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Stress and Incentives at Work*

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Abstract

An extensive medical and occupational-health literature finds that an imbalance between effort and reward is an important stressor which produces serious health consequences. We incorporate these effects in a simple agency model with moral hazard and limited liability, and study their impact on the agent's effort and utility, assuming that agents differ in their stress susceptibility. We test our predictions using the 2015 wave of the European Working Condition Survey. We find that individuals who are more susceptible to stress work harder and have lower subjective well-being.

JEL CLassification: D82, I31, J33, L2.
Keywords: Effort-Reward Imbalance, incentives, stress, subjective well-being.

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1 Introduction

The workplace is a social environment where subjects are potentially exposed to a great variety of stressors of different nature and intensity. This is problematic as stress influences the immune response and causes significant health consequences (Padgett and Glaser, 2003; Cohen, Janicki-Deverts and Miller, 2007). The cost of stress-related illnesses accounts for approximately 5 - 8 percent of annual healthcare costs in the U.S. and for 10 - 38 percent of differences in life expectancy across demographic groups (Goh, Pfeffer and Zeinos, 2016). Causes and consequences of stress in the workplace have therefore been the object of major attention in the occupational health and medical literature (see Ganster and Rosen, 2013 for a review).

One particularly powerful stressor is the perceived imbalance between the effort provided at work and the reward received: individuals who work with high intensity without obtaining an adequate reward are more vulnerable to pro-inflammatory immune reactions, paving the way to major illnesses (see Siegrist et al., 2004 or Tsutsumi and Kawakami, 2004 for a survey). A number of studies have then shown that higher rewards are associated with lower stress (Siegriest, 1996) and greater work effort with more stress (Avgoustaki and Frankort, 2019). These studies have the merit to analyse links between effort, rewards and stress, but they treat effort and rewards as exogenous, thus failing to recognize the relationship between the two, suggested by the economic theory of incentives.[1] In this latter literature, however, the link between stress, effort and rewards has not received so far specific attention.[2]

In this paper, we make a first step to bridge the gap, by introducing stress considerations in a standard Principal-Agent model with moral hazard and limited liability. A key aspect of our analysis is that individuals are heterogeneous in their susceptibility to stress and related illnesses. Empirical evidence indeed finds that such heterogeneity arises either because of personality differences (Hintsanen et al., 2011) or of job characteristics (Knowles, Nelson and Paolombo, 2008). Specifically, we consider a setting in which an agent's unobservable effort increases the probability of good performance; the realized performance is verifiable and the agent obtains some private nonmonetary benefit as well as a monetary bonus when good performance realizes. An agent who exerts effort but does not receive the monetary bonus suffers a loss that increases with the level of effort exerted and with the agent's degree of stress susceptibility. The agent does not suffer any loss when either he does not exert effort or when performance is good and thus he receives

[1] See Laffont and Martimort (2002) for a comprehensive presentation of the theory of incentives.

[2] Stress and health consequences of economic decisions are issues still under-explored in economics. Only recently, a literature on trade and health has started to emerge (see for example Colatone, Crinò and Ogliari, 2019, who study how import competition affects mental distress at the worker level).

the monetary bonus.

In this context, when choosing his effort, the agent balances off two possibly conflicting targets: maximizing the expected (monetary and nonmonetary) reward linked to good performance and minimizing the expected stress-related loss linked to a possible effort-reward imbalance. We show that, under some condition, stress susceptibility motivates the agent to work harder in an attempt to reduce the risk of suffering the loss, and the more so the greater the stress susceptibility of the agent. This result rationalises findings from the medical and occupational-health 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, Weigl and Kudielka, 2008). Our model also predicts that the principal gains from the stress susceptibility of the agent, whilst agents with greater stress susceptibility enjoy a lower utility at work.

Equipped with these theoretical predictions, we use the 2015 wave of the European Working Condition Survey (EWCS) to investigate the relationship between stress susceptibility (measured by work-related stress), effort (measured by work intensity) and incentive rewards (binary variable for receiving incentive pay). Whilst our data does not allow us to address possible endogeneity and/or reverse causality from effort to stress (e.g. self selection of agents into different types of jobs), they do provide some interesting insights. First, in line with the theoretical predictions, the data shows that the correlation between effort and susceptibility to stress is positive and always increasing in the level of work-related stress, especially when the worker receives incentive pay. In particular, low to intermediate/high levels of stress workers put more effort in the presence of incentive pay; while, on average, workers reporting high or very high levels of stress are overall less sensitive to incentive pay.

Second, empirically, the likelihood of receiving incentive pay is increasing in stress susceptibility. If we think of the use of incentive pay as involving some cost for the principal (cost of verifying the output, administrative costs, and costs of drafting the performance related contract), this is consistent with the theoretical result that incentive pay generates a more positive effect on the principal's payoff when stress susceptibility increases.

Third, consistently with the theoretical predictions, we find evidence that the heterogeneity in stress susceptibility due an imbalance between effort and reward is negatively associated with workers' subjective well-being: types with intermediate to high levels of susceptibility to stress are more likely to report lower job satisfaction.

The rest of the paper is organized as follows. In Section 2 we present the theoretical framework and the testable implications for the empirical analysis. In Section 3 we introduce data and variables that are used in Section 4 for the empirical analysis. Section 5 concludes.

2 Stress, Effort and Incentives

2.1 A Simple Model

We consider a risk-neutral agent employed by a risk-neutral principal to deliver some verifiable output, q. Output is stochastic and it is affected by the agent's unobservable effort a in the following way:

$$q = \begin{cases} \Delta & \text{with probability} \quad \pi(a) \in [0,1], \\ 0 & \text{with probability} \quad 1 - \pi(a), \end{cases}$$

with $\pi'(a) \geq 0, \pi''(a) \leq 0$. The cost of effort is denoted by $c(a)$ with $c'(a) \geq 0$ and $c''(a) \leq 0$.

The agent enjoys some nonmonetary private benefit $b \geq 0$ in case of good performance and receives an incentive pay $\tau(q)$, which comprises a base payment τ^L paid in case of bad performance ($q = 0$) and a bonus $\tau^H > \tau^L$ in case of good performance ($q = \Delta$). We assume that the agent is protected by limited liability, in the sense that monetary payments must be non-negative: $\tau^L, \tau^H \geq 0$.

We depart from the standard Principal-Agent theory by assuming that the agent suffers a loss, due to stress and illness risk, when he receives no monetary reward for the effort exerted; the loss increases with effort and with the agent's susceptibility to work-related stress, which we denote by $\theta \in [0, \bar{\theta}]$. θ can be interpreted also as a measure of how stressful the job is, or as a mix of characteristics of the job and of the individual (e.g. temperament traits). The agent does not suffer any loss when he does not exert effort and/or when he receives the monetary bonus, τ^H. Formally, the loss function is given by:

$$L(\theta, a, \tau(q)) = \begin{cases} \theta g(a) & \text{when } \tau(q) = \tau^L \text{ and } a > 0, \\ 0 & \text{when } \tau(q) = \tau^H \text{ and/or } a = 0. \end{cases}$$

The expression $\theta g(a)$ denotes the stress cost of an effort-reward imbalance. We assume: $g(0) = 0$ and $g'(a), g''(a) \geq 0, g'''(a) = 0$. Thus, the stress cost of bad performance is minimal when effort is zero and it is increasing and convex in effort. The expected utility of an agent with stress susceptibility θ is therefore:[3]

$$U(\theta) \equiv \pi(a)\tau^H + (1-\pi(a))\left[\tau^L - \theta g(a)\right] - c(a). \tag{1}$$

Effort generates three effects on the agent's expected utility:

1. *Incentive pay.* It increases the likelihood $\pi(a)$ of receiving the bonus τ^H beyond enjoying the nonmonetary benefits, b.

2. *Loss probability.* It reduces the likelihood $(1-\pi(a))$ of incurring the loss $\theta g(a)$.

3. *Loss size.* It increases the size of the loss $\theta g(a)$.

Compared to a standard Principal-Agent setting where only the first effect is present, effort-reward imbalance adds the second and third effect. In other words, if susceptibility to effort-reward imbalance were absent, i.e., if $\theta = 0$, we would go back to a standard Principal-Agent formulation where only the first effect is present.

To analyze the implications of stress susceptibility to effort-reward imbalance, we consider the choice of effort by the agent under the optimal incentive scheme. As anti-discrimination regulations forbid unequal pay based on individual characteristics, we assume that the incentive pay $\tau(q)$ must be invariant with respect to individual stress susceptibility, θ.

Maximizing the expected utility of the agent (ex. 1) with respect to a, we obtain the equilibrium level of effort $a^*(\theta) \equiv \min\{\hat{a}(\theta), \bar{a}\}$, where $\bar{a}$ denotes some maximal effort (for example the level of effort such that $\pi(a) = 1$) and $\hat{a}$ the interior solution to:[4]

$$\pi'(\hat{a})\left[b + \tau^H - \tau^L + \theta g(\hat{a})\right] - \left[1-\pi(\hat{a})\right]\theta g'(\hat{a}) - c'(\hat{a}) = 0, \tag{MH}$$

with

$$\frac{d\hat{a}\left(\theta, \tau^H, \tau^L\right)}{d\theta} = \frac{1}{-U''}\left[\pi'(\hat{a})\, g(\hat{a}) - (1-\pi(\hat{a}))\, g'(\hat{a})\right].$$

[3] Loss averse individuals evaluate losses relative to a reference point as more painful than equal-sized gains (see Koszegi and Rabin, 2006 and 2007). Our utility formulation shares some feature with the loss aversion framework, if we think of stress susceptibility as some degree of aversion to a loss that arises when reward is below expectation. However, our agents are not averse to pay dispersion, as in the loss aversion literature, and the loss does not arise when effort is zero.

[4] The second order condition is:

$$U'' \equiv \pi''(a)\left[b + \tau^H - \tau^L + \theta g(a)\right] + 2\theta g'(a) - \left[1-\pi(a)\right]\theta g''(a^*) - c''(a) \leq 0. \tag{SOC}$$

which is satisfied provided $\theta g'(a)$ is sufficiently small.

At the interior solution, more susceptible agents exert (weakly) greater effort if:

$$\frac{\pi'(\hat{a})}{1-\pi(\hat{a})} \geq \frac{g'(\hat{a})}{g(\hat{a})}. \tag{2}$$

When choosing his effort, the agent balances off two possibly conflicting targets: maximizing the expected reward and minimizing the loss due to stress. As in standard principal-agent models, greater effort increases the expected monetary reward. In addition, here effort also affects the expected loss due to the stress consequences of an effort-reward imbalance. In particular, on the one hand, by increasing the probability $\pi(a)$ of good performance, effort reduces the risk of incurring the loss $\theta g(a)$, thus generating a benefit $\pi'(a)\theta g(a)$ to the agent. On the other hand, greater effort raises the size of the loss $\theta g(a)$ suffered when bad performance realizes, and therefore generates an additional cost $(1-\pi(a))\theta g'(a)$ to the agent. Both effects increase with the agent's degree of stress susceptibility θ. However, when condition (2) holds, the former effect dominates: the stress consequences of an effort-reward imbalance makes more susceptible agents work harder not just in pursuit of higher income, but also indirectly to avoid the stress (and illness) consequences of weak performance.[5] As long as the private benefit or stress susceptibility are not too high to make the agent work at maximal effort even absent incentive pay, effort keeps increasing with the level of stress susceptibility of the agent.

To analyze the impact of stress susceptibility on the principal, consider the optimal incentive scheme. If the intrinsic benefit b is high enough that the equilibrium effort is $\bar{a}$ absent incentive pay, then clearly the principal will simply offer the agent a base salary to satisfy his participation constraint.[6] This will continue to hold, as long as the corner solution $\bar{a}$ is obtained for a wide range of values of θ. In the appendix, we derive an example where maximal effort is obtained for values of θ above a certain thresold, and thus for larger values of stress susceptibilty θ. Therefore, let us assume here that b is small enough that for a wide range of θs there is an interior solution to (MH). In this case, it is easy to show that, as in standard Principal-Agent setting, the principal minimizes the base reward, by setting $\tau^L = 0$.[7] Furthermore, the concavity of the utility function of the agent implies that when (MH) is satisfied then the agent's expected utility is non-negative and thus the participation constraint, $U(\theta) \geq 0$, is satisfied. Therefore, the

[5] Clearly, when (2) holds, effort is also greater than in standard moral hazard settings where $\theta = 0$.

[6] Note that $\hat{a}(\theta)$ increases with b :

$$\frac{d\hat{a}(\theta)}{db} = \frac{\pi'(\hat{a})}{-U''} \geq 0.$$

[7] If τ^L were positive, the principal could lower it, reduce proportionally τ^H and leave effort unchanged whilst saving on the expected pay.

optimal bonus simply maximizes the principal's expected payoff given by:

$$V\left(\tau^H,\theta\right) \equiv E_\theta \hat{a}\left(\theta,\tau^H\right)\left(\Delta-\tau^H\right),$$

which yields:

$$\tau^{H*} = \Delta - \frac{E_\theta \hat{a}\left(\theta,\tau^H\right)}{E_\theta \frac{\pi'\left(\hat{a}\left(\theta,\tau^H\right)\right)}{-U''}} < \Delta.$$

When (2) holds, and thus the agent responds to stress by working harder, the principal gains from the stress consequences of effort-reward imbalance:

$$\frac{dV\left(\theta\right)}{d\theta} = \left(\Delta-\tau^{H*}\right)\frac{E_\theta d\hat{a}\left(\theta\right)}{d\theta}.$$

Instead, more stress susceptible agents are always worse off, as (from 1):

$$\frac{dU\left(\theta\right)}{d\theta} = -\left(1-\pi\left(\hat{a}\right)\right)g\left(\hat{a}\left(\theta\right)\right) \leq 0.$$

Due to limited liability, in the presence of an incentive pay, the principal must give up an informational rent to the agent to incentivize his unobservable effort. By inducing the agent to work harder, for any given level of the monetary bonus, stress susceptibiity to effort-reward imbalance then reduces the size of this rent, benefiting the principal but hurting the agent. As an illustration, in the Appendix we provide a linear example.

2.2 Testable Implications

A number of testable hypothesis can be obtained from our theoretical framework. The first one relates to the relationship between stress susceptibility and effort, when (2) holds.

- *Hypothesis 1: Individuals who are more susceptible to stress exert weakly greater work effort, especially in presence of incentive pay.*

As we cannot observe individual susceptibility to stress but only the reported level of stress, we analyze this relationship considering the link between the level of work effort exerted by individuals and the level of work-related stress that they report (more details in the next section, when describing the data and the variables).

Our theoretical analysis also emphasizes that when stress susceptibility induces agents to work harder, the principal enjoys a greater payoff. This result is obtained assuming that an incentive pay scheme is available at no cost to the principal. However, if the adoption of an incentive scheme implied a fixed cost (e.g., administrative cost), the principal would be more likely to use it when the benefit is greater. This happens when stress susceptibility (as measured by work-related stress) is higher. This theoretical result suggests the following second prediction.

- *Hypothesis 2: Incentive pay is more likely when individuals report higher levels of stress susceptibility, unless effort is already maximal, absent incentive pay.*

The theoretical analysis finds that the stress-related consequences of effort-reward imbalance leads agents with higher stress susceptibility to enjoy a lower utility. Our third prediction is as follows.

- *Hypothesis 3: Conditional on effort and pay, the subjective well-being (e.g. job satisfaction) of individuals decreases with their degree of susceptibility to stress.*

In the next session we discuss how to operationalize the concepts of stress, effort, rewards and well-being, finding empirical proxies for these economic concepts.

3 Data and variables

3.1 Data

Our dataset consists of a pooled cross section of employees from the latest available 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; 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. Our final sample includes about 22,100 employees from across 35 countries.

3.2 Variables

The first set of variables measures 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. 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 work effort is not available. The problem of measurement can be solved 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).[8] We follow Green (2001a, 2001b, 2004) and construct a Work effort index that measures working time intensity on a 0 - 100 scale, obtained normalizing in that interval the sum of answers to five survey questions. Whenever needed, we invert the scoring of the items such that the effort index is increasing in work intensity. The questions ask 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? How often you work in free time to meet work demands (similar but 1 - 5 scale)? The latter captures overcommittment, a situation in which the agent is willing to minimize the probability of failures ($q = 0$) by providing a substantial amount of over effort with respect to standard job requiremets (Siegriest, 2002).

We proxy stress susceptibility by two variables that capture work-related stress. They are both categorical and asking workers to indicate on a 5 point ordered scale increasing in the level of stress (4 = always; 3 = most of the time; 2 = sometimes; 1 = rarely; 0 = never) the extent to which: (i) they experience stress at work; (ii) over last 12 months, they kept worrying about work when not working. None of the two measures is a perfect proxy for θ, but the use of both would minimise the informative loss.

As for Incentive Pay, the amount of rewards linked to individual performance is rarely

[8] Also Hamermesh and Lee (2007) define work effort as work intensity, in particular as the 'intensity' of working time, e.g. tight deadlines: given the number of hours spent at work, this excess of effort is costly for the individual. Avgoustaki and Frankort (2019) 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).

availble with survey data and EWCS makes no exception. We know if the worker's earnings from the main job include a fixed salary/wage and/or also additional variable pay. Each worker may receive more than one form of variable pay, which are not mutually exclusive. We use this information to define two dummies (1 = yes/0 = no) that summarize the reward structure. The first is for receiving basic salary/wage (Fixed pay), while the second for being rewarded with at least one of the following in addition to the base salary (Incentive Pay of any kind): (i) Piece rate or productivity pay; (ii) payments based on individual performance, (iii) on performance of the team/group/department, (iv) on the overall performance of the company, (v) on income from shares of the company. We also define two additional dummies that distinguish between incentive pay based on individual performance (Individual performance pay), i.e. (i) and (ii) as defined above; and on non-individual performance measures (Other performance pay), i.e. (iii) to (v) as defined above.

Finally, we capture U (utility from working) through a 0 to 4 ordered variable increasing in job satisfaction (on the whole, 0 = not at all satisfied, 1 = not very satisfied, 3 = satisfied, 4 = very satisfied with working conditions of the main job). With some caveats, categorical measures of reported job satisfaction have proved to be a reliable and reasonable proxy for work-related subjective well-being (see Judge and Klinger, 2008). In the empirical analysis we also control for a large number of factors that may confound associations between work effort, incentive pay and wellbeing (Avgoustaki 2016), such as additional work practices. Task rotation is a dummy (1 = yes; 0 = no) capturing whether an employee's job involves rotating tasks. 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 several hazards in the last two months.[9] 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. We also have information on payments for overtime (Paid overtime), as well as controls for workplace training.[10] Additional variables control for individual characteristics (tenure, education, occupation), firm attributes (industry dummies), public/private sector and country dummies.[11] Table 1 describes and presents summary statistics of the main vari-

[9] They are: (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.

[10] These are three dummy variables (1 = yes; 0 = no) for the types of training employees have undergone during the past 12 months: Employer-provided, Employee-funded, and On-the-job training.

[11] Net monthly earnings are available in the survey, but with many missing answers (about 5,000). We preferred to preserve the sample size and to exclude the information on wages from the empirical analysis. In any respect, wage effects are indirectly accounted for by age, education, sector, occupation dummies etc, that we include in our analysis. Sensitivity checks run on the restricted sample with non missing

ables used in the empirical analysis. As for our main variables of interests, few workers report having never or rarely suffered from stress at work (12% and 20% respectively), while most of workers report it occurs at least sometimes or most of the time (39% and 18% respectively). Only 11% of workers report to always suffer from it. As for the second stress susceptibility variable, keep on thinking to job-related worries while at home is less an issue. It does never or rarely happen in the 57% of cases issues, and it is always a problem only for the 4% of individuals. The pairwise unconditional correlation between the two work stress variables is 0.35, suggesting that they capture different features of work-related stress. The mean of the work effort index is around 37, which is intermediate in the 0 - 100 scale.[12] A fixed base salary is earned by 96% of the sample, while a little less of one third (30%) receives additional Incentive Pay components. Variable rewards are based on individual performance in the 23% of cases and on other performance measures by the 16.4%. Satisfied or very satisfied workers represent more than the 80% of the sample.

4 Empirical Analysis

Tables 2 to 5 provide the empirical evidence on the main implications of the theoretical model. Table 2 shows OLS results from a regression of susceptibility to work-related stress on work effort. The specification also includes controls for worker's age, country, industry, occupation, level of education and a set of variables capturing work organization. Since the values of the 0 - 100 effort scale has no direct interpretation, we standardize the original effort scale and interpret regression coefficients in standard deviations terms. For all tables, we acknowledge that reverse causality and simultaneity concerns, e.g. that high levels of stress are the consequence of high work intensity, prevent to interpret empirical results as causal. Rather, they will provide robust descriptive evidence about the relationships of interest or, at the best, higher bounds of true effects. Regressions also include fixed pay and variable pay dummies. As for variable pay, in Columns (1), (3) and (5) we control for the presence of Incentive pay of any kind. In the remaining columns, we distinguish between pay based on individual performance and on other performance measures. For the sake of brevity, we report only results for key variables.[13] Results show

earnings values (and controlling for log earnings) are qualitatively similar to the ones reported here and available upon request.

[12] A note of caution is that, since the effort index is an aggregation of ordinal variables, its interpretation in a cardinal sense may not be straighforward.

[13] Full result are available upon request from the authors. Overall, we find that job environment and organisation variables have little effects on the relationship between work stress and effort. This suggests that effort-reward imbalance motives underlying observed behaviours are general enough to apply to different work environments. More in detail, as expected, all of these variables are significant

Table 1: Variables' definition and summary statistics

Variable name	**Description**	**Range**	**Mean**	**Std.Dv.**
Work effort	Normalized sum of answers to: Does your job involve: A-working at a very high speed; B-working to tight deadlines? How often you: A-have to interrupt a task to make unforeseen tasks; B-work in free time to meet work demands? Have you enough time to make the job done?	0-100	36.902	18.895
Stress at work	Ordered scale for stress at work	0-4	1.963	1.137
0 = Never			0.12	0.325
1 = Rarely			0.198	0.398
2 = Sometimes			0.394	0.488
3 = Most of time			0.179	0.383
4 = Always			0.111	0.314
Worried at home for work issues	Ordered scale for keeping worrying about work when not working (last 12 months)	0-4	1.28	1.15
0 = Never			0.332	0.471
1 = Rarely			0.244	0.429
2 = Sometimes			0.279	0.448
3 = Most of time			0.104	0.305
4 = Always			0.042	0.201
Fixed pay	The remuneration includes fixed pay	0-1	0.964	0.19
Incentive pay (any kind)	The remuneration includes at least one of the following: Piece rate, Payments based on individual performance, Team/Department based pay, Profit or firm ownership sharing	0-1	0.302	0.461
Individual performance pay	Variable pay is based on individual performance: Piece rate and/or Payments based on individual performance	0-1	0.23	0.421
Other performance pay	Variable pay is based on non individual performance: Team/Department based pay and/or Profit and/or firm ownership sharing	0-1	0.164	0.37
Job satisfaction	Satisfaction with working conditions in main paid job (ordered)	0-3	2.001	0.699
0 = not at all sat.			0.033	0.178
1 = not very sat.			0.146	0.353
2 = satisfied			0.609	0.488
3 = very satisfied			0.212	0.409
Other controls				
Male	Dummy for males	0-1	0.533	0.499
Age (years)		15-65	41.63	11.80
Education	Highest attained schooling degree (ordered)	0-6	2.783	1.636
Hazard	normalized sum of answers to items for exposure to job hazards in last two months	0-100	17.7	15.513
Task rotation	Whether an employee's job involves rotating tasks	0-1	0.545	0.498
Teamwork	The job involves doing all or part of work in a team	0-1	0.631	0.483
N. observ.	22,120			

that more stressed workers exert on average greater effort, which, for both of our proxies, is monotonically increasing in the level of stress. For example (see Column (1) and (2)), as compared to workers who are never stressed by work, the level of effort of workers who feel such most of the time is one standard deviation higher. This value increases up to 1.2 standard deviations for workers always stressed. The effects are similar (see Column (3) and (4)) if we measure stress in terms of thinking about job-related issues while at home. If this happens all the time, workers are more stressed by 1 standard deviation than workers never worried. Column (5) and (6) show that the two proxies for θ capture complementary features of stress susceptibility: when used together they both maintain their explanatory power. In terms of matching between theory and empirical results, results of Table 2 suggest that (2) holds such that they are consistent with *Hypothesis 1* that high susceptible workers, i.e. those for whom well-being losses from effort-reward imbalance matter more, are more likely to develop a deep attitude towards effort: they work hard and establish a high commitment to the job. Overall, the statistical association between fixed pay and effort is (weakly) negative and in some cases statistically significant. Conversely, receiving incentive pay of any kind is associated with higher effort, by about 0.12 standard deviation. These results are consistent with standard economic models of incentives provision. They also show that, whenever used, pay based on individual performance is two times more correlated with worker's effort than pay based on more aggregate performance measures. Incentives are stronger when the link between workers' effort and reward is stronger.

In Table 3 we focus on the role that incentive pay plays in the relationship between work effort and work stress. In particular, following Hypothesis 1 we analyze to what extent the positive association between incentive pay and effort (pure intercept effect), observed in Table 2, is due to a differential effect of work stress on work effort by incentive pay (slope effect). To this purpose, we interact the incentive pay dummies with each category of the work stress variable. Results show that effort is monotonically increasing in work stress independently from the presence or not of incentive pay. Looking at the coefficients of the interaction terms (shown in panel 1 to 3), results show that workers who receive incentive pay exert additional effort with respect to the baseline, except when they are 'Always' stressed (see Columns (1) and (3)). In light of our theoretical model - and hence under incentive pay -, this seems to suggest that the sign of Eq. (2) may depend on θ: it is positive for low to intermediate/high levels of stress susceptibility and negative for highly susceptible workers. For the latter, perhaps, the additional cost

determinants of effort. Interestingly, and in line with the theoretical predictions, the correlation between the fixed component of labour income and work effort is statistically significant but rather low. Working in an hazardous environment is positively associated with effort. A one standard deviation increase in the hazard scale result in a 0.25 standard deviation increase in effort.

Table 2: Work effort and Work-related stress (OLS estimates)

	Dep.Variable: Work Effort					
	(1)	(2)	(3)	(4)	(5)	(6)
- Proxies for susceptibility to work-related stress (θ):						
1) Stress at work:						
Rarely	0.257***	0.257***			0.214***	0.214***
	(0.03)	(0.03)			(0.03)	(0.03)
Sometimes	0.574***	0.574***			0.471***	0.471***
	(0.03)	(0.03)			(0.03)	(0.03)
Most of time	1.034***	1.034***			0.866***	0.866***
	(0.04)	(0.04)			(0.04)	(0.04)
Always	1.205***	1.205***			0.992***	0.992***
	(0.06)	(0.06)			(0.05)	(0.05)
2) Worried when at home for work issues:						
Rarely			0.221***	0.221***	0.156***	0.156***
			(0.02)	(0.02)	(0.02)	(0.02)
Sometimes			0.489***	0.489***	0.334***	0.333***
			(0.03)	(0.03)	(0.02)	(0.02)
Most of the time			0.812***	0.811***	0.541***	0.541***
			(0.04)	(0.04)	(0.03)	(0.03)
Always			1.023***	1.022***	0.688***	0.687***
			(0.07)	(0.07)	(0.06)	(0.06)
- Pay variables:						
Fixed pay	−0.079**	−0.073**	−0.058	−0.047	−0.056*	−0.050
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)
Incentive pay (any kind)	0.124***		0.114***		0.114***	
	(0.02)		(0.02)		(0.02)	
Individ. perf. pay		0.117***		0.119***		0.109***
		(0.02)		(0.02)		(0.02)
Other perf. pay		0.066***		0.043**		0.056***
		(0.02)		(0.02)		(0.02)

Note: Number of observations: 22,120. Significance levels: *** 1%,**5%, *10%. Standardised OLS regression (coefficients are express in terms of standard deviations of the dependent variable). Standard errors of coefficients in parenthesis. Heteroskedastic-consistent standard errors are clustered by country. Estimates also include a constant term, gender and age dummies (35-49, 49+); country, industry, occupation, level of education dummies, training dummies, a dummy for being paid for overtime work, the Hazard index, a dummy for task rotation and one for teamwork.

generated by greater effort when a bad performance occurs more than compensate the benefits associated with the reduction in the risk of facing that loss.[14]

Finally, Table 3 also shows that this is true especially for rewards based on individual performance measures (see Columns (2) and (4)). It also reports that the link between workers stress and effort is somehow different when workers are rewarded by incentive pay based on 'other' (i.e. not individual pay for performance) performance measures. In this circumstance, 'Most of the time' and 'Always' stressed workers put on average additional effort.

Table 4 is an empirical assessment of Hypothesis 2 and shows the statistical association between the variables measuring work stress and incentive pay. We use a logit model and present results as odd ratios (i.e. the effect of a unit change in one explanatory variable on Prob(Incentive pay = 1)/Prob(Incentive pay = 0)).[15] We add a specification with a dummy for the work effort index being 0 (Columns from (3) and (4)). To save on space, we omit estimates that include both work stress variables.

Estimates in Columns (1) and (2) refer to a model of incentive pay of any kind; Columns (3) and (4) of incentive pay based on individual performance; Columns (5) and (6) presents estimates of a model for incentives based on 'other' performance pay. We include them for completeness and comparative purposes but we do not discuss them in detail, focusing on results from the first four columns. We first observe that there is a clear positive relationship between stress at work (as opposed to the baseline of being never stressed) and the likelihood of incentive pay, which is higher when the level of stress is bigger than the excluded category ('Never'): if stress happens 'Rarely', 'Sometimes' and 'Most of time' there is a 15 - 25% (depending on the stress variable) increase in the odds of incentive pay with respect to workers never stressed. Especially for rewards based on individual performances, this link is stronger for higher levels of stress. For example, in the case of a worker rarely stressed there is a 15% increase in the odds to receive individual performance pay as compared to an individual never stressed. This percentage goes up to 25% for workers stressed most of time or sometimes. In the case that workers' stress concerns being worried at home for work issues (see column 4), the odds to receive incentive pay are even bigger (almost 30% for sometimes or higher). When stress is very high ('Always') the odds are somehow lower than for intermediate stress levels, in both cases.

Results are broadly consistent with *Hypothesis 2*. The probability of incentive pay increases with stress, with the partial exception of workers 'Always' stressed (i.e. very

[14]see pag. 6 and the Appendix for a discussion about the occurrence non monotonicities of effort in θ

[15]An odds >1 by x decimal point (e.g. 1.20) means that a unit increase in the regressor makes Incentive pay relatively more likely by x percent (20 percent). An odds <1 (e.g. 0.7) is associated with a reduction in the relative likelihood by $1-x$ percent (30 percent).

Table 3: Work effort and Work-related stress by Incentive pay (OLS estimates)

Dep.Var: Work Effort	Proxies for Work-related stress susceptibility (θ): Stress at work		Worry for work issues	
	(1)	(2)	(3)	(4)
- Baseline coefficients (no Variable pay)				
Rarely	0.214***	0.216***	0.188***	0.191***
	(0.03)	(0.03)	(0.03)	(0.02)
Sometimes	0.549***	0.550***	0.458***	0.457***
	(0.03)	(0.03)	(0.03)	(0.03)
Most of the time	0.992***	0.991***	0.761***	0.759***
	(0.04)	(0.04)	(0.04)	(0.04)
Always	1.202***	1.199***	1.001***	0.996***
	(0.06)	(0.06)	(0.08)	(0.08)
- Interactions with Incentive pay variables				
Incentive pay (any kind)				
Rarely	0.150***		0.103***	
	(0.03)		(0.03)	
Sometimes	0.104***		0.092***	
	(0.02)		(0.03)	
Most of the time	0.129***		0.147***	
	(0.03)		(0.04)	
Always	0.021		0.060	
	(0.05)		(0.08)	
Variable pay based on individual performance				
Rarely		0.162***		0.121***
		(0.03)		(0.03)
Sometimes		0.109***		0.077**
		(0.02)		(0.03)
Most of the time		0.090**		0.113**
		(0.04)		(0.04)
Always		−0.058		−0.073
		(0.05)		(0.09)
Variable pay based on other performance				
Rarely		0.040		0.008
		(0.03)		(0.04)
Sometimes		0.037		0.066
		(0.02)		(0.05)
Most of the time		0.119***		0.130***
		(0.04)		(0.05)
Always		0.146**		0.230**
		(0.06)		(0.08)

Note: see Table 2. Here, estimates also include a dummy for fixed pay.

Table 4: Incentive pay and Work-related stress (Logit estimates - Odds Ratios)

Dep.Variable	Incentive pay (any kind)		Individ Perf. Pay		Other Perf. Pay	
	(1)	(2)	(3)	(4)	(5)	(6)
Proxies for susceptibility to work-related stress (θ):						
1) Stress at work:						
Rarely	1.121		1.154*		1.014	
	(0.08)		(0.10)		(0.08)	
Sometimes	1.188**		1.250***		0.987	
	(0.09)		(0.10)		(0.09)	
Most of time	1.184**		1.252**		1.007	
	(0.10)		(0.11)		(0.10)	
Always	1.134*		1.235***		0.943	
	(0.09)		(0.10)		(0.10)	
2) Worried when at home for work issues:						
Rarely		1.220***		1.178***		1.254***
		(0.08)		(0.07)		(0.09)
Sometimes		1.294***		1.288***		1.314***
		(0.07)		(0.07)		(0.10)
Most of time		1.240***		1.296***		1.093
		(0.07)		(0.09)		(0.08)
Always		1.264**		1.273**		1.373**
		(0.14)		(0.15)		(0.19)

Note: Number of observations: 22,120. Significance levels: *** 1%,**5%, *10%. Standard errors of Odds Ratios in parenthesis. Heteroskedastic-consistent standard errors are clustered by country. Estimates include the same set of controls of Table 2.

susceptible to stress and effort-reward imbalance), as their work effort is already maximal, making incentive pay ineffective. This is consistent with the results of Table 3: the ability of incentive pay policies to extract extra effort from workers who are 'Always' stressed appears rather limited, the likelihood they receive incentive pay is not dissimilar from that of intermediate workers with intermediate stress level, and perhaps lower.

Finally, Table 5 shows the job satisfaction implications of work stress. Results shown are in the form of odds ratios from an ordered logit model. We estimate two specifications. Columns (1) and (2) are the baseline. Columns (3) and (4) also include work effort (as a standardised measure) and the dummy for incentive pay (of any kind).

In light of the theoretical model, Columns (1) and (2) are a naive empirical proxy of optimal well-being at different values of θ. The empirical findings are consistent with *Hypothesis 3*: utility rents (net job satisfaction) decrease moving from low to high levels of work-related stress. For example, the odds of high job satisfaction (e.g. satisfaction equal to 3 with respect to lower levels) decreases by about 30% when work-related stress moves up one step from 'Never' to 'Rarely', and by a substantial 84% when we step up from the baseline to 'Always' (see column 1). Once we look at stress due to job worries, the qualitative picture is similar, but the reduction in the odds of high satisfaction is smaller: being always worried reduces the change of being very satisfied by around 70% (see column 2).[16]

Coefficients of Columns (1) and (2) combine the direct effect of stress susceptibility and effort-reward imbalance tastes on job satisfaction with the indirect effects through effort and incentives provision. By controlling for Work effort and Incentive pay, in Columns (3) and (4) we attempt to approximate $U(a, (\tau(q), \theta)$, which would allow to disentangle direct from indirect effects. Consistent with *Hypothesis 3*, effort reduces workers' well-being: a one standard deviation (20 points in the 0 - 100 scale) increase in effort is associated with a 30 - 35% reduction in the odds of being very satisfied. Once we control for effort, variable pay schemes are just additional rewards, which, unsurprisingly, positively contribute to job satisfaction (30% more in the odds of high satisfaction). We also find that if we (were able to) keep effort and incentives constant, more stressed workers would still be less likely to be very satisfied. For example, workers who spend most of the time at home thinking at job worries have an odds of being very satisfied which is 44% (1 - odds-ratio = 1 - 0.561 = 0.439) lower than workers who are never stressed. This suggests that the direct effect of stress susceptibility on well being is negative. We note that this correlation is smaller than that in Columns (1) and (2), where the odds ratio (direct plus indirect effects) goes up to 60% (1 - odds-ratio = 1 - 0.403 = 0.597). The 16% difference accounts for the

[16] About work-related controls, results are as expected, e.g. one standard deviation (about 15 points out of 100) increase in the hazard index reduces the odd of high satisfaction by 20%.

Table 5: Job satisfaction and Work-related stress (Ordered Logit estimates - Odds Ratios)

	Dep.Variable: Job satisfaction			
	(1)	(2)	(3)	(4)
Proxies for susceptibility to work-related stress (θ):				
1) Stress at work:				
Rarely	0.706***		0.765***	
	(0.04)		(0.04)	
Sometimes	0.429***		0.515***	
	(0.02)		(0.03)	
Most of time	0.228***		0.316***	
	(0.02)		(0.02)	
Always	0.165***		0.240***	
	(0.02)		(0.02)	
2) Worried when at home for work issues:				
Rarely		0.796***		0.868***
		(0.04)		(0.04)
Sometimes		0.579***		0.699***
		(0.03)		(0.04)
Most of time		0.403***		0.561***
		(0.04)		(0.05)
Always		0.330***		0.496***
		(0.05)		(0.06)
Effort			0.708***	0.642***
			(0.01)	(0.02)
Fixed pay			1.364***	1.334***
			(0.13)	(0.13)
Incentive pay			1.417***	1.431***
			(0.07)	(0.07)

Note: Number of observations: 22,120. Significance levels: *** 1%,**5%, *10%. Standard errors of Odds Ratios in parenthesis. Heteroskedastic-consistent standard errors are clustered by country. Estimates include the set of controls of Table 2.

indirect effect, which contributes to further reduce workers' subjective well-being. Also, this reduction is increasing in the level of stress. Since, according to estimates in Tables 2 and 3, more stressed workers put more effort and are more likely to get incentive pay, the evidence suggests that the indirect effect of effort more than compensate for that of incentive pay.

5 Conclusions

This paper constitutes a first attempt to bridge the economic theory of incentives with medical and occupational health studies on the causes and effects of stress at work. It shows that the stress and health consequences of incentive pay schemes can produce contrasting and surprising effects on workers' efforts and utility, and on the principal welfare. The empirical evidence shows that work effort is increasing in work-related stress, e.g. by 1.4 standard deviations comparing workers 'never' and 'always' stressed. We also find that, despite these differences in the level of effort, workers with very low and low susceptibility to stress have a similar probability to receive incentive pay. This probability is higher for intermediate to high stress susceptibility. Our findings also suggest that workers with intermediate to high levels of susceptibility to stress are also more likely to report lower job satisfaction (subjective well-being). For example, the odds of high job satisfaction decreases by about 85% when work-related stress is always experienced rather than never. While we are not claiming any causality of these results, we can interpret them as robust statistical associations that support the findings of the theoretical model, suggesting that when workers have heterogeneous levels of susceptibility to stress, effort-reward imbalance motivations matter for individual's well being and effort decisions.

On policy side, both the theoretical and empirical results warn that organizations may benefit from putting agents under stressful conditions, and that an heterogeneous susceptibility to effort-reward imbalance may result in inequality of opportunity even when agents are apparently rewarded the same.

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7 Appendix

Suppose that $\pi(a) = a$, $g(a) = a$; $c(a) = a^2$ and let θ be uniformly distributed over the interval $[0,1]$ with $\theta^{av} = 0.5$ denoting the average value. Condition (2) becomes:

$$\frac{1}{1-a} \geq \frac{1}{a},$$

which holds if $a \geq 0.5$. The agent's choice of effort solves:

$$a^* \equiv \arg\max_a U = \tau^L + a\left(b + \tau^H - \tau^L - \theta\right) - (1-\theta)\, a^2,$$

yielding:

$$a^*\left(\tau^H, \tau^L, \theta\right) \equiv \min\{\hat{a}\left(\tau^H, \tau^L, \theta\right), \bar{a}\}, \text{ where } \hat{a}\left(\tau^H, \tau^L, \theta\right) = \frac{b + \tau^H - \tau^L - \theta}{2(1-\theta)}, \bar{a} = 1. \tag{3}$$

The second order condition is satisfied, as $-2(1-\theta) \leq 0$.

with $\frac{\partial \hat{a}\left(\tau^H,\tau^L,\theta\right)}{\partial b} = \frac{1}{2(1-\theta)} > 0$ and $\frac{\partial^2 \hat{a}\left(\tau^H,\tau^L,\theta\right)}{\partial b \partial \theta} = \frac{1}{2(1-\theta)^2} > 0$ and with:

$$\begin{aligned}
\frac{\partial \hat{a}\left(\tau^H,\tau^L,\theta\right)}{\partial \theta} &= \frac{b+\tau^H-\tau^L-1}{2\left(1-\theta\right)^2}, \\
&= \frac{2\hat{a}-1}{2\left(1-\theta\right)}.
\end{aligned}$$

Thus, effort increases with the private benefit b at a rate that increases with the degree of stress susceptibility θ. Effort increases with stress susceptibility if $2\hat{a} > 1$. The principal chooses τ^H, τ^L to solve:

$$\begin{gathered}
\max E_\theta \left[a\left(\Delta-\tau^H\right)-\tau^L\right] \\
s.t.:\ (3) \\
a\left(b+\tau^H\right)+\left(1-a\right)\left(\tau^L-\theta a\right)-a^2 \geq 0, \\
\tau^H, \tau^L \geq 0,
\end{gathered}$$

which yields:

$$\begin{aligned}
\tau^{H*} &= \frac{1}{2}\left(\theta^{av}+\Delta-b\right), \\
\tau^{L*} &= 0.
\end{aligned}$$

Substituting for these values in the interior effort function (expression 3), we obtain:

$$\hat{a}\left(\theta\right) = \frac{\frac{1}{2}\left(\theta^{av}+\Delta+b\right)-\theta}{2\left(1-\theta\right)},$$

where $0 \leq \hat{a}\left(\theta\right) \leq 1$ provided that:

$$2-\theta \geq \frac{1}{2}\left(\theta^{av}+\Delta+b\right) \geq \theta.$$

The expected utility of an agent with stress susceptibility θ is therefore:

$$U\left(\theta\right) = a^*\left(\theta\right)\left(b+\tau^H-\theta\right)-\left(1-\theta\right)a^{*2}\left(\theta\right),$$

which is decreasing in θ, as:

$$\frac{dU\left(.\right)}{d\theta} = a^*\left(\theta\right)\left[-1+\theta a^*\left(\theta\right)\right] \leq 0.$$

The expected utility of the principal is instead given by:

$$\begin{aligned} V(\theta) &= a^*(\theta)\left(\Delta - \tau^{H*}\right) \\ &= a^*(\theta)\left(\Delta - \frac{1}{2}\left(\theta^{av} + \Delta - b\right)\right) \\ &= \frac{1}{2}a^*(\theta)\left(\Delta - \theta^{av} + b\right), \end{aligned}$$

which does not vary with θ if $a^* = \bar{a}$. For values such that $a^* = \hat{a}$:

$$\frac{dV(.)}{d\theta} = \frac{d\hat{a}(\theta)}{d\theta}\left(\Delta - \tau^{H*}\right) \begin{array}{ll} < 0 & \text{if } \hat{a}(\theta) < 0.5, \\ > 0 & \text{if } \hat{a}(\theta) > 0.5. \end{array}$$

and it therefore increases in stress susceptibility if the effort reward imbalance induces the agent to work harder.

Example. Let $b = 0, \Delta = 2$. The equilibrium effort is then: $a^*(\theta) \equiv \min\{\hat{a}(\theta), 1\}$ with:

$$\begin{aligned} \hat{a}(\theta) &= \left[\frac{\frac{1}{2}\left(\theta^{av} + \Delta\right) - \theta}{2(1-\theta)}\right]_{\Delta=2,\theta^{av}=0.5} \\ &= \frac{1.25 - \theta}{2(1-\theta)} > 0.5. \end{aligned}$$

and with $\hat{a}(\theta) \leq 1$ for $\theta \leq \frac{3}{4}$. As $\hat{a}(\theta)$ is strictly greater than 0.5, effort $\hat{a}(\theta)$ is increasing in θ.

The agent's expected utility for $\theta \leq \frac{3}{4}$, is therefore:

$$\begin{aligned} U(\hat{a}(\theta)) &= \left[\frac{\frac{1}{2}\left(\theta^{av} + \Delta\right) - \theta}{2(1-\theta)}\left(\frac{\Delta + \theta^{av}}{2} - \theta\right) - (1-\theta)\left(\frac{\frac{1}{2}\left(\theta^{av} + \Delta\right) - \theta}{2(1-\theta)}\right)^2\right]_{\Delta=2,\theta^{av}=0.5} \\ &= \frac{16\theta^2 - 40\theta + 25}{64(1-\theta)} \end{aligned}$$

which is strictly decreasing in θ for $\theta \leq \frac{3}{4}$. For $\theta > \frac{3}{4}$, $a^* = 1$ and the agent's utility is:

$$\begin{aligned} U(a^* = 1) &= \left[\left(\frac{\Delta + \theta^{av}}{2} - \theta\right) - (1-\theta)\right]_{\Delta=2,\theta^{av}=0.5} \\ &= 0.25. \end{aligned}$$

For $\theta \leq \frac{3}{4}$, the principal obtains:

$$\begin{aligned} V(\theta) &= a^*(\theta)\left(\Delta - \tau^H\right) \\ &= \left[\frac{\frac{1}{2}(\theta^{av} + \Delta) - \theta}{2(1-\theta)}\left(\Delta - \frac{1}{2}(\theta^{av} + \Delta)\right)\right]_{\Delta=2,\theta^{av}=0.5} \end{aligned}$$

which is strictly increasing in θ. For $\theta > \frac{3}{4}$, $a^* = 1$ and the principal obtains:

$$\begin{aligned} V(\theta) &= \left[\left(\Delta - \frac{1}{2}(\theta^{av} + \Delta)\right)\right]_{\Delta=2,\theta^{av}=0.5} \\ &= 0.75. \end{aligned}$$

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