\lambda}}$$

worker i learns his circumstances κ_i and knows the luck distribution. Hence, he solves:

$$\max_{e_i \geq 0} \; x\;pq + s_i\,x\;p(1-q) + (1-s_i)\,x\;(1-p)q - c(e_i) \tag{10}$$

Maximizing with respect to e_i gives:

$$c'(e_i) = \frac{x\,(1-\kappa_i)\,s_i}{e_i^2\,\overline{\lambda}} \tag{11}$$

[62] I also derive in Appendix A4 the optimal effort with the more general case where $s \sim \mathcal{U}\left[\underline{\lambda}, \overline{\lambda}\right]$

[63] I assume that i knows κ_i but not κ_j. When worker i knows both κ_i and κ_j, then $q = \frac{e_j\,\overline{\lambda}+k_j-1}{e_j\overline{\lambda}}$. Using this does not change the result of the maximization problem.

In the rest of the paper, I assume that $c(e_i) = b\frac{e_i^2}{2}$, then:[64]

$$e_i^* = \left(\frac{x\,(1-\kappa_i)\,s_i}{b\,\overline{\lambda}} \right)^{\frac{1}{3}} \tag{12}$$

Corner case:

Given their circumstances and the luck distribution, it is optimal for the worker to exert no effort if the optimal effort prescribed by solving problem (10) is too small to yield a positive probability of success. Using (9), the probability of success is positive if:

$$e_i > \frac{1-\kappa_i}{\overline{\lambda}} \tag{13}$$

Any positive optimal effort e_i^* must satisfy (13). If this condition does not hold, it is impossible for the worker to succeed even if they draw the highest possible luck $\overline{\lambda}$, and so they are better off exerting no effort. Note that even if the worker provides no effort, the expected payoff may still be positive. This occurs if they expect the third party to redistribute some income to the person who fail by choosing $1 - s_i > 0$.

Given e_i^* for our effort cost function, we plug in (12) on the left-hand side of (13) and can rewrite:

$$\kappa_i > 1 - \overline{\lambda} \left(\frac{x\,s_i}{b} \right)^{\frac{1}{2}} \tag{14}$$

This gives a lower bound on the worker's circumstances for which the worker exerts positive effort. If (14) does not hold, the circumstances is too small and the worker will never reach the target given the optimal effort induced by $c(e_i)$, hence chooses $e_i^* = 0$.

To sum up, the optimal effort is:

$$e_i^* = \begin{cases} \left(\frac{x\,(1-\kappa_i)\,s_i}{b\,\overline{\lambda}} \right)^{\frac{1}{3}} & \text{if} \quad (14) \quad \text{holds} \\ 0 & \text{otherwise} \end{cases}$$

[64] DellaVigna & Pope (2018) use the power cost function $c(e_i) = \frac{b\,e_i^{1+\gamma}}{1+\gamma}$ to estimate their model parameters, using data from a real-effort experiment. They also consider an exponential cost function $c(e_i) = \frac{b\,exp(\gamma e_i)}{\gamma}$.

A.2 Proof of Proposition 2: Optimal Effort Comparative Statics

$$e_i^* = \left(\frac{x\,(1-\kappa_i)\,s_i}{b\,\overline{\lambda}}\right)^{\frac{1}{3}}$$

Proposition Proposition 2 *If the optimal effort is positive, then it is increasing in x and s_i, and decreasing in b, κ_i and $\overline{\lambda}$.*

Proof.

$$\frac{\partial e_i*}{\partial \kappa_i} = \underbrace{-\frac{1}{3}(1-\kappa_i)^{-\frac{2}{3}}}_{\leq 0}\left(\underbrace{\frac{x\,s_i}{b\,\overline{\lambda}}}_{>0}\right)^{\frac{1}{3}}$$

Recall that $\kappa_i \leq 1$ (the circumstances is never greater than the target, which I normalize to 1). Hence, $\frac{\partial e_i*}{\partial \kappa_i} \leq 0$.

$$\frac{\partial e_i*}{\partial x} = \underbrace{\frac{1}{3}x^{-\frac{2}{3}}}_{>0}\left(\underbrace{\frac{(1-\kappa_i)\,s_i}{b\,\overline{\lambda}}}_{\geq 0}\right)^{\frac{1}{3}}$$

Hence, $\frac{\partial e_i*}{\partial x} \geq 0$.

$$\frac{\partial e_i*}{\partial s_i} = \underbrace{\frac{1}{3}(s_i)^{-\frac{2}{3}}}_{>0}\left(\underbrace{\frac{x\,(1-\kappa_i)}{b\,\overline{\lambda}}}_{\geq 0}\right)^{\frac{1}{3}}$$

Hence, $\frac{\partial e_i*}{\partial s_i} \geq 0$.

$$\frac{\partial e_i*}{\partial b_i} = \underbrace{\frac{1}{3}(-\frac{1}{b_i^2})^{-\frac{2}{3}}}_{<0}\left(\underbrace{\frac{x(1-\kappa_i)\,s_i}{\overline{\lambda}}}_{\geq 0}\right)^{\frac{1}{3}}$$

Assuming $b_i > 0$, $\frac{\partial e_i*}{\partial b_i^s} \leq 0$.

$$\frac{\partial e_i*}{\partial \overline{\lambda}} = \underbrace{\frac{1}{3}(-\frac{1}{\overline{\lambda}^2})^{-\frac{2}{3}}}_{<0}\left(\underbrace{\frac{x(1-\kappa_i)\,s_i}{b_i}}_{\geq 0}\right)^{\frac{1}{3}}$$

Hence, since $\overline{\lambda} > 0$, $\frac{\partial e_i*}{\partial \overline{\lambda}} \leq 0$.

A.3 Proof of Propositions 3 and 4: Third Party's Conditional Beliefs

First, note that the unconditional beliefs about luck and circumstances are simply

$$\mathbb{E}[\lambda_i] = \frac{\overline{\lambda}}{2} \text{ and } \mathbb{E}[\kappa_i] = k$$

The expected optimal effort is:

$$\begin{aligned}\mathbb{E}[e_i^*] &= \int_{\kappa-\delta}^{\kappa+\delta} \Big(\frac{x\,(1-\kappa_i)\,s_i}{b_i\,\overline{\lambda}}\Big)^{\frac{1}{3}}\,dk \\ &= \Big(\frac{x\,s_i}{b_i\,\overline{\lambda}}\Big)^{\frac{1}{3}}\,\frac{3}{4}\Big((1-\kappa+\delta)^{\frac{4}{3}} - (1-\kappa-\delta)^{\frac{4}{3}}\Big)\end{aligned}$$

Proposition 3 *The expected circumstances conditional on success and failure are respectively given by:*

$$\mathbb{E}[\kappa_i|P_i \geq 1] = \int_{\kappa-\delta}^{\kappa+\delta} \kappa_i\, \frac{p(P_i \geq 1|\kappa_i, e_i^*)\; p(\kappa_i)}{\int_{\kappa-\delta}^{\kappa+\delta} p(P_i \geq 1|\kappa_i, e_i^*)\; p(\kappa_i)\;dk}\;dk \tag{15}$$

$$\mathbb{E}[\kappa_i|P_i < 1] = \int_{\kappa-\delta}^{\kappa+\delta} \kappa_i\, \frac{p(P_i < 1|\kappa_i, e_i^*)\; p(\kappa_i)}{\int_{\kappa-\delta}^{\kappa+\delta} p(P_i < 1|\kappa_i, e_i^*)\; p(\kappa_i)\;dk}\;dk \tag{16}$$

Proposition 4 *The expected effort conditional on success and failure are respectively given by:*

$$\mathbb{E}[e_i|P_i \geq 1] = \Big(\frac{x\,(1-\mathbb{E}[\kappa_i|P_i \geq 1])\,s_i}{b\,\overline{\lambda}}\Big)^{\frac{1}{3}} \tag{17}$$

$$\mathbb{E}[e_i|P_i < 1] = \Big(\frac{x\,(1-\mathbb{E}[\kappa_i|P_i < 1])\,s_i}{b\,\overline{\lambda}}\Big)^{\frac{1}{3}} \tag{18}$$

Proofs:

The only information available to the third party is whether the worker reach the target or not. Conditional on observing success or failure, the third party will form a belief about the circumstances of the worker. Upon seeing a worker succeeds, the expected circumstances is:

$$\mathbb{E}[\kappa_i|P_i \geq 1] = \int_{\kappa-\delta}^{\kappa+\delta} \kappa_i \ p(\kappa_i|P_i \geq 1) \ dk$$

$$= \int_{\kappa-\delta}^{\kappa+\delta} \kappa_i \ \frac{p(P_i \geq 1|\kappa_i, e_i^*) \ p(\kappa_i)}{\int_{\kappa-\delta}^{\kappa+\delta} p(P_i \geq 1|\kappa_i, e_i^*) \ p(\kappa_i) \ dk} \ dk$$

where $p(P_i \geq 1|\kappa_i, e_i^*) = \frac{e_i^* \overline{\lambda} + \kappa_i - 1}{e_i^* \overline{\lambda}}$.

If a worker fails, the third party expects the worker to have drawn a circumstances of

$$\mathbb{E}[\kappa_i|P_i < 1] = \int_{\kappa-\delta}^{\kappa+\delta} \kappa_i \ p(\kappa_i|P_i < 1) \ dk$$

Finally, the expected (optimal) effort conditional on success or failure is just found by plugging the expected circumstances in the optimal effort function.

$$\mathbb{E}[e_i|P_i \geq 1] = \Big(\frac{x\,(1 - \mathbb{E}[\kappa_i|P_i \geq 1])\,s_i}{b_i\,\overline{\lambda}}\Big)^{\frac{1}{3}}$$

Influence of effort cost and luck distribution on the third party's conditional beliefs. The third party's inference are also influenced by changes in the individual cost of effort b_i and the distribution of luck. Increasing the cost of effort b_i decreases e_i^*, thus reducing the probability of success for all κ_i. As a result, only those with high κ_i to begin with keep succeeding. This increases $\mathbb{E}[\kappa_i|P_i \geq 1]$, which causes $\mathbb{E}[e_i|P_i \geq 1]$ to drop. Decreasing the upper bound of the luck distribution $\overline{\lambda}$ has two opposite effects. First it increases the optimal effort for all κ_i, which increases the overall chance of success. On the other hand, a decrease in $\overline{\lambda}$ reduces the chance of getting a good λ_i draw which decreases the probability of success $p(P_i \geq 1|\kappa_i, e_i^*)$. It is not clear which of the two effect dominates.

A.4 Optimal Effort When $s \sim \mathcal{U}\left[\underline{\lambda}, \overline{\lambda}\right]$

We follow the same reasoning as in A.1. When $s \sim \mathcal{U}\left[\underline{\lambda}, \overline{\lambda}\right]$, the probability that i succeeds is:

$$p = p(\lambda_i \geq \frac{1-\kappa_i}{e_i}) = 1 - p(\lambda_i < \frac{1-\kappa_i}{e_i}) = 1 - \frac{\frac{1-\kappa_i}{e_i} - \underline{\lambda}}{\overline{\lambda} - \underline{\lambda}} = \frac{e_i\overline{\lambda} + \kappa_i - 1}{e_i(\overline{\lambda} - \underline{\lambda})}$$

and the probability that j succeeds is

$$q = p\left(s_j \geq \frac{1 - \mathbb{E}[k_j]}{e_j}\right) = \frac{e_j\overline{\lambda} + \kappa - 1}{e_j(\overline{\lambda} - \underline{\lambda})}$$

Substituting p and q in (10) and maximizing with respect to e_i gives:

$$c'(e_i) = \frac{x\,(1-\kappa_i)\,s_i}{e_i^2\,(\overline{\lambda} - \underline{\lambda})} \tag{19}$$

Assuming that $c(e_i) = b_i \frac{e_i^2}{2}$, (19) becomes:

$$e_i^* = \left(\frac{x\,(1-\kappa_i)}{b_i\,(\overline{\lambda} - \underline{\lambda})} s_i\right)^{\frac{1}{3}}$$

A.5 Optimal Effort With Known Circumstances and Known Luck

When there is no uncertainty about λ_i, the worker knows exactly which level of effort is required to reach the target. Hence, if $\mathbb{E}[\pi_i|s_i, x, e_i, \kappa_i, \lambda_i] \geq c(e_i)$, the optimal effort is $e_i^* = 1$ when $\kappa_i = 0$, and $e_i^* = 1 - \kappa_i$ when $\kappa_i > 0$. If $\mathbb{E}[\pi_i|s_i, x, e_i, \kappa_i, \lambda_i] < c(e_i)$, then $e_i^* = 0$.

B Appendix B: Additional Analyses and Robustness Checks

B.1 Effect of Ability, Exhaustion and Time-Limit on Effort

In this section, I show that ability, fatigue and time constraints have little effect on worker's effort. Thus, knowing that participants achieve their desired effort level, we can compare effort between rounds and treatments.

Ability: I compute for each participant the average time spent per slider in each round. For example, a participant who correctly positions 200 sliders in 6 minutes (360 seconds) has an average time per slider of 1.8 seconds. Figure 11 display the distribution of the best average time per slider for each participant. I use this as a proxy for participant's ability, as it measures the maximal efficiency a participant is able to achieve across all their rounds. At their best, around two-thirds of participants spend between 1.75 and 2.25 seconds per slider.[65]

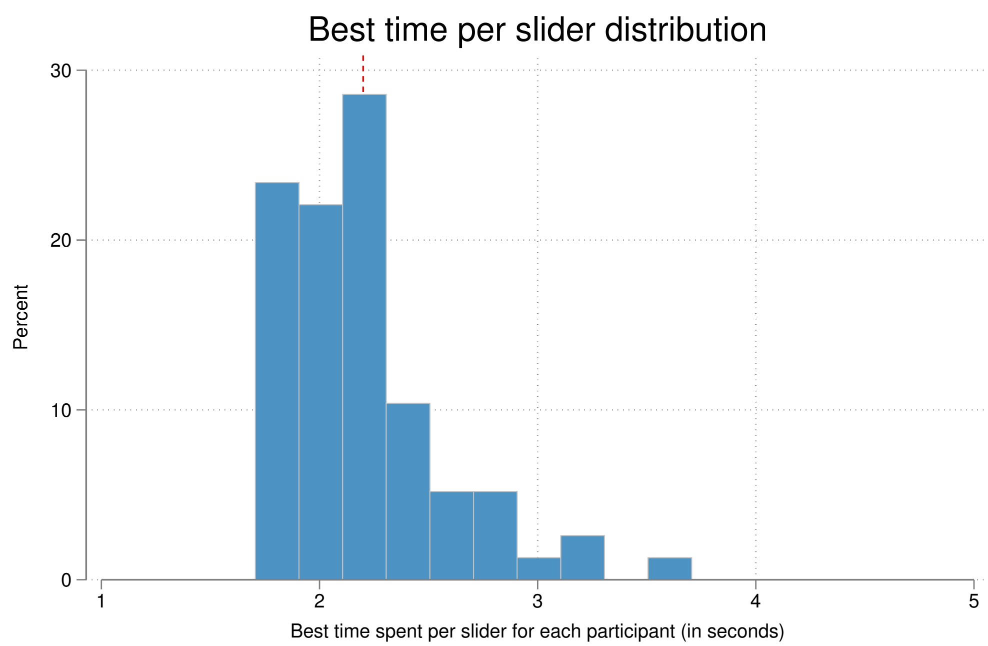

Figure 11: Distribution of participant's maximal efficiency: smallest time spend per slider across all rounds for each participant

Exhaustion and time constraint: Next, within subject, effort should not be affected by exhaustion or time constraint, so that any effort variation can be attributed to changes in the experiment parameters i.e., circumstances and luck. There is evidence that time is rarely binding, and of a limited effect of exhaustion. In the stage 1, most participants finish before the end of the 45 minutes that is allowed to do the five rounds. Participants spend on average 38 minutes and 45 seconds in the first round. Only four participants spend no time in the last round of the first stage because they run out of time, having spent the 45 minutes in the first four rounds. Around 93.1% of participants enter round 5 with more than four minutes left to complete the round. Therefore for the vast majority of our subjects, time is not binding. Next, figure 12 display for each round the average number of sliders solved and the average time spent per slider. Focusing on stage 1,

[65]More precisely 56 out of 87 (64.3%) participants spend between 1.75 and 2.25 seconds per sliders. Ninety percent of participants spend between 1.7 and 2.7 seconds per sliders.

there is no evidence of fatigue occurring in our experiment.[66] If anything, it seems that people are getting slightly more efficient with time as they spent 2.8 seconds per slider in the first round and only 2.38 seconds in round five. Those evidences suggest that the difference in within-subject effort levels observed in this experiment are the result of endogenous effort choice driven by our experiment parameters (while between-subject differences are due to unobserved individual effort cost), and not difference in abilities, fatigue or time constraint. In the next section, we show that individual effort in fact responds to changes in our parameters, and that effort is different across treatments.

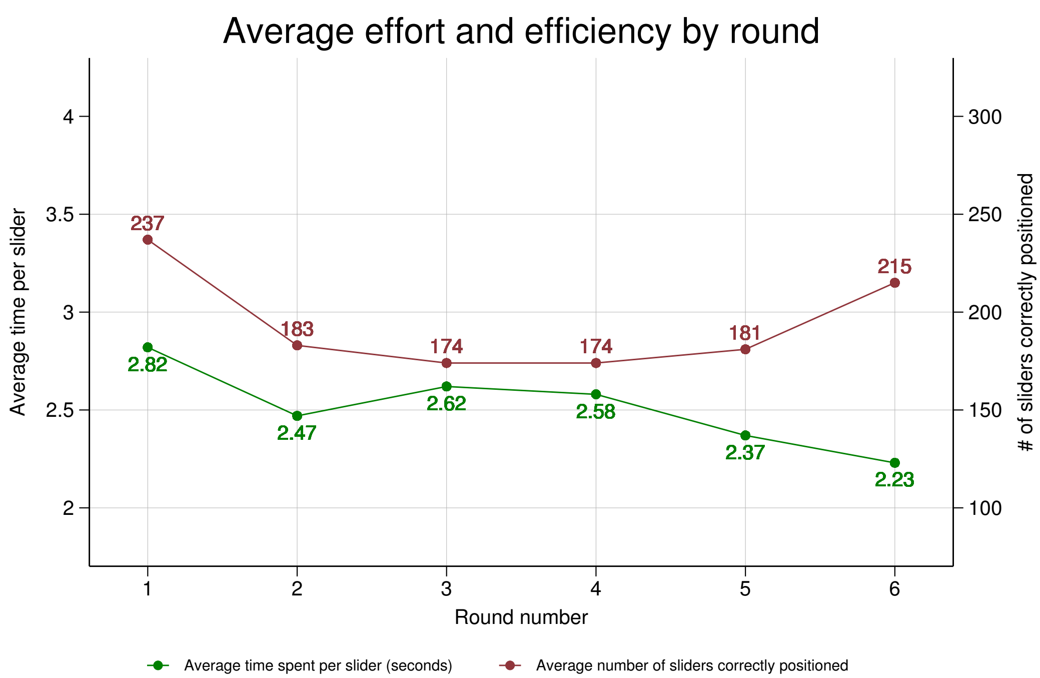

Figure 12: Average number of sliders solved and average time spent per slider for each round. Note: rounds 1 to 5 occur in the first stage, while round 6 occur in stage three at the end of the experiment.

B.2 Beliefs Conditional on The Outcome for all Treatments

[66]I focus on the first stage because participants spend around 10 minutes between the end of the stage 1 and stage 3 in which the last round of slider task occur. This delay may help people replenish their cognitive resources which could partially explain an increase in productivity in the last round.

Table 9: Beliefs conditional on *success*

		Treatment			Absolute difference	
		IL	IH	Heter.	IL vs IH	IL vs Heter.
Average effort if succeed	Truth	259	228	216	31^{***}	43^{***}
	Belief	215	197	205	18^{**}	10
	Δ Belief - Truth	-44	-31	-11		
Average luck if succeed	Truth	7.4	12.5	6.8	5.1^{***}	0.6
	Belief	6.8	11.9	6.5	5.1^{***}	0.3
	Δ Belief - Truth	-0.6	-0.6	-0.3		
Average circumstances if succeed	Truth	1250	1250	1649	0	399^{***}
	Belief	n/a	n/a	1497	n/a	n/a
	Δ Belief - Truth	n/a	n/a	-152		

Two-sample t-test: $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 10: Beliefs conditional on *failure*

		Treatment			Absolute difference	
		IL	IH	Heter.	IL vs IH	IL vs Heter.
Average effort if fail	Truth	190	161	154	29	37^{**}
	Belief	164	151	175	13	11
	Δ Belief - Truth	-26	-10	+21		
Average luck if fail	Truth	3.0	4.8	3.7	1.8^{**}	0.7
	Belief	3.6	6.1	3.8	2.5^{***}	0.3
	Δ Belief - Truth	+0.6	+1.3	+0.1		
Average circumstances if fail	Truth	1250	1250	843	0	407^{***}
	Belief	n/a	n/a	868	n/a	n/a
	Δ Belief - Truth	n/a	n/a	+25		

Two-sample t-test: $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

B.3 Heterogeneous Circumstances Treatment: Beliefs Conditional on the Outcome

The table below classify participants according to their beliefs about the circumstances and the level of effort made by the participants, depending on their outcome. For example, 55 participants believe that those who succeed on average have better circumstances *and* exert more effort than those who fail.

Table 11: Subject classification according to their beliefs conditional on the outcome (Heterogeneous treatment).

		Circumstances belief			
		Better if succeed	Same	Worse if succeed	**Total (%)**
Effort belief	Higher if succeed	55	2	4	**61 (70.1)**
	Same	4	0	0	**4 (4.6)**
	Lower if succeed	20	0	2	**22 (25.3)**
	Total (%)	**79 (90.8)**	**2 (2.3)**	**6 (6.9)**	**87 (100)**

Table 12: Beliefs **conditional on outcome** (Heterogeneous)

		Outcome		Difference
		Succeed	Fail	Succeed vs Fail
Average effort	Truth	216	154	63^{***}
	Belief	205	175	30^{***}
	Δ Belief - Truth	-11	+21	
Average luck	Truth	6.8	3.7	3.1^{***}
	Belief	6.5	3.8	2.6^{***}
	Δ Belief - Truth	-0.3	+0.1	
Average circumstances	Truth	1649	843	807^{***}
	Belief	1497	868	629^{***}
	Δ Belief - Truth	-152	+25	

Two sample t-test (truth) and paired t-test (beliefs): $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

B.4 Effect of Participants' Outcome on Their Belief

Does participants' performance affect their conditional beliefs? We identify two instances where conditional beliefs seem affected by the participant's outcome. In the baseline treatment, the belief about the average effort exerted by workers who succeed is significantly lower among participants who fail to reach the target compared to participants who succeed (205 vs 228, $p < 0.05$). In the *Heterogeneous* treatment, participants who miss the target provide a lower estimate for the average circumstances of workers who fail compared to their peers who reach the target (733 vs 982, $p < 0.01$).[67]

B.5 Fairness Preferences

The table below classify participants according to their redistribution behavior in the *luck only* and *effort only* benchmark cases. In *effort only* the redistributed share corresponds to the share sent from the best performer to the worst performer. In *luck only* the share corresponds to the share sent from the lucky to the unlucky. Third parties can redistribute up to 100 points (worth $1 in the experiment), hence this renders the interpretation of the redistributed amount of points straightforward in terms of percentage.

Table 13: Redistribution behavior in the benchmark cases

		redistributed share: *effort only*				
		0	1-49	50	51-100	**Total (%)**
redistributed share: *luck only*	0	4	0	1	1	**6 (6.9)**
	1-49	5	9	2	2	**18 (20.7)**
	50	13	25	11	7	**56 (64.3)**
	51-100	0	2	1	4	**7 (8.0)**
	Total (%)	**22 (25.3)**	**36 (41.4)**	**15 (17.2)**	**14 (16.1)**	**87 (100)**

B.6 Redistribution Conditional on the Outcome

The table below reports the results of a regression for each separate treatment. Note that I do not use the circumstances beliefs or difference in circumstances beliefs as regressors for the treatments with identical circumstances, precisely because circumstances are fixed in those cases.

[67]Both types of participants underestimate the truth in the baseline treatment, which is 259. In the *Heterogeneous* treatment, the average circumstances of workers who miss is 843, so participants who miss the target underestimate the circumstances of workers who fail, while participants who reach the target overestimate them.

Table 14: Regression of Belief and Preference on Redistributed Share

	Identical-Low		*Identical-High*		*Heterogeneous*	
	(1)	(2)	(3)	(4)	(5)	(6)
Belief difference in effort	-0.052		-0.074*		-0.072	
	(0.038)		(0.042)		(0.050)	
Belief difference in luck	2.996**		1.034		-0.962	
	(1.292)		(0.722)		(1.161)	
Belief difference in circumstances					-0.000	
					(0.556)	
Belief average effort if succeed		-0.073		-0.081		-0.108
		(0.054)		(0.064)		(0.065)
Belief average effort if fail		0.045		0.074*		0.067
		(0.044)		(0.042)		(0.050)
Belief average luck if succeed		4.078**		1.544		-2.175
		(1.860)		0.946		(1.500)
Belief average luck if fail		-1.465		-0.676		-0.585
		(2.143)		(0.827)		(1.610)
Belief average circumstances if succeed						0.002
						(0.006)
Belief average circumstances if fail						0.003
						(0.008)
Luck only redistribution	0.366*	0.358*	0.469***	0.0492***	0.270*	0.265*
	(0.199)	(0.198)	(0.110)	(0.120)	(0.149)	(0.157)
Effort only redistribution	0.174	0.185	0.080	0.079	0.220**	0.192*
	(0.120)	(0.122)	(0.082)	(0.082)	(0.104)	(0.107)
Constant	5.808	-1.376	7.933	0.095	22.001**	40.021**
	(8.400)	(19.124)	(8.366)	(15.864)	(8.290)	(17.711)
Observations	87	87	87	87	87	87

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Robust standard errors in parentheses.

Notes: the "Belief difference in effort" independent variable is the difference between the expected effort of workers who succeeds and the expected effort of workers who fail. Same goes for the "Belief difference in luck" and "Belief difference in circumstances" beliefs. "*Luck only* redistribution" refers to the amount transferred from the lucky to the unlucky worker in the *luck only* benchmark case. "*Effort only* redistribution" refers to the amount transferred from the best to the worst performer in the *effort only* benchmark case. A Breusch-Pagan test for heteroskedasticity was not significant for the *Identical-High* and *Hetergogeneous* treatment, but was highly significant for the *Idential-Low* treatment. Hence, I adopt a conservative approach and use robust standard errors for all the treatments.

C Appendix C: Experiment Instructions

Welcome to the experiment. You will now take part in an experiment on decision making. In addition to the show-up fee of $5, you can earn additional money which will be paid in cash at the end of the experiment. How much you earn depends on your decisions, the decisions of others, and on chance.

Instructions

Overview

There are **three stages** in this experiment. We will give you instructions at the beginning of each stage.

This **first stage consists of 5 rounds**. During each round, you will perform the same task.

The task involves a screen with 300 sliders. Each slider is initially positioned randomly. You can use the mouse in any way you like to move each slider. You can readjust the position of each slider as many times as you like. Your *slider score* will be determined by the number of sliders that are positioned exactly in the middle when you decide to stop working on the task. A green dot will appear on a slider when it is correctly positioned. How many sliders you decide to correctly position is up to you. You don't have to correctly position all the sliders in each task.

You may take as much time as you want working on a task, but you have 45 minutes to finish the 5 rounds of the first stage. A timer will indicate how much time you have left. If you finish early, you may use your phone silently while others finish the stage.

In each round, **if you reach a production target of 2500 you will receive 100 points. If you don't reach the target you will receive 0 points.** Your production is calculated as follows:

1. First, in each round you will receive a starting line, which is a randomly selected integer with a minimum value of 0 but never greater than the target. You will always know what your starting line is before adjusting the sliders.
2. Next you will receive a multiplier value, which is a randomly selected integer with a minimum value of 0 but never more than 20. Unlike the starting line, you will NOT know the value of your multiplier before adjusting the sliders.
3. After you complete the task, your production will be calculated as follows: first we will multiply your slider score (the number of sliders correctly positioned) by your multiplier. Then we will add your starting line. The formula is as follows:

Production = Starting line + (Multiplier * Slider score)

Examples

Example 1:
Suppose your randomly selected starting line (which you will know) is **1500**, and that your

randomly selected multiplier (which you won't know before adjusting the sliders) is **5.**

If you correctly position 100 sliders, your slider score is **100**. Then your production will be **1500** + **5***100** = 2000. Since your production is less than the target production of 2500, you miss the target and receive 0 points.

Instead, if you correctly position 250 sliders, your slider score is **250**. Then your production will be **1500** + **5***250** = 2750. Since your production is equal to the target of 2500, you reach the target and receive 100 points.

As shown in this example, you might not need to correctly position all the 300 sliders to reach the target.

Example 2:
Suppose your randomly selected starting line is **500**, and that you correctly position 300 sliders, so your slider score is **300**.

If your randomly selected multiplier is **5**, then your production will be **500** + **5***300** = 2000. Since your production is less than the target, you receive 0 points.
Instead, if your randomly selected multiplier is **10**, then your production will be **500** + **10***300** = 3500. Since your production is greater than the target, you receive 100 points.

As shown in this example, you might not reach the target even if you correctly position all the 300 sliders.

<u>Starting line and multiplier</u>

Ranges

You will always be told the possible ranges for your starting line and multiplier. But the ranges may change depending on the round, so it is important to check these at the beginning of each round because they will affect your production value.

In some rounds, your multiplier will be selected between 0 and 10. In other rounds it will be selected between 0 and 20.

In some rounds, your starting line is set at 1250. In other rounds it will be selected between 0 and 2500.

Random selection

When your multiplier or starting line is randomly selected in a given range, **each number in the range (boundary points included) has an equal probability of being selected.**

For instance, if your multiplier is randomly selected between 0 and 10, then each number (0, 1,..., 9, 10) has an equal chance (1/11) of being selected.

If your starting line is randomly selected between 0 and 2500, then each number (0, 1,..., 2499, 2500) has an equal chance (1/2501) of being selected.

Earnings

You can earn points in this experiment in two ways :

First, you can earn points based on whether you succeed or fail in reaching the target.

In each round, **if you reach the target you will receive 100 points.** If your production exceeds the target, it does not matter by how much your production exceeds the target. In all such cases you will receive the same 100 points.

On the other hand, **if you don't reach the target you will receive 0 points.** It doesn't matter whether you miss the target by a lot or almost reach it.

In addition, you can also earn points based on the accuracy of your guesses to some questions. Since you will be asked to make multiple guesses, you may in fact earn more points from your guesses than from reaching the target. For each guess, you will be paid according to the following rule:

100 points - Penalty

If the difference between your guess and the true value is less than 40, the penalty is equal to:

$$6\%*(\text{Guess} - \text{Truth})^2$$

Otherwise, the penalty equals 100 points.

The formula means that the closer your guess is to the true value, the smaller your penalty will be and the more points you will receive, regardless of whether your guess is above or below the true value. Since the maximum penalty is 100 points, you will never lose points if your guess is too far from the truth.

Example:
Suppose we ask you to guess the percentage of participants who reach the target in a given round. If 50% of participants reach the target, and your estimate is 70% (or 30%), the difference

is 20 percentage points. The penalty is $6\% * (70-50)^2 = 6\% * (20)^2 = 6\% * 400 = 24$ points. Thus, you earn 100 - 24 = 76 points.

Using this formula, if 50% of people reach the target, your earnings from your guess are:

If your guess is	Difference between your guess and the truth	Penalty (pts)	Earnings (pts)
50	0	0	100
55 or 45	5	1.5	98.5
60 or 40	10	6	94
70 or 30	20	24	76
80 or 20	30	54	46
90 or 10	40	96	4
less than 10 or more than 90	>40	100	0

To calculate your final payment at the end of the experiment, we will convert your total number of points earned into dollars at a rate of 1 point = $0.01.
For instance, if you accumulated 1000 points over the course of the experiment, you will receive a payment of 1000*0.01=$10, in addition to the show-up fee, for a total of $15.

Stage 2

In the next screens, you will be presented with a series of decisions to make. Each decision involves sharing a bonus of 100 points between two participants.

These choices are hypothetical, meaning they won't affect your earnings or the earnings of other participants. However, try to answer the questions as if they had real consequences.

Stage 3

In this stage, there will be **one last slider task**. The time limit is 10 minutes. As before, if you reach the target you will receive 100 points. If you don't reach the target, you will receive 0 points.

After completing the slider task, **you will be paired with another participant**. A pair will always consist of one member who reached the target, and one who didn't. So, if you reached the target you will be paired with someone who did not, and vice versa.

Your pair will be randomly assigned to at least one other participant, who will decide how to allocate a bonus of 100 points between the two of you. The other participant will be told who reached the target in the pair, and their decision will directly affect your earnings.

You won't know the identities of the other person in your pair or the person making the redistribution decision. If your pair is shown to more than one participant, we will randomly choose one of the decisions made for your pair to determine the amount you will earn.

You will also have to decide how to allocate a bonus of 100 points between the members of one or two randomly chosen pairs of other participants. Your decision will directly affect their earnings.

You won't know the identities of these participants, and they won't know who made the redistribution decision for them. You will never have to make a redistribution decision for a pair to which you belong.

Additional information

We would now like to give you additional information regarding how likely it is to reach the target given different combinations of starting line and slider score. This is displayed in the table below, for the case that the multiplier value is between 0 and 10.

		Slider score						
		1	50	100	150	200	250	300
Starting line	0	0%	0%	0%	0%	0%	0%	17%
	500	0%	0%	0%	0%	0%	20%	33%
	1000	0%	0%	0%	0%	25%	40%	50%
	1500	0%	0%	0%	33%	50%	60%	67%
	2000	0%	0%	50%	67%	75%	80%	83%
	2500	100%	100%	100%	100%	100%	100%	100%

This table tells you, for instance, that participants who correctly position 200 sliders have a 75% chance of reaching the target with a starting line of 2000 (whether they succeed or not depends on the value of their multiplier). With the same slider score of 200, they have a 50% chance of reaching the target with a starting line of 1500, a 25% chance with a starting line of 1000, and a 0% chance with a starting line of 500 and below. **So, if two participants make the same effort and obtain the same slider score, the one who draws a higher starting line has a greater chance of reaching the target.**

Looking at the table, we also see that if participants want, for example, a 50% chance of reaching the target, then they must correctly position 300 sliders if their starting line is 1000, 200 if their starting line is 1500, and only 100 if their starting line is 2000. **So, participants drawing lower starting lines must put in more effort to have the same chance of reaching the target as those with higher starting lines.**