Minimum Wage, Fairness, and Worker Productivity

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Will a minimum wage affect worker productivity? If there does exist an effect, will it be the same for high-wage and low-wage workers? In this paper, I develop a theoretical framework to demonstrate how the effect of a minimum wage on worker productivity can be transmitted via two channels: (a) workers adjust their perceived fair wage to the new minimum wage; (b) group norms for effort change under the new minimum wage. Moreover, the framework also considers whether the minimum wage is actively introduced or passively complied with by the firm, which reveals the intention behind the action and interacts with the above two channels to influence worker productivity. To test the model's predictions, I propose a laboratory experiment where "workers" perform real effort tasks and choose their effort level under varying wage schemes.

Minimum wages are on the rise in the United States. On the federal level, the Biden administration has vowed to push Congress to increase the federal minimum wage to $15 per hour by 2025 from the current $7.25 per hour since as early as his presidential campaign. On the state level, for example, Florida passed a measure in 2020 to raise the state's minimum wage to $15 per hour by 2026 from the current $8.56 per hour. On the business level, for example, Amazon raised its minimum

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wage for all U.S. employees to $15 per hour in November 2018 and Target has also been raising its minimum hourly wage since 2017 and met its target of $15 in July 2020. Do the workers who made below and above the new minimum wage have the same view on the fairness of the policy? If they do not, how will the different views affect their productivity?

The study of minimum wage has always been accompanied by debates and controversies. Economists have long had different opinions on the (dis)employment effects of the minimum wage: while some of the empirical research finds negative effects of an increase in the minimum wage on low-wage employment, other studies provide evidence for an insignificant or even positive employment effect. Researchers have also found conflicting evidence of minimum wage's impact on prices. Using different methods, some empirical studies obtain evidence for rising prices in response to an increase in the minimum wage while others fail to detect statistically significant changes in prices following a minimum wage hike. Another example of an area in which the effect of the minimum wage lacks conclusive evidence is firm profitability. While some find that the value of firms sees no difference in response to increases in the minimum wage, others find a fall in firm profitability in the event of a minimum wage increase. To get a glimpse of the recent minimum wage discussions, see, for examples, Cengiz et al. (2019), Neumark and Shirley (2021), Clemens (2021), and Brown and Hamermesh (2019).

Amidst all the controversies surrounding the minimum wage, a question less studied is its effect on worker productivity. To the best of my knowledge, there have only been three studies that directly tackle this problem so far: Hill (2018), Ku (2020), and Coviello et al. (2020).

Using data from a large strawberry farm in Northern California that employs strawberry pickers who are under a piece-rate contract with an hourly minimum wage, Hill (2018) is the first to present empirical evidence of individual-level productivity responses to minimum wage changes. She develops a principal-agent

model in which workers endowed with different levels of ability choose an effort supply to maximize their utility under different wage schemes and harvest conditions. Her model predicts that the average worker productivity will decrease in response to a minimum wage increase and that the change in medium ability workers' effort supply is what drives the decline. Using a worker-specific fixed effects model that controls for the harvest condition and the piece rate, Hill finds a seven percent decrease in average worker productivity after a three percent increase in an *employer set* minimum wage. Using the same method but dividing the workers by their levels of ability, Hill also finds that there is no change in low-ability workers' effort level while both medium- and high-ability workers decrease productivity significantly, which deviates partially from her model's prediction.

Ku (2020) uses personnel records from a large tomato farm in Florida which employs piece-rate workers to pick tomatoes in the field on a day-to-day basis to study workers' effort responses to a minimum wage increase. She hypothesizes that low productivity workers who are more likely to receive the minimum wage will exert more effort out of fear of selective non-employment in the face of a minimum wage increase. Using a difference-in-differences (DID) model that exploits the differential levels of threat that low- and high-wage workers perceive, Ku finds that a six percent increase in the *statutory* minimum wage leads workers who are in the bottom 40^{th} percentile of the productivity distribution to increase their effort by 4.6 percent more than their co-workers who are in the higher percentiles of the productivity distribution. Using the same DID model but further dividing workers into quintiles by productivity, Ku also finds that the effort responses from the workers in the first and second quintiles are significantly more positive than that from the workers in the third quintile (the reference category). In addition, the effort responses from the workers in the higher quintiles are, although insignificant, also slightly more positive than that from the reference group. Ku argues that this shows that the relatively positive response from the low-wage workers is indeed driven by

the higher effort exerted by the low-wage workers rather than lower effort exerted by the high-wage workers.

Coviello et al. (2020) uses personnel records of salespeople who are under commission-based pay from a large U.S. retail chain to study the effect of minimum wage increases on individual worker productivity. They develop a "hybrid" model in which a minimum wage increase affects worker productivity through two channels — a dominating efficiency wage channel and a pay-for-performance channel. In their model, workers of different productivity choose an effort level given the local minimum wage and the level of supervision that they receive to maximize utility. Their model predicts that, as long as there exists supervision, increasing the minimum wage will lead to an increase in individual worker productivity. Using a border-discontinuity design that compares workers who are on the side of the border that experiences a minimum wage increase to workers who are on the other side of the same border where there is no increase, they find that average worker productivity increases by 4.5% in the face of a $1 *statutory* increase in the minimum wage. Using the same border-discontinuity design but dividing workers into low- (bottom 4% of the pay distribution), medium-, and high-wage types (top 25% of the pay distribution), they find that a $1 increase in the minimum wage boosts the low type's productivity by 22.6% and the medium type's by 8.2% while the effect vanishes for the high type.

This study employs a different approach to answer the question of the minimum wage's impact on worker productivity. Compared to Hill (2018), Ku (2020), and Coviello et al. (2020), all of whom only consider the change in wages and/or the level of supervision that workers receive, I incorporate fairness considerations into the workers' utility maximization problem. More specifically, I hypothesize that, when a minimum wage is introduced, in the short run, 1) the change in the relative wage between the high- and low-wage workers will differentially impact the productivity of these two types of workers by changing their perceived fair wage;

2) the change in the treatment of a worker's co-workers will shift the worker's opinion about how fair the firm is to its employees, and that high- and low-wage workers will also have different views about how their co-workers' treatment changes, which diverges the minimum wage's impacts on these two types of workers. Moreover, whether the minimum wage is actively introduced by the firm or mandated by the government also makes a difference in its impact on worker productivity through interactions with the above two fairness channels. When it comes to reciprocating fair or unfair behaviors, people care about not only the fairness outcome, which is altered by the above two channels, but also the intention behind the action that leads to that outcome. When the minimum wage is not a fully intentional action of the firm as in the case of a government mandate, I hypothesize that workers will assign less responsibility to the firm for the same fairness outcome as opposed to when the minimum wage is a more or less intentional act of the firm when it is, for example, a self-announced action. The two fairness outcome channels and the fairness intention factor all come from tested theories of fairness, and I am putting these theories together and applying them to the setting of the minimum wage in this paper.

Furthermore, to open the "black box" of the minimum wage's impact on worker productivity and to test the above hypotheses, I design a laboratory experiment to measure the effect of the intention factor and separate the impacts of the two channels. A laboratory experiment is necessary in this case because it is highly unlikely that natural experiments, such as the ones used by Hill (2018), Ku (2020), and Coviello et al. (2020), could satisfy the numerous conditions needed for a decomposition. In the experiment, the participants perform as workers tasks that are familiar to entry-level research assistants, and the experimenter alters settings such as the wage scheme to observe changes in worker productivity. I also propose a DID approach to compare the data from different experiment sessions to study the respective impacts of the intention factor and the two channels.

The rest of the paper is organized as follows. Section I provides motivations to incorporate fairness considerations into a worker's utility function. Section II formalizes the theoretical framework and makes predictions about the short-term impact of the minimum wage on worker productivity. Section III provides a laboratory experimental design to test the predictions and an empirical strategy to analyze the experiment data. Section IV concludes with a discussion of the shortcomings of the study, future research directions, and potential policy implications.

I. Motivation

To provide a context for the theoretical framework and the experimental design, I first discuss here the motivations for adding to the standard neoclassical model the two fairness channels — the fair wage channel and the sympathy channel — and the intention factor that interacts with these channels.

The setting that I use in this section is as follows: I consider a firm that has two lines of production and two groups of workers (one group per production line). In addition, one line of production is more complicated than the other, and the workers that work on the more complicated line is paid a higher wage w_H than the workers that work on the less complicated line, who are paid w_L. All the workers at this firm knows the firm's complete wage scheme $w = \{w_H, w_L\}$.

A. Fair Wage

In their seminal work, Akerlof and Yellen (1990) proposes the fair wage-effort hypothesis, in which workers will withdraw effort proportionally if they believe that their actual wage is lower than their fair wage and that they will supply at most the "normal effort" even if their actual wage exceeds their fair wage:

(1) $$e = min\left(\frac{w}{w^*}, 1\right).$$

Here, w denotes the actual wage, w^* denotes the fair wage, and the effort e is denoted such that 1 is the "normal effort," which is the effort a worker will supply if their actual wage is equal to their fair wage. For the definition of the fair wage, Akerlof and Yellen assume in their relative deprivation model of the fair wage that it is determined by 1) the actual wage received by other workers at the same firm and 2) the market-clearing wage:

(2) $$w_i{}^* = \beta w_{-i} + (1-\beta) w_i{}^c,$$

where $w_i{}^*$ denotes the fair wage of workers in group i, w_{-i} the actual wage received by group i's reference group -i, and $w_i{}^c$ the market clearing wage of group i. Here, β describes the weight that the worker puts on the other workers' wage relative to the market-clearing wage when she determines her fair wage, and thus $0 \leq \beta \leq 1$.

In the context of this study, there are two groups of workers at the firm: high-wage workers (whose wage has always been higher than the minimum wage) and low-wage workers (whose wage is lower than the minimum wage before its introduction and increases to the level of the minimum wage afterwards). Following Akerlof and Yellen's definition of the fair wage,

(3) $$w_H{}^* = \beta w_L + (1-\beta) w_H{}^c$$

and

(4) $$w_L{}^* = \beta w_H + (1-\beta) w_L{}^c,$$

where $w_H{}^*$ denotes high-wage workers' fair wage, $w_L{}^*$ low-wage workers' fair wage, w_H high-wage workers' actual wage, and w_L low-wage workers' actual wage if it is assumed that the high-wage workers' reference group is the low-wage workers and that, symmetrically, the low-wage workers' reference group is the high-wage workers.

Moreover, adopting the above definitions of the fair wage,

(5) $$e_H = min\left(\frac{w_H}{w_H{}^*}, 1\right) = min\left(\frac{w_H}{\beta w_L + (1-\beta) w_H{}^c}, 1\right)$$

and

(6) $$e_L = min\left(\frac{w_L}{w_L{}^*}, 1\right) = min\left(\frac{w_L}{\beta w_H + (1-\beta) w_L{}^c}, 1\right).$$

where e_H denotes the effort that the high-wage workers choose to supply and e_L the effort that the low-wage workers choose to supply.

To see the effect of the introduction of a minimum wage on worker productivity through the lens of the fair wage-effort hypothesis, one can compare the amount of effort that a worker chooses to supply in periods $t = 0, 1$, where there is no minimum wage when $t = 0$ and a minimum wage *MW* when $t = 1$:

(7) $$e_{H,t} = min\left(\frac{w_{H,t}}{\beta w_{L,t} + (1-\beta) w_{H,t}{}^c}, 1\right)$$

and

(8) $$e_{L,t} = min\left(\frac{w_{L,t}}{\beta w_{H,t} + (1-\beta) w_{L,t}{}^c}, 1\right).$$

Assume

(9)
$$\begin{cases} w_{L,1} < w_{H,1}, \\ w_{H,1} = w_{H,2}, \\ w_{L,1} < MW, \\ w_{L,2} = MW < w_{H,2} \\ {w_{H,0}}^c = {w_{H,1}}^c \end{cases}$$

Moreover, when the market is competitive, if the minimum wage is introduced by and implemented within one firm (scenario MW_F), the short-term market clearing wage for the low-wage workers is not affected. Denote this market clearing wage of the low-wage workers ${w_{L_F,1}}^c$. If the minimum wage is mandated by the government (scenario MW_G), the short-term market clearing wage should also be the same as before (one can think of it as the workers having a quicker reaction than the whole market). Denote this market clearing wage of the low-wage workers ${w_{L_G,1}}^c$. In summary, in the short run that this study focuses on,

(10)
$$ {w_{L,0}}^c = {w_{L_F,1}}^c = {w_{L_G,1}}^c. $$

Then

(11)
$$ e_{H,1} = min\left(\frac{w_{H,1}}{\beta w_{L,1} + (1-\beta){w_{L,1}}^c}, 1\right) = min\left(\frac{w_{H,0}}{\beta MW + (1-\beta){w_{H,0}}^c}, 1\right) $$

and

(12)
$$ e_{L,1} = min\left(\frac{w_{L,1}}{\beta w_{H,1} + (1-\beta){w_{L,1}}^c}, 1\right) = min\left(\frac{MW}{\beta w_{H,0} + (1-\beta){w_{L,0}}^c}, 1\right) $$

Therefore,

(13) $$\Delta e_H = e_{H,1} - e_{H,0} = min\left(\frac{w_{H,0}}{\beta MW + (1-\beta){w_{H,0}}^c}, 1\right) - min\left(\frac{w_{H,0}}{\beta w_{L,0} + (1-\beta){w_{H,0}}^c}, 1\right)$$

and

(14) $$\Delta e_L = e_{L,1} - e_{L,0} = min\left(\frac{MW}{\beta w_{H,0} + (1-\beta){w_{L,0}}^c}, 1\right) - min\left(\frac{w_{L,0}}{\beta w_{H,0} + (1-\beta){w_{L,0}}^c}, 1\right).$$

Solve the above equations and one can get that, **through the fair wage channel**,

(15) $$\Delta e_H \begin{cases} = 0, \text{ if } \frac{w_{H,1}}{{w_{H,1}}^*} \geq 1 \\ < 0, \text{ if } \frac{w_{H,1}}{{w_{H,1}}^*} < 1 \end{cases}$$

and

(16) $$\Delta e_L \begin{cases} = 0, \text{ if } \frac{w_{L,0}}{{w_{L,0}}^*} \geq 1 \\ > 0, \text{ if } \frac{w_{L,0}}{{w_{L,0}}^*} < 1 \end{cases}.$$

Intuitively, the solutions show that, under the fair wage-effort hypothesis, in normal circumstances when neither the high-wage workers nor the low-wage workers are overpaid, in the short run, the high-wage workers will supply less effort in the face of a minimum wage, and the low-wage workers will supply more effort when a minimum wage is introduced.

B. Sympathy for Co-workers

In his gift-exchange model, Akerlof (1982) proposes that workers' utility depends on not only the effort they supply, the wage they receive, and the type of worker they are but also the group norms for effort that determines a fair day's work. More specifically, a worker *i* of trait ϵ has a utility function $u_i(e_{n,i}, e_i, w_i, \epsilon_i)$ where

$$e_{n,i} = e_{n,i}(w, e_{min,i}, u_1, \dots, u_j; w_{0,i}, e_{0min,i}, \omega, b_u). \tag{17}$$

Here, e_i denotes the effort that the worker supplies, w_i the wage that the worker receives, ϵ_i the type of the worker, and $e_{n,i}$ the norms for effort of the group that the worker identifies with. In particular, the group norm $e_{n,i}$ is influenced by 1) w, the firm's wage scheme, 2) $e_{min,i}$, the minimum amount of work required by the firm, 3) u_j, the utility of the jth worker at the firm as perceived by worker *i*, 4) $w_{0,i}$, the wage that the other firms are willing to pay for such a worker, 5) $e_{0min,i}$, the minimum amount of work required by the other firm, 6) ω, the unemployment rate, and 7) b_u, the unemployment benefit. The utility of other workers at the firm can influence the group norm because workers acquire sympathy for each other in working together and the firm's treatment to any one worker is seen as a response to the collective effort of the entire group.

Among the factors that influence the group norm, two are especially relevant to the introduction of a minimum wage: the firm's wage scheme and the utility of other workers at the firm. When there are low-wage workers at the firm that are paid below the minimum wage, it changes the wage scheme. When the low-wage workers get a pay raise because of the minimum wage, the high-wage workers can clearly see that it increases the low-wage workers' utility; however, if the workers are only sophisticated enough to focus on the material impact of the minimum

wage, the low-wage workers will perceive no change in the high-wage workers' utility since the high-wage workers are already paid more than the new minimum wage.

The other factors have less pronounced changes when the short-term impact of a new minimum wage on worker productivity is under consideration. First, firms are unlikely to change the minimum output requirement immediately after the introduction of the minimum wage unless they want to be seen as cold-blooded employers that stop at nothing when it comes to exploiting their workers. Second, when the minimum wage is introduced by and implemented within one firm, the factors that are exogeneous to the firm ($w_{0,i}$, ω, and b_u) should stay the same. Third, when the minimum wage is mandated by the government, which means that all the firms in the economy are impacted, $w_{0,i}$ would increase to the new minimum wage for the workers that are paid below the minimum wage before, but ω, and b_u should also stay the same in the short-term (when the workers make instantaneous reactions).

To see the effect of the introduction of a minimum wage on worker productivity through the lens of the gift-exchange model, one can compare the amount of effort that a worker of type $\epsilon \in \{H, L\}$ chooses to supply in periods $t = 0, 1$, where there is no minimum wage when $t = 0$ and a minimum wage MW when $t = 1$:

$$\max_{e_{H,t}} u_H({e_{n,t}}^H, e_{H,t}, w_H) \tag{18}$$

where

$${e_{n,t}}^H = {e_{n,t}}^H\left(w_t, {e_{min,t}}^H, u_{1,t}, \dots, u_{j,t}; {w_{0,t}}^H, {e_{0min,t}}^H, \omega_t, b_{u,t}\right),$$

and

$$\max_{e_{L,t}} u_L({e_{n,t}}^L, e_{L,t}, w_L) \tag{19}$$

where

$$e_{n,t}{}^{L} = e_{n,t}{}^{L}(w_t, e_{min,t}{}^{L}, u_{1,t}, \dots, u_{j,t}; w_{0,t}{}^{L}, e_{0min,t}{}^{L}, \omega_t, b_{u,t}).$$

Assume

$$\begin{cases} w_{L,1} < w_{H,1}, \\ w_{H,1} = w_{H,2}, \\ w_{L,1} < MW, \\ w_{L,2} = MW < w_{H,2} \end{cases} . \tag{20}$$

In addition, as discussed above,

$$\begin{cases} e_{min,0}{}^{H} = e_{min,1}{}^{H}, \\ e_{0min,0}{}^{H} = e_{0min,1}{}^{H}, \\ e_{min,0}{}^{L} = e_{min,1}{}^{L}, \\ e_{0min,0}{}^{L} = e_{0min,1}{}^{L}, \\ \omega_0 = \omega_1, \\ b_{u,0} = b_{u,1} \\ w_{0,0}{}^{H} = w_{0,1}{}^{H} \\ w_{0_F,0}{}^{L} = w_{0_F,1}{}^{L} \\ w_{0_G,0}{}^{L} < w_{0_G,1}{}^{L} \end{cases} . \tag{21}$$

Moreover, for reasons discussed in the fair wage section earlier, when a minimum wage changes the firm's wage scheme, a fair day's work to the high-wage workers decreases and a fair day's work to the low-wage workers decreases. Lastly, the

high-wage workers perceive an increase in the low-wage workers' utility and the low-wage workers perceive no change in the high-wage workers' utility.

Therefore, for the high-wage workers, after a minimum wage is introduced either by their firm or by the government, their actual wage stays the same, but the change in their group norms for effort is unclear because while all the other factors stay constant, the change in w decreases ${e_n}^H$ and their low-wage co-workers' higher perceived utility motivates them to increase ${e_n}^H$. As a result, the effect of a minimum wage on high-wage workers' productivity is ambiguous.

For the low-wage workers, after a minimum wage is introduced by the firm, their actual wage increases, and their group norms for effort also increases because they are motivated by both the firm's nicer wage scheme while all the other factors are constant. As a result, the low-wage workers will supply more effort.

Lastly, also for the low-wage workers, after a minimum wage is introduced by the government, their actual wage increases, but the change in their group norms for effort can be either zero or slightly positive because, although they are motivated by the firm's nicer wage scheme, their enthusiasm is dampened by the fact that the other firms in the market have also increased the wage of the workers like themselves. As a result, the effect on the low-wage workers' productivity is less pronounced when it is mandated by the government compared to when it is introduced by the firm — there could be no increase or a smaller increase in the low-wage workers' effort supply depending on the change in their group norms.

Compared to the fair wage-effort hypothesis, the gift-exchange model makes quite ambiguous predictions both direction- and magnitude-wise of the effect of a new minimum wage on worker productivity. Looking more closely, one can see that the ambiguity comes largely from the addition of the sympathy element. To single out the effect of sympathy for co-workers on worker productivity when a minimum wage is introduced, I calculate the partial derivative of the optimal effort e^* with respect to the perceived utility of co-workers $\Upsilon = \{u_1, \dots, u_j\}$, i.e.

(22) $$\frac{\partial e^*}{\partial Y} = \frac{\partial e^*}{\partial e_n} \cdot \frac{\partial e_n}{\partial Y}$$

Intuitively, when a worker believes that a fair day's work entails more effort, she exerts more effort. In addition, when a worker has sympathy for her co-workers, if she thinks the firm increases her co-workers' utility, she will increase the amount of effort that she expects for a fair day's work. As a result, the partial derivative of the optimal effort with respect to the perceived utility of co-workers is positive, i.e.

(23) $$\frac{\partial e^*}{\partial Y} = \frac{\partial e^*}{\partial e_n} \cdot \frac{\partial e_n}{\partial Y} > 0$$

Moreover, the above discussion shows that, when a minimum wage is introduced, the high-wage workers perceive an increase in the low-wage workers' utility and the low-wage workers perceive no change in the high-wage workers' utility. As a result, the gift-exchange model predicts that, **through the sympathy channel alone,** the introduction of a minimum wage has a positive impact on the high-wage workers and no impact on the low-wage workers, i.e.,

(24) $$\begin{cases} \Delta e_H = e_{H,1} - e_{H,0} > 0 \\ \Delta e_L = e_{L,1} - e_{L,0} = 0 \end{cases}$$

C. Fairness Intention

I have discussed above two channels related to the concept of "fairness" through which the minimum wage impacts worker productivity: the fair wage-effort relationship and the workers' sympathy for their co-workers that constitutes the group norms for effort that determine a fair day's work. I have shown that a minimum wage will generally decrease the high-wage workers' effort and increase

the low-wage workers' effort through the fair wage channel. I have also shown that a minimum wage will increase the high-wage workers' effort and have no impact on the low-wage workers' effort through the sympathy channel. Now, let us turn our attention to a factor that affects the minimum wage's influence on worker productivity through interactions with the above two channels: fairness intention.

Whether or not fairness intention is important has long been debated: some models of reciprocity (e.g., Fehr and Schmidt (1999) and Bolton and Ockenfels (2000)) only considers whether the outcome is fair while others (e.g., Rabin (1993), Dufwenberg and Kirchsteiger (2004), and Falk and Fischbacher (2005)) include fairness intention in their utility function. To help settle this debate, Falk, Fehr, and Fischbacher (2008) conduct an experiment and provide empirical evidence for fairness intention's relevance, showing that Falk and Fischbacher's model, in which both the intention and outcome matter, fits the data best. Therefore, I will adopt here Falk and Fischbacher's model to analyze how the fairness intention factor shapes the minimum wage's impact on worker productivity.

Falk and Fischbacher's original model is a two-player extensive form game with a finite, but indefinite, number of stages. To adapt it for the study of short-term effects of a new minimum wage on worker productivity, I simplify the game into a one-shot interaction between a firm and its worker *i*, where the firm moves first and chooses the minimum wage and the worker moves second and decides her effort supply given the minimum wage, i.e.,

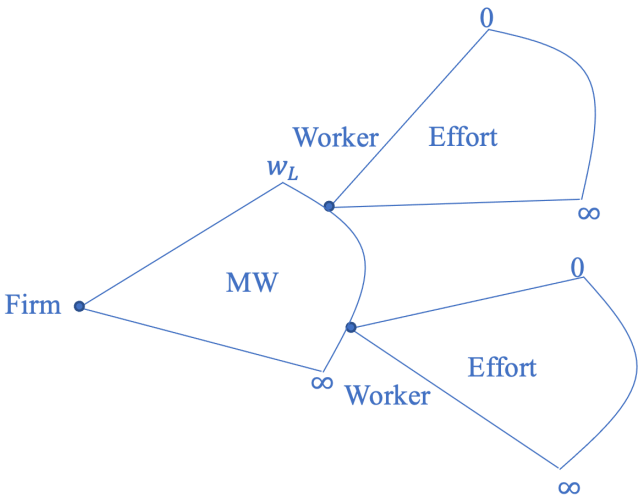

FIGURE 1. EXTENSIVE FORM REPRESENTATION OF THE INTRODUCTION OF A NEW MINIMUM WAGE

Notes: This figure shows a two-stage game in which the firm chooses a minimum wage in the first stage and the workers decide their effort supply in the second stage after observing the firm's choice. The firm can choose to introduce any minimum wage from w_L to ∞, and the workers can choose to supply any effort from 0 to ∞.

The firm can choose not to introduce a minimum wage by setting $MW = w_L$ or can otherwise introduce a minimum wage $MW > w_L$. Having observed the firm's action, the worker then chooses the amount of effort that she wants to supply to maximize the following utility function:

$$u_i = w_i - c_i(e_i) + \rho_i \varphi_F \sigma_i(e_i) \tag{25}$$

$$\text{subject to } e_i \geq 0$$

where

$$\varphi_F = \Delta_F \cdot \vartheta_F$$

Here, u_i is the utility of a worker i, e_i is the worker's effort supply, $w_i - c_i(e_i)$ is the worker's material payoff where w_i is the worker's wage and $c_i(\cdot)$ the worker's cost of exerting effort, and ρ_i is the worker's reciprocity parameter, which is a non-negative constant that captures how important the worker believes reciprocity is

relative to material payoffs. One thing to note is that when $\rho_i = 0$, which means that the worker does not value reciprocity at all, this model collapses into the standard neoclassical model. I will only consider the case when $\rho_i > 0$ onwards. φ_F is the "kindness term" and σ_i is the "reciprocation term." They are discussed in more detail below.

Kindness term.—The "kindness term" φ_F measures how kind the firm is to the worker in its action. The firm's kindness is determined by two factors: the fairness outcome of its action, Δ_F, and the firm's fairness intention ϑ_F when it chooses its action. The fairness outcome is negative, or unkind, when the firm's action drives the worker's utility further away from the fairness point and is positive when the worker's utility gets closer to the fairness point. The fairness intention factor ϑ_F takes on a value between 0 and 1 (inclusive). Falk and Fischbacher measures intention by two conditions: 1) does the player has true alternatives when she makes the decision and 2) does the player has full control over her decision. If the firm has true alternatives *and* full control over its decision, $\vartheta_F = 1$; conversely, if the firm does not have any true alternatives *or* has no control over its decision, $\vartheta_F = 0$.

Reciprocation term.— The "reciprocation term" σ_i measures the effect of the worker's reciprocal action on the firm's utility. If the firm is kind, the worker chooses $\sigma_i > 0$ to reward the firm; if the firm is unkind, the worker chooses $\sigma_i < 0$ to punish the firm. Since the worker reciprocates by adjusting her effort supply to the firm, σ_i is a function of e_i. More specifically, σ_i measures how much the worker alters the expected payoff of the firm with choosing e_i. The worker has a belief about the how much the firm expects the worker to exert after it chooses the minimum wage: if the worker chooses an effort e_i that is greater than this expected effort e_{i_f}, the worker reciprocates the firm's kindness by giving the firm a gift of

$v \cdot (e_i - e_{i_f})$ where v is the value of each unit of effort; conversely, if the worker chooses an effort e_i that is smaller than this expected effort e_{i_f}, the worker negatively reciprocates the firm's kindness by taking away from the firm $v \cdot (e_{i_f} - e_i)$.

Since the focus of this study is the worker's productivity reaction after the firm chooses its minimum wage MW, I will take the firm's action as given and limit my attention to the subgame in which the worker chooses her effort supply. In this subgame, the worker's optimal effort supply e_i^* is such that

(26) $$\max_{e_i} u_i = [w_i - c_i(e_i)] + \rho_i \cdot (\Delta_F \cdot \vartheta_F) \cdot \left[v \cdot \left(e_i - e_{i_f}\right)\right]$$

subject to $e_i \geq 0$

$\Rightarrow$

$$-c_i'(e_i^*) + \rho_i \cdot (\Delta_F \cdot \vartheta_F) \cdot v = 0$$

$\Rightarrow$

$$e_i^* = \max\left[c_i'^{-1}(\rho_i \cdot \Delta_F \cdot \vartheta_F \cdot v), 0\right].$$

Here, $c_i'^{-1}(\cdot)$ is the inverse function of $c_i(\cdot)$. It is an increasing function since $c_i'(\cdot) > 0$ and $c_i''(\cdot) > 0$ as in the standard neoclassical model. Therefore, one can see that, if $e_i^* \neq 0$, the worker's optimal level of effort is increasing in the reciprocity parameter ρ_i, the firm's fairness intention φ_F, and the value of each unit of effort v, i.e.,

$$(27) \qquad \begin{cases} \frac{\partial e_i^*}{\partial \rho_i} > 0 \\ \frac{\partial e_i^*}{\partial \Delta_F} > 0 \\ \frac{\partial e_i^*}{\partial \vartheta_F} > 0 \\ \frac{\partial e_i^*}{\partial v} > 0 \end{cases}$$

To see the effect of the introduction of a minimum wage on worker productivity through the lens of Falk and Fischbacher's model, I compare the amount of effort that the worker chooses to supply when $MW = w_L$ (scenario 0) and when $MW > w_L$ (scenario 1) with the same level of intention. In addition, I also compare the amount of effort that the worker chooses to when a minimum wage $MW > w_L$ is actively introduced by the firm (scenario *F*) versus when it is passively complied by the firm as a government mandate (scenario *G*).

In all four scenarios, ρ_i is the same because a person's preference for reciprocity should be a trait that does not vary depending on situations. v is also the same because the value of the worker's output does not change as fast as the worker reacts to the firm's action.

Between scenarios *F* and *G*, the only difference is the fairness intention. The fairness outcomes are identical because the magnitude of the minimum wages introduced in both scenarios is the same. Measuring by Falk and Fischbacher's standard, the fairness intention in scenario *F* should be larger than the fairness intention in scenario *G*. In scenario *F*, even though the firm might be under external pressure when it decides to introduce the minimum wage (such as being called out by a senator for terrible treatment of its employees) so that $\vartheta_F > 0$, it nevertheless has the final say in whether to cave in. Therefore, $0 < \vartheta_F < 1$ when the minimum wage is introduced by the firm. However, in scenario *G*, any law-abiding firm just

simply does not have any alternative but to comply with the government's mandate and implement the minimum wage. In essence, the game is reduced to

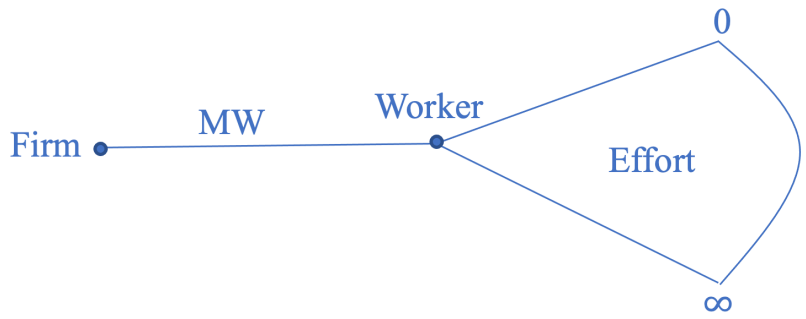

FIGURE 2. EXTENSIVE FORM REPRESENTATION OF THE INTRODUCTION OF A GOVERNMENT-MANDATED MINIMUM WAGE

Notes: This figure shows a two-stage game in which the firm "chooses" a minimum wage in the first stage and the workers decide their effort supply in the second stage after observing the firm's choice. The firm actually has no choice but to comply with the government's mandated minimum wage *MW* but the workers can choose to supply any effort from 0 to ∞.

Therefore, $\vartheta_F = 0$ when the minimum wage is introduced by the government and $\vartheta_{F,F} > \vartheta_{F,G}$. Combined with the relation that $\frac{\partial e_i^*}{\partial \vartheta_F} > 0$, when only the effect of the **fairness intention factor** is under consideration,

(28) $$e_{i,F}{}^* > e_{i,G}{}^*, \text{ if } e_{i,F}{}^* > 0.$$

Between scenarios 0 and 1, the only difference is the fairness outcome, which Falk and Fischbacher define as the expected payoff difference between the two players. One caveat of this definition is that if a firm that has a heterogenous body of workers as in the setting of this study, the fairness outcome that the workers care about includes not only the distribution of profit between the firm and themselves but also other fairness considerations like the two that I talk about in the fair wage section and the sympathy section earlier. With this extension in mind, let us put the question on hold and discuss it in greater detail in the Theoretical Framework section below.

II. Theoretical Framework

I have shown in the previous section that, in the short run, 1) under Akerlof and Yellen's fair wage-effort hypothesis, a change in the relative wage between high-low-wage workers caused by a minimum wage will generally lead high-wage workers to decrease effort and low-wage workers to increase effort; 2) under Akerlof's gift-exchange model, the change in the group norms for effort brought by the minimum wage will increase high-wage workers' effort supply and have no effect on low-wage workers; 3) under Falk and Fischbacher's model of reciprocity, the effect of the minimum wage transmitted via the above two channels will be more pronounced when it is introduced by the firm than when it is mandated by the government. Now, let us put together the two channels and the intention factor to examine the overall effect of the minimum wage on worker productivity.

In the setting of this theoretical framework, a firm has two lines of production, τ_H and τ_L. τ_H is more complicated than τ_L, and the workers who perform τ_H is thus paid more than those who perform τ_L. Like how Amazon pays its warehouse workers, this firm pays the workers that perform the same task the same wage w_τ (w_H to τ_H workers and w_L to τ_L workers), which is a lump-sum payment per period that does not depend on the worker's productivity. Moreover, this firm also has a minimum output requirement — workers on production line τ must produce at least $\underline{q_\tau}$ items per period, or they will be fired. The minimum output requirement is the same for all the workers that perform the same task, but different for different tasks. A more subtle version of this practice can also be found at Amazon, where the warehouse workers are under constant surveillance and (implied) threats of disciplinary action and even termination of employment. Together, the task-based wages w_H and w_L of both groups of workers are denoted as the firm's wage scheme $w = \{w_H, w_L\}$.

Under this setting, a worker *i* employed by the firm to perform task τ chooses the amount of effort $e_{i,t}$ to supply in period *t* to maximize her utility $u_{i,t}$. The worker determines $e_{i,t}$ in the following way:

1) She takes into consideration the wage w_τ that the firm directly offers to her;
2) She puts her own wage w_τ into the context of the firm's overall wage scheme w to decide whether or not the firm is treating her fairly;
3) She puts the wage of her co-workers $w_{-\tau}$ into the context of the firm's overall wage scheme w to decide whether or not the firm is treating them fairly;
4) She decides whether or not she believes that the firm chooses its overall wage scheme w intentionally;
5) She takes into consideration the disutility of supplying effort $e_{i,t}$;
6) She stays alert to the firm's minimum output requirement $\underline{q_\tau}$;
7) She chooses the amount of effort $e_{i,t}$ that she wants to supply to reflect her judgements in steps 1 to 6.

Adopting the structure of the social preference model of DellaVigna et al. (2016), I summarize the above utility maximization problem as

$$(29) \qquad \max_{e_{i,t}} u_{i,t} = w_\tau - C_i(e_{i,t}) + \rho_i \cdot F(\vartheta_{i,t}, R_{i,t}(w), S_{i,t}(w)) \cdot e_{i,t}$$

$$\text{subject to } P_i(e_{i,t}) \geq \underline{q_\tau}$$

A worker's utility has four components: the utility from the material payoff of her wage, the cost, or disutility, associated with effort exertion, the minimum output requirement, and the utility that the worker derives from reciprocating the firm with respect to the fairness of the firm's wage scheme *w*. The cost function $C(\cdot)$ translates a worker's effort into her disutility. As in the standard neoclassical model,

$C'(\cdot) > 0$ and $C''(\cdot) > 0$. Moreover, each worker has her own cost function since workers are of diverse abilities and thus have different costs of producing the same output. Each worker also has her own productivity function $P(\cdot)$ that maps effort to output, which must be at least as large as the minimum output requirement for the worker to keep her job. A worker's output increases in effort in a decreasing rate, i.e., $P'(\cdot) > 0$ and $P''(\cdot) < 0$.

Reciprocation utility.—The last component of a worker's utility is her reciprocation utility, $\rho_i \cdot F(\vartheta_{i,t}, R_{i,t}(w), S_{i,t}(w)) \cdot e_{i,t}$. Here, like Falk and Fischbacher's model of reciprocity, there is a reciprocity parameter ρ_i, a non-negative constant that measures how much worker i values the utility derived from reciprocal behaviors relative to the material utility arising from wage and the disutility arising from effort exertion. The more important the worker thinks reciprocation is, the larger the ρ_i. The special case is when $\rho_i = 0$, which means the worker does not value reciprocity at all and makes the model collapse into a standard neoclassical model. I will only consider the case when $\rho_i > 0$ onwards. There is a function $F(\cdot)$, which is the worker's fairness response to the firm per each unit of effort. $F(\cdot)$ depends on 1) $\vartheta_{i,t}$, a non-negative parameter that measures the firm's fairness intention perceived by the worker; 2) $R_{i,t}(w)$, how fair the worker thinks the wage scheme w is through the fair wage channel; and 3) $S_{i,t}(w)$, how fair the worker thinks the wage scheme w is through the sympathy channel. It is defined that the larger the parameter $\vartheta_{i,t}$, the more intentional the worker thinks the firm is, and stronger the fairness response will be, i.e.

(30) $$\frac{\partial F}{\partial \vartheta} > 0$$

It is also defined that $R_{i,t}(w)$ and $S_{i,t}(w)$ are increasing in the fairness of the wage scheme w. For example, if the worker finds the new wage scheme *w'* fairer than the old wage scheme *w* through the fair wage channel, $R_{i,t}(w') > R_{i,t}(w)$. In addition, the fairness response $F(\cdot)$ is also increasing in $R(\cdot)$ and $S(\cdot)$, i.e.

(31) $$\frac{\partial F}{\partial R} > 0$$

and

(32) $$\frac{\partial F}{\partial S} > 0$$

This means that the fairer the worker finds the wage scheme through either channel, the stronger the fairness response will be. Lastly, I define $F(\cdot)$ such that it can be both negative, positive, and zero. The workers will show a negative fairness response if they find the firm to be unpleasantly unfair, they will show a positive response if they find the firm to be delightfully fair, and they will show no response if the firm's actions simply do not strike them as either fair or unfair.

To solve worker *i*'s utility maximization problem in equation (29), I first derive the first-order condition

(33) $$-C_i'\left(e_{i,t}{}^*\right) + \rho_i \cdot F\left(\vartheta_{i,t}, R_{i,t}(w), S_{i,t}(w)\right) = 0.$$

Therefore,

(34) $$e_{i,t}{}^*(\rho_i, \vartheta_{i,t}, w) = \max\left[C_i'^{-1}\left(\rho_i \cdot F\left(\vartheta_{i,t}, R_{i,t}(w), S_{i,t}(w)\right)\right), P_i'^{-1}(\underline{q}_\tau)\right]$$

When the fairness considerations are dominated by the fear of getting fired, the workers' effort exertion is driven entirely by the minimum output requirement $\underline{q_\tau}$. Here, $P_i'^{-1}(\cdot)$ is the inverse function of $P'(\cdot)$ and $P_i'^{-1}(\underline{q_\tau})$ is a constant for each worker i that measures how much effort she needs to exert to meet the minimum output requirement. However, when the fairness considerations are stronger than the fear, the worker supplies effort $e_{i,t} = C_i'^{-1}\left(\rho_i \cdot F\left(\vartheta_{i,t}, R_{i,t}(w), S_{i,t}(w)\right)\right)$. Here, $C_i'^{-1}(\cdot)$ is the inverse function of $C'(\cdot)$. It is an increasing function since $C'(\cdot) > 0$ and $C''(\cdot) > 0$. Therefore, one can see that worker i's optimal level of effort $e_{i,t}{}^*$ is increasing in the reciprocation importance ρ_i, the fairness intention $\vartheta_{i,t}$, and the fairness outcome of the wage scheme w, i.e.,

$$\begin{cases} \frac{\partial e^*}{\partial \rho} > 0 \\ \frac{\partial e^*}{\partial \vartheta} > 0 \\ \frac{\partial e^*}{\partial R} > 0 \\ \frac{\partial e^*}{\partial S} > 0 \end{cases} \tag{35}$$

For notation convenience, I denote onwards the scenario where $e_{i,t}{}^*\left(\rho_i, \vartheta_{i,t}, w\right) = C_i'^{-1}\left(\rho_i \cdot F\left(\vartheta_{i,t}, R_{i,t}(w), S_{i,t}(w)\right)\right)$ the optimal fairness effort $e_f{}^*$ and the scenario where $e_{i,t}{}^*\left(\rho_i, \vartheta_{i,t}, w\right) = P_i'^{-1}(\underline{q_\tau})$ the optimal minimum effort $e_{min}{}^*$.

A. Firm-introduced Minimum Wage and High-wage Workers

First, I consider the effect of a firm-introduced minimum wage (in period $t = 1$) in comparison to when there is no minimum wage (in period $t = 0$) on high-wage workers' productivity. The wage schemes in periods 0 and 1 are

$$\begin{cases} w_{L,0} < MW < w_{H,0} \\ w_{L,1} = MW \\ w_{H,1} = w_{H,0} \end{cases} \tag{36}$$

As discussed in the motivation section, the high-wage workers believe that the introduction of a minimum wage makes the firm's wage scheme less fair since it decreases their relative wage. Therefore,

$$\Delta R_H = R_{H,1}(w_1) - R_{H,0}(w_0) < 0. \tag{37}$$

However, high-wage workers also believe that a minimum wage is beneficial to their low-wage co-workers and that the firm is kind in this respect. Therefore,

$$\Delta S_H = S_{H,1}(w_1) - S_{H,0}(w_0) > 0. \tag{38}$$

In addition, the fairness importance parameter ρ_i is constant over time and is thus the same in periods 0 and 1. The fairness intention parameter $\vartheta_{i,t}$ can also be reasonably assumed to be constant considering that the minimum wage is actively introduced by the firm in period 1, and that the firm also actively chooses its wage scheme in period 0.

Compare the fairness efforts in periods $t = 0$ and $t = 1$,

(39) $$\Delta {e_f}^{H^*} = {e_{f,1}}^{H^*} - {e_{f,0}}^{H^*}$$

where

$${e_{f,1}}^{H^*} = C'^{-1}\big(\rho_i \cdot F(\vartheta_i, R_0(w) + \Delta R_H, S_0(w) + \Delta S_H)\big).$$

Since

(40) $$\begin{cases} \Delta R_H < 0 \\ \Delta S_H > 0 \\ \frac{\partial {e_f}^*}{\partial R} > 0 \\ \frac{\partial {e_f}^*}{\partial S} > 0 \end{cases}$$

It is unclear whether the negative fairness response from the fair wage channel or the positive response from the sympathy channel dominates given the known information. In other words,

(41) $$\Delta {e_f}^{H^*} ? \, 0.$$

There are four possible scenarios of effort supply in periods $t = 0$ and $t = 1$: $({e_{min}}^*, {e_{min}}^*)$, $({e_{min}}^*, {e_f}^*)$, $({e_f}^*, {e_{min}}^*)$, and $({e_f}^*, {e_f}^*)$ where the first term is the worker's effort supply in period 0 and the second term the worker's effort supply in period 1. It is easy to derive the change in effort in the first three scenarios, where it is 0, positive, and negative respectively. In the last case, where the fairness considerations prevail in both periods, the change in effort brought by the introduction of the minimum wage is unclear, since $\Delta {e_f}^{H^*} ? \, 0$ as discussed above. It is also worth noting that it is only in the first and the last scenarios that $\Delta {e_f}^{H^*}$ is

truly unknown — it is necessary that $\Delta {e_f}^{H^*} > 0$ in the second scenario and that $\Delta {e_f}^{H^*} < 0$ in the third scenario.

B. Firm-introduced Minimum Wage and Low-wage Workers

Next, I consider the effect of a firm-introduced minimum wage (in period $t = 1$) in comparison to when there is no minimum wage (in period $t = 0$) on low-wage workers' productivity. The wage schemes in periods 0 and 1 are also

$$\begin{cases} w_{L,0} < MW < w_{H,0} \\ w_{L,1} = MW \\ w_{H,1} = w_{H,0} \end{cases} . \tag{42}$$

Unlike the high-wage workers, the low-wage workers believe that the introduction of a minimum wage brings the firm's wage scheme closer to fairness since it increases their relative wage. Therefore,

$$\Delta R_L = R_{L,1}(w_1) - R_{L,0}(w_0) > 0. \tag{43}$$

In addition, the sympathy channel has no effect on the low-wage workers' perception of the firm as long as they are not complicated enough to take into consideration the high-wage workers' belief about the minimum wage's impact on the low-wage workers themselves. Therefore,

$$\Delta S_L = S_{L,1}(w_1) - S_{L,0}(w_0) = 0. \tag{44}$$

As discussed in the above section, the fairness importance parameter ρ_i and the fairness intention parameter $\vartheta_{i,t}$ can also be reasonably assumed to be constant.

Compare the fairness efforts in periods $t = 0$ and $t = 1$,

(45) $$\Delta {e_f}^{L^*} = {e_{f,1}}^{L^*} - {e_{f,0}}^{L^*}$$

where

$${e_{f,1}}^{L^*} = C'^{-1}\left(\rho_i \cdot F\left(\vartheta_i, R_0(w) + \Delta R_H, S_0(w)\right)\right).$$

Since

(46) $$\begin{cases} \Delta R_L \\ \frac{\partial e_f{}^*}{\partial R} > 0 \end{cases},$$

It is clear that the low-wage workers have a higher optimal fairness effort in period 1 than in period 0, i.e.,

(47) $$\Delta {e_f}^{L^*} > 0.$$

There are three possible scenarios of effort supply in periods $t = 0$ and $t = 1$: $({e_{min}}^*, {e_{min}}^*)$, $({e_{min}}^*, {e_f}^*)$, and $({e_f}^*, {e_f}^*)$ where the first term is the worker's effort supply in period 0 and the second term the worker's effort supply in period 1. The change in effort in each scenario is 0, positive, and positive respectively. It is worth noting that the positive change in the worker's optimal fairness effort is masked by the high minimum output requirement in the first scenario. In addition, $({e_f}^*, {e_{min}}^*)$ is impossible in this theoretical framework since it requires that $\Delta {e_f}^{L^*} < 0$.

C. Firm-introduced and Government-mandated Minimum Wages

Lastly, I consider the difference in the impacts on worker productivity when the minimum wage is introduced by the company itself (scenario *F*) versus when it is mandated by the government (scenario *G*). The wage schemes in both scenarios in periods 0 and 1 are

$$\begin{cases} w_{L,0} < MW_E < w_{H,0} \\ w_{L,1} = MW_E \\ w_{H,1} = w_{H,0} \end{cases} \tag{48}$$

where

$$E \in \{G, F\}.$$

As discussed in the conceptual framework section, workers believe that the firm should take more responsibility when the minimum wage is introduced by the firm itself. Therefore,

$$\Delta\vartheta = \vartheta_F - \vartheta_G > 0. \tag{49}$$

The fairness importance parameter ρ_i is only dependent on a worker's fairness preference and is thus the same in scenarios *G* and *F*. In addition, since the minimum wages implemented in both scenarios are identical except for the introducer, the workers' perception of the change in the wage scheme's fairness outcome should also be the same, i.e.,

$$\Delta S(w)_{F,\tau} = \Delta S(w)_{G,\tau} \tag{50}$$

and

$$\Delta R(w)_{F,\tau} = \Delta R(w)_{G,\tau}. \tag{51}$$

Compare the change in the fairness efforts in scenarios *G* and *F*,

$$\Delta\Delta {e_f}^* = \Delta {e_f}^{F^*} - \Delta {e_f}^{G^*} = \Delta\Delta {e_f}^{F^*}(\Delta\vartheta), \tag{52}$$

which means that the difference in the changes in effort after the minimum wage's introduction comes solely from the difference in the fairness intention factors. This makes sense since the factors that influence the optimal fairness effort are all constant except the intention factor ϑ.

Moreover, since

$$\frac{\partial {e_f}^*}{\partial\vartheta} > 0, \tag{53}$$

$$\frac{\partial\Delta\Delta {e_f}^*}{\partial\Delta\vartheta} > 0,$$

which means that the larger the difference in responsibility the workers perceive between the two scenarios, the larger the difference in the change in worker's fairness effort after the minimum wage introduction. In addition, because the worker's effort supply before the policy should be the same in both scenarios,

$$\left|{e_f}^{F^*}\right| > \left|{e_f}^{G^*}\right|. \tag{54}$$

Table 1 summarizes all the possible scenarios of effort supply in periods $t = 0$ and $t = 1$ for high-wage and low-wage workers in both scenarios *F* and *G*:

TABLE 1—WORKERS' OPTIMAL EFFORT SUPPLY BY TIME AND WORK TYPE

$t = 0$	$t = 1$	$t = 1$	$t = 1$	$t = 1$
All workers	Firm High-wage	Government High-wage	Firm Low-wage	Government Low-wage
${e_{min,\tau}}^*$	${e_{min,H}}^*$	${e_{min,H}}^*$	${e_{min,L}}^*$	${e_{min,L}}^*$
${e_{min,\tau}}^*$	${e_{f,1}}^{F,H^*}$	$[{e_{min,H}}^* \text{or } {e_{f,1}}^{G,H^*}]_a$	${e_{f,1}}^{F,L^*}$	$[{e_{min,L}}^* \text{or } {e_{f,1}}^{G,L^*}]_a$
${e_{f,0}}^{\tau^*}$	${e_{min,H}}^*$	$[{e_{min,H}}^* \text{ or } {e_f}^*]_a$	${e_{f,1}}^{F,L^*}$	${e_{f,1}}^{G,L^*}$
${e_{f,0}}^{\tau^*}$	${e_{f,1}}^{F,H^*}$	${e_{f,1}}^{G,H^*}$	${e_{f,1}}^{F,L^*}$	${e_{f,1}}^{G,L^*}$

[a] Whether $e^* = {e_{min}}^*$ or $e^* = {e_f}^*$ depends on $\Delta\vartheta$ and $\Delta{e_f}^*$.

Notes: This table summarizes the gift-exchange model's predictions of a worker's optimal effort supply under different conditions. $t = 0$ is the period in which there is no minimum wage and $t = 1$ is the period where there is a minimum wage. The minimum wages in columns 2 and 4 are introduced by the firm and the minimum wages in columns 3 and 5 are introduced by the government. Columns 2 and 3 show the optimal effort supply of the workers whose wage has always been higher than the minimum wage and columns 4 and 5 show the optimal effort supply of the workers whose wage is increased to the minimum wage. ${e_{min,\tau}}^*$ denotes the firm's minimum productivity requirement for the workers on production line τ. ${e_{f,1}}^{F,H^*}$ denotes the high-wage workers utility-maximizing effort supply under a firm-introduced minimum wage.

III. Laboratory Experiment Design

From Table 1 one can see that the predictions of the minimum wage's effect on worker productivity can get quite messy when both the fairness considerations and the minimum output requirement are at play. In particular, the changes in the optimal fairness effort induced by the minimum wage could get masked by the minimum output requirement. Since the focus of this study is no other than these changes, it is important to make them as salient as possible. Therefore, to examine the fairness considerations that transmit the minimum wage policy to changes in worker productivity, the minimum wage output requirement should be eliminated so that the workers' fairness considerations become their sole incentive to exert effort. In this setting, the workers' effort supply should resemble the scenario in the last row of Table 1. It is also worth noting that workers have generally been observed to exert positive effort in previous experiments when they receive an

hourly wage and are under no minimum output requirement (see, for examples, Gneezy and List (2006), Hennig-Schmidt et al. (2010) and DellaVigna et al. (2016)). Therefore, in the terms used in the theoretical framework, it can be reasonably expected that ${e_{f,0}}^{\tau^*} > 0$, which means that there exists some comfortable wiggle room with which workers who perceive themselves to be unfairly treated can express negative reciprocity.

When only the scenario where there is no minimum output requirement is considered, the theoretical framework provides 4 hypotheses that can be tested with a laboratory experiment. More specifically, these hypotheses are:

Hypothesis 1: When a minimum wage is introduced, the fair wage channel leads high-wage workers to decrease effort and low-wage workers to increase effort, i.e.
Hypothesis 2: When a minimum wage is introduced, the sympathy channel leads high-wage workers to increase effort and has no impact on low-wage workers.
Hypothesis 3: the effects of the fair wage channel and the sympathy channel are less pronounced when the minimum wage is mandated by the government than when it is introduced by the firm.
Hypothesis 4: When a minimum wage is introduced, low-wage workers increase their overall effort and high-wage workers overall effort response depends on the relative magnitude of the fair wage channel and the sympathy channel.

An experiment is an appropriate strategy to test the hypotheses. Our goal is to not only see the overall impact of a minimum wage on worker productivity but also decompose the impact and identify the different channels at work, which is hard to achieve even with the individual-level personnel records used by Hill (2018), Ku (2020), and Coviello et al. (2020). Hypothesis 4 is the most straightforward to test, and it is what Hill, Ku, and Coviello et al. do in their studies. However unlikely, it is still possible to test Hypothesis 3 if a firm that operates in multiple states raises

its minimum wage for all locations when some of the states raise their local minimum wages while the others do not. The large retail chain in Coviello et al.'s study certainly has the ideal setting. However, even though it is its headquarter that sets the salespeople's compensation scheme, which is the same nationwide, the firm has so far been choosing to make up for the gap between the actual earnings and the increased minimum wage in the affected states instead of changing the nationwide scheme altogether. Lastly, separating the impacts from Hypotheses 1 and 2 requires a setting that is unlikely to happen naturally. Two similar firms are needed — one with workers who care about each other and another whose workers do not care about each other. Therefore, to test all four hypotheses, let us turn to experiment.

A. Design

In the experiment, the experimenter acts as the firm and the participants act as the workers. As in the theoretical framework, the experimenter has two real effort tasks, τ_H and τ_L, that she wants completed. Half of the participants in each experiment session are assigned to τ_H and the other half are assigned to τ_L. The participants that perform τ_H are paid w_H and the participants that perform τ_L are paid w_L, and $w_H > w_L$. The wages are lump-sum payments per production period that do not depend on the individual worker's productivity. There is no minimum output requirement throughout the experiment.

The less complicated real effort task τ_L is adopted from DellaVigna et al. (2016), who have their participants prepare mailing envelops for real charities. In this experiment, the type *L* participants are instructed to prepare mailing envelops for a researcher that needs to send the results of an experiment to her previous participants. More specifically, this task includes 1) folding a piece of letter-sized paper and putting it into an envelope and 2) putting a preprepared sticker that

contains the recipient's name and address on the envelop. This task is an ideal simple task because its performance requires real effort but little to no skill except the ability to match the names on the result sheet and the sticker. In addition, as shown in DellaVigna et al., it is also a job that real workers do, which gives the laboratory experiment more resemblance to the field.

The more complicated real effort task τ_H is similar to the one used by Hennig-Schmidt et al. (2010), who have their participants type abstracts of papers that are yet to be digitalized. In this experiment, the type *H* participants are instructed to type legible handwritten answers to survey questionnaires into an Excel file (see Appendix I for a sample handwritten questionnaire, a sample Excel file given to the participants, and a sample Excel file with transcribed questionnaire answers). This task is chosen for two reasons. First, transcribing questionnaires is a real duty that actual research assistants perform, which brings the laboratory experiment closer to real life.[1] Second, transcription requires multiple skills (e.g., memory, spelling, reading, typing, Excel, and general computer skills), which helps justify the higher wage paid to the workers that perform this task compared to the low wage paid to the workers who prepare mailing envelopes. To make the comparison of worker productivity easier, all participants are given the same questionnaires to transcribe, and they are instructed to transcribe the questionnaires in the same order. However, they will not be informed that the questionnaires are the same to keep the task as close to real work as possible.

The experiment starts with an assessment test. The experimenter first explains to the participants that they are to perform one of two types of task after the test and that the payments for the two tasks are different. The participants are also informed that the half of the participants who perform better in the test get to do the high-

[1] The experimenter has transcribed her fair share of handwritten questionnaires, a lot of which were in far more illegible handwriting.

wage task and the other half are assigned the low-wage task. The test is a simple one-minute online typing test (see Appendix I for a sample online typing test). All participants are given the same test so that it is easier to compare their ability.

After the assessment test, the participants are divided into two groups: workers that perform τ_H and workers that perform τ_L. For notation convenience, let us denote the first group the high-wage workers and the second group the low-wage workers. The remainder of the experiment is divided into three sections for both groups: an Instruction Section, a Practice section, and a Production section. The Production Section is further divided into two periods: Period 0 and Period 1. The high-wage group and the low-wage group go through the same section in parallel after the Assessment Test. The only difference between the two groups in the last three sections is the type of task that the workers perform. The proceeding of the experiment is illustrated in Figure 3.

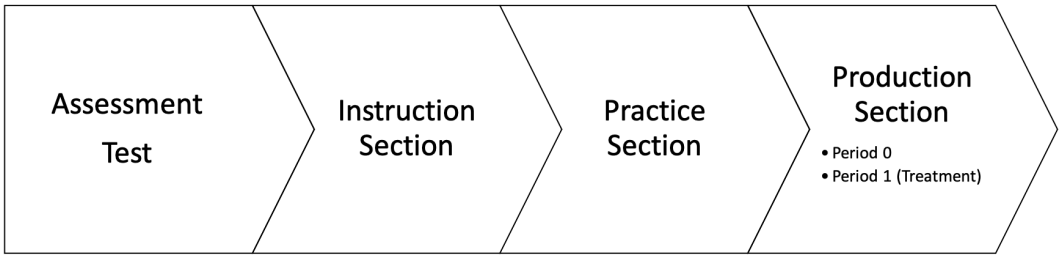

FIGURE 3. EXPERIMENT PROCEEDING

Notes: This figure shows the proceeding of an experiment session. The experiment starts with an assessment test that divides participants into production lines. Afterwards, participants are given instructions regarding how to perform their tasks in the instruction section. Prior to the start of the actual production section, participants are given time to practice performing their tasks. Lastly, participants work for two thirty-minute periods, the second of which is when treatments are assigned.

Instruction Section.—For the high-wage group, an experimenter first explains how to transcribe questionnaire answers to the provided Excel file. The Participants are also shown the sample finished Excel file to get a better sense of what they are expected to produce. For the low-wage group, another experimenter demonstrates

how to fold and put the experiment result into an envelope as well as how to find the matching sticker and put it on the envelope.

Practice Section.— First, before the actual practice begins, the experimenters share with the workers in their respective groups explicit cost and surplus information of hiring them to perform the task to make the experimenters' roles as the firm more salient. This approach follows Hennig-Schmid et al. (2010) who find that for a positive wage-effort relation to exist in the laboratory, workers need to be able to calculate the firm's surplus from the work contract by themselves. Explaining to a worker the surplus that could be made off of her is undoubtedly something that a real-life employer would never do; however, as shown by Hennig-Schmid et al., this setting is a "necessary evil" to get participants in laboratory experiments into the role of workers. In the context of this study, the surplus information for the high-wage group is the experimenter's opportunity costs of replacing the participants with actual research assistants. To the experimenter's knowledge, an actual research assistant at the University of Michigan usually has an hourly rate between twelve and fifteen dollars. Combined with the crude estimation that the experimenter, a relatively proficient transcriber, can transcribe a questionnaire in three minutes at best and the consideration that actual research assistants would not work nonstop for an hour, the cost of hiring an actual research assistant for the task is about one dollar per questionnaire. For the low-wage group, the surplus information in the context of this study is also the experimenter's opportunity costs of replacing the participants with actual research assistants. The participants are informed roughly how much a research assistant is paid per prepared mailing envelope. Next, the practice begins. For the high-wage group, the participants try transcribing one questionnaire into the provided Excel file. The experimenter then checks every participant's output to make sure that all participants understand the requirement. This should provide enough practice to weed out potential learning

effects in the Production Section. Similarly, the low-wage workers try preparing 2 envelopes and the experimenter checks their output and answers any questions that they might have in this section.

Production Section (Period 0 and Period 1).— After the Practice Section ends, the paying Production Section begins. This Section is divided into two thirty-minute periods, Period 0 and Period 1, with a short break in between in which the workers can take a rest and the experimenter checks every worker's output and answers questions from the participants. Workers are paid w_τ in Period 0 in all experiment sessions. One of the treatments are assigned in Period 1 to each experiment session and the workers' pay in this period depends on which treatment their session receives. The high-wage group and the low-wage group in the same session get the same treatment.

Treatment 1: The Constant (C). In this treatment, the participants do not have any previous connections and there is no minimum wage introduced. The high-wage workers are paid w_H and the low-wage workers are paid w_L. The workers' productivity in this treatment provides a baseline of the effort that workers choose in Period 1 without the influence of a minimum wage. To describe it using the theoretical framework's term, under this treatment,

(55) $$\Delta R = R_1(w_1) - R_0(w_0) = 0$$

and

(56) $$\Delta S = S_1(w_1) - S_0(w_0) = 0.$$

Treatment 2: The Relative Wage (RW). In this treatment, the participants do not have any previous connections, but a minimum wage that is higher than w_L but

lower than w_H is announced by the experimenter (the firm) and the high-wage workers' wage stays at w_H. This means that the low-wage workers get a wage increase while the high-wage workers get nothing, which triggers the fair wage channel in the theoretical framework, i.e.,

$$\Delta R = R_1(w_1) - R_0(w_0) \neq 0. \tag{57}$$

Moreover, since the participants do not know each other before the experiment and they have no opportunity to interact with each other in the laboratory, it is not unreasonable to assume that they do not care about their co-workers' utility (or, at the very least, do not care as much about their co-workers' utility as when they are acquaintances or even friends), i.e.,

$$\Delta S = S_1(w_1) - S_0(w_0) = 0 - 0 = 0. \tag{58}$$

Therefore, the difference between the workers' productivity in the Relative Wage treatment and the workers' productivity in the Constant treatment in Period 1 isolates the effect of the fair wage channel and can be used to test Hypothesis 1.

Treatment 3: The Sympathy (S). In this treatment, the participants are friends with each other, and a minimum wage that is higher than w_L but lower than w_H is announced by the experimenter (the firm) and the high-wage workers' wage will stay at w_H. To ensure that the participants have previous connections, they are required to sign up for the experiment as a group. In this way, the participants can be assumed to care about each other's utility, and the sufficient condition for the Sympathy channel to work is satisfied.[2] In addition, since a minimum wage is

[2] It is likely that recruiting participants will be much harder for this treatment compared to the treatments that has no such sign-up requirement. One possible solution is to bring the recruitment to (random) student organizations or small classes.

introduced, the fair wage channel also works for reasons discussed above in Treatment 2. Therefore, under this treatment, when the minimum wage is introduced by the experimenter, both the fair wage channel and the sympathy channel are triggered, i.e.,

(59) $$\Delta R = R_1(w_1) - R_0(w_0) \neq 0$$

and

(60) $$\Delta S = S_1(w_1) - S_0(w_0) \neq 0.$$

Therefore, the difference between the workers' productivity in the Sympathy treatment and the workers' productivity in the Relative Wage treatment reveals the effect of the sympathy channel, which can be used to test Hypothesis 2. In addition, the difference between the workers' productivity in the Sympathy treatment and the workers' productivity in the Constant treatment reveals the overall effect of the minimum wage, which can be used to test Hypothesis 4.

Treatment 4: The Intention (I). Simulating the setting where the minimum wage is government mandated is more difficult in a laboratory experiment. In laboratories, experimenters are deemed to have full control over all of their actions by the participants. Even if the experimenter tries to create an "alternative universe" in the laboratory and claims that there exists an outside force, such as the "government" in this universe, that thrusts a minimum wage upon her, it is unlikely that the participants will believe the story and assign less responsibility to the experimenter. Therefore, it is necessary to jump out of the existing experimental setting to test Hypothesis 3.

The approach follows Spurlino (2017), whose study focuses on the differential impacts of a wage increase on worker productivity when it is externally mandated versus when it is actively chosen by the employer. Spurlino conducts a laboratory experiment in which some of the participants act as employers and the others act as workers. The employers decide the wages that they want to pay to each of their workers and the workers perform a real effort task that generates profits for the employers. In the mandated treatment, after two rounds of productions in which every worker is paid $8 per round, the experimenter acts as the authority and orders the employers to pay all the workers $10 per round; in the active treatment, after the two initial $8 rounds, the experimenter informs all participants that the employers can choose to pay a worker either $8 or $10. Spurlino finds that the workers who receive a wage increase in the active treatment exert more extra effort than the workers in the mandated treatment. Spurlino's success in convincing the workers that the experimenter is indeed an external higher authority comes from his setting that some participants, instead of the experimenter, are the employers. As mentioned earlier, an experimenter is usually deemed to have control over everything in the laboratory, and that includes the participants that act as the employers.

Therefore, I adopt Spurlino's experimental design and have two participants as the employer while the experimenter acts as the government. More specifically, at the beginning of the Intention treatment, two participants are randomly selected as the employers and the rest of the participants are the workers. The experimenter then tells the participants about the two types of tasks, the Assessment Test and how workers are divided into task groups, as well as which employer is in charge of which task. The experimenter goes on to inform all the participants how they will be paid in the Production Period: the employers have a payoff function that depends on their group's output and the wages that they pay to the workers, and the workers' pay depends on 1) the uniform group wage that their group employer

chooses and 2) the task they perform since the low-wage workers' employer cannot choose a group wage that is higher than the high-wage workers'. Before the Assessment Test begins, the experimenter tells the employer-participants how to perform the employer duties that the experimenters themselves do in the other treatments. The duties include conducting the assessment test and dividing workers into task groups, explaining and demonstrating the task, checking worker output, organizing production, and answering workers' questions. In addition, the employers are secretly instructed by the experimenter to set the wages to $w_{L,0}$ and $w_{H,0}$ in Period 0 so that the wages are comparable to those in the other treatments. They are also secretly informed that their actual payment is either a lump-sum payment proposed by the experimenter or what comes out of the above payoff function. This makes the employer-participants' pay more reasonable since they will not have to bear potential negative consequences of a decision over which they have no control.

The experiment officially begins with the Assessment Test. After they divide the workers into two groups, the employers announce what they are paying to their workers to all participants. At this point, the workers are fully aware of the treatments of their co-workers and themselves, but they are also under the impression that the wage scheme is chosen by the employers, as in the other treatments.

The experiment goes on with the Instruction Section, the Practice Section, and the Production Section with the employer-participants acting as the employer in place of the experimenters as in the other treatments until Period 1 of the Production Section. At this point, the experimenter announces a mandatory minimum wage increase to the low-wage workers, and the low-wage workers' employer is publicly instructed to increase w_L to the new minimum wage level. In addition, in line with the settings of the other treatments, the high-wage workers' employer is privately instructed to keep w_H constant. The workers go on to perform the task for thirty

minutes and then the experiment ends. One additional setting of this treatment is that the participants are also required to sign up as a group so that the outcome is comparable to the Sympathy treatment's.[3]

Under this treatment, when the minimum wage is introduced by the government (the experimenter) in Period 1, both the fair wage channel and the sympathy channel are triggered, i.e.,

(61) $$\Delta R = R_1(w_1) - R_0(w_0) \neq 0$$

and

(62) $$\Delta S = S_1(w_1) - S_0(w_0) \neq 0.$$

However, the entity that triggers the channels are different in the Sympathy treatment and this treatment: it is the firm in the Sympathy treatment and the government in this treatment, i.e.,

(63) $$\vartheta_S \neq \vartheta_I.$$

Therefore, the difference between the workers' productivity in the Intention treatment and the workers' productivity in the Sympathy treatment reveals the effect of the factor of intention, which can be used to test Hypothesis 3.

[3] A short note on why I choose not to use this employer-worker setting in the other treatments: as can be seen in the Intention treatment, the "employers" are really an extension of the will of the experimenter whose inclusion in the other treatment sessions does not provide any additional information. However, they still need to be paid. When funding is limited, it is good practice to cut all unnecessary expenditure.

B. Empirical Strategy

I compare the change in worker productivity from Period 0 to Period 1 across experiment sessions to evaluate the effect of the introduction of a minimum wage. However, before discussing the empirical strategy, let us first determine how to measure worker productivity.

Measurement of Productivity.—For high-wage workers, recall that the workers' tasks in the experiment are transcribing handwritten answers to survey questionnaires into an Excel file. Moreover, the workers are provided the same set of questionnaires. This means that, if they follow the experimenter's instruction and do the transcription correctly, the content of their output will be identical. Therefore, the basic unit of the measurement of productivity here is the number of words they manage to transcribe in the given amount of time. The more words a worker transcribe, the more productive the worker is.

However, the scenario in which workers make mistakes also needs to be taken into consideration. In the most extreme case, a worker can make up every word in the Excel sheet to increase the transcription speed, producing a large output that is utterly unusable and totally worthless to the firm. Therefore, in addition to the number of words transcribed, two more methods of measurement are introduced to account for the quality of the output following Hennig-Schmidt et al. (2010): the number of words correctly transcribed, and the number of words incorrectly transcribed. The reason to include the number of correct words is straightforward — the correct words are the immediately usable output to the firm — but the decision to include the number of incorrect words needs a more detailed explanation. As Hennig-Schmidt et al. point out, the incorrect words also need to be corrected before the output as a whole can be usable to the firm, and the correction has a cost since it needs to be carried out by either the worker, who is

going to bill more hours to the firm, or an independent proofreader, whose service the firm also needs to pay for. For example, there are two workers at the firm that both correctly transcribe 200 words. However, worker A transcribe 300 words in total and worker B transcribe exactly 200 words. It is not hard to see that worker B is more productive than worker A from the firm's perspective.

In all, a high-wage worker's productivity ${e_i}^H$ is measured by

(64) ${e_i}^H = \text{words correctly transcribed} - \varsigma \cdot \text{words incorrectly transcribed}$

where ς is the cost of correcting mistakes relative to the benefit of having a correct output.

Following the same line of thought, the productivity ${e_i}^L$ of a low-wage worker who prepares mailing envelope is measured by

(65)${e_i}^L = \text{envelopes correctly prepared} - \zeta \cdot \text{envelopes incorrectly prepared}$

where ζ is the cost of having another person re-prepare the incorrect envelope relative to the benefit of having a correct output.

Now that the measurement of worker productivity for both groups of workers has been established, let us start discussing the empirical strategy.

To evaluate the effect of a minimum wage introduction, I use the difference-in-differences (DID) method to compare the change in individual worker productivity from Period 0 to Period 1 in the Production Section across experiment sessions:

(66) $$e_{it} = \beta_0 + \beta_1 Treated_i + \beta_2 Period_t + \beta_3 Treated_i \cdot Period_t + \varepsilon_i.$$

Here, e_{it} is worker *i*'s productivity in Period t in the Production Section, $Treated_i$ is a binary variable that equals 1 if worker *i* is in the experiment session that receives

the treatment and 0 if her session receives the control, $Period_t$ is a binary variable that equals 0 if it is Period 0 when the treatment has not taken place and 1 if it is Period 1 when the treatment has taken place, and ε_i is the error term. The standard errors are clustered at the session level to account for potential influence of group dynamics on individual worker productivity. One thing to note is that, since I want to separate the two fairness channels and the fairness factor that help the minimum wage introduction affect worker productivity, which sessions are the treatment and control groups depends on which hypothesis I am testing. For example, when I want to test Hypothesis 1, which is about the effect of the fair wage channel, the control group is the workers whose session receives the Constant treatment, and the treatment group is the workers whose session receives the Relative Wage treatment. Workers whose session receives neither treatment do not enter the estimation.

The coefficient β_1 measures the difference in average worker productivity between the treatment and control groups in Period 0. When there is a large enough number of participants, β_1 should not be statistically significantly different to zero. The coefficient β_2 measures the difference in average worker productivity between Periods 0 and 1 for the control group. β_2 captures the effect of time on worker performance, including possible fatigue, boredom, learning effects, etc. Lastly, β_3 is the coefficient of interest in this study. It measures the differential impact of going from Period 0 to Period 1 for the treatment group and the control group. In other words, it is the difference between the change in average worker productivity between Periods 0 and 1 for the treatment and the control groups. Using β_3 instead of the difference in average worker productivity in period 1 for estimation makes possible to the greatest extent under the current experimental setting studying the impact of the treatment without the influence of unbalanced pre-treatment worker productivity between groups. Even though the unbalanced groups situation is unlikely to happen with a large enough sample, it is still good to have the insurance.

As mentioned earlier, different subsamples of experiment sessions are plugged into equation (66) to test different hypotheses.

To test Hypothesis 1, which is the separate effects of the fair wage channel for high-wage and low-wage workers, the treatment group is the sessions that get the Relative Wage treatment, and the control group is the sessions that get the Constant treatment, divided by worker type. In this case, β_3 captures

(67) $$\overline{\Delta e_{RW}} - \overline{\Delta e_C} = \left(\overline{e_{RW,1} - e_{RW,0}}\right) - \left(\overline{e_{C,1} - e_{C,0}}\right),$$

and

(68) $$\beta_{3,H} < 0,$$

(69) $$\beta_{3,L} > 0$$

if the hypothesis is correct.

To test Hypothesis 2, which is the separate effects of the sympathy channel for high-wage and low-wage workers, the treatment group is the sessions that get the Sympathy treatment, and the control group is the sessions that get the Relative Wage treatment, divided by worker type. In this case, β_3 captures

(70) $$\overline{\Delta e_S} - \overline{\Delta e_{RW}} = \left(\overline{e_{S,1} - e_{S,0}}\right) - \left(\overline{e_{RW,1} - e_{RW,0}}\right),$$

and

(71) $$\beta_{3,H} > 0,$$

(72) $$\beta_{3,L} = 0$$

To test Hypothesis 3, which is the effect of the fairness intention factor, the treatment group is the sessions that get the Intention treatment, and the control group is the sessions that get the Sympathy treatment. In this case, β_3 captures

(73) $$\overline{\Delta e_I} - \overline{\Delta e_S} = \left(\overline{e_{I,1} - e_{I,0}}\right) - \left(\overline{e_{S,1} - e_{S,0}}\right),$$

and

(74) $$\beta_3 < 0$$

if the hypothesis is correct.

To test Hypothesis 4, which is the overall effects of the minimum wage on worker productivity for high-wage and low-wage workers, the treatment group is the sessions that get the Sympathy treatment, and the control group is the sessions that get the Constant treatment, divided by worker type. In this case, β_3 captures

(75) $$\overline{\Delta e_S} - \overline{\Delta e_C} = \left(\overline{e_{S,1} - e_{S,0}}\right) - \left(\overline{e_{C,1} - e_{C,0}}\right),$$

and

(76) $$\beta_{3,H} ? 0,$$

(77) $$\beta_{3,L} > 0$$

if the hypothesis is correct.

IV. Conclusion

I hypothesize two fairness-related channels and a factor that interacts with those channels to study how the introduction of a minimum wage can affect worker

productivity. I also incorporate my hypotheses into the standard neoclassical model to account for the fairness considerations that workers have when they decide their effort supply. Lastly, I design a laboratory experiment to test the theoretical framework's predictions. If my hypotheses are correct, the introduction of a minimum wage will have differential impacts on high-wage and low-wage workers. High-wage workers will make an ambiguous modification to the overall effort supply depending on whether they are more unsatisfied with their lower relative wage to the low-wage workers than they are happy with the firm's better treatment to their co-workers. Low-wage workers will exert more effort in my theoretical framework, wanting to reciprocate the firm for their higher relative wage and not seeing any change in their co-workers' utility that comes from the minimum wage.

The shortcomings of my study mainly come from the stylized settings of the theoretical framework and the experiment. In terms of the theoretical framework, there could be other fairness considerations that affect worker productivity other than the two channels; each individual worker might assign different weights to the two channels' impacts; when the magnitude of the two channels change, their weights might shift as well; the wage scheme that workers face are usually not dichotomy, and a lot of the workers who make the minimum wage are under a piece-rate instead of an hourly rate wage scheme; firms are also not an island but an integrated part of the market, which means that the decision to raise the minimum wage, even actively, is not exogenous. In terms of the experimental design, the one-shot nature of laboratory experiment coupled with the fact that the participants are unlikely to enter the production to actually support their lives could make the sympathy channel a lot less pronounced; workers are also likely to make more arbitrary, less calculated decisions in a laboratory experiment than they would in a field experiment, let alone in the real world; most importantly, most places already have a minimum wage in place and the more important question should be

the effect of an increase in the minimum wage. Future research could focus on the aforementioned problems to make the results more fit for wider extrapolation.

With that being said, policy implications can still be drawn if the fairness considerations are proven to be relevant. First, when considering introducing a minimum wage or increasing the existing minimum wage, it is important to consider its impact not only on low-wage workers whose wage are below the minimum wage but also on the high-wage workers who already make above the minimum wage. Second, fostering interpersonal relationship at workplace might have an extra advantage for the firm. When high-wage workers care more about the low-wage workers, a strong bond between them can mitigate possible negative effects from the minimum wage. Lastly, companies should take advantage of the intention factor and consider actively raising its minimum wage when it gets wind of a potential statutory minimum wage increase to reap the benefit of an assertive image.

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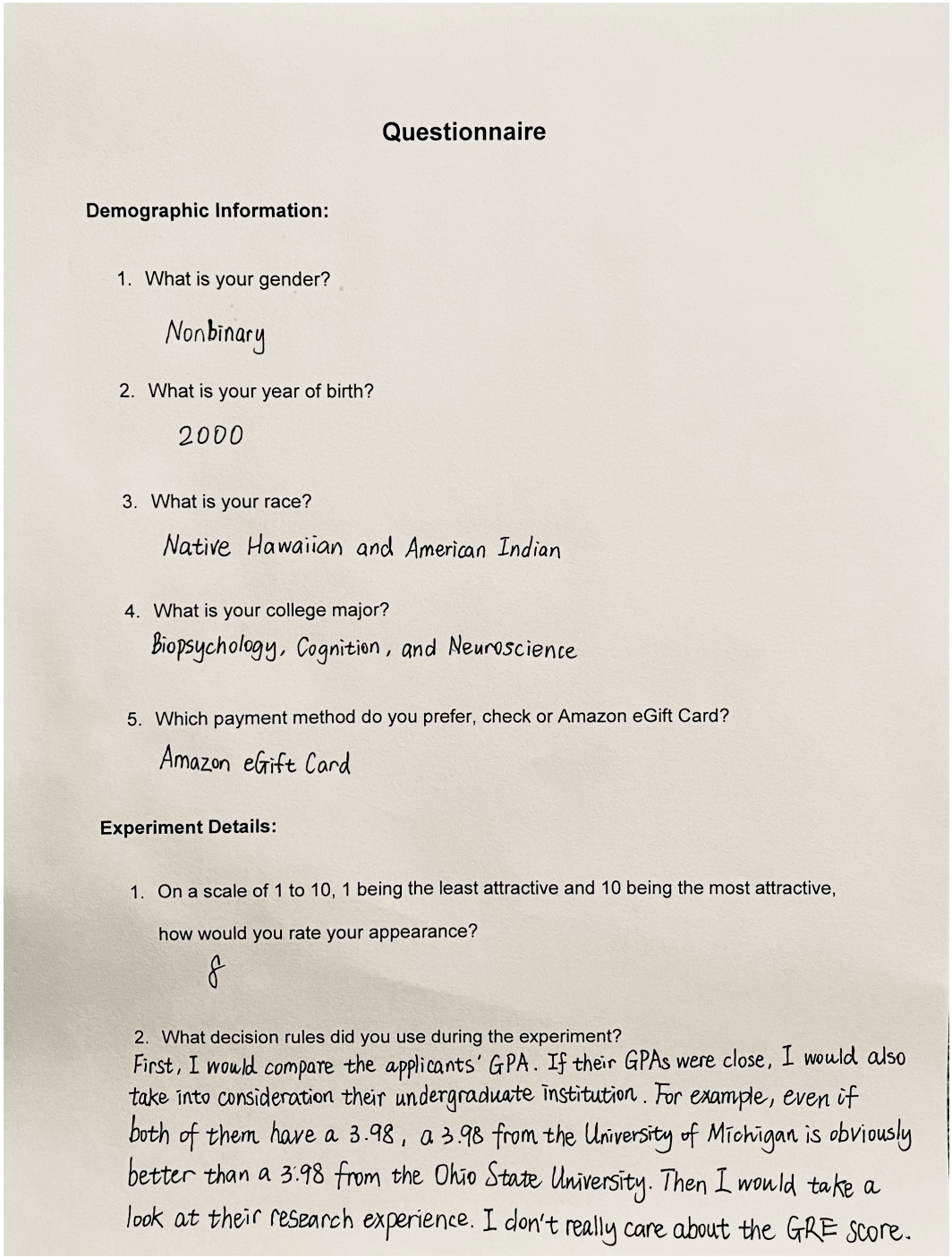
APPENDIX I: Sample Experiment Materials



Questionnaire

Demographic Information:

1. What is your gender?

   Nonbinary

2. What is your year of birth?

   2000

3. What is your race?

   Native Hawaiian and American Indian

4. What is your college major?

   Biopsychology, Cognition, and Neuroscience

5. Which payment method do you prefer, check or Amazon eGift Card?

   Amazon eGift Card

Experiment Details:

1. On a scale of 1 to 10, 1 being the least attractive and 10 being the most attractive, how would you rate your appearance?

   8

2. What decision rules did you use during the experiment?

   First, I would compare the applicants' GPA. If their GPAs were close, I would also take into consideration their undergraduate institution. For example, even if both of them have a 3.98, a 3.98 from the University of Michigan is obviously better than a 3.98 from the Ohio State University. Then I would take a look at their research experience. I don't really care about the GRE score.

FIGURE A1. SAMPLE HYPOTHETICAL HANDWRITTEN QUESTIONNAIRE

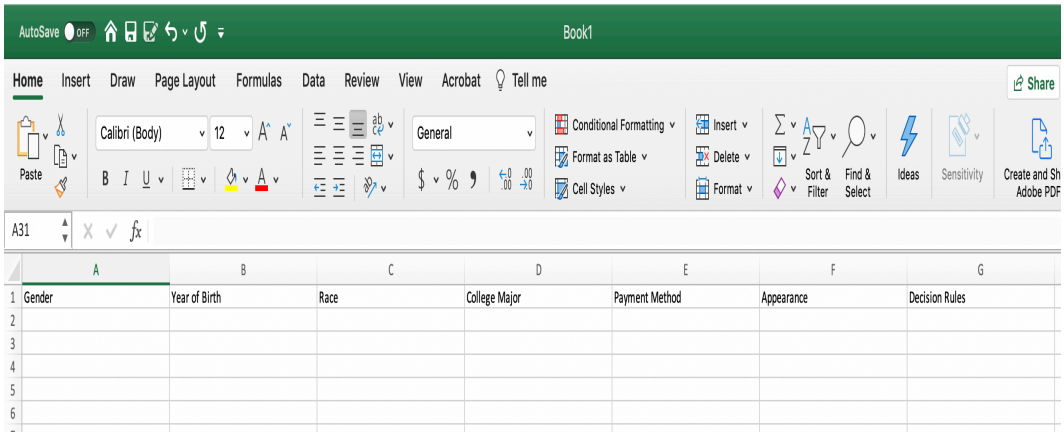


FIGURE A2. SAMPLE EXCEL SHEET PROVIDED TO PARTICIPANTS

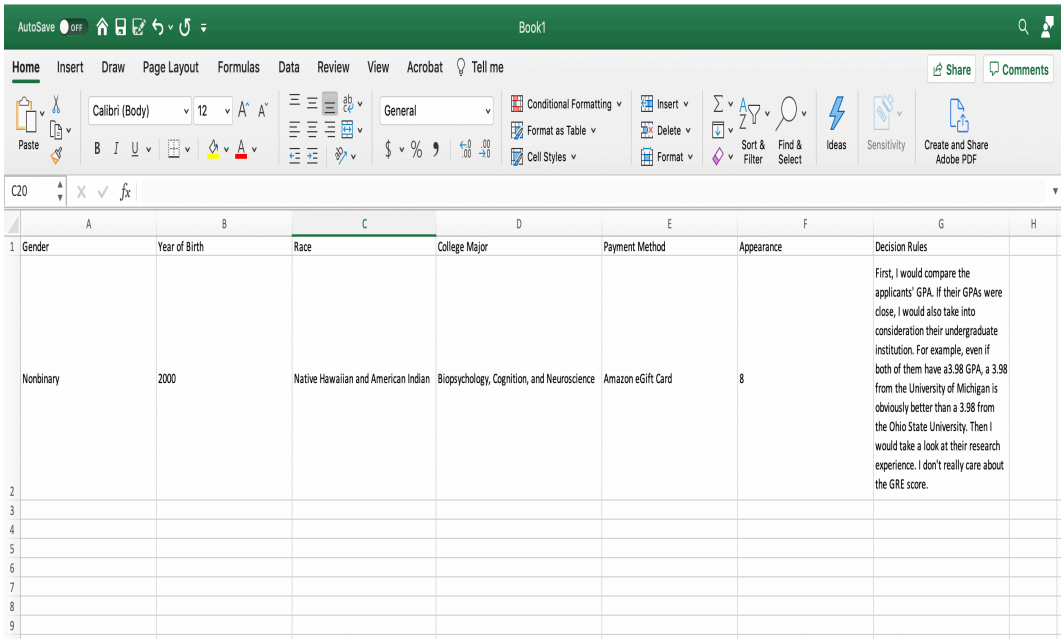


FIGURE A3. SAMPLE FINISHED EXCEL SHEET

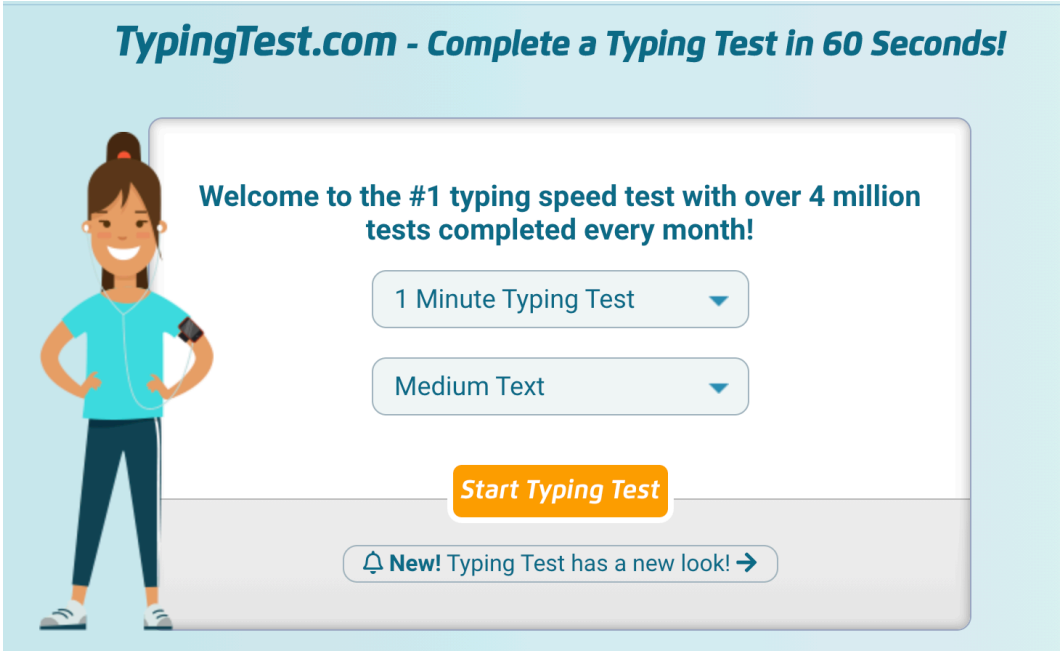


FIGURE A4. SAMPLE ONE-MINUTE TYPING TEST FROM TYPINGTEST.COM

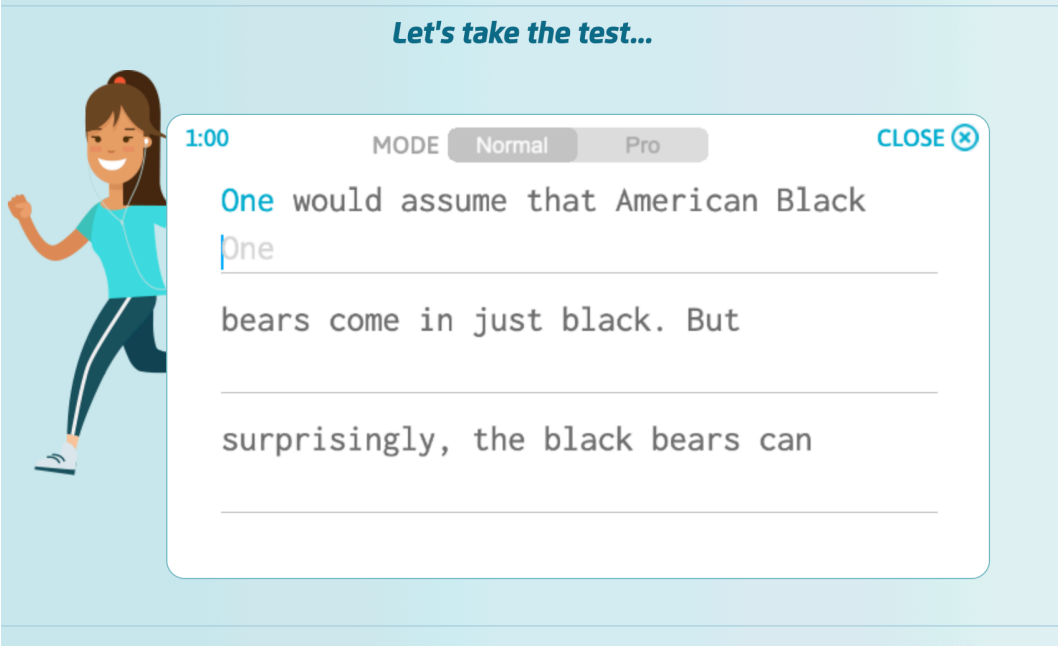


FIGURE A5. SAMPLE TEST INTERFACE ON TYPINGTEST.COM

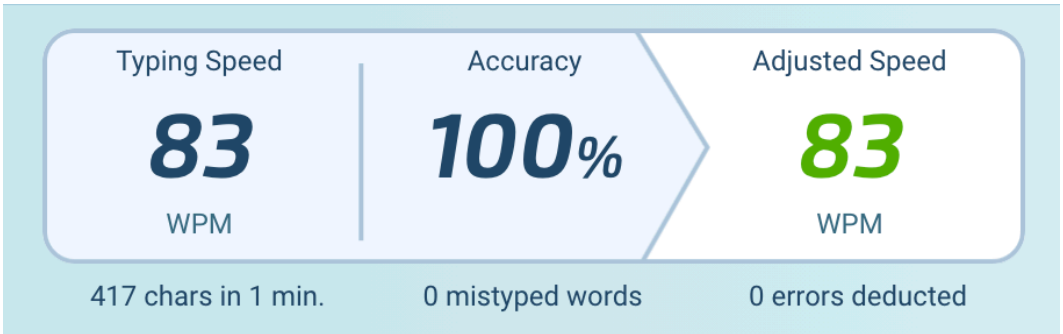


FIGURE A6. SAMPLE TEST RESULT FROM TYPINGTEST.COM[4]

[4] This study is neither sponsored by nor affiliated with TypingTest.com ☺