

Effort-Reward Imbalance as a Workplace Stressor: Implications for Incentives and Contract Design*

Elena Cottini[†], Paolo Ghinetti[‡], Elisabetta Iossa[§] and Pierluigi Sacco[¶]

March 4, 2019

Abstract

An extensive medical literature has shown that the imbalance between effort and reward acts as a powerful pathogenic agent (Siegriest et al., 2014), causing major immune reactions and ultimately illnesses. We extend a simple agency model with moral hazard and limited liability to study the impact of this pathogenic agent on contract design. We find that, depending on individual illness susceptibility, incentives may become ineffective but also lead to more effort, with principals gaining from the pathogenic consequences of effort-reward imbalance on well-being. The model predicts that workers with higher incentive-based rewards on the one hand tend to work with more intensity but are more likely to suffer from higher stress levels and lower well-being. Empirical evidence provides results consistent with the model's prediction.

JEL Classification: D82, I12, I18, L2.

Keywords: Effort-Reward Imbalance, incentives, loss aversion, over-commitment, workplace stressors.

*We thank Andrea Attar, Eloisa Campioni, Salvatore Piccolo, Federico Quartieri, Rosario Crinò and Claudio Lucifora for useful comments.

[†]Università Cattolica del Sacro Cuore: elena.cottini@unicatt.it

[‡]Università del Piemonte Orientale: paolo.ghinetti@uniupo.it.

[§]University of Rome Tor Vergata and IEFE-Bocconi. Elisabetta.iossa@uniroma2.it
This author thanks financial support from "Bando Doppia Cattedra", University of Rome Tor Vergata.

[¶]IULM, metaLAB (at) Harvard, Harvard University and FBK-IRVAPP, Trento. pierluigi.sacco@iulm.it

1 Introduction

A rapidly growing medical literature shows that work relations act as external pathogenic agent and may cause significant health consequences (Padgett and Glaser, 2003). Many pathogenic conditions are strongly associated with stressors even if they are of a purely psychological nature (Cohen et al., 2007).

The costs of illness-related work loss are substantial. Pfeffer and Zenios (2015) estimate that more than 120,000 deaths per year, and approximately 5%–8% of annual healthcare costs are associated with, and may be attributable to, how U.S. companies manage their work-forces. Furthermore, mental diseases cost up to 4% of GDP in terms of direct treatments, disability benefits, and productivity losses (OECD 2014), and these are often work related. Colantone et al. (2015) link the recent worsening of workers' mental health in the UK to the increased workload and worsened expectations of job promotions due to greater import competition, as firms adjust to foreign competitive pressure by switching to longer and more demanding working schedules.

According to a large literature in occupational health, one particularly powerful pathogenic stressor associated with work relations is their perceived 'fairness' and 'reciprocity' (e.g. Siegrist, 1996). Failed reciprocity may create an imbalance between the effort provided and the rewards received (Effort-Rewards Imbalance, ERI). As numerous studies have documented, ERI is associated with several negative well-being effects, as it may lead to higher illness risks, and worse health. For example, individuals who work with high intensity without obtaining an adequate reward are more vulnerable to pro-inflammatory immune reactions, paving the way to a multitude of major illnesses. These health-adverse effects can be quite significant (see Siegrist et al., 2004 for a survey).

In this literature, effort and rewards are exogenous, and a minor role is attributed to economic incentives. Hence, a policy of higher rewards - of any kind (fix salaries, bonuses, promotions) - is always able to increase health and well-being by reducing ERI and stress. However, in a Principle-Agent model with moral hazard, if effort is not observable and if rewards are incentive based, high pay policies are not neutral in terms of effort levels, and this may feedback on stress and illnesses.

From both a theoretical and policy perspective, the impact that alternative payment schemes produce on individual stress and ultimately illness has received little or no attention in the economic literature.¹ We know from this

¹See Laffont and Martimort, 2002 for a comprehensive presentation of the theory of incentives using principal-agent models.

literature that when the effort of the agent is not observable and it stochastically affects performance, it is optimal for the principal to condition the agent's reward to the realized performance. Thus, high effort can be associated with low rewards simply because of the occurrence of exogenous events which negatively affected the individual's performance. In other words, an imbalance between effort and reward can be an equilibrium phenomenon of any standard performance-based incentive contract.

In this paper, first, we bridge medical and occupational health studies with the economics literature on incentives in order to study how the potential pathogenic effects of effort-reward imbalance (ERI) affect the design of incentive contracts. We construct a simple Principal-Agent model with moral hazard and limited liability. A key ingredient is that individuals are heterogeneous with regard to their susceptibility to illness, as any medical literature would confirm.² We assume that the agent's unobservable effort increases the probability of good performance, but an imbalance between effort and reward generates a cost for an individual which increases with the degree of illness susceptibility. Equipped with this framework, we study how individual susceptibility to effort-reward imbalance affects the design of the optimal incentive scheme, the agent's effort and the payoffs of principal and agents. To our knowledge, this is the first model in the literature that tackles the Principal-Agent interaction taking into account the stress impact of incentives.

This approach allows us to raise a number of new questions: If the cost of effort-reward imbalance is taken into account and individuals illness susceptibility is observable by principals, will principals be incentivized to design contracts that prevent more stress-vulnerable types to exert too much effort by under-rewarding success? Or will the reward for success increase so as to compensate for the stress? And how should the incentive scheme vary depending on the stressful nature of the job, or the illness susceptibility of the individual? What are the consequences of failing to acknowledge the effects of effort-reward imbalance at organizational level?

Second, we use the 2015 wave of the European Working Condition Survey (EWCS) to analyse whether our theoretical predictions receive empirical support. Siegriest (1996) documented that higher rewards are associated with lower stress, but neglects the role of effort. Avgoustaki and Frankort (2018) find that greater work effort (work intensity) strongly relates to increased stress, and this effect is even bigger than that e.g. induced by overtime work. They however do not consider the role of rewards. We introduce an addi-

²Empirical evidence even shows that personality differences play a key role in explaining individual sensitivity to stressors (Hintsanen et al., 2011).

tional channel, and analyse to what extent the relationships between rewards (pay for performance) and work stress, is mediated by and passes through effort (work intensity).

On the theoretical side, our main results suggest that, under ERI, effort cannot be induced when illness susceptibility is particularly high (or for very stressful jobs). For lower levels of illness susceptibility, ERI results in greater effort than under the standard model. This occurs because agents anticipate that more effort reduces the probability that an imbalance between effort and reward will occur, and will therefore work harder to reduce the risk. For some agents' types, this greater effort attenuates the underinvestment problem due to moral hazard. For yet other types, effort becomes greater than the first best level. The occurrence of over-effort is particularly striking, as it rationalizes findings from the medical literature according to which effort-reward imbalance is often associated with overcommitment, i.e. a fundamentally passive coping strategy that reacts to the stressor by further increasing the level of effort (see e.g. Bellingrath et al. 2008, 2010). Unsurprisingly, agents are always hurt by their illness susceptibility. Somewhat surprisingly instead, principals may either gain or lose; the impact depends on the illness susceptibility of the agents (and on the stressfulness of the job). Overall, principals may gain from the illness susceptibility of agents to ERI, as this induces them to work harder, which explains why in practice principals under-react to the presence of stress at work.

Results show that a one unit increase in work effort is associated with a 2 percent increase in the odds of reporting fatigue and with a 5 percent increase in work stress. These effects are almost halved once we control also for overcommitment: a one unit increase in its indices is associated with around a 3 percent increase in the odds of reporting both fatigue and work stress. Moreover we also find evidence in support of extra-effort especially by workers with intermediate to high levels of susceptibility to illness. These workers are also more likely to report higher levels of ill-related health. Workers in the upper 25 percent of the effort distribution are 1.5 times more likely to express fatigue and 2.4 times to have higher instead of lower levels of work stress. This effect increases once moving up in the overcommitment distribution. In particular, being in the highest quartile in the overcommitment distribution increases around 3.7 times the odds of both reporting fatigue and of expressing higher levels of work stress.

The paper is organized as follows. In Section 2, we review some further theoretical literature, taking a multidisciplinary perspective. In Section 3 we present the model. We start discussing two useful benchmarks, the first best and the case where effort is unobservable but effort-reward imbalance involves no illness risk. We then derive the optimal contract under ERI, discussing

its consequences in terms of effort and monetary transfers, and the effect on the principal's payoff. Finally, we discuss a number of implications for the empirical analysis. In Section 4 we introduce data and variables that are used in Section 5 for the empirical analysis. Section 6 concludes.

2 Theoretical background

Our paper is linked to a number of management, medical and biological studies on work related stressors and on the economics literature on loss aversion.

Managing Stress at work: The workplace is a social environment where subjects are potentially exposed to a great variety of stressors of different nature and intensity. Studies in the medical literature have shown the high incidence of potentially harmful relational settings such as competitiveness (Fletcher et al., 2008), hierarchy (Bacharach et al., 1993), dominance (Rospenda et al., 2008), etc. Goh, Pfeffer and Zeinos (2016) estimate that assignment to more or less stressful workplace conditions account for a range of 10-38 percent of difference in life expectancy across demographic groups. It is therefore not surprising that stress in the workplace and its effects have been the object of major attention in the management literature (see e.g., Ganster and Rosen, 2013). Our paper contributes to this literature by emphasizing the impact of contract design on work stressors, thus reinforcing the view that personnel policies are a potentially intrinsic factor of workplace stress, including bad promotion opportunities and low working time control, whereas adequate salary is a countering factor.

Reference Dependant Utility: A powerful body of work has demonstrated that individuals evaluate economic outcomes not just according to an absolute standard attached to the outcomes in question but also relative to subjective reference points. Loss averse individuals, in particular, evaluate losses relative to a reference point as more painful than equal-sized gains (see Koszegi and Rabin, 2006 and 2007). In this spirit, a growing literature analyzes the implications on incentives and contract design of difference assumptions on the agent's reference point. This literature has shown that under loss aversion pay may be insensitive to performance (De Meza and Webb, 2006), a binary bonus scheme can be optimal even for a rich performance measure (Herweg, Mueller and Weinschenk 2009) and the principal may implement high effort with lower-powered incentives because the agent has high self-expectation (Daido and Itoh 2010). Loss aversion can also make team incentives optimal even when they would not be optimal under standard risk aversion or risk neutrality (Daido and Murooka, 2015; Gill and

Stone (2015)). Brown et al. (2011) develop a theoretical rationale for a typical result of studies in the Organisational and human resource management literature, ie that establishing a committed and loyal workforce may be associated with enhanced workplace performance through less opportunistic behaviours by employees or through an higher supply of effort (see Green, 2008). They introduce employee commitment and loyalty in a principal agent model , where the cost of effort negatively depends from the utility the worker receives from his/her sense of identity and attachment to the organization where he/she is employed, and from from the penalty associated divergence between actual effort levels and the 'ideal' ones, given his/her identity. ones 'identity' identity Our paper contributes to this literature in two ways. First, we rationalize an individual loss aversion to poor performance by linking it to the biological and medical studies on illness risk from ERI. Like in Hart and Moore (2008), contingencies in the contracts act as reference point, where in our setting the reference point is given by the payment that the agent would receive if performance was good. Second, by introducing heterogeneous types, and thus the possibility that agents differ in their degree of illness susceptibility, we tackle policy issues such as equal pay role and incentives of principals to hire loss averse agents which are unexplored.

3 A model of performance pay under ERI

Our model introduces ERI in a standard Principal-Agent framework with moral hazard and limited liability. In particular, we consider a risk-neutral agent employed by a risk-neutral principal to deliver some verifiable output q . Output is stochastic and its realized value is affected by the agent's effort e , in the following way:

$$q = \begin{cases} Q & \text{with probability } e \\ 0 & \text{with probability } 1 - e \end{cases} .$$

Thus, the agent's effort raises the probability that high output will realize. The cost of effort is given by $\frac{e^2}{2}$ and, to ensure an interior solution, we assume

$$2Q \leq 1. \tag{A0}$$

The agent's effort is non-verifiable whilst realized output is verifiable; thus, it is possible to write a contract that makes the payment to the agent contingent on the realized level of output but not on the effort chosen by the agent.

We depart from the standard Principal-Agent theory by assuming that an imbalance between effort and reward increases illness risk. Agents exhibit

different degrees of illness susceptibility to effort-reward imbalance (ERI), due to temperament traits or other individual characteristics. Formally, when the agent exerts effort $e > 0$, with probability $1 - e$ output is low and the agent suffers an effort-reward imbalance that raises his cost by $\theta(T - t)$, where T denotes the transfer paid by the principal to the agent when the realized output is high ($q = Q$), and $t \leq T$, the transfer paid to the agent when output is low ($q = 0$). θ captures illness susceptibility; it is a random variable uniformly distributed over the interval $[0, \bar{\theta}]$. More illness susceptible agents suffer greater consequences from ERI. We shall sometimes also interpret θ as a measure of how stressful the job is, a characteristic of the job rather than the individual. We focus on the case where θ is publicly observable. The assumption of symmetric information is reasonable given that there is an impressive amount of patient-generated data that is generally not covered from privacy protection regulations, which often suffices for a full (or at least substantial) disclosure of individual health conditions or for its predictive profiling.

The expected utility of the agent can then be written as:

$$U \equiv eT + (1 - e)t - \frac{e^2}{2} - (1 - e)\theta(T - t)\gamma. \quad (1)$$

where γ is an indicator taking unit value if the effort exerted by agent with type θ is positive, and zero otherwise. This indicator allows us to capture the fact that only agents who exert effort will not suffer from ERI.³

We assume limited liability, in the sense that the agent cannot receive negative monetary transfers. $T, t \geq 0$.

The principal maximizes expected output net of the transfer paid to the agent:

$$V \equiv e(Q - T) - (1 - e)t.$$

Social welfare is given by the sum of the utility of the principal and the agent:

$$W \equiv U + V$$

Remark 1 *The stress cost of ERI, which we model, rationalizes a particular form of loss aversion in which the reference income is given by the bonus payment that the agent is contractually promised in case of good performance. To see this, consider a loss-averse agent with utility:*

$$\hat{U} \equiv \tau - \frac{e^2}{2} - L(\theta, e, \hat{\tau} - \tau),$$

³We also analyzed the case where the cost of ERI is proportional to the level of effort exerted, which provided an interesting though less tractable framework. The qualitative results of our paper were however unchanged.

where $\hat{\tau}$ denotes the reference income, τ the realized income and $L(\theta, e, \hat{\tau} - \tau)$ the loss of utility that the agent suffers when his realized income is below his reference income. By letting $\hat{\tau} = T$, $\tau \in \{T, t\}$ and by assuming

$$L(\theta, \hat{\tau} - \tau) = \begin{cases} 0 & \text{if } \hat{\tau} = \tau \text{ and/or } e = 0 \\ \theta(\hat{\tau} - \tau)\gamma & \text{if } \hat{\tau} \geq \tau \text{ and } e > 0. \end{cases}$$

we obtain our utility specification. In this interpretation, the illness susceptibility of individuals, given by θ , captures the degree of loss aversion of the agent.

3.1 Benchmarks

In the analysis that follows, we consider two relevant benchmarks.

3.1.1 First Best: Effort Verifiable

In the benchmark case in which effort is observable and verifiable, the principal will find it optimal to condition the transfer paid to the agent to his level of effort, regardless of the level of realized output. The agent is fully insured against risk, which brings the benefit of avoiding the possibility of an imbalance between the effort exerted by the agent and the agent's reward.

Under the first-best, effort and payoffs are then given by:

$$\begin{aligned} t^{FB}, T^{FB} &= \frac{Q^2}{2}; e^{FB} = Q; \\ W^{FB}, V^{FB} &= \frac{Q^2}{2}; U^{FB} = 0. \end{aligned}$$

The flat monetary transfer paid to the agent when he exerts the contractually specified effort e^{FB} is then set at the minimum level that satisfies the individual-rationality constraint of the agent. As the agent is never exposed to ERI, it receives the same payment regardless of his level of illness susceptibility.

3.1.2 Standard second best: $\theta = 0$

As further benchmark, consider the case where effort is unobservable but effort-reward imbalance has no health consequences, i.e.: $\theta = 0$, as in the standard Principal-Agent setting. The agent now chooses a level of effort e^{SB} to solve the following problem:

$$e^{SB} \equiv \arg \max_e \left[t + e(T - t) - \frac{e^2}{2} \right],$$

which gives the following moral hazard constraint:

$$e^{SB} (T - t) = (T - t).$$

We report in Appendix the derivation of the optimal second best mechanism. Second-best effort and payoffs are given by:

$$t^{SB} = 0, T^{SB} = \frac{Q}{2}, e^{SB} = \frac{Q}{2} < e^{FB}; U^{SB} = \frac{Q^2}{8}, V^{SB} = \frac{Q^2}{4}.$$

As is known, under the standard second-best mechanism, the agent obtains a greater monetary transfer when output is high and enjoys a limited-liability rent. Compared to the first best, the agent under-provides effort: $e^{SB} < e^{FB}$. Intuitively, in order to induce the agent to exert effort, the principal must pay the agent a greater transfer when output is high than when it is low. That is, $T > t$. As paying t is costly for the principal and it has a negative impact on effort ($e^{SB} (T - t)$ decreases in t), the principal sets t at the minimum possible level, which is given by $t = 0$ due to limited liability. The principal then chooses a positive bonus payment T in order to induce the agent to choose the optimal second-best level of effort. Due to limited liability, the agent enjoys a positive rent U^{SB} . As inducing effort is now more costly than when the agent's effort is observable, it becomes optimal for the principal to pay a lower bonus and obtain a lower level of effort than under the first best.

3.2 Incentives with ERI and illness susceptibility

Suppose now that individuals suffer health consequences from ERI and that effort is unverifiable. The choice of effort by the agent may now depend on his degree of illness susceptibility θ . In particular, each type of agent will choose whether to exert no effort (i.e. $\gamma(\theta) = 0$), so as not to risk of suffering ERI, or to exert a positive level of effort that maximizes expression (1) at $\gamma(\theta) = 1$. In the first case, the agent's output will be always low and therefore the agent will obtain:

$$\bar{U} = t.$$

In the second case, the agent's effort will be given by:⁴

$$e(\theta, T - t) \equiv (1 + \theta)(T - t). \quad (2)$$

We note that this effort is increasing in the incentive payment $T - t$. As expected, a greater incentive pay increases the reward of the agent from a

⁴Provided that there is an interior solution satisfying $e(\theta, T - t) \leq 1$, otherwise $e(T - t) = 1$.

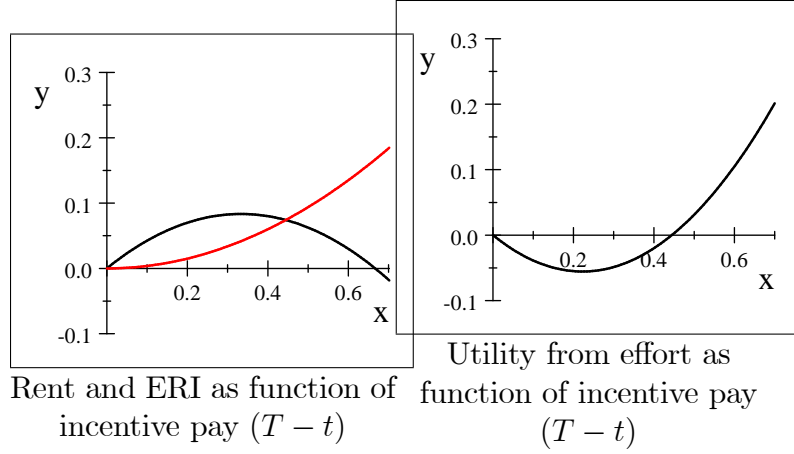
good performance and thus it boosts his incentive to exert effort. However, effort $e(\theta, T - t)$ is also increasing in the illness susceptibility of the agent θ , somehow surprising. This holds because a greater level of effort reduces the probability that a low performance will be observed and that therefore the agent will suffer ERI. For given incentive pay, more illness susceptible types will therefore be inclined to exert greater effort in order to minimize the illness risk.

To see whether a type θ agent will be willing to exert effort, let us calculate the utility for the agent from exerting effort by substituting for $e(\theta, T - t)$ in expression (1)). We obtain:

$$\begin{aligned} U(\theta, T - t) &\equiv t + \frac{(1 - \theta^2)(T - t)^2}{2} - \theta[1 - (1 + \theta)(T - t)](T - t), (3) \\ &= t + \frac{(1 + \theta)^2(T - t)^2}{2} - \theta(T - t). \end{aligned}$$

Comparing $U(\theta, T - t)$ with \bar{U} , we note that exerting effort entails both a benefit and a cost for the agent. On the one hand, the benefit is given by the term $\frac{(1 - \theta^2)(T - t)^2}{2}$, which represents the rent that the agent obtains thanks to the limited liability constraint and the non observability of effort. For given transfers, this rent decreases with the level of illness susceptibility θ ; as exerting effort for more illness susceptible types brings the benefit of reducing the probability of illness risk, which makes them work harder. On the other hand, the illness risk that ERI brings about a new cost of effort, which is given by the term $\theta[1 - (1 + \theta)(T - t)](T - t)$ (note that this term is positive for any $e(\theta, T - t) < 1$). Importantly for what follows, incentive pay $(T - t)$ has an ambiguous effect on the cost of ERI. On the one hand, the loss from ERI raises with the incentive pay $T - t$, as this illness risk. On the other hand, by increasing effort, incentive pay reduces the probability that ERI will be suffered, which reduces the expected cost of ERI. The red and black curves in Figure ??(a) represent the cost (black line) and benefit (red line) of incentive pay (we restrict attention to values of $T - t \leq \frac{1}{1 + \theta}$ that

satisfy the condition $e \leq 1$).



As shown in the picture, the function $U(\theta, T - t)$ is increasing in the incentive pay $T - t$ only if illness susceptibility is not too high, that is if⁵:

$$T - t \geq \frac{\theta}{(1 + \theta)^2},$$

and therefore the utility from effort $U(\theta, T - t)$ is greater than \bar{U} only if the incentive pay is sufficiently high, namely greater than the positive root solving $U(\theta, T - t) = \bar{U}$, which gives

$$\theta^*(T - t) : T - t = \frac{2\theta^*}{(1 + \theta^*)^2}. \quad (4)$$

We have therefore two constraints:

- (i) $T - t \leq \frac{1}{1 + \theta}$ to ensure $e \leq 1$,
- (ii) $T - t \geq \frac{2\theta}{(1 + \theta)^2}$ to ensure $e > 0$.

⁵Note that, using the envelop theorem, the utility of the agent unambiguously decreases with illness susceptibility:

$$\begin{aligned} \frac{dU(\theta, T - t)}{d\theta} &= \frac{\partial U(\theta, T - t)}{\partial \theta} + \underbrace{\frac{dU(\theta, T - t)}{de} \frac{de(\theta, T - t)}{d\theta}}_{=0} \\ &= -(1 - e)(T - t)\gamma \leq 0. \end{aligned}$$

Together these two conditions require $\frac{1}{1+\theta} - \frac{2\theta}{(1+\theta)^2}$, which is always satisfied for $\theta \in [0, 1]$. Furthermore, the term $\frac{2\theta}{(1+\theta)^2}$ increases in illness susceptibility, it follows that types who are more susceptible to illness will need a greater incentive pay to be willing to exert effort.

An important implication of the above discussion is that, from expression (4), it follows that for $T - t > 0$ there exists a cutoff level $\theta^*(T - t) \leq 1$, such that all types with illness susceptibility $\theta \leq \theta^*(T - t)$ exert positive effort whilst all types with illness susceptibility $\theta > \theta^*(T - t)$ will exert zero effort. A higher level of the incentive pay corresponds to a lower cutoff and thus to more types exerting effort. Let us therefore define as: $\theta_A \equiv \theta^*(\frac{Q}{2})$ and $\theta_B \equiv \theta^*(Q)$, where $\theta_A < \theta_B \leq 1$ (see Appendix). We identify three regions:

$$\begin{aligned} \text{Region A} & \text{ if } \theta \in [0, \theta_A] \\ \text{Region B} & \text{ if } \theta \in (\theta_A, \theta_B] . \\ \text{Region C} & \text{ if } \theta > \theta_B. \end{aligned}$$

The proposition below highlights how the characteristics of the incentive pay and the effort exerted by the agent will then depend on the region in which the illness susceptibility of the agent falls.

Proposition 1 *For low illness susceptibility (Region A), the optimal payment scheme under ERI is the same as under the standard second best mechanism; the agent exerts positive effort and gains a positive rent. For intermediate illness susceptibility (Region B), the payment scheme provides for a greater expected payment, the agent exerts positive effort but he obtains no rent. For high illness susceptibility (Region C), the payment scheme provides for a fixed salary independent of output and no effort is exerted.*

Proof. See the Appendix. ■

Effort can be induced only if the limited liability rent paid to the agent is sufficiently high to compensate the agent for the higher cost of effort due to the illness risk brought by ERI. In Region A, the second best liability rent suffices to do that. In Region B, the second best liability rent is insufficient to induce effort because of the illness risk. Raising the lower transfer t will not help as it raises proportionally also the utility of the agent from not exerting effort. Thus, the cost of ERI can only be covered by increasing the compensation T paid when output is high, which is optimal for all Agents with illness susceptibility in this region. As long as T remains lower than Q , the principal gains a higher payoff by raising T than by not inducing effort. However, for yet higher illness susceptibility (Region C), the loss from the illness risk due to ERI is too high, and the principal gives up incentivizing effort.

Consider now the consequences of these incentive schemes on the level of effort. As ERI increases the cost of effort, one could expect that the equilibrium effort decreased, compared to the second best benchmark. This indeed happens in Region C where no effort is now induced. However, surprisingly, the Proposition below reveals that the opposite holds in Regions A and B.

Corollary 1 *Illness susceptibility linked to ERI can either destroy incentives, or lead to stronger incentives and even to overcommitment. In particular, effort in Regions A and B is always greater than under the second best and, in the upper part of Region B, it is also greater than the first best. Effort in Region C is nil and thus lower than the second best.*

Proof. See the Appendix. ■

ERI may destroy incentives as Agents anticipate the potential illness risk from unsuccessful outcomes, but it can also lead to stronger incentives. In fact, despite the higher cost of effort, greater effort may result because higher monetary incentives, meaning $T - t$, generate two effects:

(i) The first effect is the standard incentive effect of a greater reward for success, which increases the marginal benefit of effort and, *ceteris paribus*, yields higher effort.

(ii) The second effect is new, and it is caused by the impact of monetary incentives on work-related illness due to ERI. This effect, measured by $\theta(T - t)\gamma$, can either destroy incentives or increase effort. When illness susceptibility is high, the agent gives up working harder because the cost of failure is too high. Here, illness risk destroys effort incentives, exacerbating the under-investment problem. Instead, for lower illness susceptibility, illness risk brings about greater effort. The agent increases his level of effort in order to reduce the probability that effort-reward imbalance will occur. This effect can be so strong to lead to over-effort compared to the first best ("overcommitment").

Further insights can be obtained if we interpret θ as the level of stress brought by the type of job. Some routine white collar jobs or secretarial jobs typically belong in Region A. These jobs should therefore offer employees an incentive pay. Jobs which are quite stressful should reward employees via incentive schemes that account for the cost of that stress. For yet higher levels of stress, more caution should be placed on the use of incentive schemes, as these may lead to overcommitment.

3.2.1 Effect on the Principal

Consider now the consequences of ERI on the payoff of the principal. ERI generates two contrasting effects which are payoff relevant for the principal.

On the one hand, it increases the cost of incentives (term $\theta(T - t)\gamma$), which calls for greater expected transfers in Region B. On the other hand, ERI increases the power of incentives, as the fear of ERI induces the agent to exert greater effort, for given informational rent. Ceteris paribus, this effect increases the payoff of the principal. Corollary 2 reveals that the effect which prevails depends on θ .

Corollary 2 *Effort Reward imbalance may increase the principal's expected payoff, compared to the standard second best situation. The payoff of the principal in Region A increases with the illness susceptibility of the agent, whilst it is constant in Region C and may either decrease or increase in Region B.*

Proof. See the Appendix. ■

Intuitively, as Agents earn a positive rent due to limited liability, and as this rent is sufficient to compensate for the higher cost of incentives for all $\theta \leq \theta_A$ (Region A), then the principal will gain from ERI when θ is low, benefiting from the greater effort, whilst keeping transfers unchanged. For $\theta > \theta^*$ (Region C), no effort can be induced so the principal's payoff is invariant with θ but lower than under the second best. In the intermediate region (Region B), the greater effort induced by ERI is accompanied by a greater expected transfer and the impact of ERI on the payoff of the principal depends on the parameter values. Overall, the principal may gain from the greater effort that the illness risk induced on Agents who are adverse to effort reward imbalance, which might explain why Principals seem to react so little to the mental stress caused by working conditions, unless this leads to workers burnout.

Before concluding this session, it is useful to consider what happens if the principal designs the incentive mechanism being unaware of the stress consequences of effort-reward imbalance, thus offering $T^{SB} = \frac{Q}{2}$ and $t^{SB} = 0$. If the agent is instead aware of his illness susceptibility and of ERI consequences on health, then from Proposition 1, only types in Region A will exert effort. More susceptible types with $\theta \geq \theta_A$ will be excluded from the possibility to obtain greater expected rewards. Thus unawareness by the principal is neither beneficial to the principal nor to the agent.

3.3 Implications for the empirical analysis

As ERI increases the cost of effort, one could expect that the equilibrium effort decreased, compared to the second best benchmark. However, the model shows that, in general, this may not be true, and that the effect of

ERI on effort varies, according to the susceptibility of workers to illness. In particular, when susceptibility is very high, the agent finds no more profitable to put effort because the cost of unsuccess is so high that the principal would never find optimal to offer an incentive pay scheme. For intermediate/high levels of susceptibility, the agent requires high incentive pay schemes and produces an 'excess' of effort to reduce (minimize) the probability of ERI. This leads to overeffort compared to the first best (overcommitment), even higher than the reward received in case of $q = Q$ (success).

Ex-ante (in expectation), such behaviours are optimal and maximize the expected worker's well-being. Ex-post - and moving from theory to the data - events that affect the probability of failure that are not completely internalised or perfectly anticipated when decisions are taken are likely to occur. Thus, experiencing $q = 0$ may cause high costs and severe work-related illness, and, more in general, high stress. These considerations as well as model's result suggest a number of rather general implications for the empirical analysis, that we can summarize as follows.

First, if ERI matters for workers' effort choices and its effect depends on their susceptibility to this imbalance (which is heterogeneous), we would observe a higher level of average effort for types more susceptible to stress (who then tend to overcommit). Second, if people care about ERI, higher incentive-based rewards may not necessarily reduce work-related stress. In particular, this should be true for incentive pay (e.g Pay for Performance schemes), which may induce extra effort and higher stress. Finally, incentive pay should be more likely where work effort is higher and associated with higher stress.

The mapping between these theoretical predictions and the empirical analysis is of course not perfect. One key aspect is how to operationalize the concepts of illness-risk, effort and overcommitment, i.e. to find reasonable empirical proxies for these economic concepts. Another crucial point is measuring incentives provision. These aspects will be discussed in the next session.

4 Data and variables

4.1 Data

Our dataset consists of a pooled cross section of employees from the sixth European Working Conditions Surveys (EWCS), carried out by the European Foundation for the Improvement of Living and Working Conditions in 2015. The EWCS survey stratified random samples of employees through

(face-to-face) interviews that cover issues related to work effort, work organization, well-being, and careers. Prior waves of this survey have been regularly used in the literature, for example, by Green and McIntosh (2001) to study work intensification in Europe; Ortega (2009a, 2009b) to study discretion; and Avgoustaki (2016) to study extensive work effort. In the 2015 wave of the EWCS, a total of 44,000 individuals were interviewed, covering 35 countries i.e., the EU 28, Albania, the Former Yugoslavia Republic of Macedonia, Montenegro, Norway, Serbia, Switzerland, and Turkey. We omitted from our sample self-employed individuals, individuals below 15 and above 65 years old, as well as individuals whose tenure in their firm exceeded 50 years. We also delete the observations in case of missing values on any of the variables included in our empirical specifications. Together, these sampling rules produced a sample of 18,690 employees from across 35 countries.

4.2 Variables

The first set of variables captures work-related illness risk. We follow Avgoustaki and Frankort (2018) and define two variables to capture employee well-being over the last 12 months. The first is based on a categorical variable asking respondents to indicate on a 5 point scale the extent to which workers experience stress at work (4 = always; 3 = most of the time; 2 = sometimes; 1 = rarely; 0 = never). The second is the variable Fatigue, which is a dummy measuring whether an employee suffered from overall work-related fatigue (1 = yes; 0 = no).

A second set of variables is intended to measure work effort. Green (2006) provides an insightful definition of it: "In part, work effort is inversely linked to the 'porosity' of the working day, meaning those gaps between tasks during which the body or mind rests. Yet a gradation of effort is also exercised during tasks performance, which is hard to measure except in very specific circumstances (pp. 48 - 49)". Conceptually, since work effort is the rate of physical or mental input to work tasks during working hours, it can be defined as the work intensity per unit of time. Given their nature, units of work effort are not directly observable, they depend on specific tasks and are difficult to measure even in the case of physical effort. In practice, an objective measurement of workers' work effort is not available. The problem of measurement can be resolved using people's perceptions of their own work intensity, such as working under a great deal of tension or working at a very high speed. In general, these judgments are relative, as they may reflect and be calibrated against a social norm, which may vary over time and across workplaces. However, a number of experiments showed the reliability of subjective measures of work intensity, which correlate well with laboratory

measures of physical and mental effort (Green, 2006). In addition, a clear advantage of using subjective work intensity as a proxy for work effort is that the workers themselves are likely to be the best informed party (Green, 2006). Also Hamermesh and Lee (2007) define work effort as work intensity, in particular as the ‘intensity’ of working time, eg tight deadlines: given the number of hours spent at work, this excess of effort is costly for the individual. Avgoustaki and Frankort (2018) use a similar concept that combines the amount of time an employee works in excess of normal hours (overtime work) and the level of effort supplied per unit of working time (work intensity).

We follow Green (2001a, 2001b, 2004) and construct a Work effort index that measures working time intensity on a 0-100 scale. The measure is constructed using three questions, asking the following: Does your job involve: A- working at a very high speed; B- working to tight deadlines (1 – all of the time -; 7 – Never)?; How often you have to interrupt a task to make unforeseen tasks (same 1-7 scale)?; Have you enough time to make the job done (reverse scale)?

A similar argument applies to overcommitment. Conceptually, it is meant to capture all the situations in which the agent is willing to ensure himself against the possibility of failures ($q = 0$) by providing a substantial amount of ‘over’ effort with respect to ‘standard’ job requirements. Our index of overcommitment (0-100 scale) is constructed using the following questions: Over last 12 months, kept worrying about work when not working (1 = always, 5 = never)?; Too tired after work to do household jobs (1= yes/0 = no)?; Job prevent giving desired time to my family (1 = yes/0 = no)?

As for the measurement of Incentive Pay, for each individual it would be desirable to observe the amount of variable remuneration which is linked to individual performance. Unfortunately, this information is rarely available with survey data and EWCS makes no exception. In particular, we know if the worker’s earnings from the main job include only a basic fixed salary/wage or also a number of additional payment schemes. Our variable for incentive pay captures the presence of these schemes, and it is a dummy (1 = yes/0 = no) for receiving at least one among the following: Piece rate, Payments based on individual performance, Team performance pay or Profit sharing.

In the empirical analysis we also control for a large number of factors that may confound associations between work effort, incentive pay and well-being. For example, existing evidence suggests that human resource practices are associated with effort (Avgoustaki 2016). For this reason, a set of variables is meant to control for additional work practices such as training, task rotation, teamwork and being exposed to hazardous physical working conditions. We capture training with three dummy variables (1 = yes; 0 = no) for the types of training employees have undergone during the past 12 months:

Employer-provided training (i.e., training paid for or provided by the employer), Employee-funded training (i.e., training paid for by the employee), and On-the-job training. Task rotation captures whether an employee’s job involves rotating tasks. It is a dummy (1 = yes; 0 = no). The dummy Teamwork captures whether employees perform part of their work in a team. Physical demand is captured by the variable Hazard, a summary indicator for exposure to the following hazards in the last two months: “(i) noise so loud that requires raising the voice to talk with other people; or (ii) vibrations from hand tools; or (iii) vibrations from striking whole body; or (iv) bad lighting, (v) temperature fluctuations; (vi) coldness (work outdoor or in cold rooms) or draft; (vii) skin contact with refrigerants or lubricants; (viii) solvent vapour; (ix) or passive smoke”. The hazard index is the sum of answers with response options from 1 to 6 (the extremes are “never” and “all of the time”), and it is normalised to vary in the 0 – 100 range. Employee remuneration includes payment for overtime (Paid overtime). Additional controls for individual characteristics, firm characteristics, labour income (setting a lower threshold at 100€ per month, and discarding observations below that threshold), public/private sector are also included in the analysis.

Table 1 presents summary statistics of the main variables used in the empirical analysis. As for our main variables of interests, around 40% of the sample report fatigue. Few workers report having never or rarely suffered from workstress (12% and 19% respectively), while most of workers report workstress at least sometimes or most of the time (39% and 18% respectively). Only 11% of workers report to always suffer from workstress. The mean of the work effort index is around 40, which is an intermediate value across the 0-100 scale. The average of overcommittment is somehow similar and around 36 (out of 100), although the two scales have only an ordinal (and not cardinal) interpretation and are not directly comparable. One out of three workers report that their earnings include additional Incentive Pay components.

5 Empirical Analysis

Figure 1 shows the relationship between overcommittment and work effort, which is positive and monotonically increasing. Overall, people who work with high effort and intensity are also more likely to overcommit, and viceversa. Hence, this seems to suggests that there is a high degree of complementarity between effort and overcommittment. In principle, this is not obvious. For example, if an individual is putting a lot of effort when at work, such that the total cost of effort is high, he may be less likely to keep thinking about

Table 1: Summary statistics

Main Variables	Mean	Std. Dev.	Min.	Max.	N
Fatigue	0.444	0.497	0	1	18690
Workstress	1.97	1.137	0	4	18690
Workstress=0 (Never)	0.119	0.324	0	1	18690
Workstress=1(Rarely)	0.194	0.395	0	1	18690
Workstress=2(Sometimes)	0.397	0.489	0	1	18690
Workstress=3(Most of)	0.178	0.383	0	1	18690
Workstress=4(Always)	0.112	0.315	0	1	18690
Work Effort	42.236	19.73	0	100	18690
Overcommittment	36.337	21.81	0	100	18690
Other controls					
Incentive Pay	0.261	0.439	0	1	18690
Hazards	17.76	15.415	1.852	100	18690
Employer-provided training	0.378	0.485	0	1	18690
Employee-funded training	0.067	0.249	0	1	18690
On the job training	0.384	0.486	0	1	18690
Task Rotation	0.553	0.497	0	1	18690
Teamwork	0.637	0.481	0	1	18690
Paid Overtime	0.379	0.485	0	1	18690
Income	1405.132	1616.281	100	74778.602	18690
Age	41.495	11.852	15	65	18690
Male	0.532	0.499	0	1	18690
Education	4.772	1.654	1	9	18690

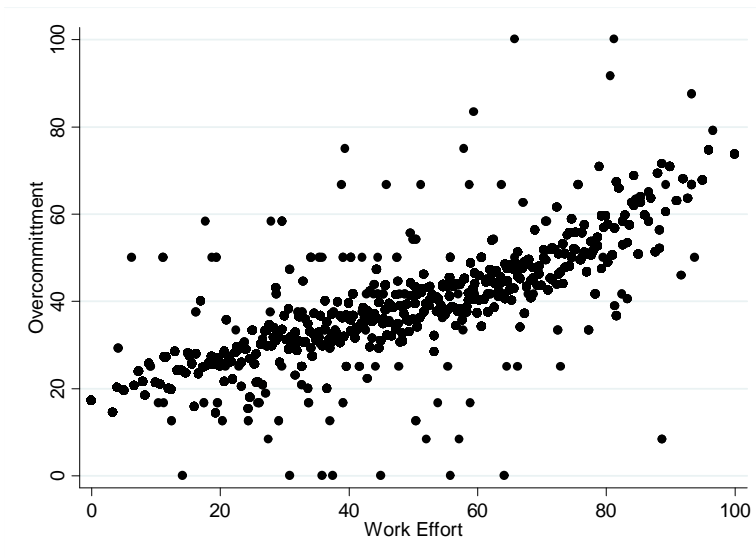


Figure 1: Relationship between Work Effort and Overcommitment.

job-related issues while at home. Alternatively, we may observe higher overcommitment especially among low effort workers, for example if they feel guilty for that and fear to be punished. Instead, our results are consistent with an ERI interpretation, and in particular that, high susceptible workers, i.e. those for whom well-being losses from ERI matter more, are more likely to develop a deep attitude towards effort such that they work very hard and establish a high commitment to the job. We will take this aspect into account and further develop the relationship between overcommitment and effort in Tables 4 and 5 below.

Moving to the core of the empirical analysis, Tables from 2 to 5 analyse the interplay between ill-health measures, incentives provision and effort. Given the nature of fatigue and work stress outcome variables, we use either logit (for fatigue that is a dummy) or ordered logit (for workstress that is an ordered variable) regression models. In these cases, we presents results in terms of odds-ratios.⁶ When the dependent variable is continuous, as in the

⁶They are the exponential of estimated coefficients. In the case of logit models, this measure how a marginal (for continuous regressors) or unit (for dummy covariates) changes in the variable of interest shift the probability of Fatigue = 1 relative to that of Fatigue = 0. For example, an odds ratio of 1.10 means that a maginal (or unitary) increase of the associated explanatory variable increases the probability of reporting fatigue by 10% more than that of reporting no fatigue. In the case of ordered logits (which has the property of proportional odds ratios) the odds is the shift in the probability of Work stress $\geq k$ with respect to Work stress $< k$, where k is one the values (say, 3) taken by the ordered

case of work effort (see Table 3) we use standard linear regression models.

Table 2 shows regression estimates of the relationship between ill-health outcomes and incentive pay, without controlling for effort and overcommitment. These are 'reduced forms' results, obtained without taking into account explicitly for ERI, which may act as a mediating channel in the statistical association between incentive pay and ill-health. In the baseline specification (columns 1 and 3) we also control for tenure, country, industry, occupation and level of education dummies; subsequently we augment the specification with a set of variables capturing work organization characteristics (columns 2 and 4). Our results seem to suggest that, on average, workers receiving some form of incentive pay are in general more stressed and perceive more fatigue. On the one hand, being paid with some incentive-based scheme is associated with a 9 percent increase in the odds of reporting fatigue, although the coefficient is marginally statistically significant at 10 percent (column 1). Results are unchanged when we include in the specification also work organization indicators (column 2). On the other hand, incentive pay is associated with an 11 percent increase in the odds of reporting higher levels of work stress with respect to lower levels (e.g. reporting work stress equal to 4 with respect to lower levels, see column 3). This goes down to 7 percent once we control for additional human resource management practices (see column 4). Among the work organisation controls hazards, employee provided and funded training and task rotation are statistically significant and show similar odds in for fatigue and work stress.

One key aspect is whether the positive association between work stress/fatigue and incentive pay is genuine or simply reflects indirectly changes in work effort. The role of effort as a mediating channel is analysed first in Table 3, where we show the relationship between work effort and incentive pay. In particular, column 1 shows that being under an incentive pay scheme is associated with an increase in work effort of around 2.8 points, which is equivalent to a movement of around half decile (5 percentiles) in the distribution of work effort. This positive relationship is not affected by the inclusion of work organization controls (see column 2). Among other controls, in line with the occupational health literature, odds ratios for hazards are always statistically significant and positive across all specifications. Also, employer provided training and employee funded training bear in some cases positive and statistically significant odds ratios. We also find some statistical significant associations for task rotation and teamwork (see column 2).

Tables 4 and 5 show results from the estimation of a richer specification than that of Table 2, where the models for fatigue (columns 1-2) and work

variable.

Table 2: Work-related illness risk and Incentive Pay, Odds Ratios

Dep.Variable:	Fatigue (0-1)		Work Stress (0-4)	
	(1)	(2)	(3)	(4)
Incentive Pay	1.091*	1.069*	1.114***	1.069**
	(0.05)	(0.04)	(0.04)	(0.03)
Hazards		1.020***		1.030***
		(0.00)		(0.00)
Employer-provided training		0.949*		1.102**
		(0.04)		(0.05)
Employee-funded training		1.203***		1.270***
		(0.07)		(0.06)
On the job training		1.039		1.006
		(0.05)		(0.03)
Task Rotation		1.090**		1.188***
		(0.04)		(0.05)
Teamwork		0.996		1.028
		(0.06)		(0.05)
Paid overtime		0.991		0.993
		(0.05)		(0.04)
Nobs	18960	18960	18960	18960

Note: Significance levels: *** 1%, **5%, *10%. Logit estimates in columns (1) and (2), Ordered Logit estimates in columns (3) and (4). Standard errors of coefficients used to construct Odds Ratios in parenthesis. Heteroskedastic-consistent standard errors are clustered by country. Estimates also include a constant term, tenure and country, industry, occupation, level of education dummies.

Table 3: Effort and Incentive Pay.

Dep. Variable:	Work Effort(0-100)	
	(1)	(2)
Incentive Pay	2.864*** (0.45)	2.481*** (0.44)
Hazards		0.378*** (0.02)
Employer-provided training		0.110 (0.35)
Employee-funded training		1.154 (0.70)
On the job training		0.827** (0.36)
Task rotation		4.309*** (0.54)
Teamwork		2.485*** (0.39)
Paid overtime		0.710 (0.43)
Nobs	18690	18690

Notes: Significance levels: *** 1%, **5%, *10%; OLS coefficients in columns (1) and (2). White heteroskedastic-consistent standard errors in parentheses clustered by country. Estimations also include a constant term, tenure and country, industry, occupation, level of education dummies.

stress(columns 3-4) include not only incentive pay but also the continuous indices of work effort and overcommitment. In this case, all estimates also control for human resources practices. One key implication of the theoretical framework developed in the previous sections is that, *di per se*, incentive pay should not have any direct effect on wellbeing, controlling for work effort and overcommitment. Further, if the ERI rationale matters for workers' choices, we expect that, if adequately incentivized, illness susceptible workers may strategically put more effort and overcommit more than the average worker, as a way to insure themselves against the probability of failure and the associated welfare costs. However, hard work and high commitment only provide a partial insurance against the risk of failure, which is less likely but still possible. Intuitively, it is conceivable that especially among more susceptible workers the true costs and benefits of working hard may not be fully and correctly anticipated. Conditional on incentive pay, this might imply that workers who exercise high effort and high commitment may be those who tend to report *ex post* lower levels of perceived health and well-being.

Table 4 shows that, as implied by the ERI model, the dummy for Incentive pay is never statistically significant once we account for work effort. By converse, work effort and overcommitment are always positive and statistically significant both in the case of fatigue and work stress. For example, there is evidence that a one unit increase in work effort is associated with a 2 percent increase in the odds of reporting fatigue (column 1) and with a 5 percent increase in work stress (column 3). These effects are almost halved once we control also for overcommitment (columns 3 and 4): a one unit increase in its indices is associated with around a 3 percent increase in the odds of reporting both fatigue and work stress. These findings are consistent with prior evidence for a negative association between work effort and well-being (e.g., Golden and Wiens-Tuers 2006; Green et al.2016).

The theory also suggests that, if ERI matters, we should observe 'extra' effort (as compared to the standard second best solution) especially by workers with intermediate to high levels of susceptibility to illness. If this is the case, we (empirically) expect that workers with these characteristics should *ex post* report higher levels of ill-related health. Table 5 replicates the analysis of Table 4 but, instead of using the 0-100 measures of effort and overcommitment, we use dummies for being in the quartiles of the work effort and overcommitment distributions. The reference group is people in the lowest quartile (0-25 percent) of effort and overcommitment. This specification is convenient as it allows the effect of these two measures to be heterogeneous across their distributions. Results are consistent with what we would expect from the naive implications of the theoretical model. More specifically, columns (1) and (3) show that, conditional on incentive pay,

Table 4: Work-related illness risk, Effort, Overcommitment and Incentive Pay, Odds Ratios.

Dep. Variable:	Fatigue (0-1)		Work Stress (0-4)	
	(1)	(2)	(3)	(4)
Work Effort	1.020*** (0.00)	1.008*** (0.00)	1.047*** (0.00)	1.035*** (0.00)
Overcommitment		1.034*** (0.00)		1.034*** (0.00)
Incentive Pay	1.018 (0.05)	1.017 (0.05)	0.963 (0.04)	0.948 (0.03)
Hazards	1.013*** (0.00)	1.008*** (0.00)	1.014*** (0.00)	1.010*** (0.00)
Employer-provided training	0.945* (0.04)	0.915** (0.04)	1.116** (0.05)	1.089** (0.05)
Employee-funded training	1.183*** (0.07)	1.070** (0.06)	1.247*** (0.07)	1.123** (0.06)
On the job training	1.023 (0.05)	1.025 (0.06)	0.971 (0.03)	0.972 (0.03)
Task rotation	1.001 (0.04)	1.007 (0.05)	0.996 (0.04)	1.013 (0.04)
Teamwork	0.946 (0.05)	0.981 (0.06)	0.926 (0.04)	0.947 (0.05)
Paid overtime	0.978 (0.04)	1.005 (0.04)	0.966 (0.04)	0.987 (0.03)
Nobs	18690	18690	18690	18690

Note: See Table 2.

low to intermediate effort levels are not significantly associated with higher fatigue and work stress. By converse, workers in the upper 25 percent of the effort distribution are 1.5 times more likely to express fatigue and 2.4 times to have higher instead of lower levels of work stress. Columns (2) and (4) show that, first, the effect of overcommitment does not substitute but reinforces that of work effort; second, conditional on effort, even low to intermediate overcommitment (say, illness susceptibility) are statistically and significantly associated with higher fatigue and work stress (with respect to the baseline of people in the 0-25 percent overcommitment distribution). This effect increases once moving up in the overcommitment distribution. In particular, being in the highest quartile seem to have substantial well-being implications, as it increase around 3.7 times the odds of reporting fatigue (see column 2) and of expressing higher levels of work stress.

Of course, we are not claiming that these results are causal, nor that they can be interpreted as a formal test of the theory developed in the previous sections. At the best, the empirical results are reduced forms that simply provide robust statistical associations, which may be generated by several underlying mechanisms. If anything, the empirical analysis seems to provide empirical support to the main implications on workplace stressors of having a population of workers with heterogenous levels of susceptibility to stress, and where ERI motivations matter for individual's well being and effort decisions are not observable and generate moral hazard problems.

6 Conclusions

To the extent of our knowledge, this paper constitutes a first attempt to incorporate considerations on the impact of incentives on stress at work and its consequences on people's health. Whilst some of the features of the model resemble models of loss aversion, our application has allowed us to open up entirely new questions, linked to the heterogeneity of types. We have focused our attention on the shape of the contract and implications of equal pay role. The results warn that organizations may benefit from putting agents under stressful conditions and inequality of opportunity may result even when all agents are apparently treated the same. Further, even simple incentive contract with type independent transfers may result in cyclical effort effects. Empirical evidence supports the theoretical model. First our results show that work effort and overcommitment are always positive and statistically significant both in the case of fatigue and work stress. Results show that a one unit increase in work effort is associated with a 2 percent increase in the odds of reporting fatigue and with a 5 percent increase in work stress.

Table 5: Work-related illness risk, quartiles of Effort and Overcomittment, and Incentive Pay, Odds Ratios.

Dep. Variable:	Fatigue (0-1)		Work Stress (0-4)	
	(1)	(2)	(3)	(4)
Work effort25_50	0.968 (0.05)	0.929 (0.05)	1.002 (0.05)	0.975 (0.05)
Work effort50_75	1.240*** (0.07)	1.106* (0.06)	1.497*** (0.08)	1.359*** (0.07)
Work effort75_100	1.474*** (0.07)	1.274*** (0.06)	2.379*** (0.20)	2.104*** (0.15)
Overcommit25_50		1.245*** (0.08)		1.245*** (0.07)
Overcommit50_75		2.059*** (0.19)		1.996*** (0.14)
Overcommit75_100		3.704*** (0.38)		3.691*** (0.37)
Incentive Pay	1.054 (0.05)	1.037 (0.05)	1.039 (0.04)	1.019 (0.03)
Hazards	1.019*** (0.00)	1.017*** (0.00)	1.027*** (0.00)	1.024*** (0.00)
Employer-provided training	0.948* (0.04)	0.925* (0.04)	1.100** (0.05)	1.082* (0.05)
Employee-funded training	1.198*** (0.07)	1.161*** (0.07)	1.270*** (0.06)	1.238*** (0.06)
On the job training	1.030 (0.05)	1.044 (0.06)	0.988 (0.03)	1.001 (0.03)
Task rotation	1.070 (0.04)	1.052 (0.04)	1.144*** (0.05)	1.134*** (0.04)
Teamwork	0.986 (0.05)	0.991 (0.06)	1.004 (0.05)	1.001 (0.05)
Paid overtime	0.986 (0.05)	0.974 (0.04)	0.987 (0.04)	0.977 (0.04)
Nobs	18690	18690	18690	18690

Note: See Table 2. Excluded categories: Work effort0_25, Overcommit0_25.

These effects are almost halved once we control also for overcommitment: a one unit increase in its indices is associated with around a 3 percent increase in the odds of reporting both fatigue and work stress. Moreover we also find evidence in support of extra-effort especially by workers with intermediate to high levels of susceptibility to illness. These workers are also more likely to report higher levels of ill-related health.

A natural extension of this analysis is the case of asymmetric information on individual illness susceptibility. The interesting question here is whether the principal may induce agents to self select. Will more illness susceptible types choose flat salary and less illness susceptible types accept incentive pay?

7 Appendix

Benchmark 1: First Best. Introducing a difference between t and T yields no benefit but brings the cost of ERI, therefore, the principal chooses $T = t$ to $\max W \equiv eQ - T$; *s.t.* : $U(\theta) = T - \frac{e^2}{2} \geq 0$, which yields $t, T = \frac{e^2}{2}$ and $e = \frac{vQ}{c}$. Equilibrium values are then obtained by substitution. ■

Benchmark 2: Standard Second Best. The principal's problem is:

$$\begin{aligned} \max_{T,t} V(t, T) &= e(Q - T) - (1 - e)t \\ \text{s.t. : (IR)} &: U(t, T) = t + e(T - t) - \frac{e^2}{2} \geq 0; \\ & (LL) : T, t \geq 0; \text{ (MH)} : e \equiv T - t. \end{aligned}$$

Suppose (IR) is satisfied. Substituting for $e(T - t)$ from (MH) in $V(T - t)$ and maximizing we obtain $t^{SB} = 0$ and $T^{SB} = \frac{Q}{2}$ and the equilibrium values in the text, which satisfy (IR). ■

Derivation of $\theta^*(T - t)$. From (4), we take the root

$$\theta^*(T - t) = \frac{1 - (T - t) - \sqrt{1 - 2(T - t)}}{(T - t)}.$$

For each incentive scheme, with $T > t$, effort can be induced only from types with $\theta \leq \theta^*(T - t)$, where $\frac{d\theta^*(T-t)}{d(T-t)} = \frac{\theta^*}{(T-t)\sqrt{1-2(T-t)}} > 0$. Note that at $T - t = \frac{Q}{2}$ and $\theta = 1$, we have:

$$U(1, \frac{Q}{2}) - \bar{U} = \frac{Q - 1}{4},$$

which is strictly negative by virtue of (A0) and therefore $\theta^*(\frac{Q}{2}) < 1$. At $T - t = Q$ and $\theta = 1$ we have:

$$U(1, Q) - \bar{U} = \frac{2Q - 1}{4}$$

which is nonpositive by (A0); therefore, for $2Q < 1$, we have $\theta^*(Q) < 1$ and $e^*(\theta, Q) < 1$; for $2Q = 1$, we have $\theta^*(Q) = 1$ and $e^*(\theta, Q) = 1$ ■

Proof of Proposition 1. For each θ in Regions A and B. the optimal payment solves:

$$\begin{aligned} \max_{T,t} V(\theta, T - t) &= e(\theta, T - t)(Q - T) - (1 - e(\theta, T - t))t \\ \text{s.t. : (IR)} &: U(T - t) \equiv t - \theta(T - t) + \frac{(1 + \theta)^2(T - t)^2}{2} \geq 0, \\ & (LL) : t, T \geq 0; \text{ (MH)} : e = (1 + \theta)(T - t). \end{aligned}$$

Suppose that effort in expression (MH) is feasible (i.e., IR is satisfied at $e(\theta, T, t)$). Substituting for expression (MH) in the payoff of the principal, we obtain:

$$V(\theta, T, t) = (1 + \theta)(T - t)(Q - T) - (1 - (1 + \theta)(T - t))t.$$

The FOCs w.r.t T and t lead to $T = \frac{Q}{2}$ and $t = 0$. For $\theta \leq \theta_A$, by definition of θ_A , these two transfers are feasible and therefore optimal. For $\theta > \theta_A$, the (IR) is not satisfied at $T = \frac{Q}{2}$ and $t = 0$; as t is costly and brings no benefit on incentives, $t^* = 0$ and, provided that the payoff of the principal is nonnegative, T^* is found by setting (IR) binding, that is:

$$\frac{\theta}{1 + \theta} = \frac{(1 + \theta)T}{2} \implies T^* = \frac{2\theta}{(1 + \theta)^2}.$$

As long as this value of T^* is smaller than Q , the payoff of the principal from inducing effort is positive and thus greater than the payoff she would obtain by not inducing effort, indeed:

$$\begin{aligned} V(\theta, T^*, t = 0) &= (1 + \theta)T(Q - T) \\ &= \frac{2\theta}{1 + \theta} \frac{Q(1 + \theta)^2 - 2\theta}{(1 + \theta)^2} \end{aligned}$$

If T^* is greater than Q , the principal will induce zero effort by setting $T = 0$. In Region C, the agent exerts no effort and therefore $T = t = 0$. ■

Proof of Corollary 1 In the light of Proposition 1, under ERI, in Region A the agent exerts effort:

$$e_A^*(\theta) = \frac{(1 + \theta)Q}{2},$$

which is increasing in θ , lower than first best effort, as $e^{FB} - e_A^*(\theta) = \frac{Q}{2}(1 - \theta) > 0$, but greater than second best effort, as $e^{SB} - e_A^*(\theta) = -\frac{\theta Q}{2}$. In Region B, the agent's effort is given by:

$$e_B^*(\theta) = \frac{2\theta}{1 + \theta},$$

which is increasing in θ . Effort may now be greater than the first best, as:

$$\begin{aligned} e^{FB} - e_B^*(\theta) &= Q - \frac{2\theta}{1 + \theta}, \\ &= \frac{Q(1 + \theta) - 2\theta}{1 + \theta}. \end{aligned}$$

Recall that at θ_A we have: $\frac{Q}{4} = \frac{\theta_A}{(1+\theta_A)^2}$ and therefore

$$\begin{aligned} e^{FB} - e_B^*(\theta_A) &= \frac{\frac{4\theta_A}{(1+\theta_A)^2} (1 + \theta_A) - 2\theta_A}{1 + \theta_A}, \\ &= \frac{2\theta_A (1 - \theta_A)}{(\theta_A + 1)^2} > 0 \end{aligned}$$

where the inequality holds as $\theta_A < 1$. Instead at $\theta = 1$ (where $1 \geq \theta_B$), we have:

$$e^{FB} - e_B^*(1) = Q - 1,$$

which is negative by (A0). As $e^{FB} - e_B^*(\theta)$ is decreasing in θ , there exists some $\hat{\theta} > \theta_A$ such that for $\theta > (\hat{\theta} \in \theta_B]$ there is over-effort: $e^{FB} > e_B^*(\theta)$.

Proof of Corollary 2 In Region A, the principal obtains:

$$\begin{aligned} V(e_A^*, T_A^*, \theta) &= e_A^*(\theta) (Q - T_A^*), \\ &= \frac{(1 + \theta) Q^2}{4} \end{aligned}$$

which is increasing in θ and equal to V^{SB} at $\theta = 0$. In Region B: $T_B^* = \frac{2\theta}{(1+\theta)^2}$, $t^* = 0$ and $e_B^*(\theta) = \frac{2\theta}{1+\theta} \leq 1$, with an associated payoff $V = e_B^*(\theta) (Q - T_B^*)$ equal to:

$$V(e_B^*, T_B^*, \theta) = \frac{2\theta}{1+\theta} \left(Q - \frac{2\theta}{(1+\theta)^2} \right),$$

with

$$\begin{aligned} V_\theta(e_B^*, T_B^*, \theta) &= \frac{2}{(1+\theta)^2} \left(Q - \frac{2\theta}{(1+\theta)^2} - \frac{2\theta(1-\theta)}{(1+\theta)^2} \right) \\ &= \frac{2}{(\theta+1)^2} \left(Q + 2\theta \frac{\theta-2}{(\theta+1)^2} \right). \end{aligned}$$

The sign of this expression is however ambiguous, as it depends on the value of θ . For example for $Q = 0.5$, $V(e_A^*, T_A^*, \theta) = 0.07$ at $\theta_A = 0.17157$ and $V_\theta(e_B^*, T_B^*, \theta) = 0$ at $\theta_B = 1$. For yet higher θ , in Region C, the principal obtains zero, as no effort is induced and $t = T = 0$. In expectation, with a uniform distribution, the principal obtains

$$\begin{aligned} EV^* &= V(e_A^*, T_A^*) \theta_A^* + V(e_B^*, T_B^*) (1 - \theta_A^*), \\ &= 0.07.3223 (0.17157) + (1 - 0.17157) \\ &= 0.8323 \end{aligned}$$

which is greater than $V^{SB} = 0.0625$.

Proof of Proposition of ?? Suppose that $\hat{\theta} \in [\theta_A, \theta_B]$, so that the optimal transfer is $T^*(\hat{\theta}) = \frac{2\hat{\theta}}{(\hat{\theta}+1)^2}$. Then, $\hat{\theta}$ solves:

$$\max_{\hat{\theta}} V(\theta, T - t) = \int_0^{\hat{\theta}} \frac{\theta}{1+\theta} \left(Q - \frac{2\hat{\theta}}{(1+\hat{\theta})^2} \right) \frac{1}{\theta} d\theta,$$

which gives as FOC:

$$\int_0^{\hat{\theta}} \left(Q - \frac{2(1-\hat{\theta})}{(\hat{\theta}+1)^3} \frac{\theta}{1+\theta} \right) d\theta + \frac{\hat{\theta}}{1+\hat{\theta}} \left(Q - \frac{2\hat{\theta}}{(\hat{\theta}+1)^2} \right) = 0,$$

i.e.

$$- \int_0^{\hat{\theta}} \frac{(1-\hat{\theta})}{(\hat{\theta}+1)\hat{\theta}} \frac{\theta}{1+\theta} T(\hat{\theta}) \frac{1}{\theta} d\theta + \frac{\hat{\theta}}{1+\hat{\theta}} \left(Q - T(\hat{\theta}) \right) = 0.$$

Let $\hat{\theta} \rightarrow \theta_A$, so that $T^*(\hat{\theta}) \rightarrow \frac{Q}{2}$, then the above equation becomes

$$\left(- \int_0^{\hat{\theta}} \frac{(1-\hat{\theta})}{(\hat{\theta}+1)\hat{\theta}} \frac{\theta}{1+\theta} d\theta + \frac{\hat{\theta}}{1+\hat{\theta}} \right) \frac{Q}{2} > 0$$

thus, it is optimal to raise T above $\frac{Q}{2}$. Let $\hat{\theta} \rightarrow \theta_B$, so that $T(\hat{\theta}) \rightarrow Q$, then the above equation becomes

$$- \int_0^{\hat{\theta}} \frac{(1-\hat{\theta})}{(\hat{\theta}+1)\hat{\theta}} \frac{\theta}{1+\theta} T(\hat{\theta}) d\theta < 0$$

thus, it is optimal to decrease T below Q . It follows that $\hat{\theta} \in (\theta_A, \theta_B)$ is a solution. ■

8 References

Avgoustaki A. (2016), Work Uncertainty and Extensive Work Effort: The Mediating Role of Human Resource Practices. *Industrial and Labor Relations Review*, 69(3), 656 - 682.

Avgoustaki, A., and W. H. T. Frankort (2018), Implications of Work Effort and Discretion for Employee Well-Being and Career-Related Outcomes: An Integrative Assessment. *Industrial and Labor Relations Review* forthcoming.

Bacharach SB, Bamberger P, Mundell B (1993), Status inconsistency in organizations: From social hierarchy to stress. *Journal of Organizational Behavior* 14, 21-36.

Bellingrath S, Weigl T, Kudielka BM (2008), Cortisol dysregulation in school teachers in relation to burnout, vital exhaustion, and effort-reward imbalance. *Biological Psychology* 78, 104-113.

Bellingrath S, Rohleder N, Kudielka BM (2010), Healthy working school teachers with high effort-reward-imbalance and overcommitment show increased pro-inflammatory immune activity and a dampened innate immune defence. *Brain, Behavior and Immunity* 24, 1332-1339.

Brown, S. , McHardy, J. , McNabb, R. and Taylor, K. (2011), Workplace Performance, Worker Commitment, and Loyalty. *Journal of Economics & Management Strategy*, 20(3): 925-955.

Cohen S, Janicki-Deverts D, Miller, GE (2007) Psychological stress and disease. *Journal of the American Medical Association* 298, 1685-1687.

Colantone, I, R Crinò and L Ogliari (2015), The hidden cost of globalization: Import competition and mental distress. CEPR, Discussion Paper 10874.

Daido, K. and H. Itoh (2010), The Pygmalion and Galatea effects: An agency model with reference-dependent preferences and applications to self-fulfilling prophecy. Working paper, Kwansei-Gakuin University.

Daido, K. and T. Murooka (2016), Team Incentives and Reference-Dependent Preferences, *Journal of Economics and Management Strategy*, 25(4): 958–989.

De Meza, D. and DC Webb (2007), Incentive Design under Loss Aversion. *Journal of the European Economic Association*, 5(1): 66-92.

Fletcher TD, Major DA, Davis DD (2008), The interactive relationship of competitive climate and trait competitiveness for workplace attitude, stress, and performance. *Journal of Organizational Behavior* 29, 899-922.

Ganster DC, Rosen CC (2013), Work stress and employee health: A multidisciplinary review. *Journal of Management* 39, 1085-1122.

Ganster, D.C., Rosen, C.C. & Fisher, G.G. (2018), Long Working Hours

and Well-being: What We Know, What We Do Not Know, and What We Need to Know. *Journal of Business and Psychology*, 33: 25.

Gill, D. and R. Stone (2015), Desert and inequity aversion in teams, *Journal of Public Economics*, 123: 42-54.

Goh J., Pfeffer, J. and SA. Zenios (2016) The Relationship Between Workplace Stressors and Mortality and Health Costs in the United States. *Management Science* 62(2):608-628.

Green, F. (2001). It's been a hard day's night: The concentration and intensification of work in late 20th century Britain. *British Journal of Industrial Relations* 39(1): 53–80.

Green, F. (2004a). Why has work effort become more intense? *Industrial Relations: A Journal of Economy and Society* 43(4): 709–41.

Green, F. (2004b). Work intensification, discretion and the decline in well-being at work. *Eastern Economic Journal* 30(4): 615–25.

Green, F. (2006). Demanding Work. The Paradox of Job Quality in the Affluent Economy. Princeton University Press.

Green, F. (2008). Leeway for the Loyal: A Model of Employee Discretion. *British Journal of Industrial Relations*, 46(1): 1-32.

Green, F., and S. McIntosh. 2001. The intensification of work in Europe. *Labor Economics* 8(2): 291–308.

Golden, L. and B. Wiens-Tuers. 2006. To your happiness? Extra hours of labor supply and worker well-being. *Journal of Socio-Economics* 35(2): 382-397.

Hamermesh D. and J. Lee (2007), Stressed out on Four Continents: Time Crunch or Yuppie Kvetch? *The Review of Economics and Statistics*, 89 (2), pp. 374-383.

Hart, O. and J. Moore (2008), Contracts as Reference Points. *Quarterly Journal of Economics*. 123 (1): 1-48.

Herweg, F., Muller K. and Weinschenk (2010), Binary Payment Schemes: Moral Hazard and Loss Aversion. *American Economic Review*, 100 (5): 2451-2477.

Hintsanen M, Hintsala T, Widell A, Kivimaki M, Raitakari OT, Keltkangas-Javarvinen L (2011) Negative emotionality, activity, and sociability temperaments predicting long-term job strain and effort-reward imbalance: A 15-year prospective follow-up study. *Journal of Psychosomatic Research* 71, 90-96.

Koszegi, Botond and Matthew Rabin (2006), A Model of Reference-Dependent Preferences, *Quarterly Journal of Economics*, 121: 1133-1165.

Koszegi, B. and M. Rabin (2007), Reference-Dependent Risk Attitudes, *American Economic Review*, 97: 1047-1073

Koszegi, B. (2014), Behavioural Contract Theory, *Journal of Economics Literature*, 52: 1075-1118.

Laffont Jean Jacques and David Martimort (2002), *The Theory of Incentives The Principal-Agent Model*. Princeton University Press.

OECD, 2014, Making Mental Health Count: The Social and Economic Costs of Neglecting Mental Health Care, OECD, Paris.

Padgett DA, Glaser R (2003) How stress influences the immune response. *Trends in Immunology* 24, 444-448.

Rospenda KM, Fujishiro K, Shannon CA, Richman JA (2008) Workplace harassment, stress, and drinking behavior over time: Gender differences in a national sample. *Addictive Behaviors* 33, 964-967.

Siegrist, J. Starke, D., Chandola T., Godin I., Marmot M., Niedhammer I. and Richard P. (2004) The measurement of effort–reward imbalance at work: European comparisons, *Social Science & Medicine*, 58(8): 1483-1499.