

Monitoring and Pay:
An Experiment on Contract Design with
Endogenous Supervision

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Are monitoring and pay substitutes or complements?

Common assumptions in previous literature

- ▶ Only two effort levels (working and shirking)
- ▶ Exogenously given effort

lead to monitoring and pay being substitutes.

Allgulin and Ellingsen (2002, J Labor Economics) showed for the more general case that they are complements.

Field evidence shows mixed results.

Does reciprocity (a positive wage–effort relation found e.g. by Fehr, Kirchsteiger, Riedl (1993, QJE)) matter?

How do we measure monitoring?

Monitoring intensity is hard to measure.

- ▶ ratio of non-production to production employees
- ▶ self-reports
- ▶ measure of job autonomy (e.g. timekeeping system)

And how do we measure effort?

Let's go to the lab!

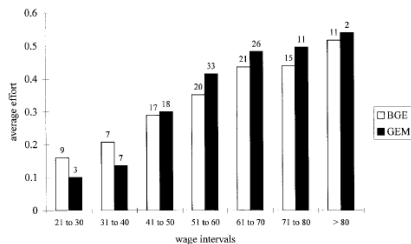
Laboratory experiments are a valuable complement to study field data.

- ▶ the essence of experiments is control (preferences, technology, possible actions, the sequence of actions, information)
- ▶ the experimenter knows what is exogenous and what is endogenous
- ▶ he can observe and identify equilibrium and off-equilibrium behavior
- ▶ measurement and causality problems are mitigated

What do we differ to earlier experiments?

- ▶ Monitoring intensity is endogenous.
- ▶ Effort choices are chosen on a continuous scale.

Some related experimental studies – Gift-Exchange Game



Source: Fehr et. al (JoLE, 1998)

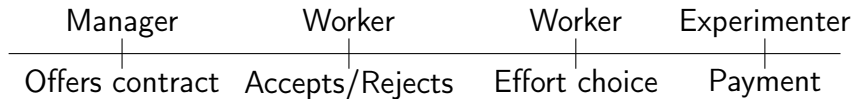
- ▶ Fehr et. al (Econometrica 1996, 2007), Fehr & Gächter (2002): Gift exchange with fixed monitoring probability, variable fine

bonus contracts are preferred over penalty contracts

trust contracts (without monitoring) are chosen rarely

effort is higher under exogenous contract choice with trust contracts, and under endogenous choice with incentive contracts

The Game



Contract $C(\tilde{e}|w, p)$

\tilde{e} desired effort

w compensation

$\mu M(p)$ investment in shirking detection technology

Normative Prediction

- ▶ There must be a positive level of monitoring in order to induce any effort.
- ▶ Under the most general conditions monitoring and pay are complements.
 - ▶ If the cost of monitoring increases monitoring intensity, wage, and desired effort should decrease.
 - ▶ If productivity increases monitoring intensity, wage, and desired effort should increase.
- ▶ Monitoring and pay are substitutes if
 - ▶ workers have only the choice between two effort levels
 - ▶ the desired effort level is exogenously given

and with fair agents...

If a proportion q of agents has Fehr & Schmidt (1999) preferences

$$U_i(x) = x_i - \alpha_i \max\{x_j - x_i, 0\} - \gamma_i \max\{x_i - x_j, 0\}$$

with $\alpha \geq \gamma \geq 0.5$

and the rest $1 - q$ is purely selfish,

even a money maximizing principal will rely on reciprocity (no monitoring, high wages) if $q \geq 0.4$ – the calibration result in Fehr & Schmidt (QJE, 1999) and (ECTA, 2007).

Alternatively, monitoring may be seen as an unkind act (Falk & Kosfeld, 2006) or may crowd out intrinsic motivation (Benabou & Tirole, 2003) leading some individuals to offer contracts without monitoring.

Procedure

- ▶ computerized with zTree
 - ▶ Employers were provided with a calculator for the monitoring cost, the (desired) effort costs, and gross profits in case of both compliance and shirking.
 - ▶ Employees were provided with a calculator for their effort costs as well as their own and their employer's earnings.
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- ▶ 124 students from the University of Innsbruck participated
 - ▶ 8 sessions, each less than 90 minutes
 - ▶ average earnings 8.64 Euro (standard deviation: 10.57)
 - ▶ losses were possible and in a few cases quite substantial

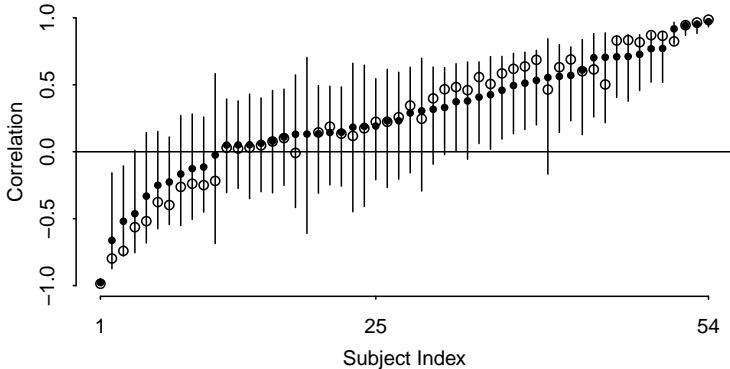
SUR estimation of wage offer and monitoring probability

- ▶ wage & monitoring probability are chosen simultaneously
- ▶ multilevel SUR estimation
(random intercept & time trend at subject level)

- ▶ higher productivity leads to higher wages and more monitoring
- ▶ lower monitoring costs leads to more monitoring
- ▶ averages are close to the normative prediction, however
- ▶ wages are too high, monitoring probabilities are too low

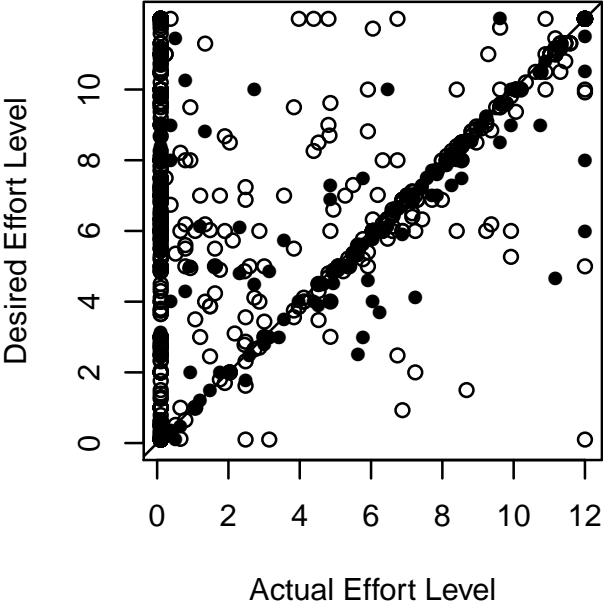
- ▶ between-subjects variation is qualitatively in line with normative predictions

Correlation of monitoring intensity and wage offers at individual level



- ▶ only 11 (3 sig.) subjects show a negative correlation; 43 (20 sig.) subjects show a positive correlation.
- ▶ average correlation is 0.26 (CI95% = (0.18, 0.33))
- ▶ small & insignificant differences between treatments; the more favorable the treatment is for the principal, the weaker the complementarity of monitoring and wages offers.

Desired & Actual Effort

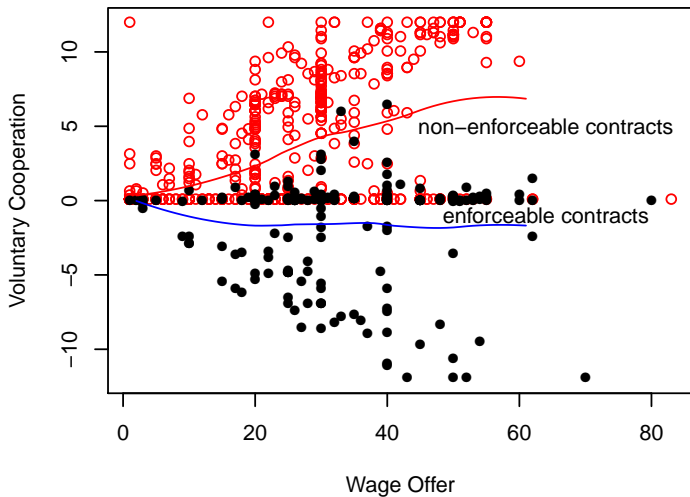


Frequency of shirking decisions

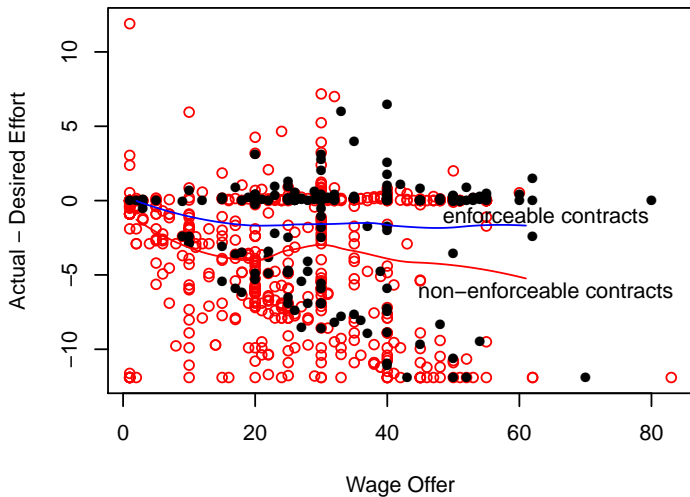
Desired Effort Level	Low Productivity		High Productivity	
	Shirking	No Shirking	Shirking	No Shirking
Enforceable	40	36	32	91
Not Enforceable	206	101	153	136

- ▶ less shirking in high productivity treatment ($p=0.014$)
- ▶ less shirking when effort enforceable ($p<0.001$)
- ▶ prob. of shirking decreases with monitoring prob. ($p<0.001$)
- ▶ prob. of shirking decreases with offered rent ($p<0.001$)

Voluntary Cooperation (Actual - Agent's Payoff Maximizing Effort)



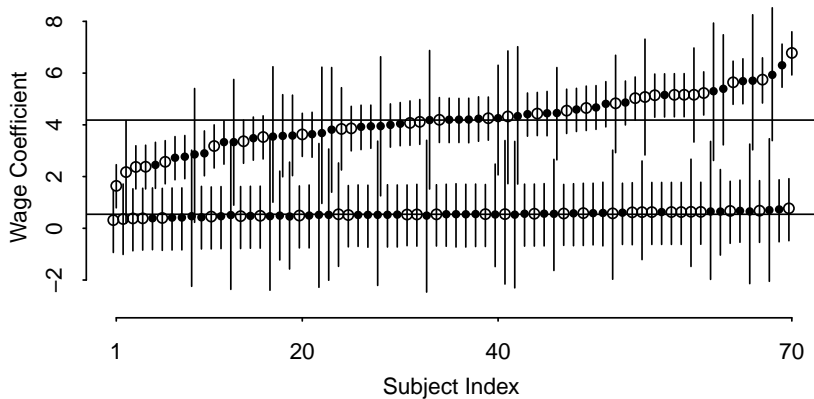
Actual - Desired Effort



OLS and multilevel regression on the amount of voluntary cooperation

Coefficient	OLS		Multilevel	
	Estimate	Std.Error	Estimate	Std.Error
Intercept	3.192**	0.150	3.246**	0.390
High Productivity	0.745**	0.255	0.829	0.427
High Monitoring Cost	0.592	0.335	0.474	0.421
No Monitoring	-1.927**	0.354	-1.718**	0.584
Enforceable Contract	-5.432**	0.421	-5.559**	0.374
Wage	4.911**	0.809	4.200**	0.512
Monitoring Probability	1.804**	0.414	1.999**	0.428
Desired Effort	-1.684**	0.470	-1.649**	0.445
Period	-0.100*	0.046	-0.105**	0.027
Wage: No Monitoring	-4.128**	1.007	-3.656**	0.752
Wage: Enforceable Contract	-4.519**	0.917	-3.698**	0.669
Monitoring Prob: Enforceable Contract	-2.420*	1.075	-2.802**	0.755
Random Effects Std. Dev. Subjects: Intercept				1.437
Random Effects Std. Dev. Subjects: Wage, p>0				1.781
Random Effects Std. Dev. Subjects: Wage, p=0				0.158
Random Effects Std. Dev. Matching Groups: Intercept				0.001
Residual Std. Error		3.419		3.006

Individual wage coefficients in the regression on voluntary cooperation



upper series: wage coefficients under monitoring

lower series: wage coefficients under no monitoring

Closed circles represent subjects who never accepted a contract without monitoring, open circles represent subjects who accepted at least once a contract without monitoring.

Summary

- ▶ between treatment variation is consistent with the normative prediction
- ▶ wages are too high, monitoring intensity too low
- ▶ we find a sig. positive correlation between monitoring and pay at the individual level
- ▶ ...but also a high degree of heterogeneity
- ▶ monitoring and pay are complements

- ▶ agents show some reciprocity – high degree of heterogeneity
- ▶ zero monitoring, no effort!
- ▶ it does not pay to rely on reciprocity alone

The ex-post utility of the principal can be expressed by

$$\Pi = \beta B(e) - w(e) - \mu M(p),$$

and the ex-post utility of the agent is

$$U = w(e) - \zeta C(e).$$

A step function $w(e) = \underline{w}$ for $e < \tilde{e}$ and $w(e) = \bar{w}$ for $e \geq \tilde{e}$ can replicate any incentive compatible contract that implements \tilde{e} .

The agent maximizes expected utility,

$$E[U] = p\underline{w} + (1 - p)\bar{w} - \zeta C(e).$$

The incentive compatibility constraint is binding and the principal will be able to enforce

$$e(p, w) = C^{-1}((\bar{w} - \underline{w})p/\zeta).$$

Her problem is to find a probability p and a wage w to maximize

$$\Pi(p, w) = \beta B(e(p, w)) - w - \mu M(p)$$

Theoretical results

- ▶ There must be a positive level of monitoring in order to induce any effort.
- ▶ Sufficient conditions for monitoring and pay to be complementary instruments are:
 - ▶ the principal's benefit function $B(e)$ and the agent's cost of effort function $C(e)$ are both represented by power functions;
 - ▶ the principal's benefit function $B(e)$ is linear, and the relative growth of costs of effort is decreasing in the effort level;
 - ▶ if the source of variation is β or μ , monitoring and pay are complementary instruments if and only if $-p^*M''(p^*)/M'(p^*) < 1$.

Normative solution under the different treatment conditions

The benefit for the employer of an effort e is

$$\beta B(e) = \beta e^{2/3},$$

the cost function for the employee of an effort e is given by

$$\zeta C(e) = \zeta e^{3/2} \quad \text{with } \zeta = 1,$$

and the cost of implementing a shirking detection probability p is

$$\mu M(p) = \mu p^2.$$

Minimum $e = 0.1$, $\underline{w} = 1$

β	μ	p^*	w^*	e^*	$\Pi(p^*, w^*, e^*)$	$U(p^*, w^*, e^*)$	$\Pi^* + U^*$
12	30	0.41	10.90	2.53	6.42	6.88	13.30
12	20	0.57	13.97	3.79	8.73	6.58	15.31
16	30	0.63	24.46	5.99	16.60	9.79	26.39
16	20	0.88	31.74	8.99	22.06	4.79	26.85

- ▶ 15 periods, Conversion rate: 7, 8, and 15 points per Euro.

and with fair agents...

If a proportion q of agents has Fehr & Schmidt (1999) preferences

$$U_i(x) = x_i - \alpha_i \max\{x_j - x_i, 0\} - \gamma_i \max\{x_i - x_j, 0\}$$

with $\alpha \geq \gamma \geq 0.5$

and the rest $1 - q$ is purely selfish, even a money maximizing principal will rely on reciprocity (no monitoring, high wages) if

$$\beta q \frac{de}{dw} = \frac{2\beta q}{\beta B'(e) + \zeta C'(e)} \geq 1.$$

In our experiment this is true for $q \geq 0.4$ – the calibration result in Fehr & Schmidt (1999).