

# Asymmetric Information in the Gig Economy: Evidence from an Online Experiment

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## Abstract

For short-term workers facing uncertain output, hourly wage contracts provide implicit insurance compared to self-employment or piece-rate pay. But like any insurance product, these contracts are prone to market distortions through moral hazard and adverse selection. Using a model of wage contracts under asymmetric information, I show how these distortions can be identified as potential outcomes in a marginal-treatment-effects framework. I apply this framework to a field experiment in which data-entry workers are offered a choice between a randomized hourly wage and a standardized piece rate. My experimental design allows me to separately identify moral hazard and adverse selection: Treatment-effect estimation isolates moral hazard, while comparisons of piece-rate workers who declined different hourly wage offers isolates adverse selection. Results from a small-scale pilot experiment find statistically significant selection effects. A one-dollar increase in hourly wage offer corresponds to a \$0.25 (SE=0.101) increase in hourly output value among those declining the hourly offer in favor of the piece rate. This adverse selection results in an inefficiently low provision of hourly wage contracts.

# 1 Introduction

The proliferation of “gig work” has transformed how millions of workers are paid (Garin et al., 2023; Collins et al., 2019; Katz and Krueger, 2019; Abraham et al., 2017; Jackson et al., 2017). Rather than clocking their hours, workers are increasingly compensated by the number of miles driven, pages written, or tasks completed. Compared to traditional time-based wages, this type of compensation can be risky and unpredictable—an hourly worker knows what they’ll earn from a day’s work, whereas a gig worker’s earnings often depend on uncertain factors like weather or traffic. But if workers value the insurance provided by hourly wages, why are so many short-term labor markets dominated by risky, piece-rate compensation and self-employment?

In this paper, I investigate how two distortionary forces—moral hazard and adverse selection—can lead to inefficiently low provision of hourly work. On the one hand, hourly wages might reduce effort through moral hazard (Lazear, 2000), leading employers to emphasize piece rates over hourly wages in labor contracts. On the other hand, if ex-ante less productive workers adversely select into hourly wage contracts, firms might post exclusively piece-rate positions to avoid attracting the wrong type of worker. Distinguishing the relative magnitudes of these two effects has important policy implications. For example, government mandates or subsidies that promote hourly wages among “high types” might mitigate welfare loss from adverse selection, but are unlikely to induce the added worker effort necessary to alleviate moral hazard.

I formalize this intuition with a model of short-term labor markets under asymmetric information. Using this framework, I show how the provision of hourly employment contracts is determined by two curves: a worker’s reservation wage—the minimum they will accept for an hour of labor—and the average value of output among workers with comparatively lower reservation wages. An hourly worker can be profitably hired only if their average value exceeds their reservation wage. By reframing the reservation wage as “resistance to treatment,” this model has a direct correspondence to the marginal-treatment effects framework

(Björklund and Moffitt, 1987; Heckman and Vytlacil, 1999, 2005, 2007). This correspondence reveals how both moral hazard and adverse selection can be expressed as functions of “marginal values”—the potential output values of workers with a given reservation wage.

Motivated by my theoretical framework, I conduct a two-stage field experiment designed to separately identify moral hazard and adverse selection into hourly wages. First, I offer workers a choice between a randomized hourly wage and a standardized piece rate in exchange for performing a data-entry task. Then, after workers choose a payment option but before work begins, I increase hourly wages for a randomized subset of those who accepted hourly offers, bringing them to parity with higher hourly wage offers. Using the *offered* wage as an instrument for working under a given *effective* wage identifies the moral hazard effect of hourly pay, while comparisons across piece-rate workers who decline different hourly wage offers identifies selection—both groups work under the same form of compensation but faced different ex-ante menus of contracts. Importantly, experimental wage offers include contracts that may not be profitable to a real-world employer, avoiding the “under-the-lamppost” problem inherent to many empirical studies of information asymmetries (Einav et al., 2010b).

Results from a small-scale pilot experiment find statistically significant selection effects. A one-dollar increase in hourly wage offer corresponds to a \$0.25 (SE=0.101) increase in output value among those declining the offer in favor of the piece rate.<sup>1</sup>

This study relates to several streams of existing research. Building upon the seminal work of Akerlof (1970), several studies have applied the theory of adverse selection to labor markets, showing how the self-sorting of workers by unobserved productivity can lead to inefficient hiring, compensation, or other labor contract provisions (Weiss, 1980; Malcomson, 1981; Jovanovic, 1982; Greenwald, 1986; Lazear, 1986; Gibbons and Katz, 1991; Levine, 1991; Kugler and Saint-Paul, 2004; Moen and Rosen, 2005). While empirical analyses of these selection phenomena are less common, several papers document differential sorting and/or treatment effects of job characteristics like compensation schemes (Shearer, 1996;

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<sup>1</sup>At present, results are limited to a small-stage pilot from March 2024. The full-scale experiment is expected to complete in May of 2024.

Lazear, 2000; Angrist et al., 2021; Shearer, 2004; Kantarevic and Kralj, 2016) or remote work (Emanuel and Harrington, 2023). These and other studies use observational data to estimate selection and incentive effects in both labor markets and elsewhere (Einav et al., 2010a; Chiappori and Salanie, 2000; Hendren, 2017), but few have used experimental methods to form these estimates. Karlan and Zinman (2009), which randomizes contract offerings on microfinance loans in South Africa, is a notable exception. Using a design similar to the second stage of my experiment, they isolate selection on unobservables by comparing borrowers who faced different menus of options but ultimately faced the same contract terms. They find strong evidence of moral hazard and weaker evidence of adverse selection.

My study design also builds upon existing experimental work using online freelancer platforms. DellaVigna and Pope (2018) and DellaVigna and Pope (2022) estimate the effects of both monetary and non-monetary incentives in an online typing task. Pallais (2014) and Pallais and Sands (2016) demonstrate the signaling benefit of entry-level hiring and employer references using online experiments. My paper complements such findings, as the unraveling phenomenon I investigate could help explain why Spence (1973)-style information treatments provide a net social benefit.

Relative to existing work on adverse selection in labor markets, my proposed experiment offers several distinct advantages. First, my experiment would reveal workers' decisions over contracts that are unavailable to them in the real world, allowing me to quantify welfare losses in unraveled markets where efficient wage contracts cannot be observed. Second, the ability to randomize wage offers allows me to reliably estimate selection into these contracts, ensuring that such patterns are not driven by unobserved characteristics of firms, contracts, or the populations of workers to which their offered. Finally, my experimental design, in which workers can choose between a randomized set of wage offers, allows me to separately identify selection-on-unobservables from the treatment effects of different compensation schemes.

The rest of this paper proceeds as follows: In Section 2, I develop a model of hourly

wage contracts under asymmetric information. In Section 3, I describe my experiment and underlying empirical strategy. In Section 4, I discuss results from a small-scale pilot experiment. Section 5 concludes.

## 2 Model of Asymmetric Information in Wage Contracts

In this section, I present model of short-term labor markets under asymmetric information. The model borrows from Einav et al. (2010a) and Herbst and Hendren (2021), who develop models of asymmetric information in health insurance markets and college financing markets, respectively. I then show how the parameters of this model can be mapped into marginal-treatment effects framework, motivating my experimental design in Section 3.

Consider a perfectly competitive labor market in which risk-neutral firms face a population of observably equivalent workers.<sup>2</sup> Each worker,  $i$ , can produce some level of hourly output,  $q_i = f(\zeta_i, e_i, \nu_i)$ , which is a function of unobserved worker characteristics ( $\zeta_i$ ), individual effort ( $e_i$ ), and random noise ( $\nu_i$ ). Firms can buy worker output at a constant market price of  $p$  per unit.<sup>3</sup> Alternatively, they can offer a flat, up-front wage of their own choosing,  $w$ , in exchange for a claim on a worker's hourly output,  $q_i$ .<sup>4</sup>

For individual  $i$ , I define the reservation wage,  $\bar{w}_i$ , as the minimum  $w$  at which they would accept an hourly contract. The relative supply of hourly workers is given by

$$S(w) \equiv \Pr(\bar{w}_i < w). \quad (1)$$

Assuming strict monotonicity ( $S(w) > S(w')$  for all  $w > w'$ ), I index workers by a type parameter,  $\theta_i \in [0, 1]$ , equal to the share of the worker population willing to accept a lower wage than worker  $i$ 's reservation wage,  $\theta_i \equiv S(\bar{w}_i)$ . I can then rewrite a worker's reservation

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<sup>2</sup>I focus on perfect competition because it serves as a useful benchmark for welfare calculation. It is straightforward to adapt the model to alternative market structures, including those in which employers hold monopsony power.

<sup>3</sup>Directly purchasing a worker's product of labor can be thought of as either piece-rate employment or hiring a self-employed contractor.

<sup>4</sup>While a worker's output,  $q_i$ , can vary between hourly and piece-rate contracts (e.g., through moral hazard effects), I assume an hourly worker's output does not vary with the wage,  $w$  (i.e., no wage effects).

wage as a function their type,  $\bar{w}_i = \bar{w}(\theta_i)$ , where

$$\bar{w}(\theta) \equiv S^{-1}(\theta). \quad (2)$$

Facing this population of observably identical workers with unknown types, employers set wages to maximize profits. I define the *marginal value* of type  $\theta$  as

$$MV(\theta) \equiv E[Y_i | \theta_i = \theta], \quad (3)$$

where  $Y_i = pq_i$ , the incremental value of output  $q_i$  produced under an hourly contract.<sup>5</sup> Absent any behavioral response to the hourly contract,  $MV(\theta)$  equals type  $\theta$ 's expected earnings under the market piece rate,  $p$ . If  $\theta$  were risk averse, we would expect their reservation wage to fall below this “actuarially fair” wage (i.e.,  $\bar{w}(\theta) < MV(\theta)$ ). In other words, they would accept lower expected earnings in exchange for the implicit insurance provided by hourly wages relative to piece rates. In this case, a fully informed employer could profit from offering an hourly wage of  $w = \bar{w}(\theta)$  exclusively to type  $\theta$ .

However, if employers cannot observe types, they cannot prevent borrowers with  $\theta_i \neq \theta$  from opting into a contract offered at wage  $w$ . In this case, the hourly position would be accepted by all types  $\theta_i$  such that  $\bar{w}(\theta_i) \leq w(\theta)$ . So instead of obtaining type  $\theta$ 's marginal value,  $MV(\theta)$ , the employer would obtain their *average value*, defined as

$$AV(\theta) \equiv E[Y_i | \theta_i \leq \theta]. \quad (4)$$

The average value,  $AV(\theta)$ , of type  $\theta$  is given by the average value of output produced among all types  $\theta_i < \theta$ . When we account for this selection into contracts, the employer's profits are given by

$$\Pi(w) = S(w)(AV(\theta^w) - w), \quad (5)$$

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<sup>5</sup> $Y_i$  reflects the market value of  $q_i$  units of output, or, equivalently, the amount the firm saves by not buying hourly worker  $i$ 's output at the piece rate. This measure of incremental value is analogous to the incremental cost of insurance defined in Einav et al. (2010a).

where  $\theta^w \equiv S(w)$ , the worker type with reservation wage equal to  $w$ .

I assume that at least one worker's marginal value exceeds their reservation wage, ( $\bar{w}(\underline{\theta}) > MV(\underline{\theta})$  for some  $\underline{\theta} > 0$ ). This assumption will hold unless all workers are risk-loving, risk-neutral, or hold over-optimistic beliefs about their productivity. I further assume that  $MV(\theta)$  crosses the supply curve at most once (if  $\bar{w}(\bar{\theta}) < MV(\bar{\theta})$  for some  $\bar{\theta}$ , then  $\bar{w}(\theta) < MV(\theta)$  for all  $\theta > \bar{\theta}$ ). With these simplifying assumptions in hand, the equilibrium condition for the share of workers under hourly contracts,  $\theta^{EQ}$ , is given by

$$\bar{w}(\theta^{EQ}) = AV(\theta^{EQ}). \quad (6)$$

Figure 1 illustrates the welfare impacts of adverse selection for an example population. An efficient allocation of contracts would lead to hourly employment for all types  $\theta \leq \theta^{EF}$ , as these workers would accept wages at or below their marginal values ( $\bar{w}(\theta) \leq MV(\theta)$ ). But while type  $\theta^{EF}$ 's reservation wage (red line) is equal to their marginal value (blue line), an employer offering an hourly wage of  $w = \bar{w}(\theta^{EF})$  would only recoup the average value (green line) of labor product among everyone accepting the offer (i.e., all  $\theta \leq \theta^{EF}$ ). The employer could lower their wage offer, but that would drive those with the highest productivity out of the market, further reducing the contract's average value. This process continues across all types for whom  $\bar{w}(\theta) > AV(\theta)$ , so that the equilibrium share of workers under hourly contracts is  $\theta^{EQ}$ , where  $\bar{w}(\theta^{EQ}) = AV(\theta^{EQ})$ . In this stylized example, roughly one-third of the population— $\theta \in (\theta_{EQ}, \theta_{EF})$ —cannot obtain hourly employment despite a willingness to work for less than their expected earnings under the market piece rate. The result is a welfare loss corresponding to the area of the region shaded in pink.

In summary, because private information creates a gap between the marginal and average values of labor, it has the potential to prevent Pareto-improving exchanges from taking place, reducing welfare below what it would be under a full-information benchmark. In the following section, I demonstrate how my experimental results can be used to estimate this welfare loss.

## 2.1 Incorporating Moral Hazard

Note that the model above allows for moral hazard effects, even if those effects are not explicitly discussed. To see how, consider worker  $i$ 's potential output values under counterfactual contracts. Specifically, let  $Y_{1i}$  denote  $i$ 's output value if they work under the hourly wage, and let  $Y_{0i}$  denote their output value if they work under the piece rate. The moral hazard effect for worker  $i$  is given by their individual treatment effect of the hourly wage,  $MH_i \equiv Y_{1i} - Y_{0i}$ .<sup>6</sup> However, since piece-rate workers sell their output at a constant price per unit, their productivity-per-hour has no affect on firm profits. So while firms care about a worker's output under the offered hourly wage ( $Y_{1i}$ ), they don't care how this output compares to the piece-rate counterfactual ( $Y_{0i}$ ). For this reason, profit conditions and welfare calculations are inclusive of any incentive effects—both  $AV$  and  $MV$  are defined conditional on accepting the hourly contract, and thus depend only on output under hourly wages,  $Y_{1i}$ .

Separating the effects of moral hazard can nonetheless be useful, as firms might have ways of mitigating the moral hazard response to hourly wage contracts. For example, a firm might combine hourly wages with a smaller piece-rate portion to ensure workers have some “skin in the game,” similar to restaurant tipping or sales commissions. This type of compensation would likely attenuate disincentive effects, but would do little to prevent adverse selection—low-productivity workers would still prefer the partial insurance of mixed compensation compared to a pure piece rate. This scenario can easily incorporated into my framework—it simply requires reframing the model as a market for supplemental hourly wages on top of a preexisting piece rate. Empirically, however, it requires separating the selection from treatment effects for the “pure” hourly wage offers in my experiment.

To separate the incentive response of the contract from selection on underlying unobservables, I must consider the value of worker output across types under hourly wage and both with *and without* the hourly wage contract. To do so, I split Equations (3) and (4)

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<sup>6</sup>Strictly speaking,  $Y_{1i} - Y_{0i}$  captures worker  $i$ 's overall output response to the hourly wage contract. This response could result from behavioral phenomena not traditionally classified as moral hazard.



into two pairs of curves. First, I define marginal values of a type  $\theta$  as the conditional means of potential output value with ( $Y_{1i}$ ) and without ( $Y_{0i}$ ) the hourly wage:

$$MV_1(\theta) \equiv E[Y_{1i}|\theta_i = \theta] \quad (7)$$

$$MV_0(\theta) \equiv E[Y_{0i}|\theta_i = \theta] \quad (8)$$

Note that  $MV_1(\theta)$  is simply a relabeling of  $MV(\theta)$  from Equation (3)—it captures the expected output value under hourly wage  $w = S^{-1}(\theta)$  for the worker who is indifferent between accepting or declining the offer.  $MV_0(\theta)$ , on the other hand, captures the expected output value of that same worker if they had instead rejected wage offer  $w$  and remained on the piece rate.<sup>7</sup> The difference between these two marginal value curves identifies the moral hazard effect for a given type:

$$MH(\theta) \equiv MV_1(\theta) - MV_0(\theta). \quad (9)$$

Similarly, the average value curve can be split into two counterfactuals:

$$AV_1(\theta) \equiv E[Y_{1i}|\theta_i \leq \theta] \quad (10)$$

$$AV_0(\theta) \equiv E[Y_{0i}|\theta_i \leq \theta]. \quad (11)$$

$AV_1(\theta)$  is equivalent to  $AV(\theta)$  from Equation (4); it equals the average value of output among hourly-pay workers with lower reservation wages than type  $\bar{w}(\theta)$ .  $AV_1(\theta)$ , on the other hand, equals the average value among those same workers if they had instead worked under a piece rate.

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<sup>7</sup>In a loose sense, these two curves can be thought of as bounds. If firms have some way of mitigating moral hazard, the true marginal value curve would lie somewhere between  $MV_0(\theta)$  and  $MV_1(\theta)$ .

## 2.2 Correspondence to Marginal Treatment Effects

With the introduction of potential outcomes under hourly versus piece-rate counterfactuals, this framework has a useful mapping to the causal-inference literature. Treating the wage offer  $w$  as a continuous instrument, marginal values among workers of a given type are equivalent to mean potential outcomes among individuals with a given “resistance to treatment,” where “treatment” is take-up of the hourly contract, and “resistance” is quantile reservation wage,  $\theta_i \equiv S(\bar{w}_i)$ . The moral hazard effect in Equation 9 is therefore equivalent to the marginal treatment effect of the hourly contract,  $MTE(\theta) \equiv E[Y_{1i} - Y_{0i} | \theta_i = \theta]$ . (Björklund and Moffitt, 1987; Heckman and Vytlacil, 1999, 2005, 2007). It measures the average effect of treatment (hourly contract take-up) among those whose resistance to treatment (quantile reservation wage,  $\theta_i \equiv S(\bar{w}_i)$ ) is equal to a given propensity score (share of hourly workers,  $\theta = S(w)$ ). This correspondence is illustrated in Figure 2.

## 2.3 Wage Effects

The framework above allows workers’ expected output to vary between hourly versus piece-rate compensation. It does not, however, allow that output to vary with the wage level under an hourly contract. In other words, it ignores any potential wage effects that higher hourly compensation might have on worker output. I can, however, extend the model to allow for wage effects by allowing each worker’s potential output under the hourly contract to vary with the wage (i.e.,  $Y_{1i} = Y_{1i}(w)$ ). With this added dimension to potential outcomes, I rewrite  $AV_1(\theta)$  as the average value of output among lower types *at  $\theta$ ’s reservation wage*:

$$AV_1^E(\theta) \equiv E[Y_{1i}(\bar{w}(\theta)) | \theta_i \leq \theta]. \quad (12)$$

Assuming wage effects are weakly positive and non-decreasing in  $\theta$ , the equilibrium condition is given by  $\bar{w}(\theta^{EQ}) = AV_1^E(\theta^{EQ})$ . In this case, wage effects will push average value curve upwards and increase the share of hourly contracts under asymmetric information.

Note, however, that the efficient equilibrium—the one that would exist in a full-information

counterfactual—is also complicated by the presence of wage effects. A fully-informed firm may benefit from paying a worker above their reservation wage if their expected increase in output exceeds the wage premium (i.e., if  $E[Y_{1i}(w) - Y_{1i}(\bar{w}_i)|\theta_i = \theta] > w - \bar{w}(\theta)$  for some  $w$ ).<sup>8</sup> I thus rewrite  $MV_1(\theta)$  as the marginal value of type  $\theta$ 's output *at their profit-maximizing wage*, so

$$MV_1^E(\theta) \equiv E[Y_{1i}(w^*(\theta))|\theta_i = \theta], \quad (13)$$

where

$$w^*(\theta) \equiv \operatorname{argmax}_w E[Y_{1i}(w) - w|\theta_i = \theta]. \quad (14)$$

Note that allowing for wage effects means I can no longer interpret Equation 9 as the marginal treatment effect of hourly-contract take-up—if the wage level influenced worker output independently of the hourly compensation structure, the wage-offer instrument would no longer satisfy the exclusion restriction. However, my empirical design allows me to separate wage effects by distinguishing between *offered* wages and *contract* wages. By randomly raising the effective wages of those accepting lower hourly offers to reach parity with higher hourly offers, I can identify the marginal treatment effect of being paid a particular hourly wage for those indifferent to a particular offered hourly wage.

### 3 Experimental Design

In this section, I describe my experimental design and empirical strategy. The goal of my experiment is to two-fold: First, I aim to identify the incentive effects of hourly wage contracts on worker performance (moral hazard). Second, I want to identify how workers with different unobserved productive potentials self-select into these contracts (adverse selection). Separately identifying these forces poses an empirical challenge—differences in

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<sup>8</sup>I avoid the term “efficiency wages,” which refers to a class of models explaining unemployment as a general-equilibrium consequence of firms’ strategic wage-setting behavior (Weiss, 2014; Krueger and Summers, 1988; Yellen, 1984). In many efficiency-wage models, above-market wages are driven not by causal effects of wages on productivity, but by worker selection, firms’ monitoring ability, or turnover costs (Salop, 1979; Weiss, 1980). Other explanations, like unemployment avoidance (Shapiro and Stiglitz, 1984) or employee loyalty (Akerlof, 1982) are less applicable to short-term labor markets.

realized output between workers who opted into a given wage offer reflect both the ex-ante productivity differences between those self-selected groups and the causal effect of the different wage offers they chose.

To overcome this challenge, my experimental design offers workers a choice between a randomized hourly wage and a standardized piece rate. Comparing realized output between individuals who faced different hourly wage offers but ultimately chose the common piece rate identifies adverse selection—both groups ultimately face the same compensation scheme but made decisions under different alternative options. So, if workers choose contracts based on their privately known productivities, those who decline more generous hourly payments should perform better than those foregoing more modest wages. At the same time, because I observe worker output under both contract choices in each treatment group, a standard two-stage-least-squares estimation allows me to separately identify treatment effects of hourly wages among those who accept the offer.

To formalize this intuition, consider a potential outcomes framework in which some worker  $i$  chooses between two mutually exclusive contracts—a piece rate ( $p$ ) and an hourly wage ( $w$ ). As in Section 2, let  $Y_{1i}$  denote  $i$ 's output if they work under the hourly wage, and let  $Y_{0i}$  denote their output if they work under the piece rate. Given these potential outcomes, worker  $i$ 's observed output,  $Y_i$ , is given by

$$Y_i = D_i Y_{1i} + (1 - D_i) Y_{0i}, \quad (15)$$

where  $D_i$  is a binary indicator for whether  $i$  chooses the hourly wage. A comparison of realized outputs between hourly ( $D_i = 1$ ) and piece-rate ( $D_i = 0$ ) workers would yield the following:

$$E[Y_i | D_i = 1] - E[Y_i | D_i = 0] = \underbrace{E[Y_{1i} - Y_{0i} | D_i = 1]}_{\text{Treatment on the Treated (TOT)}} + \underbrace{E[Y_{0i} | D_i = 1] - E[Y_{0i} | D_i = 0]}_{\text{Selection into Treatment } (\Delta\mu_0)}. \quad (16)$$

This difference is the sum of two components. The first is the treatment-on-the-treated

effect,  $TOT$ , which equals the average effect of hourly pay among those who accept wage offer  $w$  over the piece rate. The second is the selection into treatment,  $\Delta\mu_0$ , which equals the average difference in potential outcomes under the piece rate between those choosing hourly pay ( $D_i = 1$ ) and those choosing the piece rate ( $D_i = 0$ ). These components are difficult to separate because piece-rate outcomes among hourly workers ( $Y_{0i}|D_i = 1$ ) are always unobserved.

Now suppose that, rather than face a uniform menu of piece rate and hourly wage offers, workers are randomly assigned to one of two offer conditions,  $Z_i \in \{0, 1\}$ . Only workers assigned to  $Z_i = 1$  are offered the choice between the piece rate and hourly wage, while workers assigned to  $Z_i = 0$  are paid the piece rate with no alternative. Comparing worker output across these two treatment-offer groups and scaling by the hourly-wage take-up rate yields the classic  $TOT$  estimator from Wald (1940):

$$\begin{aligned} TOT &\equiv E[Y_{1i} - Y_{0i}|D_i = 1] \\ &= \frac{E[Y_i|Z_i = 1] - E[Y_i|Z_i = 0]}{\pi}, \end{aligned} \tag{17}$$

where  $\pi \equiv Pr(D_i = 1|Z_i = 1)$ , the probability an individual accepts the hourly contract conditional on an offer.

In the context of this paper, however, the selection component  $\Delta\mu_0$  from Equation (16) is equally as important as treatment effects. I can identify this component by simply comparing output between piece-rate workers in the control group ( $Z_i = 0$ ) and piece-rate workers in the hourly-offer group ( $Z_i = 1$ ) who declined the hourly wage offer:

$$\begin{aligned} \Delta\mu_0 &\equiv (E[Y_{0i}|D_i = 1, Z_i = 1] - E[Y_{0i}|D_i = 0, Z_i = 1]) \\ &= \frac{E[Y_i|Z_i = 0] - E[Y_i|D_i = 0, Z_i = 1]}{\pi}, \end{aligned} \tag{18}$$

where equality follows from randomized assignment.<sup>9</sup> Figure 3 provides a graphical illus-

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<sup>9</sup>Randomized assignment implies  $E[Y_{0i}|Z_i = 1] = E[Y_{0i}|Z_i = 0] = E[Y_i|Z_i = 0]$ , so  $E[Y_{0i}|D_i = 1, Z_i = 1] = \frac{E[Y_i|Z_i = 0] - (1-\pi)E[Y_i|D_i = 0, Z_i = 1]}{\pi}$ . Equation (18) can also be derived by subtracting

tration of the intuition from Equation (18). The control group, by construction, is subject to the standardized piece rate, while the treatment-offer group is offered an hourly wage as an alternative. Selection is identified by comparing the control group ( $D_i = 0, Z_i = 0$ ) to those in the treatment group ( $D_i = 0, Z_i = 1$ ) who chose to remain on the piece rate. This selection-on-unobservables estimator captures the average difference in potential untreated outcomes for “compliers” versus “never-takers” (Black et al., 2022; Kowalski, 2023; Huber, 2013).

### 3.1 Estimating Marginal Values Across Continuous Wage Offers

The example above simulates a simplified version of my experimental design with a binary treatment assignment,  $Z_i \in \{0, 1\}$ . In practice, however, my experiment features several experimental groups facing different hourly wage offers. In this section, I show how treating these wage offer as continuous instrument in a marginal-treatment-effects framework identifies (potential) marginal worker output across a range of wage offers. As I showed in Section 2, estimates of these marginal outcomes map directly to my model of asymmetric information, allowing me to estimate welfare losses with minimal parametric assumptions.

To see how a continuous wage-offer instrument identifies marginal outcomes from my model, first note that the supply curve in equation (2) can be straightforwardly identified as the share of accepters across wage offers:

$$S(w) \equiv \Pr(\bar{w}_i < w) = \Pr(D_i = 1 | w_i = w). \quad (19)$$

Next, note that the (potential) average value curve under the hourly wage can be identified using average output value among workers accepting the wage offer equal to type  $\theta$ 's

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the Wald estimator (17) from the difference in hourly versus piece-rate outcomes in the treatment-offer group,  $E[Y_i | D_i = 1, Z_i = 1] - E[Y_i | D_i = 0, Z_i = 1]$ .

reservation wage, ( $w = S^{-1}(\theta)$ ):

$$AV_1(\theta_w) \equiv E[Y_{1i}|\theta_i \leq \theta] \quad (20)$$

$$= E[Y_i|w_i = w, D_i = 1]. \quad (21)$$

Likewise, the (potential) average value curve under the piece rate can be identified using average output value among workers *declining* the wage offer:

$$AV_0(\theta_w) \equiv E[Y_{0i}|\theta_i \leq \theta] \quad (22)$$

$$= \frac{E[Y_{0i}] - (1 - \theta)E[Y_{0i}|\theta_i > \theta]}{\theta} \quad (23)$$

$$= \frac{E[Y_i|w_i = 0] - (1 - \theta)E[Y_i|w_i = w, D_i = 0]}{\theta}, \quad (24)$$

where  $E[Y_i|w_i = 0]$  is the average output value of workers in the control group, who all work under the piece rate.

Finally, marginal value can be identified by separately differentiating take-up weighted conditional means for decliners and accepters of each offer:

$$\begin{aligned} MV_1(\theta) &= \frac{\partial (E[Y_{1i}|\theta_i \leq \theta] \theta)}{\partial \theta} \\ &= \frac{\partial (E[Y_i|w_i = w, D_i = 1] S(w))}{\partial w} \left( \frac{\partial S(w)}{\partial w} \right)^{-1} \end{aligned} \quad (25)$$

$$\begin{aligned} MV_0(\theta) &= - \frac{\partial (E[Y_{0i}|\theta_i > \theta] (1 - \theta))}{\partial \theta} \\ &= - \frac{\partial (E[Y_i|w_i = w, D_i = 0] (1 - S(w)))}{\partial w} \left( \frac{\partial S(w)}{\partial w} \right)^{-1}. \end{aligned} \quad (26)$$

Intuitively, Equations (26) and (25) identify marginal values by differentiating total value ( $TV(\theta) \equiv AV(\theta) * \theta$ ) with respect to  $\theta$  under hourly and piece-rate counterfactuals, similar to the marginal cost calculation in Einav et al. (2010a).

### 3.2 Estimating Wage Effects

The framework above uses experimental wage offers,  $w$ , as an instrument for take-up of an hourly contract,  $D_i = 1$ . However, if higher hourly wages induce greater productivity through increased motivation or satisfaction, my estimates would be biased; wage offers would correlate with potential outcomes under hourly wages ( $w_i \not\perp Y_{1i}$ ) violating the exclusion restriction.

I separate hourly incentive effects from wage effects by adding an additional dimension of randomization in the spirit of Karlan and Zinman (2009). After randomizing *offered* wages in the first stage of the experiment, I increase *contract* wages for a random subset of those accepting lower wage offers, bringing their effective wages to parity with higher treatment-offer groups. Revealing this surprise wage increase to hourly workers before they begin the task allows me to separate potential wage effects from moral hazard and adverse selection: Wage effects can be identified by comparing groups that accepted the same wage offers but face different contracted wages, moral hazard can be identified by instrumenting for hourly take-up with offered wage holding the contract wage constant, and selection on wage offers can be estimated by comparing groups that faced different ex-ante wage offers but ultimately worked under the same contract wages.

Figure 4 illustrates the variety of treatment and selection margins I can investigate with multiple wage offers in a two-stage design with multiple treatment arms. The top row of boxes represents individuals in each of the three experimental groups who remain on the piece rate. Because all three groups face the same ex-post payment terms but different ex-ante wage offers, comparisons between them isolates worker selection on underlying productivity under the piece rate. The bottom two boxes represent workers who opted into low and high hourly wages, respectively. In the second stage of the experiment, a random subset of those accepting the low hourly wage are promised an additional top-up compensation before they begin working on the task. This surprise top-up equalizes their effective wage with that of the high-offer group, allowing me to separate wage effects (diagonal arrow)



from underlying differences in productivity under the high hourly wage.<sup>10</sup>

### 3.3 Setting and Implementation

Participants in my experiment are recruited on Amazon Mechanical Turk (MTurk), an online platform that allows clients to hire online workers for short-term tasks. MTurk is a popular platform for both researchers and private firms seeking survey responses, language translation, data entry, or image classification (DellaVigna and Pope, 2022, 2018; Paolacci and Chandler, 2014; Kuziemko et al., 2015). The job posting for my experiment offers participants a \$1.00 reward for transcribing handwritten text into typed form for ten minutes. Such transcription tasks are common on the MTurk platform. The posting also informs participants they “can earn an additional \$0.03 in bonus compensation for each correctly typed sentence.” A screenshot of the job posting is provided in Figure 5A.

Workers could only see my experimental job posting if they met the following screening criteria: (1) located in the United States, (2) successfully completed 100 or more previous tasks, and (3) earned an approval rate above 97 percent on previous tasks. These screening criteria accomplish two things: first, they allow me isolate “professional” MTurk workers who regularly perform tasks to earn income, as opposed to casual users who may take the tasks less seriously. Second, they restrict the sample to workers who are observably equivalent to a hypothetical employer. The goal of my experiment is to identify selection on *private* information, so I want to remove any selection on screenable characteristics.

Workers who accept the job posting are taken to an external link to perform the task.<sup>11</sup> After clicking this link, workers are randomized into one of four experimental groups.<sup>12</sup> Each group is offered a different menu of bonus compensation options for completing the ten-minute data-entry task: In the first treatment group, participants are offered a choice between a flat bonus of \$0.50 for completing the task or a piece rate of \$0.03 per correctly

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<sup>10</sup>A formal proof of this result is provided in Appendix A

<sup>11</sup>The task is hosted on the Qualtrics platform. Readers can view and perform a replication of the task [here](#).

<sup>12</sup>The four experimental groups described here are part of a small-stage pilot launched in March 2024. The full-scale experiment, expected to complete in May of 2024, includes several additional treatment arms.

typed sentence. In the second treatment group, participants are offered a choice between a flat \$1.00 bonus or the same \$0.03 piece rate. In the third treatment group, participants are offered a \$2.00 bonus alongside the \$0.03 piece rate. Finally, a control group is offered the \$0.03 piece rate for each correctly typed sentence, with no alternative option. Experimental conditions for the pilot are summarized in Table 1.

After receiving detailed instructions on the data-entry task, workers are presented with the bonus options corresponding to their experimental condition, as shown in Figure 5B. Once workers choose their compensation scheme and click “Begin Task,” they are brought to a new page displays a handwritten sentence and a text box. The worker types a sentence in the box and clicks the “Next” button, bringing them to a new page with a different sentence. This process continues for ten minutes. Worker output is validated in real time, so workers can see a running tally of their “score” (the number of correctly typed sentences) and their bonus earnings in the lower-left corner of each page. Workers also see a countdown timer displaying the number of minutes and seconds remaining in the task.<sup>13</sup> When the timer reaches zero, the screen refreshes to an end-of-task page displaying a performance summary and a unique survey code to validate results on MTurk.

Importantly, requesters on the MTurk platform have the ability to reject or approve a given worker’s assignment. Rejected assignments do not earn rewards and lower workers’ approval ratings. The reputational damage from rejected assignments is an especially salient concern among MTurk workers. As in most labor markets, this threat of rejection threat creates an incentive for MTurk workers to maintain a minimum standard of performance, even if they are paid a flat hourly wage.

### 3.4 External Validity

The setting and design for this experiment raise several potential concerns regarding external validity. First, my experimental results may not generalize to other settings or tasks. For

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<sup>13</sup>Figure 5C provides a screenshot of the task. The display and submission methods for this task designed to prevent workers from cheating through automation software or “bots.” While it is possible that some participants may have tried to make use of such software, performance statistics suggest any such attempts were unsuccessful at increasing output.

example, the pattern of selection on data-entry skills likely differs from how delivery workers would sort on driving ability. But given the economy-wide division of labor into increasingly specialized roles, such limits to generalizability are nearly ubiquitous in applied research on worker incentives. Whether they come from rideshare drivers (Angrist et al., 2021; Cook et al., 2021), agricultural workers (Brune et al., 2022; Bandiera et al., 2010), cashiers (Mas and Moretti, 2009), or automotive glass repairers (Lazear, 2000), parameter estimates concerning worker productivity are usually difficult generalize beyond narrowly defined labor markets.<sup>14</sup> While my study is not exempt from these limitations, several elements of my experiment are designed to mitigate these concerns. First, workers in my experiment are recruited through MTurk, a widely used and well-established freelancing platform with over 100,000 workers (Difallah et al., 2018). The ubiquity of MTurk and similar platforms (e.g., Upwork, Fiverr) means that even the most conservative interpretation of my estimates holds non-trivial welfare implications. Second, workers are not aware that they are part of an experiment until after they perform the task, so estimates are biased by their potential desire to generate a particular result.<sup>15</sup> Third, my experimental typing task requires a dimension of effort and skill commonly needed for gig work. “Traditional keyboarding” is a job requirement for 66 percent of American workers (Bureau of Labor Statistics, 2024), suggesting my estimates of selection and incentive effects could plausibly generalize to a variety of labor markets.

A second threat to external validity concerns the selection of workers into the experiment itself. Even if the eligible population for my study were representative of the broader population of gig workers, I still only observe outcomes for those who initially agreed to the task. If my job posting only attracted low-productivity workers, my estimates would exclude selection among high-types because they never received an offer. I mitigate this concern by advertising a generous up-front fee for accepting the task. By posting a guaranteed \$1.00

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<sup>14</sup>Indeed, Herbst and Mas (2015) finds that for one particular parameter—peer effects on worker output—estimates vary dramatically from one study to another, regardless of whether estimates are taken from the lab or the field.

<sup>15</sup>Rather than elicit consent prior to the task, I debriefed participants on the nature of the experiment after its conclusion. The experimental task resembles those commonly requested for non-research purposes.

plus the \$0.03-per-sentence piece rate offered to all treatment groups, I am likely to attract a broad swath of workers who meet my screening criteria.

Finally, external validity might suffer if the identifying variation in contracts is too localized. To credibly estimate welfare effects of information asymmetries, the observed variation in wage offers must cover the entire range of contracts that might exist under a benchmark counterfactual where firms are fully informed. This limitation is especially relevant in research involving information asymmetries, because the presence of those asymmetries can often limit the set of contracts observed in existing markets. As a result, methods using real-world wage contracts are likely to understate the consequences of adverse selection (Einav et al., 2010b). My design holds a distinct advantage over these “under-the-lamppost” methods, as my experiment allows me to create a market for hourly wage contracts that real-world employers might deem unprofitable due to market unraveling.

## 4 Results

This section describes results from a small-scale pilot ( $N = 148$ ) of the experiment described above. The full-scale experiment ( $N \approx 4,000$ ) is expected to complete in May of 2024.

The bar chart in Figure 6 shows the share of borrowers in each treatment group who accepted their hourly wage offer instead of the \$0.03 piece rate. Unsurprisingly, the relative supply of hourly workers increases with the offered wage—acceptance rates for \$3, \$6, and \$12 hourly wage offers were 0.73, 0.75, and 0.82, respectively.

In Figure 7, I examine how output value varies between piece-rate and hourly workers in each experimental group. “Output value” is defined as the number of correctly typed sentences per hour multiplied by \$0.03. Vertical bars measure mean outcomes among those who choose hourly wages (blue) and those who choose piece rates (red). Green circles measure mean outcomes among all individuals in each experimental group.

Comparing piece-rate workers (those declining hourly wage offers) across treatment groups, I find that those declining the \$3/hr offer produce \$0.95 of output value, those

declining the \$6/hr offer produce \$1.94 of output value, and those declining the \$12/hr offer produce \$3.19 of output value. While this pattern is consistent with adverse selection on productivity, I cannot reject equality in piece-rate worker output in any two treatment-level means due to the limited power of this small-scale pilot experiment. I can, however, reject null selection effects across continuous wage offers in a linear model. Table 2 reports coefficients from an OLS regression of output value against hourly wage offers interacted with a dummy for whether an individual accepted the hourly offer over the piece rate. The estimated coefficient on “Hourly Wage Offer” implies that a one-dollar increase in hourly wage offer corresponds to a \$0.25 (SE=\$0.1) increase in output value among those declining the offer in favor of the piece rate.

A comparison across any two experimental-group means (green points) in Figure 7 estimates an intent-to-treat effect for one wage offer relative to another. I find no significant change in mean output value between any two experimental groups. I can also estimate the overall treatment effect of hourly wages relative to the piece rate by estimating a two-stage least-squares model where I instrument for hourly wage takeup with treatment-group assignment. This estimate corresponds to the local average treatment effect of hourly wages on output value among “complier” participants who are induced into hourly pay by their treatment group’s wage offer. Table 3 reports estimates of this “treatment-on-the-treated” (TOT) effect. While point estimates are consistent with labor supply disincentives under hourly pay, they are statistically indistinguishable from zero.

Note that, due to the lack of statistical precision in estimates from my small-scale pilot experiment, I have deferred marginal-value and welfare calculations until after completion of the large-scale experiment in May of 2024.

## 5 Conclusion

Short-term labor contracts provide a valuable benefit to workers. Gig work can offer valuable flexibility to workers with time constraints (Mas and Pallais, 2017). They can also provide

liquidity to credit-poor individuals facing income shocks (Garin et al., 2020; Koustas, 2018). However, these benefits come at a cost—a gig worker can choose their own hours, but they often face more uncertainty over what they’ll earn during those hours. This trade off is likely not a coincidence—traditional employers can profitably sustain hourly wage contracts because their repeated interactions with workers mitigate information asymmetries. Short-term employment relationships, on the other hand, offer less opportunity to reveal workers’ latent productivity, making the implicit insurance of hourly wages more prone to moral hazard and adverse selection on worker productivity.

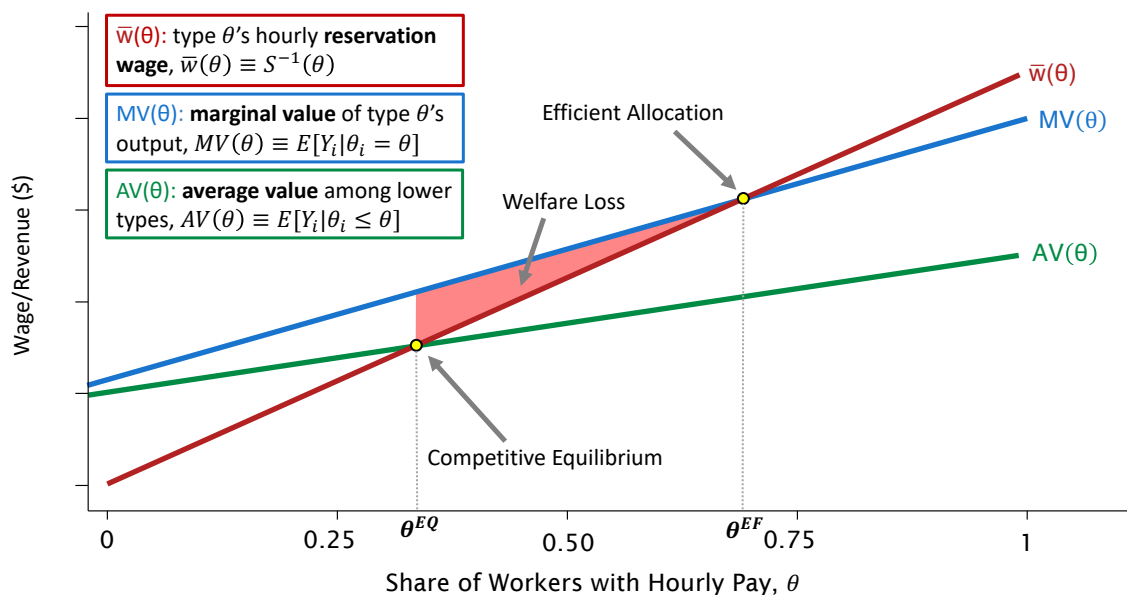
This paper uses an experimental approach to investigate information asymmetries in short-term labor markets. The experiment offers participants a choice between a performance-based piece rate and a randomized hourly wage, allowing me to separately identify selection and treatment effects of wage contracts.

Findings from a preliminary pilot experiment reveal significant selection effects—a one-dollar increase in the offered hourly wage correlates with a \$0.25 (SE=0.101) increase in hourly output among those who prefer the piece rate. This result provides evidence of adverse selection in contract preference, wherein workers with higher latent productivity are more likely to forego guaranteed wages in favor of performance-based compensation.

I place these experimental estimates into a theoretical framework that shows how the provision of hourly employment contracts is determined by two factors: a worker’s reservation wage—the minimum compensation they will accept in exchange for an hour of labor—and the average output of workers with comparatively lower reservation wages. These objects can be straightforwardly identified for workers in my experimental sample—first by comparing the shares of workers opting into hourly wages across offer treatments, then by comparing the average output among hourly workers in each group. I then show how to use these model estimates to quantify the welfare loss associated with inefficiently low provision of hourly positions.

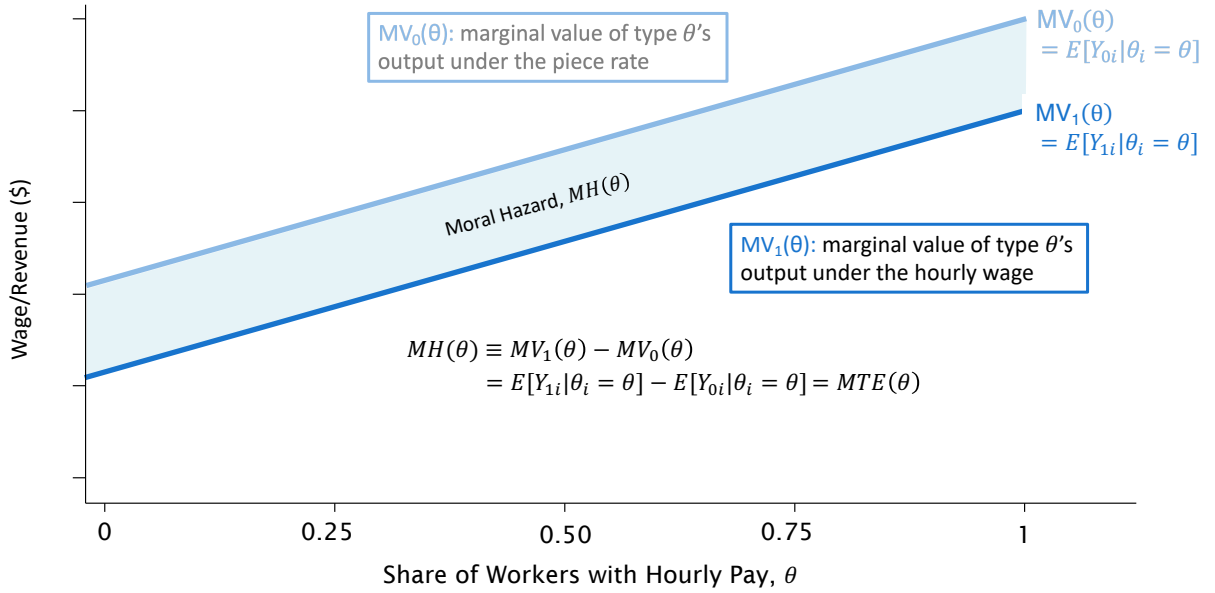
## Figures and Tables

Figure 1: Model of Asymmetric Information in Wage Contracts



*Note:* This figure provides a graphical representation of market unraveling for hourly wages. On the horizontal axis, types  $\theta$  are enumerated in ascending order based on their hourly reservation wage,  $\bar{w}_i$ . The blue line plots the marginal value curve,  $MV(\theta) \equiv E[Y_i | \theta_i = \theta]$ , which is equal to expected worker output value conditional on their type. The red line plots hourly reservation wage,  $\bar{w}(\theta)$ , which equals the inverse of labor supply,  $\bar{w}(\theta) \equiv S^{-1}(\theta)$ . The green line plots the average value curve,  $AV(\theta)$ , which corresponds to the average expected output among lower-type workers,  $AV(\theta) \equiv E[Y_i | \theta_i \leq \theta]$ .

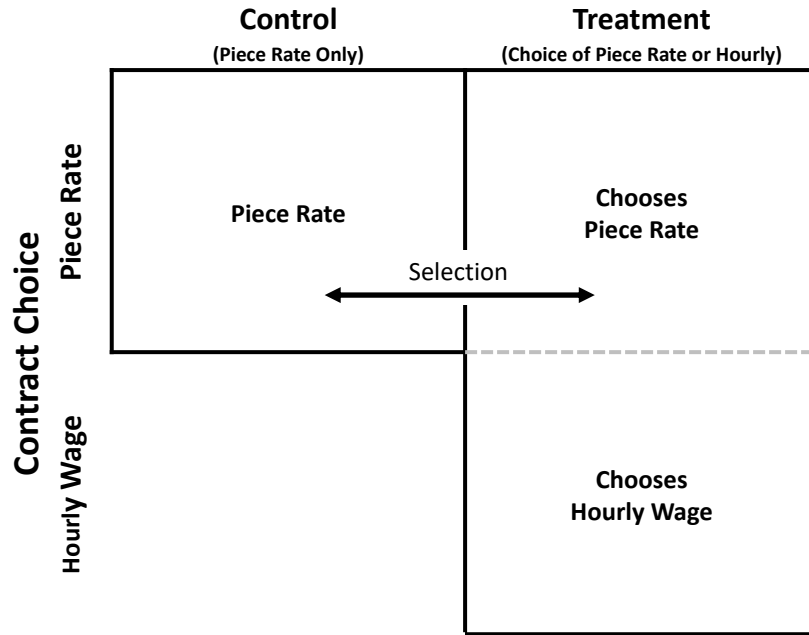
Figure 2: Model of Asymmetric Information in Wage Contracts: Moral Hazard Effects



*Note:* This figure provides a graphical representation of moral hazard in my model. On the horizontal axis, types  $\theta$  are enumerated in ascending order based on their hourly reservation wage,  $\bar{w}_i$ . The solid blue line plots  $MV_1(\theta)$ , which is equal to the expected output value among workers of type  $\theta$  under the hourly wage,  $MV_1(\theta) \equiv E[Y_{1i}|\theta_i = \theta]$ . The shaded blue line plots  $MV_0(\theta)$ , which is equal to the expected output value among the same workers if they were instead paid a piece rate,  $MV_0(\theta) \equiv E[Y_{0i}|\theta_i = \theta]$ . The difference between the two marginal value curves identifies the moral hazard effect for a given type,  $MH(\theta) \equiv MV_1(\theta) - MV_0(\theta)$ , which is equivalent to the marginal treatment effect of the hourly contract among those whose resistance to treatment (quantile reservation wage,  $\theta_i \equiv S(\bar{w}_i)$ ) is equal to the propensity score (share of hourly workers,  $\theta = S(w)$ ) for their assigned instrument (wage offer,  $w_i$ ).

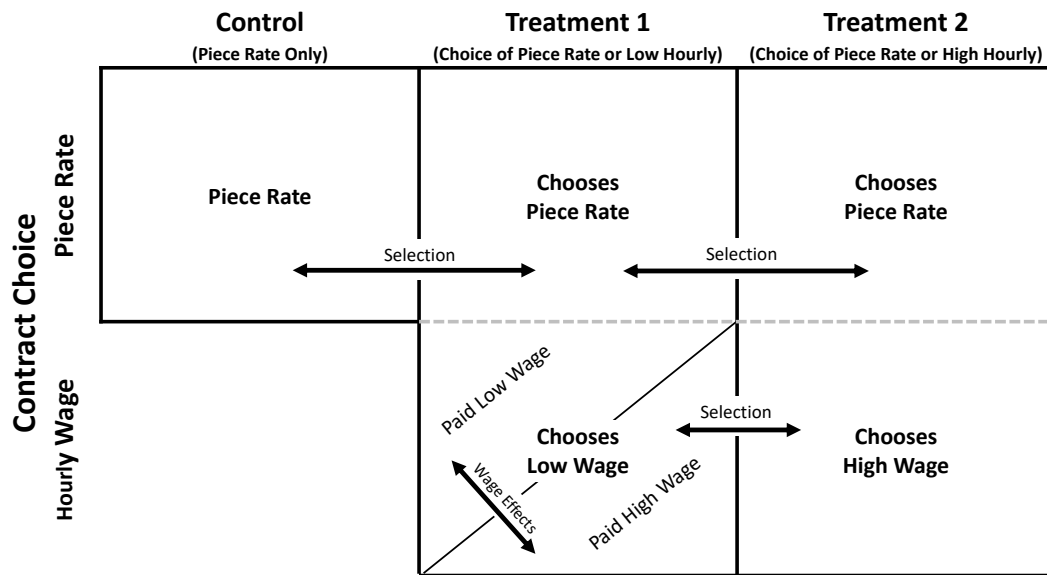


Figure 3: Experimental Design: Single Treatment



*Note:* This figure provides a graphical representation of a single-offer version of my experimental design. Columns denote experimental groups with different menus of wage options, and rows denote the realized wage contracts chosen by workers within each group. The control group, represented by the left column, is not offered an hourly wage option and is compensated entirely through the piece-rate contract (upper box). The treatment group, represented by the right column, is separated into those who accept the piece-rate contract (upper box) and those who accept the hourly contract (lower box). The solid arrow denotes comparison groups to measure adverse selection—groups that were offered different menus of contracts but ultimately face the same repayment terms.

Figure 4: Experimental Design: Multiple Treatments



*Note:* This figure provides a graphical illustration of my two-stage experimental design with two treatment offers. Columns denote initial hourly wage offers, and rows denote the type of contract that workers choose. The diagonal split in the bottom box of Treatment 1 (low-wage offer) represents the second stage of randomization, in which some workers accepting the low hourly wage are promised the higher wage before they begin the task. Horizontal arrows denote comparison groups to measure adverse selection—groups that were offered different menus of contracts but ultimately face the same repayment terms. The diagonal arrow denotes comparison groups to measure wage effects. The treatment effect of a hourly wages relative to piece rates (moral hazard) is identified by instrumenting for a given (paid) hourly wage with initial wage offers.

Figure 5: Example Job Posting

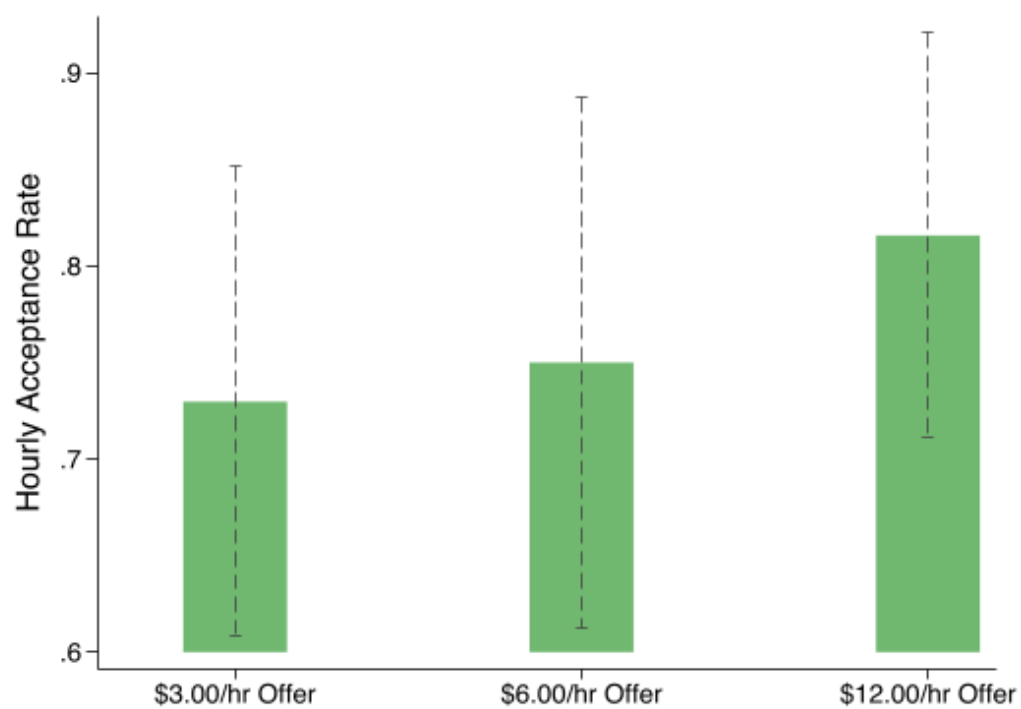
(A) Job Posting

(B) Example Wage Offer

(C) Typing Task

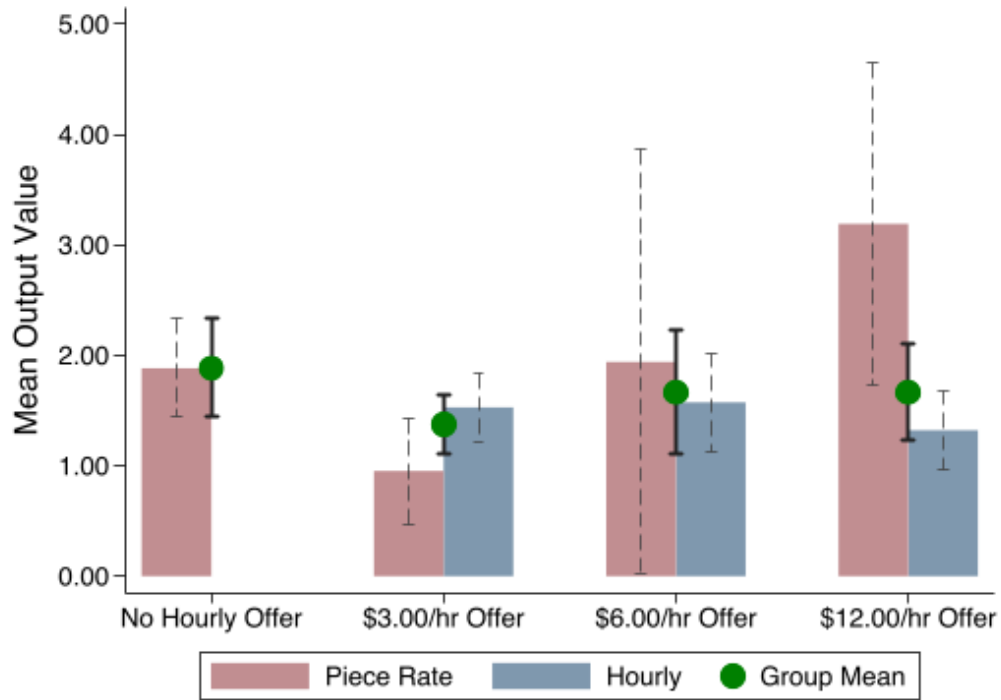
*Note:* This figure provides screenshots of the experimental intervention. Panel A shows the experimental job posting on MTurk. Panel B shows an example wage offer participants see before they begin the task. Panel C shows the sentence-typing task while it is being performed.

Figure 6: Hourly Wage Take-Up



*Note:* This figure reports hourly-wage acceptance rates by treatment group. The y-axis measures the share of borrowers in each group who declined the \$0.03 piece rate in favor of the hourly wage offer displayed on the x-axis. Dotted bands indicate 90% confidence intervals.

Figure 7: Worker Output by Treatment Offer and Compensation Choice



*Note:* This figure shows mean worker output value by wage-offer groups and compensation choice. “Output value” is defined as the number of correctly typed sentences per hour multiplied by \$0.03. Control and treatment groups are labeled on the x-axis. Green circles measure mean outcomes among all individuals in each experimental group. Vertical bars measure mean outcomes among those who choose hourly wages (blue) and those who choose piece rates (red). Bold and dotted bands indicate 90% confidence intervals for overall and hourly/piece-rate group means, respectively.

Table 1: Pilot Experiment Group Assignment

| Experimental Group | Hourly Wage Offer | Piece-Rate Offer    | Number of Participants |
|--------------------|-------------------|---------------------|------------------------|
| Control            | N/A               | \$0.03 per sentence | 45                     |
| Treatment 1        | \$3.00            | \$0.03 per sentence | 37                     |
| Treatment 2        | \$6.00            | \$0.03 per sentence | 28                     |
| Treatment 3        | \$12.00           | \$0.03 per sentence | 38                     |

*Note:* This table summarizes the treatment conditions and sample sizes for each experimental group in the pilot. *Piece-rate offer* denotes the performance-based bonus offer, which is awarded on a per-sentence basis and common across all experimental groups. *Hourly wage offer* denotes the time-based rate of compensation offered to participants for the 10-minute task, prorated to one hour.

Table 2: OLS Estimates of Selection by Wage Offer

|                                     | (1)<br>Output Value |
|-------------------------------------|---------------------|
| Hourly Wage Offer                   | 0.246**<br>(0.101)  |
| Accepted                            | 1.354**<br>(0.678)  |
| Accepted $\times$ Hourly Wage Offer | -0.272**<br>(0.106) |
| Constant                            | 0.293<br>(0.630)    |
| Mean Dep. Var.                      | 1.56                |
| R-squared                           | 0.110               |
| N                                   | 103                 |

*Note:* This table reports estimated coefficients from OLS regressions of output value (sentences  $\times$  \$0.03) against hourly wage offers interacted with a dummy for whether an individual accepted the hourly offer (“Accept”) over the piece rate. The coefficient on “Hourly Wage Offer” captures the dollar change in output value among piece-rate workers for each dollar increase in their hourly wage offer. \*\*\* = significant at 1 percent level, \*\* = significant at 5 percent level, \* = significant at 10 percent level.

Table 3: 2SLS Estimates of Treatment Effects of Hourly Wages Relative to Piece Rates

|                       | (1)<br>Output Value |
|-----------------------|---------------------|
| Accepted Hourly Offer | -0.396<br>(0.400)   |
| Constant              | 1.870***<br>(0.269) |
| Mean Dep. Var.        | 1.66                |
| R-squared             | 0.018               |
| N                     | 148                 |

*Note:* This table reports estimated coefficients from two-stage least-squares regressions of output value against hourly wages, where I instrument for hourly wage with treatment-group assignment. \*\*\* = significant at 1 percent level, \*\* = significant at 5 percent level, \* = significant at 10 percent level.



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## Appendix A Identification of Wage Effects

Consider an individual  $i$  who receives a job offer,  $J_i$ , at one of two randomized wages: a high offer ( $J_i = H$ ) or a low offer ( $J_i = L$ ). Let  $D_{J_i}$  denote the individual's choice to accept a given offer, so that  $D_{Hi} = 1$  if  $i$  would accept the high offer and  $D_{Li} = 1$  if  $i$  would accept the low offer. Furthermore, let  $Y_{Hi}$  and  $Y_{Li}$  denote the potential output levels produced by  $i$  if they were paid hourly wages of  $H$  and  $L$ , respectively. Note that if realized wages reflected accepted offers, comparing output between those who accept  $H$  and those who accept  $L$  would yield the following:

$$\begin{aligned} & E[Y_i | J_i = H, D_{Hi} = 1] - E[Y_i | J_i = L, D_{Li} = 1] \\ &= \underbrace{E[Y_{Hi} - Y_{Li} | D_{Li} = 1]}_{\text{Treatment Effect}} + \underbrace{E[Y_{Hi} | D_{Hi} = 1] - E[Y_{Hi} | D_{Li} = 1]}_{\text{Selection}}. \end{aligned} \quad (27)$$

This difference is the sum of both the treatment effect and selection of  $H$  relative to  $L$ , which cannot be separated without observing  $E[Y_{Hi} | D_{Li} = 1]$ .

Now let  $W_i$  be an indicator whether individual  $i$  receives a surprise wage increase of  $\Delta = H - L$  after accepting their contract.  $W_i$  is randomly assigned among those who received low offers ( $J_i = L$ ) and accepted them ( $D_{Li} = 1$ ) but is zero for everyone else. With this randomized wage raise, I can estimate treatment effects by comparing output between low- and high-wage workers in the low-offer group:

$$\begin{aligned} \text{Wage Effect} &= E[Y_i | J_i = L, D_{Li} = 1, W_i = 1] - E[Y_i | J_i = L, D_{Li} = 1, W_i = 0] \\ &= E[Y_{Hi} - Y_{Li} | D_{Li} = 1] \end{aligned} \quad (28)$$

And I can estimate selection by comparing output between low- and high-offer groups with

high realized wages:

$$\begin{aligned}\text{Selection} &= E[Y_i|J_i = H, D_{Hi} = 1] - E[Y_i|J_i = L, D_{Li} = 1, W_i = 1] \\ &= E[Y_{Hi}|D_{Hi} = 1] - E[Y_{Hi}|D_{Li} = 1]\end{aligned}\tag{29}$$