Self-Control at Work

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Abstract

Workers with self-control problems do not work as hard as they would like. This changes the logic of agency theory by partly aligning the interests of the firm and worker: both now value contracts that elicit more effort in the future. Three findings from a year-long field experiment with data entry workers suggest the quantitative importance of self control at work. First, workers choose dominated contracts—which penalize low output but provide no greater reward for high output—36% of the time to motivate their future selves; use of these contracts increases output by the same amount as an 18% increase in the piece-rate. Second, effort increases as the (randomly assigned) payday gets closer: output rises 8% over the pay week; calibrations show that justifying this would require a 4% daily exponential discount rate. Third, for both findings there is significant and correlated heterogeneity: workers with larger payday effects are both more likely to choose dominated contracts and show greater output increases under them. This correlation grows with experience, consistent with the hypothesis that workers learn about their self-control problems over time. We conclude with a model of how self-control heterogeneity creates an adverse selection problem for firms; we show that firms may impose high-powered incentives and job design features that benefit workers with self-control problems, but this need not be socially optimal because it creates costs for time consistent workers.

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I. Introduction

Agency theory emphasizes a tension between workers and firms. Because employers provide insurance, workers do not benefit fully from their effort. This creates moral hazard: workers do not work as hard as the employer would like (Holmstrom 1979; Grossman and Hart 1983). Introspection suggests another tension at work. Self-control problems mean that workers often do not work as hard as they themselves would like.\(^1\) Looking to the future, they would like to work hard; when the future arrives, they may end up slacking.\(^2\)

Self-control at work thus differs than self-control in other contexts, such as savings or smoking (Laibson 1997, Ashraf et al. 2006, Giné et al. 2010). In many of these other contexts, the market provides commitment only if the consumer demands it sufficiently as to create a new institution. Worker self-control problems, however, hurt employer profits directly. As a result, both the firm and the employee have self-interest in curbing them. The workplace exists to organize effort provision by its workers. The same features that mitigate moral hazard—incentive contracts and job design features such as fixed hours of work—can also mitigate self-control problems. In other words, the employer has both the means and motives to (implicitly) provide commitment devices.\(^3\)

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\(^2\) Baicker, Mullainathan and Schwartzstein (2012) refer to this as *behavioral hazard*. In moral hazard, inefficiencies arise because people face the wrong “price”. In behavioral hazard, psychology generates inefficiencies even when facing the right price.

\(^3\) This suggests a potential additional rationale for organizing production in firms—in addition to providing workers with incentives or addressing free riding in team production (Cheung 1969, Alchian and Demsetz 1972).
We build a simple model to create testable predictions from these ideas.\footnote{O’Donoghue and Rabin (1999, 2006) formalize how firms use deadlines to motivate procrastinators and produce interesting implications for screening. DellaVigna and Malmendier (2004), Eliaz and Spiegler (2006), and Spiegler (2011) study contract design in other contexts. Kaur et al. (2010) discuss contracting in the work context.} The model provides one stark prediction. In agency models, workers must be compensated for a sharpening of incentives: they face extra risk. With self-control, no compensation may be needed. Workers who are aware of their self-control problem (sophisticated in the sense of O’Donoghue and Rabin 1999) will value sharper incentives as a way to motivate future selves. As a result, sophisticated workers may voluntarily choose a dominated contract, one that pays less for a low output realization and the same for high output realizations.\footnote{This prediction (and our model) presumes that there is a limited availability of other external devices to help workers with their self-control problems.}

In addition to predicting demand for dominated contracts, our model also suggests that the timing of pay affects effort. As the payday gets closer, the source of the self-control problem diminishes: the rewards of work and the cost of work are closer together in time. As a result, output should increase. The model also suggests an important role for heterogeneity. Workers with greater self-control problems should show both larger payday effects and a greater desire for dominated contracts.

The primary contribution of this paper is a 13-month field experiment to test these predictions.\footnote{Ariely and Wertenbroch (2002) test for procrastination in effort by hiring university students to proofread text over 3 weeks with a maximum total payout of $10. They find that allowing students to self-impose intermediate deadlines raises performance. Burger et al. (2008) pay students to study, and examine the impact of externally imposed deadlines and the relationship with willpower depletion; the deadlines actually lower performance. However, since students are not given the option to self-impose penalties for procrastination, the results are more difficult to interpret. More generally, there is scant empirical evidence on self-control in realistic workplace settings involving non-student populations, high stakes (i.e. full-time earnings), and long durations.} A growing literature emphasizes the importance of natural environments, realistically high stakes, and sufficiently long durations in experimental tests of theory (Levitt and List 2007).\footnote{In pioneering work on this point, List (2006) shows that while experienced sports card traders exhibit gift exchange in the lab, this effect is strongly attenuated in an actual market environment. In a field experiment on gift exchange,
number of accurate fields entered each day. First, to test the demand for dominated contracts, on random days workers were offered the option to choose a target for the day: if they met the target they received the standard piece rate; if they fell short of the target, they received only half the piece rate for their output. On average, workers selected positive targets—which correspond to choosing dominated contracts—36% of the time. The option to choose a dominated contract increases production, with a Treatment on the Treated Effect of 6% for those workers who accept the dominated contract. A production increase of this size corresponds to that induced by an 18% increase in the piece rate wage (computed using exogenous wage changes). We show this is a lower bound on the extent of time inconsistency. It implies that workers value the net benefits of future effort by at least 18% more at the time of contract choice than at the time they actually exert that effort.

Second, to test the impact of paydays, workers were randomized into different payday groups—all were paid weekly but the exact day of payment varied. Worker output is 8% higher on paydays than at the beginning of the weekly pay cycle. An effect of this magnitude corresponds to a 24% increase in the piece rate or about one additional year of education in our sample. A calibration of our model suggests that the pay cycle effect cannot be explained in an exponential discounting framework—it requires an exponential discount rate of 4% per day or 1.65x10^6% per year.

Third, we find substantial heterogeneity in the extent of the payday and contract effects. This heterogeneity is in fact predictive: workers with above mean payday effects are 49% more likely to choose dominated contracts. Providing these workers the option to choose a dominated

Gneezy and List (2006) find that treatment effects on worker effort wear off after a few hours—suggesting that short run responses can provide misleading estimates. A growing literature uses field experiments to test features of worker effort other than self-control (e.g. Shearer 2004, Bandiera et al. 2007, Fehr and Goette 2008, and Hossain and List 2009). For excellent reviews of this literature, see Levitt and List (2009) and List and Rasul (2011).
contract increases their output by 9%, implying a Treatment on the Treated Effect on output of 28% for those workers who select the contract. This implies that for these workers, dominated contracts have production impacts comparable to an 85% increase in the piece rate wage.\(^8\)

While these results broadly support self-control models, one finding does not. Workers are no more likely to select dominated contracts for the more distant future than they are for the nearer future: take-up on the morning of the workday and the evening before are similar. *Ex post* analysis suggests a possible reason: workers face output uncertainty—e.g. from network speed fluctuations or uncertain commute times—that is (partly) resolved when they arrive to the office. When such uncertainty is low, workers are indeed more likely to demand targets the evening before work than the morning of work.

We also find evidence of learning. While payday effects do not change with experience, the demand for dominated contracts does. Early on, many workers experiment with these contracts when offered the option. As they gain experience, the correlation between payday effects and choice of dominated contracts increases. After 2 months of experience, workers with high payday effects are 20 percentage points (73%) more likely to select dominated contracts than workers with low payday effects.

We conclude with an equilibrium model of contracts and job design when workers are heterogeneous in their self-control problems. Firms respond by providing higher-powered incentives or by structuring jobs to allow monitoring and enforcement of effort. But firms may also impose such contracts and job features on workers without self-control problems. This

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\(^8\) Although we find strong correlation between the payday and contract choice effects, neither effect is well predicted by conventional “lab experiment” measures of time inconsistency, such as subjects’ choices among cash payments at different times. These results line up well with the interesting lab results of Augenblick, Niederle, and Sprenger (2013), who find present bias in effort tasks but fail to find it for cash discounting tasks among student subjects.
suggests a nuanced view of the welfare implications of these remedies. Additionally, in the presence of adverse selection, the decentralized solution is not necessarily optimal.

The rest of the paper is organized as follows. Section II lays out a simple model of effort choice and demand for contracts by time-consistent and time-inconsistent workers. Section III explains the experimental design and our context. Section IV presents results. Section V discusses possible alternative explanations. Section VI constructs a simple model of how self-control may affect equilibrium contracts and job design.

II. Choice of Contracts and Effort by Time-Consistent and Time-Inconsistent Workers
In this section, we use a simple model to derive empirically testable predictions allowing us to distinguish the behavior of time-consistent and time-inconsistent workers.

Preferences: Assume worker $i$ has the per-period utility function $w(e) - \alpha^t c(e)$ where $e$ is effort, $w(\cdot)$ is the wage schedule, and $\alpha^t > 0$ reflects individual variation in the cost of effort. We assume the cost of effort, $c(\cdot)$, is increasing, convex, and twice differentiable and that $\lim_{e \to \infty} c'(e) = \infty$. We will sometimes specialize to the case in which $c(e) = e^\theta$ where $\theta > 1$.

Time-consistent workers discount the future using an exponential discount factor: $d^C(t) = \delta^t$. Time-inconsistent workers use a discount factor $d^I(t)$ that is assumed to be

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9 This nuanced view reconciles historians’ conflicting views on the development of work, such as the replacement of the putting out system of home production in the 18th century textile industry with the factory system. Some cite this as evidence of capitalists imposing discipline on workers (Thompson, 1967; Marglin, 1974, 2008). Clark (1994) notably interprets it as a means chosen by workers themselves to overcome their self-control problems. These results suggest that both may have been right: the factory system may have helped resolve self-control problems and may have been imposed on those who had little or no self-control problems.
hyperbolic. Specifically for any delay \( s \), \( \frac{d^i(t+s)}{d^i(t)} \) is strictly increasing in \( t \).\(^{10}\) The time-inconsistent worker is at least as impatient as the time-consistent one: \( \frac{d^i(t+1)}{d^i(t)} \leq \delta \) for all \( t \). We write \( d^i(t) \) for worker \( i \)'s discount factor. We additionally assume time-inconsistent workers are sophisticated—they know \( d^i(t) \) and accurately predict their own future actions.

**Timing and Production**: Contracts are signed in period 0, effort is exerted in each period 1 to period \( T \), and output is realized and workers are paid in period \( T \). We normalize units of effort so that expected output equals the sum of total effort in each period, \( e = \sum_{k=1}^{T} e_k \). We focus on the deterministic case in which can \( e \) be used to represent both total effort and output. (Section VI considers a case in which observable output is a stochastic function of effort.) Wages are an affine function of total output: \( w(e) = a + be \), where \( a \) is a base wage and \( b \) is the piece rate.

**Optimal Effort**: In period 0, when contemplating the optimal stream of future effort, worker \( i \) discounts the cost of period \( k \)'s effort by \( d^i(k) \), and discounts the payoff from that effort by \( d^i(T) \). So in period 0 the worker would ideally choose future effort levels to maximize:

\[
\max_{\{e_k\}_{k=1}^{T}} \left\{ d^i(T)w(e) - \sum_{k=1}^{T} d^i(k)\alpha^i c(e_k) \right\}. \tag{1}
\]

Of course any future period \( t \) self will choose effort according to:

\[
\max_{\{e_k\}_{t}^{T}} \left\{ d^i(T - k)w(e) - \sum_{k=t}^{T} d^i(k - t)\alpha^i c(e_k) \right\}. \tag{2}
\]

\(^{10}\) The hyperbolic discount function \( d(t) = (1+\alpha t)^{-\gamma} \) (Lowenstein and Prelec 1992) satisfies this property. Note that for a quasi-hyperbolic function (see Laibson 1997) \( d^i(t) = \beta \delta^{t} \), \( \frac{d^i(t)}{d^i(t)} = \beta \delta \) and \( \frac{\delta t + t}{\delta t} = \delta \) for \( t > 0 \)—so it satisfies this property for \( t = 0 \). In what follows, we model time inconsistent agents with general hyperbolic preferences, but also briefly discuss the case of quasi-hyperbolic preferences.
Let $e_t^{(s)*}$ denote the optimal effort in period $t$ from the perspective of worker $i$’s period $s$ self. Since the decision of how much effort to actually exert in period $t$ is made by the period $t$ self, the case when $s = t$, $e_t^{(t)*}$, will always denote the level of effort that is actually exerted in period $t$. Note that under quasi-linear utility, optimal effort in each period is separable from effort choice in other periods. From the perspective of period 0, the optimal effort in period $t$, $e_t^{(0)*}$ is pinned down by the FOC from expression (1):

$$\alpha_t c'(e_t^{(0)*}) = \frac{d^t(T)}{d^t(0)} b.$$  

(3)

The effort level actually exerted by the worker in period $t$, $e_t^{(t)*}$, is given by the FOC from (2):

$$\alpha_t c'(e_t^{(t)*}) = \frac{d^t(T-t)}{d^t(t)} b = d^t(T-t)b.$$  

(4)

Equation (4) implies that output increases as the payment period approaches, since $\partial e_t^{(t)*}/\partial T < 0$. Lemma 1 establishes an equivalence between how the discount rate and the piece rate affect output.

**Lemma 1 (Equivalence of Discounting and Piece Rate Changes):**

Suppose worker $i$ produces output $e_t^{(t)*}$ at time $t$ and $e_{t+1}^{(t+1)*}$ at time $t+1$ under piece rate $b$. If $b'$ is the piece rate needed to generate output $e_{t+1}^{(t+1)*}$ in time $t$, then:

$$d^t(T-t-1) b' = d^t(T-t)b.$$  

(5)

**Proof:** Define $b'$ as the piece rate that the worker must be paid in period $t$ to elicit effort equivalent to $e_{t+1}^{(t+1)*}$, which is the effort level exerted by the worker in period $t+1$. The FOC for worker $i$ at period $t+1$ under the original piece rate is: $d^t(T-t-1)b = \alpha_t c'(e)$. The

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$^{11}$The regularity conditions and the properties of $c'(\cdot)$ guarantee single-peakedness of the maximand. Hence there will be a unique maximum either at the interior or at the corner where $e = 0$. It is straightforward to verify that the maximum will not be zero if the derivative of the maximand with respect to $e$ is positive at $e = 0$. That will be the case if $\alpha_t < d^t(T)b/c'(0)$ for all $i$. Workers for whom this condition is not satisfied would not participate in the program described below; hence we assume this condition is satisfied for all workers. Under this condition, the first order conditions will be both necessary and sufficient for a global maximum.
FOC for worker \(i\) at period \(t\) under the alternate piece rate \(b'\) is: \(d^i(T - t)b' = \alpha^i c'(\theta)\). This implies \(\frac{d^i(T-t-1)}{d^i(T-t)} = \frac{b'}{b}\). ■

Using Lemma 1, Proposition 1 allows us to recover the slope of a worker’s discount function from the output increase over the pay cycle.

**Proposition 1 (Pay Cycle Effect):**

Let \(\varepsilon^i_t\) denote the elasticity of output to the piece rate \(b\) at time \(t\) for worker \(i\). As time periods become arbitrarily small:

\[
\frac{d^i(T - t - 1) - d^i(T - t)}{d^i(T - t)} = \frac{1}{\varepsilon^i_t} \left[ \frac{e^{i(t+1)*}_t - e^{i(t)*}_t}{e^{i(t)*}_t} \right].
\]

(6)

The left hand side of expression (6) reduces to \(\frac{1}{\delta}\) if workers are exponential discounters, and is greater than \(\frac{1}{\delta}\) if they are time inconsistent. This implies that output increases over the pay cycle will be larger for time inconsistent workers than time consistent ones.

**Proof:** As time periods get arbitrarily small—so that period \(t + 1\) approaches period \(t\)—the change in the discount factor will be arbitrarily small, implying arbitrarily small changes in effort between periods \(t\) and \(t + 1\). As a result:

\[
\varepsilon^i_t = \frac{\partial e^i_t}{\partial b} \frac{b}{e^i_t} = \left( \frac{e^{i(t+1)*}_t - e^{i(t)*}_t}{e^{i(t)*}_t} \right) \left( \frac{b' - b}{b} \right).
\]

(7)

Substituting in for \(\frac{b'}{b}\) from Lemma 1 gives the relationship between the output increase over the paycycle and the change in the discount factor:

\[
\frac{d^i(T-t-1) - d^i(T-t)}{d^i(T-t)} = \frac{1}{\varepsilon^i_t} \left[ \frac{e^{i(t+1)*}_t - e^{i(t)*}_t}{e^{i(t)*}_t} \right].
\]

For a general utility function the relationship will only be approximate if the period length is non-trivial, since the elasticity of output to the piece rate will change from \(e = e^{i(t)*}_t\) to \(e = e^{i(t+1)*}_{t+1}\). However, when \(c(e) = e^\theta\), the elasticity of effort with respect to the piece rate will be constant at \(1/\theta\). In this case, equation (6) will hold with equality over time periods of any length.

To compare the magnitude of the pay cycle increase across the two types of workers, consider a time consistent and time inconsistent worker, both of whom exert the same effort level in period \(t\): \(e^c_t = e^{i(t)*}_t\). Then, both types of workers will have the same elasticity in period \(t\). Since \(\frac{d^c(T-t-1)}{d^c(T-t)} > \frac{d^i(T-t-1)}{d^i(T-t)}\), then equation (6) implies that the output increase from period \(t\) to \(t + 1\) will be larger for time inconsistent workers. ■

For quasi-hyperbolic discounting, the pay cycle effect would be a sharp output increase on the pay period; in earlier periods, these workers would behave like time consistent
exponential discounters. For more general hyperbolic functions, the difference would not be so concentrated on the last pay period. For short pay cycles—in our study they are a week—one can make stronger statements. We will show in Section IV that for an exponential discounter, for reasonable values of $\delta$ and $\epsilon$, output should not noticeably change over a weekly pay cycle.

**Contract Choice:** For time consistent workers, since $\frac{dC(T)}{dT} = \frac{dC(T-t)}{dT(0)} = \delta^{T-t}$, the first order conditions for optimal effort (3) and (4) are exactly the same. Hence the effort level chosen by period $t$ is also optimal from the perspective of period 0: $e_t^{C(0)*} = e_t^{C(t)*}$. This is because utility from the standpoint of the period $t$ self is simply a multiple of utility from the perspective of the period 0 self. Both selves weigh the benefits of income at the payday relative to the costs of effort at time $t$ exactly the same.

In contrast, from the perspective of a time inconsistent worker in period 0, the period $t$ self will supply too little effort. Specifically, since $\frac{dV(T)}{dT} > \frac{dV(T-t)}{dT(0)}$, $e_t^{0*(0)} > e_t^{0*(t)}$. Because the period 0 self weighs the benefits of effort relative to the costs more heavily than the period $t$ self, the period 0 self desires more effort than the period $t$ self. This is the essence of the time inconsistency problem. In Proposition 2, we show that this time-consistency problem will lead time-inconsistent workers to demand dominated contracts—which punish workers by paying less than $w(\cdot)$ if effort is below a threshold and pay the same as $w(\cdot)$ for effort above the threshold.

**Proposition 2 (Demand for Dominated Contracts, Bounds on Time Inconsistency):**

a) Suppose that in period 0 workers are offered the following dominated wage schedule, which allows them to choose a target output level, $\hat{e}$, for period $t$:

$$v_t^{0*(0)}(e) = \begin{cases} a + b^p e, & e < \hat{e} \\ a + be, & e \geq \hat{e} \end{cases},$$

where $0 \leq b^p < b$. Time inconsistent workers’ period 0 selves will strictly prefer $v_t^{0*(0)}(\cdot)$ over $w(\cdot)$ and will choose $\hat{e}$ such that $e_t^{0*(0)} < \hat{e} \leq e_t^{0*(0)}$. In contrast, time consistent workers will never strictly prefer $v_t^{0*(0)}(\cdot)$. 


b) Denote the ratio of output under $v_t^{(l)}(\cdot)$ to output under $w(\cdot)$ at time $t$ as $x_t^l$. Then the level of time inconsistency is bounded below by $x_t^l$ divided by the effort elasticity:

$$\frac{d'(T)/d'(t)}{d'(T-t)/d'(0)} - 1 \geq \frac{x_t^l}{\varepsilon_t^l}. \quad (8)$$

**Proof:** The period 0 self chooses $\hat{\varepsilon}$ to maximize its utility, subject to the constraint that the period $t$ self will choose the level of effort that maximizes its utility given the dominated wage schedule with target $\hat{\varepsilon}$.

For time consistent workers, $e_t^{C(t)*} = e_t^{C(0)*}$ and so $v_t^{(0)}(\cdot)$ has no benefits and will never be strictly preferred.

In contrast, time inconsistent workers’ period 0 selves will prefer $e_t^{l(0)*}$ while their period $t$ selves will prefer $e_t^{l(t)*}$, so there is potentially scope for the period 0 self to influence the period $t$ self’s choice of effort. To characterize the optimal $\hat{\varepsilon}$, we solve backwards, starting with the period $t$ self’s problem given the $\hat{\varepsilon}$ chosen by the period 0 self. The period $t$ self will solve for the utility maximizing level of effort in the range $[\hat{\varepsilon}, \infty)$ and the utility maximizing $e$ in the range $(0, \hat{\varepsilon})$ and choose whichever yields greater utility. By the convexity of $c(\cdot)$, the period 0 self will never choose $\hat{\varepsilon} < e_t^{l(t)*}$ and given such an $\hat{\varepsilon}$, the period $t$ self will never choose $\hat{\varepsilon} \geq e_t^{l(t)*}$.

Denote as $e^{p*}$ the optimal level of effort from the perspective of period $t$ when the piece rate is $b^p$: $e^{p*} \equiv \arg\max_e \{d'(T-t)(a + b^p e) - \alpha^t c(e)\}$. Note that $e^{p*} < e_t^{l(t)*}$ since $b^p < b$. In general, the period $t$ self will choose $\hat{\varepsilon}$ over $e^{p*}$ if and only if $d'(T-t)(a + b\hat{\varepsilon}) - \alpha^t c(\hat{\varepsilon}) \geq d'(T-t)(a + b^p e^{p*}) - \alpha^t c(e^{p*})$.

There is always some $\hat{\varepsilon}$ that will make the time zero self strictly prefer $v_t^{(l)}(\cdot)$ to the $w(\cdot)$ schedule. To see this, note that since the period 0 self’s FOC is satisfied with equality at $e_t^{l(0)*}$, $bd'(T)/d'(t) - \alpha^t c'(e)$ will be positive and decreasing in $e$ for $e < e_t^{l(0)*}$. Thus, by the convexity of $c(\cdot)$, higher levels of effort are preferred for $e < e_t^{l(0)*}$. Consequently, the period 0 self will prefer to induce as high an effort level as possible in the range $e < e_t^{l(0)*}$.

There is always some $\hat{\varepsilon} > e_t^{l(t)*}$ that the period $t$ self can be induced to supply under $v_t^{(l)}(\cdot)$. To see this, write $\hat{\varepsilon} = e_t^{l(t)*} + \mu$. As $\mu \to 0$, the time $t$ self will be arbitrarily close to indifferent between exerting $e_t^{l(t)*} + \mu$ under $v_t^{(l)}(\cdot)$ and exerting $e_t^{l(t)*}$ under $w(\cdot)$. Hence for any $b^p < b$, there will be some $\mu$ small enough such that the worker’s period $t$ self will prefer $\hat{\varepsilon}$ over any other value of $e$.

Note that increasing $\hat{\varepsilon}$ beyond $e_t^{l(0)*}$ will reduce utility for period 0 and by the convexity of $c(\cdot)$ will reduce utility from the standpoint of period $t$, making it harder to induce to induce $\hat{\varepsilon}$. Thus for time inconsistent workers, some $\hat{\varepsilon}$ in the range $e_t^{l(t)*} < \hat{\varepsilon} \leq e_t^{l(0)*}$ will maximize period 0’s utility, and $v_t^{(l)}(\cdot)$ will be strictly preferred to $w(\cdot)$. The maximum level of effort, $e^{max}$, that the period $t$ self can be induced to supply under the dominated contract is implicitly given...
by: \[ d^T (T - t)[b e^{max} - b^p e^{p*}] - \alpha [c(e^{max}) - c(e^{p*})] = 0. \] Then, \( e^{i(0)*}_t \) can be induced in period \( t \) if \( e^{i(0)*}_t \leq e^{max} \). Thus, we have \( \hat{\theta} = \min \{e^{i(0)*}_t, e^{max}\} \).

Following the logic in the Proposition 1 proof, we define \( b'' \) as the alternate piece rate wage that would induce period \( t \) to choose \( \hat{\theta} \) under the wage schedule \( w(e)' = a + b''e \). The FOC in equation (4) implies: \( d^T (T - t)b'' - \alpha \cdot \tilde{c}' (\hat{\theta}) = 0 \). The FOC in equation (3) implies: \( d^T (T)b - d^T (t)\alpha \cdot \tilde{c}' (\hat{\theta}) \geq 0 \) since \( \hat{\theta} \leq e^{i(0)*}_t \). Together, these conditions imply: \( \frac{b''}{b} \leq \frac{d^T (T)}{d^T (T - t)} \).

Plugging this into the formula for elasticity gives expression (11): \( \frac{d^T (T)/d^T (t)}{\alpha} = \frac{\alpha}{\alpha} \geq \frac{x_t^T}{e_t^T} \).

Additionally, when \( c(e) = e^\theta, e_t^T = \frac{1}{\theta} \) for all effort levels, and expression (12) will hold regardless of the length of time periods.

The ratio on the left hand side of expression (8), \( \frac{d^T (T)/d^T (t)}{\alpha} \), reflects the convexity of \( d^T (T) \). The numerator captures how the period 0 self discounts the costs of effort at time \( t \) relative to the benefits of pay at time \( T \); the denominator captures this ratio for the period \( t \) self.

If the period 0 and \( t \) selves valued the benefits relative to the costs exactly the same, then this ratio would be 1. Indeed, for exponential discounters: \( \frac{\delta^T / \delta^T}{\delta^T / \delta^T} = 1 \). This underscores that time consistent workers’ output would not increase if they were offered dominated contracts. If workers had quasi-hyperbolic preferences, this ratio would equal \( 1/\beta \), which captures the level of time inconsistency between current and future periods. Note that the observed output increase, \( x_t^T \), is a lower bound on the deviation from time consistency because the period 0 self may not be able to induce its preferred effort level of \( e^{i(0)*}_t : \hat{\theta} \leq e^{i(0)*}_t \).

**Proposition 3 (Correlation of Pay Cycle and Dominated Contract Effects):**
Suppose some workers are time consistent exponential discounters with discount function \( d^C (t) \) and the others are time inconsistent with discount function \( d^T (t) \). Then, the magnitude of the output increase over the pay cycle, \( e^{i(t+1)*}_{t+1}/e^{i(t)*}_{t} \), will be positively correlated with demand for dominated contracts and the extent to which their provision increases output.

**Proof:** This follows from Propositions 1 and 2. Time inconsistent workers will exhibit larger output increases over the pay cycle. Moreover, only time inconsistent workers can be expected to
demand dominated contracts and increase output in response to being offered the choice of such contracts. ■

If the population includes exponential discounters with different discount rates and hyperbolic discounters with different $d(t)$ functions, then the correlation will not be one. The pay cycle increase reflects impatience—how much wages are discounted when the payment period is further away. In contrast, the output increase under dominated contracts reflects time inconsistency—the extent to which the period 0 and $t$ selves differ in weighing costs vs. benefits of effort in period $t$. In practice, this correlation will also be weakened if some time inconsistent workers are naïve—in this case, all time inconsistent workers would exhibit pay cycle effects but only sophisticates would choose (and be affected by) dominated contracts.

**Proposition 4 (Horizon of Choice):**

*When selecting a dominated contract for period $t$, time inconsistent workers will choose to induce a weakly higher effort level when contract choice is made further in advance of period $t.*

**Proof:** If we expand our model to allow for contract choice to be made in period $-s < 0$, then $e_t^{I(t)*} < e_t^{I(0)*} < e_t^{I(-s)*}$ where the second inequality follows from $d^I(T)/d^I(t) < d^I(s + T)/d^I(s + t)$. Consequently, following the logic in Proposition 2, the period $-s$ self will prefer to induce an effort level greater than $e_t^{I(0)*}$. However, if such an effort level is not inducible, then the period $-s$ self will choose $e = e^{\text{max}}$ and induce the same effort level as the period 0 self. ■

The model is deterministic and abstracts from the possibility of shocks to output or to the cost of effort. Suppose instead there were some probability $p > 0$ that instead of output equaling $e$, output equaled $\min\{0, e + j\}$, where $j$ is a mean zero normal error term with variance $\sigma_j^2$. Then the dominated contract derived above would be less attractive for both time consistent and time inconsistent workers, because there would be some states in which workers would face the penalty even if $e = \hat{e}$. Thus time-consistent workers would strictly prefer $w(\cdot)$ to $v_t^{I(0)}(\cdot)$. In
contrast, time-inconsistent workers could still prefer a dominated wage schedule—for small enough $p$, they would prefer $v_t^{i(0)}(\cdot)$ to $w(\cdot)$ by continuity. Since they would incur penalties with positive probability, they might choose less aggressive target effort levels. Thus, in the stochastic output case, $1+x/\varepsilon_t^{i}$ is a less tight lower bound on the extent to which the worker deviates from exponential discounting.

Shocks to the cost of effort, e.g. from illness or a family emergency, would make dominated contracts less attractive not only because workers might miss the target, losing $(b - b^p)$ per unit of output but also because even under smaller shocks, exerting the effort to reach the target might yield little surplus to the workers. These factors could lead workers in time zero to reject even dominated contracts with very small $\hat{\varepsilon}$.

In addition, as discussed further below, the risk of shocks to output or the cost of effort might vary over time. Under such time-varying stochastic shocks, time inconsistent workers might select dominated contracts some times but not other times.

In this section we have considered worker choice of effort and contracts in response to exogenously determined menus of contracts.$^{12}$ In the next sections we first use the predictions to test for time inconsistency in worker effort. We then calibrate the extent to which workers depart from standard exponential discounting using the propositions above. We defer the question of what contracts profit-maximizing firms would offer in equilibrium until Section VI.

III. Experiment Design

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$^{12}$ Another issue is that we take the period between paychecks as exogenous. Endogenizing the length of time between pay periods is an interesting issue in its own right. Even if more frequent payment mitigates the work self-control problem, it may carry transaction costs and exacerbate the consumption self-control problem, since infrequent payment may be an implicit savings commitment device. Indeed, there were several instances over the course of the project in which workers asked management to withhold their earnings for weeks at a time because this would help them save for lump sum expenditures.
III.A. Experimental Context

To assess the empirical relevance and magnitude of time inconsistency, we worked with an Indian data entry firm in Mysore—in a region that is a major data entry hub. Using the firm’s infrastructure—office space, entry software, and operational protocols—we designed and managed a field experiment over 13 months.

Workers used data entry software to type information from scanned images into fields on their computer screen (see Appendix Figure 1). The software provided them with information on their own output with about a 15-minute delay. Workers were paid a piece rate of Rs. 0.03 for each accurate field entered (see below),\(^{13}\) plus a small flat daily show-up fee of Rs. 15 that constituted about 8 percent of their compensation. Thus in the language of the model in Section II, \(w(e) = Rs. 15 + Rs. 0.03 e\). Pay levels were at par with or slightly higher than those paid by other data entry firms in the region.

Employees were recruited through the standard procedures used by the firm—the pool of resumes submitted by walk-ins and solicitations via posters and announcements in surrounding villages. Applicants were required to have completed tenth grade and be at least eighteen years old. Workers were told they were being hired for a one-time contract and were not provided reference letters upon completion of the job.

Roughly three-quarters of workers were male. Among those who reported age on their resumes, average age was 24 years (Panel A, Table 1). Workers averaged 13 years of education, most had taken a computer course and had an email address prior to joining the firm.\(^{14}\) Many

\(^{13}\) Accuracy is measured using dual entry of data, with manual checks of discrepancy by separate quality control staff—standard practice in the data entry industry.

\(^{14}\) In this and other information presented in Table 1, some employees hired in later stages of the project were not surveyed because of clerical oversight.
employees commuted from surrounding villages using buses and trains, with some traveling up to two hours in each direction.

New recruits received about two weeks of training before contract randomizations began (see below). During the first four days, they were paid a flat stipend while receiving instruction on the data entry software and production task. During the next four days, they worked under assignment to the control contract with wage schedule \( w(e) \). They also received training on the contract treatments (described below) during this time. After this, they were assigned to the dominated contract for two days under the low and medium targets, respectively. This gave them the opportunity to observe their production under both types of incentive schemes before beginning contract randomizations. The mean score on a quiz that workers took to verify they understood the contracts was 93%. Throughout the experiment, workers were randomly assigned to seats in the office and these assignments changed every one to three weeks, since some computers were slower and more sensitive to network speed fluctuations than others.

**III.B. Treatments**

To test Proposition 1, employees were randomized into three payday groups, which were paid in the evenings of Tuesday, Thursday, and Saturday, respectively, for work completed over the previous seven days. This allows us to control for other day-of-the-week factors that might affect effort, such as a post or pre-weekend effect. Workers were instructed to stop working at least 20 minutes early on paydays to allow sufficient time for their production to be computed and earnings disbursed before they left to catch their bus or train.

To test Proposition 2, we used two contracts. The linear “control” contract paid a piece rate wage of \( b \) (Rs. 0.03) for each field entered accurately. The nonlinear “dominated” contract paid
piece rate of $b$ if workers met the target, but only $b/2$ for each entered field if they fell short of the target. As shown in Figure 1, for any given production level, earnings are always weakly higher under the control contract than the dominated contract.

Each day, each worker was independently randomized into one of four contract treatments. In the first, workers were assigned to the control contract. In the second, they were assigned to the dominated contract, with an exogenous target imposed; the target was selected from three target levels—low, medium, or high.\(^{15}\) In the remaining treatments, workers were given the option to choose a dominated contract, in which they chose their own target. They could always choose a target of zero (and many did), which is the equivalent of choosing the simple linear control contract. In the third treatment, morning option to choose a dominated contract, workers chose their targets in the morning when they arrived to work. Finally, in the fourth treatment, evening option to choose a dominated contract, workers chose their targets the evening before the workday. To make workers’ information similar across these conditions, all workers were told their treatment assignment for each day the evening before.

Every worker received each of the four contract treatments in random order exactly 25 percent of the time over every 8-day or 12-day work period. As an example, Appendix Table 1 displays the contract assignments for 5 workers in the sample over a 24-day period. Our sample of 102 workers and 8,423 observations covers the eight-month period when both contract and payday treatments occurred simultaneously.\(^{16}\) Appendix Table 2 verifies that treatment assignments were balanced across the sample.

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\(^{15}\) Low, medium, and high targets were set at 3,000, 4,000, and 5,000 accurate fields, respectively. In the first month of randomizations, these corresponded to the 30th, 50th, and 70th percentiles, respectively, of production under the control contract. Initially, the Target Assignment was only to “low” or “medium” targets. Assignment to the “high” target was added later, as production levels increased. During the last month of contract randomizations, we changed these levels to 4,000, 5,000, and 6,000 accurate fields to correspond to increases in worker production over time.

\(^{16}\) The payday treatments were run for 3 additional months (during end line activities). All payday effects reported below are similar in a sample covering this longer period.
IV. Results

IV.A. Pay Cycle Effects on Production (Test 1)

We define worker production as the number of accurate fields entered by a worker in a day. When workers are absent, we code production as 0. Note first that workers produce 215 fields more on average on paydays than non-paydays on a base of roughly 5,300 fields (Table 2, Column (1)). Effects persist controlling for serial correlation in output (Column (2)).

To examine production dynamics over the weekly pay cycle more fully, we estimate a model with a full set of indicators for each day in the pay week (with 6 or more days from the next payday as the omitted category). The coefficients from this regression are displayed in Table 2, Col (3) and plotted in Figure 2. Employees are least productive on the days furthest from their next payday. Production then rises through the pay cycle. It dips slightly (and insignificantly) from the day before the payday to the payday itself—likely because workers were required to stop work at least 20 minutes early to collect their pay. Moreover, workers may have wanted to leave work early on paydays to make purchases—for example, if they were credit constrained, had time inconsistency in consumption, or worried about demands from relatives if they hung on to cash. The average change in production from the beginning to the end of the pay week is 8%. This magnitude corresponds to approximately one additional year of education in our sample.18

17 We lack the power to pin down the exact shape of the increase in output over the pay week—one could fit a convex, linear, or concave curve through the confidence intervals in Figure 2.
18 We also estimated a specification with a linear control for number of days before the next payday, a payday dummy, and standard controls. The coefficient on the linear control indicates that production increases on average by 102 fields—or 2%—per day leading up to the payday (significant at the 1% level). This specification suggests that the “time to collect paycheck” effect reduced output on paydays by 4% relative to the predicted level based on the 2% upward trend per day, almost exactly as much as would be predicted based on taking 20 minutes off to collect a paycheck.
Attendance is also higher on paydays (Col (4)) and increases steadily in the days before the payday (Col (5)), consistent with increased effort closer to paydays.\textsuperscript{19} In general, the payday cycle affects both the extensive margin—attendance and workday length—and the intensive margin—output conditional on attendance and workday length (Appendix Table 3, Panel A).

The pay cycle dynamics suggest that quasi-hyperbolic models (Laibson 1997) do not fit our data well. These models would predict that the effects would only arise on the payday itself. Instead, we see a steady increase. These dynamics also rule out an explanation based solely on workers showing up to work on the payday to collect their checks, or an explanation focused on workers taking the day after the payday off.

Further evidence for present bias is provided by festivals, which involve large expenditures and are perfectly foreseeable. Under convex effort costs, time-consistent workers should smooth production; production of time-inconsistent workers, however, would spike before festivals. Indeed, production increases by 15% in the week prior to major festivals (significant at 1%).

\textit{Calibration of Implied Discount Rate}

We can use Proposition 1 to calibrate the discount rate implied by the weekly production cyclicality. In order to estimate the elasticity of output to the piece rate, after contract randomizations were finished, workers were randomly offered one of two piece-rate wages: Rs. 0.03 (their usual piece rate) and Rs. 0.04 per accurate field. Each worker received each piece rate 5 times over a 10-day period in random order. This 33\% increase in wages increased output by 11\%, for an elasticity of 0.33 (See Appendix Table 4, Col (1)). Note that under the assumption that \( c(e) = e^\theta \), this implies \( \theta = 3 \).

\textsuperscript{19} Results are similar if a probit estimator is used instead of a linear probability model.
Since the average output increase over the six days from the beginning to the end of the payweek is 8% (Table 2 Col (3)), on average, \( \frac{e_t - e_{t+1}}{e_t} = \frac{0.08}{6} = 0.013 \). Proposition 1 therefore gives:

\[
\frac{d^t(T-t)-d^t(T-t)}{d^t(T-t)} = \frac{0.013}{0.33} = 0.04
\]

Thus on average, the daily increase in discounting is 4%.

If workers were time consistent exponential discounters, this would require an annual discount rate of 1.65x10^6 %. Standard estimates for the exponential discount rate in the literature are about 5% per year (e.g. Engen et al. 1994, 1999; Hubbard et al. 1994; Laibson et al. 1997)—far lower than those we estimate. Of course, the exact discount rate implied by the calibration above should be taken with a grain of salt since the model does not perfectly correspond to reality. As discussed above, output and effort costs may be stochastic. Some workers might be able to smooth inter-temporally using savings or credit—we would expect such workers to show more modest pay cycle increases, deepening the puzzle of our finding such large effects. While we model utility as quasi-linear, there may indeed be some income effects; however, these would generate substitutability between effort in different periods—behavior which we empirically rule out below in Section IV.B. The effort elasticity may not be exactly 0.33 and may not be constant everywhere. Yet while all these factors suggest caution regarding the precision of the calibrated discount rate of 4% per day, it seems hard to imagine that one could fail to reject the hypothesis of exponential discounting at rates of about 5% per year.

While standard estimates of implied daily discount rates under exponential discounting do not match our data, estimates that allow for hyperbolic discounting are much more consistent. For example, fitting laboratory data to a hyperbolic model, Kirby and Marakovic (1995) estimate discounting of 1-3% per day over short horizons. Calibrations from field data also produce such large estimates (e.g. Paserman 2004; Fang and Silverman 2004; Shui and Ausubel 2004).
IV.B. Demand for and Treatment Effects of Dominated Contracts (Test 2)

On average, when given the option to choose a dominated contract, workers take up the dominated contract by selecting a positive target 36% of the time when present (Table 3, Panel A). This is based on the sample of workers who were present both the day before and the day of the treatment assignment (and thus were informed of their treatment the evening before as per protocol and able to select targets). As a conservative estimate, if we code workers who are absent the day before or day of assignment as choosing zero targets, the mean take-up rate across workers is 28%.

Figure 3 plots the distribution of worker take-up rates. 16% of workers always chose a target of zero. The bottom quarter of the distribution chooses positive targets less than 10% of the time. The top quarter chooses positive targets at least 60% of the time.

As discussed in Section II, in a deterministic model in which workers had a fixed type, hyperbolic workers would always choose a positive target and exponential discounters would never choose a positive target. However, time-varying stochasticity in output or effort costs could create within-worker variation in choice of contract. Network slowdowns, assignment to a slow computer, changes in difficulty of batches of data, sickness, or family emergencies could make the risk of shocks to output or the cost of effort greater on certain days (see Section IV.D). In addition, workers might go through periods of present-biasedness, for example due to variation in family circumstances, seasonal variation in other income sources, or shocks that increase or decrease exposure to habit forming goods such as alcohol, tobacco, or caffeine. Access to other motivational devices that reduce the need for dominated contracts could also vary across days (e.g., see Kaur, Kremer, and Mullainathan 2010).
Panel B of Table 3 presents treatment effects of giving workers the option to choose targets. Relative to assignment to the *control contract*, assignment to the *option to choose a dominated contract* treatments increased production by 120 fields or 2% (significant at the 5% level; Col (1)). Looking within these treatments, *evening option to choose a dominated contract* increased output by 3% (significant at the 5% level) and *morning option to choose a dominated contract* insignificantly increased output (Col (2)). Not surprisingly, exogenously imposing a target on workers increased output—with larger effects for higher targets (Col (3)). If all workers were time-consistent, assignment to an exogenous target would generally reduce utility from working that day, and thus reduce attendance; however we see no such effect in the data (Col (4)).

The implied Treatment on the Treated Effect of choosing a positive target is approximately 6%. Given the estimated elasticity of 0.33, the magnitude of this effect corresponds to an 18% increase in the piece rate. Using Proposition 2, we can back out the implied bound on the departure from time consistency. The TOT effect of 6% implies that across workers on average, 

\[ \frac{d(t)-d(t')d(t-t)}{d(t)d(t-t)} \geq \frac{0.06}{0.33} = 0.18. \]

On average, workers value the benefits of wages on the payday, relative to the costs of effort on the workday, by at least 18% more at the time of contract choice than in the moment of effort—a major departure from time consistency.

We estimate that the chosen targets are aggressive enough that workers would have missed them 9.1% of the time if they had been assigned to the *control contract* that day.\(^{20}\) Recall that in

\[^{20}\] This is computed as follows. For observations where workers were present, we estimate a regression of production on worker, date, and computer fixed effects; lag production controls; payday distance dummies; contract assignment dummies; and log experience. For each observation in which a worker was given the *option to choose a dominated contract*, selected a positive target, and was present, we predict the worker's production under the *Control contract* using the estimates from the above regression. To this predicted value, we add the worker's vector of residuals from the above regression to arrive at a vector of potential production values, which we fit to a lognormal distribution. Evaluating the CDF of this distribution at the chosen target level gives an estimate of the probability that the worker would have missed her chosen target under the *control contract*. 9.1% is the mean of the worker-level averages for this statistic. Note that these estimates are computed only for observations in which workers were present. If workers
the model, workers choose targets in such a way that their future selves never miss them. In the actual experiment, workers missed their chosen targets under the *option to choose a dominated contract* treatment (conditional on choosing a positive target and being present) 2.6% of the time—losing almost half of their typical daily earnings on average when they did so. This is consistent with the existence of stochastic shocks to output or the cost of effort. Note that such shocks will create additional costs for workers beyond the financial penalty—such as having to stay in the office late to meet their target on days when there are negative shocks to output, or being unable to leave early when there are unexpectedly high effort costs.

Note that in the model, labor supply is separable across periods. Consistent with this, we find no evidence that higher effort in one day increases the cost of effort in subsequent days (Appendix Table 5). Specifically, assignment to *option to choose a dominated contract or target imposed* (relative to the *control* contract) does not reduce production the next day.21

**IV.C. Heterogeneity in Preferences: Correlation Between Payday and Contract Effects (Test 3)**

The payday and contract choice results each suggest that at least some workers are time inconsistent. We strongly reject the assumption that workers are homogeneous in these effects. To test for heterogeneity in payday effects, we regress production on a payday dummy, worker fixed effects, interactions of each worker fixed effect with the payday dummy, and standard controls. The p-value of the F-test of joint significance of the interaction coefficients is 0.000. Similarly, to test for heterogeneity in treatment effects of contracts, we limit the sample to choose aggressive targets ex ante but selectively stay home on days when the cost of effort is unexpectedly high, these estimates will understate the aggressiveness of the chosen targets.

21 Since workers are assigned to each treatment a fixed number of times in each 12-day period, assignment on a given day is correlated with the probability of future treatments in each block. This mechanical correlation could affect the estimates in Table 3. In Appendix Table 6, we control for the probabilities of the worker receiving each contract assignment for that observation given the worker’s previous assignments in that randomization block. An F-test of joint significance of the probability covariates has a p-value of 0.45—indicating that the assignment probabilities have little predictive power. Their inclusion also has little impact on the estimated treatment effects.
control and option to choose a dominated contract observations and regress production on worker fixed effects, an option to choose a dominated contract assignment dummy, interactions of each worker fixed effect with this dummy, and standard controls. The p-value of the F-test of joint significance of the interaction coefficients is 0.003.

Proposition 3 predicts that the payday and contract effects will be positively correlated. To test this, we define the payday impact for each worker as:

$$Payday\ impact = \frac{(Mean\ production\ on\ paydays) - (Mean\ production\ on\ nonpaydays)}{(Mean\ production\ in\ sample)}.$$ 

This measure is computed using only observations in which workers were assigned to the control contract treatment.\(^{22}\) Note that we chose this as our summary measure of a worker’s payday impact at the start of the empirical analysis because this measure does not take a strong ex ante stance on the nature of time inconsistency. The prediction that is common to both hyperbolic and quasi-hyperbolic models is that of output increases on paydays. Even in hyperbolic models, increases closer to the payday are expected to be most pronounced. In addition, calibrating a hyperbolic parameter for each worker using the increase over the full workweek would necessarily require (arbitrary) functional form assumptions. We therefore use the simple proportional difference in means between paydays and non-paydays. In ex post analysis, we have confirmed the results are robust to other measures that capture the pay cycle effect.

On average, workers with an above average payday impact are 13.8 percentage points more likely to select a positive target and select targets that are 353 fields higher (Table 4, Panel A). These coefficients correspond to a striking 47% and 49% of the mean take-up rate and target level, respectively, and are both significant at the 1% level. Workers with large payday effects

\(^{22}\) We can only compute this statistic for workers who were assigned to the control contract on both paydays and non-paydays during employment. This reduces our sample size for this analysis from 8,423 to 8,240 observations.
also increase production more in response to dominated contracts. In Table 4, Panel B, Col (1), the interaction between the option to choose a dominated contract and the high payday impact dummies is 482 fields—9% of mean production (significant at the 1% level), implying a Treatment on the Treated Effect of 28%. These results are shown graphically in Figure 3. High payday impact workers are also more likely to show up to work when assigned to option to choose a dominated contract or target imposed (Table 4, Panel B, Col (2)).\textsuperscript{23} This provides another source of evidence that high payday impact workers demand dominated contracts.

Given that we estimate our labor supply elasticity estimate of 0.33, the 9% Intent-to-Treat effect implies that providing high payday impact workers with simply the option to select targets leads to production increases comparable to a 27% increase in the piece rate wage. This magnitude corresponds to a one-year increase in education. Using Proposition 2, the TOT effects allows us to bound the level of time inconsistency of the workers which, based on their paycycle behavior, appear most time inconsistent. When these workers choose dominated contracts,

\[ \frac{d^I(\tau)/d^I(t)}{d^I(\tau-t)/d^I(0)} - 1 \geq \frac{0.28}{0.33} = 0.84; \]  

this implies that the relative value of the wage benefits to effort costs is 84% higher at the time of contract choice than at the time of effort.\textsuperscript{24}

The workers most affected by paydays also select more aggressive targets. Using the approach described in Section IV.B, we estimate that high payday impact workers would have missed their selected targets 11.8% of the time (had they been under the control contract) and

\textsuperscript{23} The large production effect of option to choose a dominated contract on high payday-impact workers does not seem to be driven completely by the impact on attendance. For high payday impact workers, the average treatment effects on production and attendance are 395 fields and 4.4 percentage points, respectively. For these workers, mean production conditional on attendance is 5581 fields. As a simple calibration, 5581*0.044 = 245 < 395. Moreover, regressing production conditional on attendance on the contract treatment dummies yields positive and significant coefficients (Appendix Table 3), although these are difficult to interpret since attendance is endogenous.

\textsuperscript{24} There are no significant differences in the elasticity of output with respect to wages between workers with above and below average payday effects (Appendix Table 4, Col (2)).
actually miss them 5% of the time. In contrast, these statistics are 7% and 1%, respectively, for low payday impact workers.

In the above analysis, we regress contract choice on payday effects, rather than the other way around, because contract choice—in particular the acceptance of dominated contracts—will depend not only on whether workers are time consistent but also on their degree of sophistication. A regression of payday effects on contract choice will thus be subject to an errors-in-variables problem. Nonetheless, we show regressions of this type in Appendix Table 7 and plot a corresponding figure in Appendix Figure 2. Specifically, using our standard specification (with production as the dependent variable), there is some evidence that workers with above average take-up rates of dominated contracts have steeper output increases over the pay cycle (Appendix Figure 2, Panel A). Since workers with different take-up rates also differ in their productivity levels, repeating this analysis using log production strengthens this result—the two groups have significantly different pay cycle trends. Specifically, workers with above average take-up of dominated contracts have greater output increases 2 days before their payday (15 log points; significant at 1%), 1 day before their payday (12 log points; significant at 5%), and on their payday (10 log points; significant at 5%) (Appendix Table 7, Col (1)). On average, the slope of the output increase over the pay cycle for workers with high dominated contract demand is more than twice as large as those with low demand (Appendix Table 7, Col (2)).

IV.D. Morning and Evening Choice (Test 4)

Contrary to our initial expectations, on average across the whole sample, workers did not select higher targets in the evening before work than in the morning of work (Table 5, Cols (1) and
Why might this prediction fail? As discussed in Section II, dominated contracts are less attractive when agents face exogenous risks. Ex post analysis and qualitative work suggests that in the evening before the workday, workers faced two types of uncertainty that were partially resolved by the morning of the workday; agents thus sometimes faced greater costs of choosing targets the evening before work than the morning of work.

First, network speed fluctuations affected the rate at which workers could send data entered from an image to the central server and retrieve the next image for entry. This wait time ranged from one second to over five minutes. When workers arrived to the office in the morning, they received new information on network speed and could use this to inform their target choice. This information was especially valuable for workers on “bad” computers, since network shocks greatly affected productivity for these computers.

To test whether network uncertainty deterred workers from choosing targets the evening before work, we asked the office management staff to consult workers to identify which computers were more sensitive to network slowdowns. Management did not know the list would be used for this purpose. The computers identified as more uncertain are indeed more sensitive to overall network fluctuations (See Appendix Table 8 and Appendix Figure 3).

When workers are assigned to a good computer (i.e., a computer that is not as sensitive to network fluctuations), they are 6.6 percentage points more likely to choose a dominated contract when given the choice the evening before production than the morning of production. However, when assigned to a bad computer, they are 1.6 percentage points less likely to choose a positive target in the evening than the morning (Table 5, Col (5)).

Note that positive take-up of dominated contracts in the morning of the workday implies that time periods are shorter than days. Consistent with this, 40% of the workers in the end line survey agreed with the statement, “Some days I get tempted to leave work earlier than I would like” (Table 1).
Second, many workers also faced uncertainty regarding commute time and thus arrival time, which was resolved by the time they arrived to work in the morning. In the end line survey who “agree strongly” with the statement: “The bus/train schedules really impact whether I can get to work on time because if I miss one bus or train, the next one I can take is much later” select targets more often the morning of production than the evening before production. The opposite is true for workers with less uncertain commute times (Table 5, Col (7)).

These results are consistent with the hypothesis that, all else equal, a greater gap between the period of contract choice and period of effort increases target levels but that there are greater expected costs of choosing targets before network speed and time of arrival uncertainty are resolved. In our data, when uncertainty is lower and similar between the evening before and the morning of work, workers are more likely to choose a dominated contract in the evening before production—further from the moment of temptation. However, when uncertainty is high the evening before production but is reduced by the next morning, take-up is higher in the morning.

IV.E. Learning over Time

As workers gain experience, do they learn about the value of the dominated contracts or perhaps find other ways around their self-control problems? Averaging across all workers, we do not find significant trends in take up of dominated contracts (Table 6, Col (1)).

However, this masks substantial heterogeneity. Figure 4 plots experience (number of workdays in the experiment) against the proportion of workers choosing positive targets (i.e. dominated contracts). High payday impact workers are shown in closed circles and low payday impact workers are shown in open circles. Mean take-up rates of dominated contracts among the two groups are initially similar. As they gain experience, there is a divergence: low payday
impact workers decrease take-up of dominated contracts while high payday impact workers increase take up (albeit insignificantly). After 2 months of experience, high payday impact workers are 20.5 percentage points, or 73%, more likely to select positive targets than low payday impact workers (p-value of 0.000; Table 6, Panel A, Col (3)).

The impact of paydays on output does not change with experience, suggesting that underlying self-control problems do not change over time (Table 6, Panel B). However, the treatment effect of giving workers the option to choose a dominated contract grows with experience. This is consistent with the trends in Panel A, which indicate that the group of workers that benefits most from the dominated contracts is more likely to select them over time.

Given the long horizon of the study, our results imply that time inconsistency is a persistent problem in the workplace. They lend credence to our view that many workplace features can plausibly be interpreted as arrangements that seek to solve self-control problems.

IV.F. Correlates of Take up and Treatment Effects
While payday effects strongly predict demand for dominated contracts, we see much less predictive power from a range of self-control correlates commonly used in the literature on psychology and economics. In Columns (1)-(3) of Table 7, we look at measures of self-control problems based on self-reports by workers during the endline survey. The correlate in Column (1) is the demeaned Self-Control Factor, obtained from a factor analysis on the endline data. In Column (2), we construct a demeaned Self-Control Index by averaging each worker’s responses to 9 self-control questions. In Column (3), we use a binary indicator for whether male workers said they had tried to quit drinking, smoking, or chewing tobacco and failed. Each of these three columns shows similar results. Workers with higher values of the correlates are less productive
on average. Each correlate positively predicts demand for the dominated contract and positively predicts treatment effects of the contracts. However, among these, only the coefficients on the Self-Control Factor are generally significant. None of these correlates predicts the payday effect.

Laboratory measures of time preference—computed by asking workers to make binary choices between monetary rewards at different time horizons (see Table 1 notes)—also have limited predictive power. In Column (4), the correlate is impatience—the proportion of times the worker chose a smaller immediate reward rather than a larger delayed reward. The Column (5) correlate is preference reversals—the proportion of times a worker chose the smaller immediate reward in the short horizon, but then displayed patience when choosing between the same amounts in the long horizon. These measures positively (but insignificantly) predict demand for dominated contracts. As before, workers with greater values of these measures are less productive on average but have larger contract treatment effects.

Education (Column (6)) positively predicts take-up of dominated contracts, but does not predict treatment effects. IQ (Column (7))—the sum of the worker’s scores on the Raven’s Matrix and Digit Span tests—does not predict any of the effects.

The strong correlation between the payday and contract effects (documented in Section IV.C) indicates that there are stable interpersonal differences across field behaviors—evidence for which has been limited in the literature. However, the findings in Table 7 are consistent with those of other studies: laboratory and survey measures of self-control predict field behavior, but often to a limited extent (e.g., see Chabris et al. 2008). This may be because of the various measurement issues with laboratory measures (see Table 1 in Chabris, Laibson, and Schuldt 2008; Augenblick, Niederle, and Sprenger 2013). Or this suggests that self-control is context dependent—predicting it in the workplace requires measures specific to that context.
V. Alternative Explanations

The results are largely consistent with a self-control agency model. Could they be explained within the context of a standard exponential discounting model? We argue that while other models could explain any one result, self-control problems are required—at least to some degree—to fit the full pattern of results: the production increases on paydays; sustained demand for dominated contracts and treatment effects of contract choice; and the correlation between the payday effects and demand for dominated contracts.

First, could workers be choosing dominated contracts because they are confused? The experiment was designed to minimize this possibility. Recall that during the training period, we assigned workers to the various contracts and tested their comprehension using a contract quiz—the mean score on which was 93%. If workers mistakenly chose dominated contracts, then we would expect the quiz score to be negatively correlated with take-up and take up to decline over the many months of the experiment. Instead, we find that quiz performance is positively (although insignificantly) correlated with take up, and education strongly predicts take-up. Moreover, demand for dominated contracts persists over time.

Second, could workers be choosing dominated contracts to signal ability to employers? Since the employer observes production directly, there is no reason to believe a worker who can achieve high production under the control contract should not appear more impressive than one who needs a dominated contract to increase output. Moreover, it is unclear why workers with larger payday effects should be more likely to signal ability on average. A signaling story also does not explain why when workers are assigned to good computers, they are more likely to choose dominated contracts the evening before production than the morning of production.
Could weekly income targeting explain the payday effects? Income targeting implies a sharp decrease in marginal utility for income levels above the target (see Camerer et al. 1997). Two pieces of evidence suggest this is not happening in our data. First, as we saw in our test for inter-temporal substitution, exogenous production increases do not decrease production on subsequent days (see Appendix Table 5). Second, a targeting model delivers an even finer testable prediction: an unexpected production increase today will lead to a larger reduction in tomorrow’s effort if the worker is closer to her payday, because there are fewer subsequent days over which the adjustment needs to be made. In Appendix Table 9, we examine the impact of being assigned to a target (and thus increasing production) the previous day. We see no evidence that this reduces production, especially around the payday. Finally, since the impact of day-to-day shocks is adjusted within the pay week to arrive at the weekly target, under income targeting the variance in production among pay weeks should be less than the variance in production among weeks defined according to some other arbitrary cycle, such as calendar weeks. We see no evidence of this (results available on request).

Finally, a different psychological explanation could be that the targets are not merely monetary motivators. Targets may also generate intrinsic motivation: the desire to hit the target may increase effort (Amabile and Kramer 2011). With data such as ours, of course, one cannot separate intrinsic from extrinsic motivation generated by the target. However, without time inconsistency it is unclear how this would explain the payday findings or the correlation between the payday and contract effects. As a result, while our data cannot rule out nonmonetary motivations, it does suggest that time inconsistency is needed in this case as well.

VI. Equilibrium Contracts
Consistent with our empirical results, in our end line survey, many employees expressed an inability to work as hard as they would like under pure piece rates. 78% of workers agreed with “Some days I don’t work as hard as I would like to” and 87% agreed with “I wish I had better attendance at work” (see Table 1). Some—but not all—expressed demand for workplace rules to increase effort. For example, 70% agreed with, “It would be good if there were rules against being absent because it would help me come to work more often”, while 24% disagreed.

The finding that some workers have time inconsistent preferences and choose dominated wage schedules raises the question of how these preferences interact with moral hazard in influencing equilibrium wage schedules and job design. A full analysis is beyond the scope of this paper, but below we derive some results on equilibrium contract choice, job design, and effort in a simple setting. We incorporate both the standard tradeoff between moral hazard and insurance in agency theory as well as the possibility that at least a subset of workers are present-biased (Mahajan and Tarozzi 2011). Time-inconsistent workers can elicit higher future effort either by accepting contracts with high-powered incentives or by accepting apparently inefficient workplace features to allow effort monitoring—such as fixed work times with restrictions on activities during work hours, and rules requiring work to be done in a factory or office, rather than at home, as in the 18th century textile industry’s “putting out” system or 21st century telecommuting. While these contracts and rules can make time-inconsistent workers more productive and better off than they would be under autarky, they make time consistent workers worse off than under the equilibrium contract in the absence of time-inconsistent workers. We show that the existence of time inconsistent workers can create an adverse selection problem for employers, which makes time-consistent workers worse off, for example by forcing them to accept riskier contracts or costly job features designed to allow effort monitoring.
These results contrast with other work on contracting with time-inconsistent preferences, such as DellaVigna and Malmendier (2004) or Eliaz and Spiegler (2006). Those papers examine contexts in which some individuals are naive about their own future preferences and firms exploit this naivety to extract resources. The underlying mechanism at work in those papers is that agents with false beliefs can be exploited by a rational homo economicus. In contrast, we examine a setting with sophisticated agents in which the presence of time-inconsistent agents creates an adverse selection problem for employers, making the time-consistent agents worse off.

We lay out the model assumptions in subsection VI.A, and derive the equilibrium wage schedule, effort level, and output in homogenous populations as a function of time preferences in subsection VI.B. In subsection VI.C, we show that heterogeneity among workers in time preferences creates an adverse selection problem for firms; in equilibrium time-consistent workers may either bear more risk than they would in the absence of present bias among other workers, or be forced to accept inefficient job design and work rules.

**VI.A Assumptions**

To consider the interaction between self-control and moral hazard, we adapt the model in Section II to allow for stochastic output and risk aversion, since the insurance-incentive tradeoff is at the heart of moral hazard models. We consider a simple setting in which effort is dichotomous. If workers exert effort, they create output $Y_H$ with probability $p_H$ and output $Y_L$ with probability $1-p_H$. If they do not exert effort, then the probability of high output $Y_H$ is $p_L < p_H$. The cost of
effort is $c$, and the cost of no effort is normalized to zero. Firms can adopt an otherwise inefficient job design that allows monitoring and enforcement of effort at per worker cost $\phi$.  

Workers sign contracts with firms in period zero, exert effort in period one, and obtain output realizations and receive wages in period two. Time-consistent workers do not discount at all, and present-biased workers discount using a factor $\beta$ between the current period and all future periods, but do not discount between any two future periods. Note that from the standpoint of period zero, workers do not discount wages relative to effort, since both occur in future periods. In period one workers maximize expected utility given by $E[U(\beta w - c(e))]$, where $U' > 0, \ U'' < 0$, and $\beta = \beta_i$ for present-biased workers and $\beta = 1$ for time-consistent workers. (For some of the analysis below it will be useful to take limits as risk aversion becomes arbitrarily weak or strong, so the reader may wish to consider a standard parametric form such as a CARA or CRRA utility function in which it is possible to approach risk neutrality or complete risk aversion.)

We will focus on the set of parameter values for which there is a time consistency problem – i.e., high effort is efficient from the standpoint of a risk-neutral period zero worker:

---

26 We model the firm as initially incurring the costs of monitoring effort and in equilibrium passing these costs along to workers in the form of lower wages, but equivalently these costs could be directly incurred by workers in the form of reduced utility (e.g., commuting costs from prohibitions on teleworking.)

27 We take this timing as imposed exogenously. We assume there is a no-slavery constraint, so firms cannot take advantage of time-inconsistent workers by paying then in period zero and forcing them to work in period one. We also assume that it is not possible to pay workers in period one, for example due to delays in the realization of output and transactions costs of paying workers very frequently. We consider a one-shot game but conjecture that if employers can commit to long-term contracts they might offer contracts with low initial wages or high initial effort as a way to screen out present-biased workers. Like the contracts we examine in our single-shot game context, such contracts would typically be inefficient for time-consistent workers. For example, if workers preferred to smooth effort and consumption, back-loaded contracts would impose costs on any credit-constrained time-consistent workers. Such contracts also inefficiently restrict job mobility. Note also that the use of back-loaded contracts is only feasible when the employer can credibly commit to pay the back-loaded amount.

28 Putting effort costs inside the concave utility function rather than making them separable from consumption is unusual, but makes the model tractable and seems no less plausible than the standard assumption of separability, particularly as some forms of effort (e.g., staying late and getting public transportation home rather than walking) involve monetary costs.
but at the time of effort choice in period one, time-inconsistent workers who own their output would prefer low effort even if they are risk neutral:

$$\beta_i (p_H - p_L)(Y_H - Y_L) < c < (p_H - p_L)(Y_H - Y_L) > c,$$

(A1)

We assume that it is impossible to extract payments from workers in any state of the world; that is, wages in any state of the world are bounded below by zero.

Contracts can either incorporate effort monitoring and specify a level of effort, or specify a wage as a function of observable output. Contracts without effort monitoring thus consist of a pair of wages ($w_L, w_H$) conditional on output ($Y_L, Y_H$). We consider an environment with many workers and free entry of firms, so an equilibrium contract is one that period zero workers will at least weakly prefer to any other contract which will deliver non-negative profits to firms and that delivers zero expected profits to firms when workers’ period one selves choose effort to maximize utility from their perspective.

### VI.B Solving for Equilibrium Contracts

In this subsection we solve for equilibrium contracts first in a population of only time-consistent workers and then in a population of only present-biased workers.

There are three potential contracts: a “low-effort contract,” a “high-effort contract without monitoring,” and a “high-effort contract with monitoring”. In the third contract, jobs are designed in ways that would otherwise be inefficient but allow high effort to be monitored and enforced. In addition to the zero profit condition, the high-effort contract without monitoring must satisfy the incentive compatibility condition that the benefit of effort is greater than or equal to the cost of effort from the standpoint of the period one worker who chooses effort. Period zero workers will choose whichever contract gives them higher utility. Below we solve
for each potential contract, and then compare worker utility under each contract to determine which will be chosen in equilibrium.

Lemma 2: (Low-effort contract) Among the set of contracts inducing low effort, the contract which maximizes worker utility while satisfying the expected zero profit condition is: \( w_H = w_L = p_L Y_H + (1 - p_L) Y_L \).

Proof: Conditional on exerting low effort, workers prefer the highest expected wage compatible with the zero profit condition. Among the set of contracts with the same expected wages, workers prefer contracts with wages equalized across states due to the concavity of utility. ■

Lemma 3: (Monitoring Contract) The high-effort contract with effort monitoring has \( w_H = w_L = p_H Y_H + (1 - p_H) Y_L - \phi \).

Proof: Workers will always exert high effort and wages thus equal expected output minus monitoring costs. ■

Lemma 4: (High-effort contract without monitoring) In the limiting case as workers become risk-neutral, if the equilibrium contract induces high effort without monitoring, it will have earnings in the high state and low state respectively that converge to

\[
\begin{align*}
w_H &= p_H Y_H + (1 - p_H) Y_L + \frac{(1 - p_H)e}{\beta(p_H - p_L)} \quad \text{and} \quad w_L = p_H Y_H + (1 - p_H) Y_L - \frac{p_HC}{\beta(p_H - p_L)}. 
\end{align*}
\]

For small enough \( \delta \), the gap between wages in the high and low state can be greater than \( Y_H - Y_L \), the gap in output between states, and thus incentives with firms can be higher-powered than if workers are residual claimants.

Proof: This contract uniquely satisfies the zero profit and incentive compatibility equations. To see this, note that if workers exert high effort, the zero profit condition is:

\[
p_H w_H + (1 - p_H) w_L = E[Y|e_H] = p_H Y_H + (1 - p_H) Y_L.
\]

The incentive compatibility condition for high effort is

\[
\begin{align*}
p_H u(\beta w_H - c) + (1 - p_H) u(\beta w_L - c) &\geq p_L u(\beta w_H) + (1 - p_L) u(\beta w_L).
\end{align*}
\]

For the limiting case when utility is linear, \( (p_H - p_L) \beta (w_H - w_L) \geq c \).

The incentive compatibility condition will bind, since among the set of contracts satisfying the zero profit condition workers will prefer those with more equal consumption until the condition binds. The wage schedule in the proposition thus uniquely satisfies the zero profit and incentive compatibility conditions. ■

Note that expected wages under the high-effort contract are equal to expected production conditional on high effort. However, the greater the time inconsistency, (i.e., the smaller \( \beta \)), the
greater the gap between $w_H$ and $w_L$, hence the greater the risk borne by workers in the high-effort contract.

We can now derive results on wages, output, and the role of firms when workers are subject to self-control problems and see how they differ from those when workers are time consistent but subject to moral hazard.

Proposition 5: Time inconsistent workers’ output under employment in firms may be higher than if they are full residual claimants. In particular, if workers are sufficiently close to risk neutral, and (A1) is satisfied, time-inconsistent workers will choose the high-effort contract without monitoring and exert high effort. If there were no firms, and workers were residual claimants, they would choose low effort and obtain lower expected output. Moreover, if workers are sufficiently present-biased and close to risk neutral, then the equilibrium wage gap across states with firms may be greater than without firms.

Proof: Risk neutral workers prefer the high-effort contract without monitoring to the low-effort contract if and only if $p_HY_H + (1 - p_H)Y_L - c > p_LY_H + (1 - p_L)Y_L$. This simplifies to $(p_H - p_L)(Y_H - Y_L) > c$, which is satisfied by assumption (A1). (A1) Assumption also implies that in the absence of firms, workers choose low effort. If workers are sufficiently close to risk neutral they will prefer the high-effort contract without monitoring to a monitoring contract, since monitoring reduces expected wages. □

Note that under the model, time-consistent workers’ earnings would never be second-order stochastically dominated by their output because time consistent workers would always be better off working for a firm that simply paid wages equal to output. In contrast, output can second order stochastically dominate earnings for time-inconsistent workers.

The next proposition identifies conditions under which time inconsistent workers choose effort monitoring. For this it will be useful to use the CRRA utility function $U(x) = x^{1-\sigma} / (1 - \sigma)$.

Proposition 6: If workers are sufficiently risk averse and sufficiently present-biased, they will not choose the high-effort contract without effort monitoring. Holding all other parameters constant, for sufficiently low monitoring cost, they will prefer jobs designed to allow effort monitoring and for sufficiently high monitoring cost they will prefer the low-effort contract.

Proof: Consider the CRRA case in which $\sigma > 1$. Since expected production if the worker exerts high effort is $p_HY_H + (1 - p_H)Y_L$, the maximum wage that a worker could receive in the high state of the world with a contract satisfying the zero profit condition and the restriction that
wages are non-negative in all states of the world is \([p_H Y_H + (1 - p_H)Y_L]/p_H\) and hence utility in the good state of the world under the high-effort contract is bounded above by \(u(\beta[p_H Y_H + (1 - p_H)Y_L]/p_H - c)\). As \(\beta\) approaches zero, arbitrarily large differences between period two utility in the low and high states of the world will be needed to induce effort in period one. Since utility in the high state of the world is bounded, as discussed above, utility in the low state of the world will have to become arbitrarily negative in order to induce effort under the high-effort contract. Expected utility under the high-effort contract without monitoring therefore also becomes arbitrarily negative. Expected utility under the low-effort contract and the monitoring contract respectively on the other hand are constant at \(u(p_L Y_H + (1 - p_L)Y_L)\) and \(u(p_H Y_H + (1 - p_H)Y_L - \varphi - c)\) respectively. Hence, for low enough \(\beta\), workers will prefer either the low-effort contract or the contract with jobs designed to allow effort monitoring to the high-effort contract without effort monitoring. For a low enough cost of effort monitoring \(\varphi\), monitoring is preferred and for high enough \(\varphi\), low effort is preferred. ■

To sum up, with a homogeneous population of workers that are not too risk averse and are time-consistent, the equilibrium contract is a standard moral hazard contract—in which workers receive expected output and the gap in wages between states is just enough to induce effort. As \(\beta\) falls, greater gaps between wages in the high and low states are needed to sustain incentive compatibility. For small enough \(\beta\), workers will have to bear so much risk under the high-effort contract that they will switch to either the low-effort contract, or the contract with effort monitoring. Either way, they will have lower expected wages, but equal wages across states.

VI.C. Equilibria when a subset of workers is present-biased

Below we show that the introduction of some present-biased workers into a population of time-consistent workers will change the equilibrium contracts, making time-consistent workers worse off. Depending on parameter values, a variety of different types of equilibria are possible: the two types of workers may sort into different contracts or pool on a single contract.

*Proposition 7:* If time-inconsistent workers are introduced into a population of time-consistent workers, the high-effort equilibrium wage contract without monitoring for time-consistent workers will no longer be an equilibrium, and time-consistent workers will be made strictly worse off.
Proof: Consider a population with only time-consistent workers, in which the high-effort contract without monitoring is the equilibrium and strictly dominates an effort-monitoring contract. Once time inconsistent workers join the population firms will no longer be able to satisfy the zero profit condition with the high-effort, no monitoring equilibrium contract for a homogenous population of time-consistent workers. To see this, note that since the gap in wages across states is just enough to induce time-consistent workers to exert effort, it will not induce time-inconsistent workers in period one to exert effort. However, since this contract achieves the constrained optimum for time-consistent workers and since time-consistent workers are indifferent between exerting effort and not exerting effort under the contract, period zero time-inconsistent workers will also obtain as much utility from accepting this contract knowing that their period-one self will exert low effort as if they could induce their period-one self to exert high effort under the contract. They will therefore prefer the high-effort equilibrium wage contract for time-consistent workers to any contract that satisfies the zero profit condition and hence will choose the contract if it is available. Firms will therefore make negative profits if they offer the high-effort contract that they would offer in a population consisting only of time-consistent workers. Since this contract strictly maximizes utility for the time-consistent workers subject to their incentive compatibility constraint, time-consistent workers’ utility will be lower under any equilibrium contract in a population with present-biased workers. $lacksquare$

Both pooling and separating equilibria are possible, depending on parameter values.

**Proposition 8: (Pooling Equilibria)** The presence of time-inconsistent workers can lead time-consistent workers to accept pooling contracts in which they either a) bear more risk, with bigger gaps between wages in low and high states than they would otherwise face; or b) have lower expected wages, because time inconsistent workers do not exert effort; or c) have lower wages because the equilibrium contract for time-consistent workers will involve designing jobs to allow costly effort monitoring.

Proof: a) Suppose some workers are time-consistent while others are present-biased. For low enough risk aversion and effort cost, there will be a pooling equilibrium in which all workers accept the high-effort contract needed to motivate present-biased workers. Recall that by Lemma 4, this will have greater wage dispersion across states than the high-effort contract for time-consistent workers. To see this, note that if risk aversion is low enough, time-consistent workers will prefer this contract to any contract in which they are pooled with workers who exert low effort, because if they are pooled with workers who exert low effort they will earn lower expected wages.

b) Time-consistent and present-biased workers may pool together on a contract which induces only time-consistent workers, but not present-biased workers, to exert effort and in which expected wages for time-consistent workers are less than their expected production, while expected wages for present-biased workers are greater than their expected production. To see this, suppose almost all workers are time-consistent, but a small number are extremely present-biased so that the contract that would induce them to exert high effort would involve very large penalties in low production states. If workers are sufficiently risk averse, time-consistent workers would prefer a contract in which they receive slightly lower expected wages and pool with present-biased workers who exert low effort to one in which wage gaps across states are sufficient to induce present-biased workers to exert high effort.
c) Fixing all other parameters, as \( \varphi \) becomes small enough, all workers will prefer paying for job design to allow effort monitoring than either bearing more risk associated with the high-effort contract without effort monitoring or pooling on a contract in which wages reflect low effort choices by present-biased workers. ■

Note that result (a) above implies that the presence of a small number of time-inconsistent workers may increase inequality, not only between time-consistent and time-inconsistent workers, but among time-consistent workers.

There may also be separating equilibria in which time-consistent workers accept contracts that induce them to exert high effort but do not induce present-biased workers to exert high effort, and in which payments in the bad state are low enough that present-biased workers decide that rather than accept these contracts and exert low effort, they will enter into a different contract. (Note that by Lemma 3, these separating equilibrium contracts must involve more risk for time consistent workers than the high effort contract without monitoring in a homogenous population of time consistent workers.)

For some parameter values, present-biased workers may accept even riskier contracts so as to induce their future selves to exert high effort. Present-biased workers will prefer their own even-riskier high-effort contract if expected utility conditional on high effort under their own high-effort contract exceeds expected utility with low effort under the high-effort separating contract for time-consistent workers.

For other parameter values, there may also be a separating equilibrium in which time consistent workers take on just enough additional risk in a high-effort contract to make time inconsistent workers prefer the low effort contract or an effort-monitoring contract.

The utility of time-consistent workers in a separating equilibrium can be only epsilon higher than if they chose a contract with less high-powered incentives and pooled with time-inconsistent workers on a contract that just induced time-consistent workers to exert high effort.
but led time-inconsistent workers to shirk. (Under CARA utility this would be the equilibrium wage contract for a homogeneous population of time-consistent workers, minus a constant reflecting the lost output due to shirking by time inconsistent workers.)

Note that under adverse selection, the decentralized equilibrium need not maximize welfare. Indeed, in the separating equilibrium example above, regulations prohibiting workers from taking on more risk than they would in a homogeneous population could potentially make time-inconsistent workers substantially better off with arbitrarily small losses for time-consistent workers. The introduction of new technologies that reduce the cost of effort monitoring, such as factory clocks in the industrial revolution or keystroke monitoring technology today, may have similarly heterogeneous effects across workers.

Some argue that the key feature of the industrial revolution was not technological, but rather the movement from the putting out system (piece rate payment with workers choosing production levels and work hours themselves) to the more rigid factory system; they see this as something capitalists imposed on workers, perhaps with the aid of new technologies (see Thompson, 1967; Marglin, 2008). In contrast, Clark’s (1994) interpretation is more benign: workers sought this shift to deal with self-control problems. Our results can help reconcile these views, suggesting that the introduction of new effort monitoring technologies may help some workers and hurt others.

In sum, our empirical results suggest that at least some workers are present biased and that this substantially affects their labor market behavior. This section suggests this may have important labor market implications for all workers, not just time-inconsistent workers, and in particular, that in equilibrium in a heterogeneous population, all workers may be subject to high-
powered incentives or costly job design to allow effort monitoring, even if only a subset of workers need these features to address self-control problems.

VII. Conclusion

We find considerable evidence that at least a subset of workers is present biased, that this substantially affects effort, and that workers are sophisticated enough about this present bias to choose dominated contracts. Output increases over the pay cycle imply a daily discount rate of 4%. Workers with above average payday effects choose dominated contracts 43% of the time they are offered, and being offered the option to choose dominated contracts increases their earnings by 9%. For other workers, payday effects and demand for dominated contracts are smaller, pointing to the importance of heterogeneity in self-control problems.

These empirical findings have potentially important implications for agency theory. Agency theory traditionally understands workplace arrangements—the existence of bosses and worker discipline—in one of two ways. The first view is that the firm exists to provide insurance. This insurance creates moral hazard. Workplace arrangements exist to mitigate that moral hazard. The second view—that joint production necessitates the need for monitoring (Alchian and Demsetz 1972)—is summarized in a story of Steven Cheung (1983): “On a boat trip up China's Yangtze River in the 19th Century, a titled English woman complained to her host of the cruelty to the oarsmen. One burly coolie stood over the rowers with a whip, making sure there were no laggards. Her host explained that the boat was jointly owned by the oarsmen, and that they hired the man responsible for flogging.”

Our results suggest a different way to understand a diverse host of workplace arrangements. Might discipline at the workplace—such as the coolie in Cheung’s story—reflect demand for
arrangements to help avoid the temptation to shirk? Do features like assembly lines, production minimums, rigid work hours, and hefty punishments for even small lapses in behavior such as tardiness—which are common in workplaces today—have self-control benefits? Might this help explain why the movement from farm to factory work has typically been accompanied by increases in labor productivity (see Kaur, Kremer, and Mullainathan 2010)? Could the organization of production itself serve to mitigate self-control problems? For example, might one of the functions of firms be to break production into smaller tasks—thereby more closely aligning the timing of effort with compensation—in order to improve motivation?

These possibilities are, of course, speculative. However, given that we find strong evidence that self-control problems distort worker effort at economically meaningful magnitudes, a closer exploration of these possibilities is warranted in future research.
References


Figure 1: Incentive Contracts

Notes: This figure displays the two types of incentive contracts offered to workers. The linear control contract paid a piece rate wage of $b$ for each accurate field entered. The nonlinear dominated contract imposed a production target, $\hat{e}$; workers were paid $b$ for each accurate field if they met the target, but only received $b/2$ for each field if they fell short of the target.

Figure 2: Production over the Pay Cycle

Notes: This figure graphs the coefficients and 95% confidence intervals from a regression of production on 6 binary indicators that capture distance from a worker’s next payday (payday, 1 day before payday, 2 days before payday, etc). The omitted category is 6 or more days before the payday. Note these coefficients correspond to those shown in Column (3) of Table 3.
Figure 3: Pay Cycle Effects - Correlation with Contract Choice and Production Impact

Notes: These figures show differences in take up rates and treatment effects on production of dominated contracts. High payday impact workers are those whose mean payday impact (the difference in production on paydays and non-paydays under assignment to the control contract, divided by mean production under the control contract) is above the sample average; low payday impacts workers are those for whom this statistic is below the sample average. The top of each chart displays the point estimates and standard errors corresponding to Table 4, Col (1). Each bar corresponds to the estimated mean for each group, along with 95% confidence intervals.

Figure 4: How the Demand for Dominated Contracts Changes with Experience

Notes: Worker experience is the number of workdays the worker has been in the sample. The proportion of times positive targets were chosen is computed for each value of the experience variable using observations in which the worker was given the option to choose a dominated contract (conditional on being present both the day before and day of treatment assignment). High payday impact workers are those whose mean payday impact (the difference in production on paydays and non-paydays under assignment to the control contract, divided by mean production under the control contract) is above the sample average; low payday impacts workers are those for whom this statistic is below the sample average.
<table>
<thead>
<tr>
<th>A. Worker Characteristics</th>
<th>Mean (1)</th>
<th>Std Dev (2)</th>
<th>Obs (5)</th>
</tr>
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<tr>
<td>Proportion female</td>
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<td>Age</td>
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<td>4</td>
<td>63</td>
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<tr>
<td>Years of education</td>
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<tr>
<td>Completed high school</td>
<td>0.84</td>
<td>0.37</td>
<td>101</td>
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<tr>
<td>Used computer prior to joining firm</td>
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<td>0.47</td>
<td>101</td>
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<td>Had email address prior to joining firm</td>
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<td>0.49</td>
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<th>B. Performance on Tests Administered During Training</th>
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<tr>
<td>Contracts comprehension quiz: percentage score</td>
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<td>IQ composite score (Raven’s Matrix plus Digit Span)</td>
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<th>C. Endline Survey: Discount Rate Measurement</th>
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<tr>
<td>Proportion of times worker chose smaller immediate reward</td>
<td>0.31</td>
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<tr>
<td>Proportion of times worker displayed preference reversal</td>
<td>0.17</td>
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<table>
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<tr>
<th>D. Endline Survey: Self-Reported Measures of Self-Control Problems</th>
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<tbody>
<tr>
<td>&quot;Some days I don’t work as hard as I would like.&quot;</td>
<td>0.76</td>
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<tr>
<td>&quot;I get tempted to leave work earlier than I would like.&quot;</td>
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<td>&quot;I wish I had better attendance at work.&quot;</td>
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<td>&quot;It would be good if there were rules against being absent because it would help me come to work more often.&quot;</td>
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<td>Self-control index: mean of responses to all 9 self-control questions</td>
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</tr>
<tr>
<td>(1=disagree strongly; 5=agree strongly)</td>
<td></td>
</tr>
<tr>
<td>Worker has tried to quit an addictive behavior and failed (males only)</td>
<td>0.12</td>
</tr>
<tr>
<td>Factor analysis: self-control factor</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Notes: This table presents summary statistics for the 111 workers that participated in the full study (contract and payday treatments). In the discount rate exercise (Panel C), workers traded off 3 sets of cash awards (Rs. 20 vs. Rs. 24; Rs. 50 vs. Rs. 57; and Rs. 100 vs. Rs. 110) under 2 different horizons: short horizon (the smaller amount today vs. the larger amount in 3 days) and long horizon (the smaller amount in 14 days vs. the larger amount in 17 days). Panel C reports statistics on the proportion of times the worker choose the smaller immediate reward out of the 6 questions, and the number of times the worker showed preference reversal (chose the smaller immediate reward in the short horizon, and choosing the larger reward in the long horizon). Panel D summarizes responses to questions that asked workers to agree or disagree with statements about self-control behavior. The Self-Control Factor (Panel D), was determined using a Factor Analysis on the full set of endline survey questions.
<table>
<thead>
<tr>
<th>Pay Cycle Treatment Effects</th>
<th>Dependent variable:</th>
<th></th>
<th>Dependent variable:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Payday</td>
<td>Production</td>
<td>Attendance</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Payday</td>
<td>215</td>
<td>140</td>
<td>428</td>
</tr>
<tr>
<td></td>
<td>(70)***</td>
<td>(63)**</td>
<td>(94)***</td>
</tr>
<tr>
<td>1 day before payday</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>539</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(95)***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 days before payday</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>417</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(113)***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 days before payday</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>374</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(112)***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 days before payday</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>332</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(123)***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 days before payday</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>176</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(119)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production on previous workday</td>
<td>0.355</td>
<td>0.355</td>
<td>(0.016)***</td>
</tr>
<tr>
<td>Production two workdays ago</td>
<td>0.135</td>
<td>0.137</td>
<td>(0.015)***</td>
</tr>
<tr>
<td>Observations</td>
<td>8423</td>
<td>8423</td>
<td>8423</td>
</tr>
<tr>
<td>R2</td>
<td>0.50</td>
<td>0.59</td>
<td>0.59</td>
</tr>
<tr>
<td>Dependent variable mean</td>
<td>5337</td>
<td>5337</td>
<td>5337</td>
</tr>
</tbody>
</table>

Notes: Production is defined as the number of accurate fields completed by the worker in a day, and as zero on days workers are absent. In columns (3) and (5), the omitted category is 6 or more days away from the payday. All regressions include fixed effects for each date, worker, and each computer seating assignment. OLS regressions are shown; robust standard errors are reported in parentheses.
### Table 3
Contract Treatments

**Panel A: Take-up of Dominated Contracts (Summary Statistics)**

<table>
<thead>
<tr>
<th>Dominated contract chosen: conditional on attendance</th>
<th>0.36</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(0.31)</td>
</tr>
<tr>
<td>Dominated contract chosen: target=0 if absent</td>
<td>0.28</td>
</tr>
<tr>
<td></td>
<td>(0.26)</td>
</tr>
</tbody>
</table>

**Panel B: Treatment Effects of Contracts**

<table>
<thead>
<tr>
<th></th>
<th>Dependent variable:</th>
<th>Dependent var:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Production</td>
<td>Attendance</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample</th>
<th>Control &amp; Option Obs</th>
<th>Control &amp; Option Obs</th>
<th>Full Sample</th>
<th>Full Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option to choose dominated contract</td>
<td>120 (59)**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evening option to choose dominated contract</td>
<td>156 (69)**</td>
<td>150 (69)**</td>
<td>0.01 (0.01)</td>
<td></td>
</tr>
<tr>
<td>Morning option to choose dominated contract</td>
<td>84 (69)</td>
<td>73 (69)</td>
<td>-0.00 (0.01)</td>
<td></td>
</tr>
<tr>
<td>Target imposed: Low target</td>
<td>3 (90)</td>
<td>0.00 (0.01)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Target imposed: Medium target</td>
<td>213 (91)**</td>
<td>0.01 (0.01)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Target imposed: High target</td>
<td>334 (150)**</td>
<td>-0.01 (0.02)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations: worker-days</td>
<td>6310</td>
<td>6310</td>
<td>8423</td>
<td>8423</td>
</tr>
<tr>
<td>R2</td>
<td>0.60</td>
<td>0.60</td>
<td>0.59</td>
<td>0.15</td>
</tr>
<tr>
<td>Dependent variable mean</td>
<td>5311</td>
<td>5311</td>
<td>5337</td>
<td>0.88</td>
</tr>
</tbody>
</table>

Notes: The Panel A sample is observations in which workers were assigned the option to choose a dominated contract. The first row limits analysis to observations in which a worker was present the day before or day of treatment assignment. The second row codes target choice as 0 if absent the day before or day of assignment. Means and standard deviations are presented for each row.

In Panel B, production is defined as the number of accurate fields completed by the worker in a day, and as zero on days workers are absent. Cols (1)-(2) limit analysis to observations where workers were assigned to the control contract or given the option to choose a dominated contract. Cols (3)-(4) include the full sample. All regressions include worker, date, and computer seating assignment fixed effects. Regressions (1)-(3) also include lagged production controls. Results from OLS regressions are shown; robust standard errors are reported in parentheses.
Table 4
Paycycle Effects: Correlation with Dominated Contract Effects

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A: Take-up of Dominated Contracts</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependent variable:</td>
<td>Domination contract chosen</td>
<td>Target level chosen</td>
</tr>
<tr>
<td>High payday impact</td>
<td>0.138 (0.044)***</td>
<td>353 (129)***</td>
</tr>
<tr>
<td>Observations: worker-days</td>
<td>4098</td>
<td>4098</td>
</tr>
<tr>
<td>R2</td>
<td>0.20</td>
<td>0.22</td>
</tr>
<tr>
<td>Dependent variable mean</td>
<td>0.28</td>
<td>759</td>
</tr>
</tbody>
</table>

| **Panel B: Treatment Effects of Contracts** |                          |                          |
| Dependent variable:  | Production                | Attendance               |
| Option to choose dominated contract | -69 (74)                 | -0.016 (0.010)           |
| Option to choose dominated contract * | 482 (126)***             | 0.058 (0.019)***         |
| High payday impact    | (148)***                 | (0.022)***              |
| Target imposed        | -35 (86)                 | -0.019 (0.012)*         |
| Target imposed *      | 483 (148)***             | 0.042 (0.022)***         |
| Observations: worker-days | 8240                     | 8240                     |
| R2                   | 0.59                     | 0.11                     |
| Dependent variable mean | 5355                     | 0.875                    |

Notes: The table presents OLS regressions.

The Panel A sample is observations in which workers were given the option to choose a dominated contract. If a worker was absent the day before or day of treatment assignment, both dependent variables are coded as zero. High payday impact is a binary indicator for whether the worker’s mean payday impact (the difference in production on paydays and non-paydays under assignment to the control contract, divided by mean production under the control contract) is above the sample average. Regressions include computer and date fixed effects and lagged production controls. Standard errors are clustered by worker.

The Panel B sample is comprised of all observations. Production is defined as the number of accurate fields entered, and as zero when absent. Each regression includes worker, date, and computer seat assignment fixed effects. The Col (1) regression also includes lagged production controls. Robust standard errors are reported.
Table 5
Demand for the Dominated Contract: Impact of Stochasticity and Timing of Choice

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Dominated contract chosen</th>
<th>Target level chosen</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Evening option to choose dominated contract</td>
<td>-0.002</td>
<td>-18</td>
</tr>
<tr>
<td>High uncertainty indicator</td>
<td>(0.012)</td>
<td>(37)</td>
</tr>
<tr>
<td>Evening option to choose dominated contract *</td>
<td>-0.013</td>
<td>-134</td>
</tr>
<tr>
<td>High uncertainty indicator</td>
<td>(0.016)</td>
<td>(63)**</td>
</tr>
<tr>
<td>Worker fixed effects</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Seat fixed effects</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>4193</td>
<td>4193</td>
</tr>
<tr>
<td>R2</td>
<td>0.33</td>
<td>0.34</td>
</tr>
<tr>
<td>Dependent variable mean</td>
<td>0.28</td>
<td>767</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Worker's assigned computer is sensitive to network fluctuations</th>
<th>Worker's morning arrival time is sensitive to bus/train schedules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominated contract chosen</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>Target level chosen</td>
<td>(3)</td>
<td>(4)</td>
</tr>
</tbody>
</table>

Notes: The sample is comprised of worker-day observations in which workers were given the option to choose a dominated contract (in the evening or morning). Both dependent variables are defined as 0 if a worker was absent the day before or day of treatment assignment.

Evening option to choose dominated contract is a dummy that equals 1 if the worker was assigned to choose the evening before the workday, and equals 0 if the worker was assigned to choose the morning of the workday. In columns (3)-(6), the high uncertainty indicator equals 1 if the worker was assigned to a computer that was highly sensitive to office network speed, and equals 0 otherwise. In columns (7)-(8), the high uncertainty indicator equals 1 if the worker “agreed strongly” with the statement: “The bus/train schedules really impact whether I can get to work on time because if I miss one bus or train, the next one I can take is much later,” during the endline survey. All regressions include date fixed effects. Robust standard errors are reported in columns (1)-(2). Standard errors are corrected to allow for clustering by computer in columns (3)-(6) and by worker in columns (7)-(8).
<table>
<thead>
<tr>
<th>Experience Measure</th>
<th>Panel A: Take-up of Dominated Contract</th>
<th>Panel B: Treatment Effects on Production</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Log Number of Days Worked</td>
<td>Log Number of Days Worked</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Experience measure</td>
<td>-0.040</td>
<td>-0.066</td>
</tr>
<tr>
<td></td>
<td>(0.027)**</td>
<td>(0.030)**</td>
</tr>
<tr>
<td>High payday impact</td>
<td>0.139*</td>
<td>-0.087</td>
</tr>
<tr>
<td></td>
<td>(0.043)**</td>
<td>(0.100)</td>
</tr>
<tr>
<td>Experience measure*</td>
<td>0.062</td>
<td>0.131</td>
</tr>
<tr>
<td>High payday impact</td>
<td>(0.026)**</td>
<td>(0.054)**</td>
</tr>
<tr>
<td>Observations</td>
<td>4098</td>
<td>4098</td>
</tr>
<tr>
<td>Dependent variable mean</td>
<td>0.28</td>
<td>0.28</td>
</tr>
</tbody>
</table>

**Notes:** OLS regressions are shown. In Cols (1)-(2), the measure of experience is the log of the number of workdays a worker has been in the sample. In Col (3), the measure is a binary indicator for more than 50 workdays (~2 months) of experience.

The Panel A sample is comprised of observations in which workers were given the option to choose a dominated contract. Dependent variables are defined as 0 if a worker was absent the day before or day of treatment assignment. High payday impact is a binary indicator for whether the worker’s mean payday impact (the difference in production on paydays and non-paydays under assignment to the control contract, divided by mean production under the control contract) is above the sample average. All regressions control for date and computer seat assignment fixed effects and lagged production. Standard errors are corrected to allow for clustering by worker.

In Panel B, the sample is comprised of all observations. Production is defined as 0 when a worker is absent. The covariates in each regression are dummies for: option to choose a dominated contract; target imposed (not shown); payday; and interactions of the experience measure with each indicator. All regressions also include worker, date, and computer seat fixed effects and lagged production controls. Robust standard errors are reported in parentheses.
Table 7: Heterogeneity in Treatment Effects - Correlates of Self-Control

<table>
<thead>
<tr>
<th>Correlate of self-control</th>
<th>Factor analysis: Self-control factor (1)</th>
<th>Self-control index (2)</th>
<th>Addictive behaviors dummy (males only) (3)</th>
<th>Discount rate: Proportion impatient responses (4)</th>
<th>Discount rate: Proportion preference reversals (5)</th>
<th>Years of education (6)</th>
<th>IQ test index score (7)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correlate</td>
<td>0.056</td>
<td>0.057</td>
<td>0.139</td>
<td>0.070</td>
<td>0.143</td>
<td>0.029</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(0.025)**</td>
<td>(0.046)</td>
<td>(0.082)</td>
<td>(0.115)</td>
<td>(0.189)</td>
<td>(0.015)*</td>
<td>0</td>
</tr>
<tr>
<td>Observations</td>
<td>3106</td>
<td>3106</td>
<td>2245</td>
<td>2454</td>
<td>2470</td>
<td>4056</td>
<td>4089</td>
</tr>
<tr>
<td>R2</td>
<td>0.22</td>
<td>0.21</td>
<td>0.26</td>
<td>0.23</td>
<td>0.23</td>
<td>0.19</td>
<td>0.19</td>
</tr>
</tbody>
</table>

Panel A: Dependent variable: Dominated contract chosen (Option to choose dominated contract observations)

| Correlate                 | -255                                   | -209                   | -247                                     | -1254                                    | -826                                            | 127                  | 13                     |
|                           | (103)**                                | (148)                  | (395)                                    | (318)**                                  | (461)*                                          | (65)*                | (6)**                  |
| Option to choose dominated contract | 91                                      | 38                     | 113                                      | 116                                      | 147                                            | 147                  | 150                    |
|                           | (82)                                   | (83)                   | (114)                                    | (83)*                                    | (83)*                                           | (73)**               | (73)**                 |
| Correlate                 | (92)**                                 | (146)                  | (263)                                    | (305)**                                  | (447)*                                          | (45)                 | (5)                    |
| Payday                    | 156                                    | 156                   | 115                                      | 135                                      | 131                                            | 153                  | 181                    |
|                           | (87)*                                  | (87)*                  | (119)                                    | (106)                                    | (107)                                           | (74)*                | (71)**                 |
| Correlate                 | 31                                     | 77                     | 58                                       | -53                                      | -234                                           | 27                   | 0                      |
| Payday                    | (87)                                   | (138)                  | (246)                                    | (308)                                    | (544)                                           | (40)                 | (4)                    |
| Observations              | 4674                                   | 4674                   | 3376                                     | 3701                                     | 3701                                            | 6101                 | 6149                   |
| R2                        | 0.57                                   | 0.57                   | 0.55                                     | 0.59                                     | 0.58                                            | 0.56                 | 0.55                   |

Notes: The self-control correlate in column (1) is the demeaned Self-control Factor, obtained from a principal factors analysis on the endline survey data. The column (2) correlate is a demeaned Self-Control Index, obtained by averaging each worker’s responses to the 9 self-control questions in the endline survey. The correlate in column (3) is computed for male workers; it equals 1 if the worker said he has tried to quit drinking, smoking, or chewing tobacco and failed, and equals 0 otherwise. The correlates in columns (4)-(5) are computed from the discount rate exercise, in which workers traded off cash rewards between different time horizons. The column (4) correlate measures the proportion of times the worker chose the smaller immediate reward instead of the larger delayed reward. The column (5) correlate measures preference reversals—the proportion of times a worker chose the larger immediate reward in the short horizon, but then chose the smaller delayed reward when choosing among the same amounts in the long horizon. The correlates in columns (6) and (7) are, respectively, demeaned years of education and demeaned composite IQ score (the sum of the worker’s score on the Raven’s Matrix and Digit Span tests).

OLS regressions are shown. All dependent variables in Panels A-C are defined as 0 if a worker was absent the day before or day of treatment assignment. All regressions include date and computer seat assignment fixed effects, and lagged production controls. Standard errors are corrected to allow for clustering by worker.

Note that observations change between columns because not all workers provided education information or took the IQ tests, and because the endline survey and discount rate exercise were administered only at the end of the project.