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# ABSTRACT

## Worker Stress and Performance Pay: German Survey Evidence

While performance pay can benefit firms and workers by increasing productivity and wages, it has also been associated with a deterioration of worker health. The transmission mechanisms for this deterioration remain in doubt. We examine the hypothesis that increased stress is one transmission mechanism. Using unique survey data from the German Socio-Economic Panel, we find performance pay consistently and importantly associates with greater stress even controlling for a long list of economic, social and personality characteristics. It also holds in instrumental variable estimations accounting for the potential endogeneity of performance pay. Moreover, we show that risk tolerance moderates the relationship between performance pay and stress. The risk tolerant receiving performance pay suffer less stress than the risk averse.

**JEL Classification:** J33, I31, J32

**Keywords:** performance pay, worker health, stress, risk tolerance

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## 1. Introduction

Performance pay has traditionally been seen as aligning worker and firm objectives. Indeed, a series of studies have shown that performance pay is associated with both higher productivity and higher wages.[1] Yet, increasingly performance pay has also been seen as a cause of unintended deterioration of worker health as we will make clear. Less consensus exists over the transmission mechanisms driving the association between performance pay and health. We examine the hypothesis that stress is a mechanism through which performance pay causes a deterioration of health. Performance pay increases stress and stress harms health.

Our study uses German survey data to directly explore the link between performance pay and stress. We take for granted that stress damages health. Stress disturbs sleep, causes depression, weakens the immune system, is associated with high blood pressure, increased risk of heart failure and musculoskeletal disorders (Uchino et al. 2007 and Rohleder 2014 in general and Eurofound 2010 for Germany in particular). Even industrial accidents have been shown to be more likely and costly when related to stress (Perkins 1994).

Critically, the single largest source of stress is work. Work related stress generates more health complaints than any other source of stress including financial or family problems (CDC 1999). Healthcare expenditures in the US are nearly 50 percent greater for workers with high levels of stress (CDC 1999), workplace stress costs the UK economy around 1 percent of its GDP (Chandola 2010) and forty percent of all job turnover is due to stress (Hoel, et al 2001). Moreover, the prevalence and level of stress associated with work has been increasing in Europe for the last twenty years (Rigo et al. 2021). This also holds

for Germany where there are concerns that an intensification of work has contributed to the increase in health problems such as psychosomatic problems, burnout, and depression (Franke 2015, Wilken and Breucker 2000).

Stress can be caused not just by inherent work characteristics, but also by the social and managerial organization of work. Organizational characteristics generating stress include (but are not limited to) long hours worked, work overload, supervisory pressure, unclear job boundaries and duties, and the lack of individual control and decision making (Goh et al. 2015, Michie 2002). These organizational characteristics can be altered at varying costs and may bring varying degrees of stress reduction. Thus, in thinking about the potential role of performance pay, confirming an association with stress and identifying its magnitude becomes valuable in weighing whether it retains organizational and societal advantages on net.

Using the German Socio-Economic Panel (SOEP), we develop a composite measure of stress for individual workers. Despite including a wide variety of worker characteristics and known determinants of stress, we find performance pay consistently and importantly associates with greater stress. This remains true even controlling for a broad set of personality traits and economic and demographic characteristics. It also remains true in exploratory instrumental variable (IV) estimations accounting for the potential endogeneity of performance pay.

We find that risk tolerance appears to be associated with reduced stress in all these estimates, but we go on to examine it as an important moderating influence. We confirm that risk tolerance alone does not play a direct role, but that the interaction of risk tolerance with performance pay emerges as critical.

The risk tolerant who receive performance pay suffer less stress than the not risk tolerant. This finding suggests that performance pay may generate stress not just by increasing workload pressure and effort, the standard logic, but also by increasing income uncertainty. This pattern again remains in IV estimations controlling for the potential endogeneity of performance pay.

In what follows, we first set the stage by placing our work in the context of past examinations of the health consequences of performance pay. We emphasis the centrality of stress in these examinations even when it is not explicitly measured or used in empirical exercises. Section 3 presents our data and variables. Section 4 presents the results. Section 5 concludes.

## 2. Setting the Stage

Building from Adam Smith's (1776) concern that piece rates create incentives for workers to ruin their health by overworking themselves, a large literature examines the health consequences of performance pay. This literature stands beside survey and experimental evidence showing that performance pay increases productivity by aligning the interests of workers and firms (e.g., Lazear 2000). In an early examination, Foster and Rosenzweig (1994) show that agricultural workers paid by the piece expend sufficient extra effort that their basic physical health is measurably worse. Transitioning to piece rates increased accident rates among Swedish loggers (Sundstroem-Frisk 1984) and heart attacks among Canadian loggers (Toupin et al. 2007). Industrial accidents are more common for piece rate workers than time rate workers in India's fertilizer industry (Saha et al. 2004). US truck drivers paid by the mile have greater accident rates than those paid by the hour (Monaco and Williams 2000). A German steel plant

experienced increased sickness absence when it introduced production bonuses (Frick et al. 2003). Bender et al. (2012) use the European Working Conditions Survey to show that piece rates are associated with an increased risk of workplace injury. Artz and Heywood (2015) show that blue-collar workers in the US experience a higher risk of workplace injury when paid output-based pay (piece rates or bonuses). DeVaro and Heywood (2017) examine a representative set of workers and a broader measure of performance pay than just piece rates. They confirm greater sickness absence and physical ailments among UK workers at establishments using performance pay.

The literature studies more than absence and injury. Davis (2016) examines workers in Vietnamese clothing factories controlling for the factory's occupational safety and health compliance. She reports that piece rate workers report both *lower physical and emotional health*. In fact, piece rate payment is the strongest and most consistent determinant of poorer emotional health. This pattern is not unique to piece rates in developing countries. Bender and Theodossiou (2014) demonstrate a larger hazard of falling out of good self-reported health for UK workers receiving a very broad measure of performance pay (including bonuses, commissions and other more common white-collar performance pay). Sales workers demonstrate greater emotional exhaustion, the greater the performance pay component in compensation (Habel et al. 2021).

Dahl and Pierce (2020) examine the relationship between performance pay and prescription drug use in the Netherlands. The adoption of performance pay increases the use of anti-anxiety drugs and anti-depressants by four to six percent. They argue that performance pay induces stress and anxiety which harms mental health increasing the associated prescriptions. Self-medication may be

even more profound. Broad measures of performance pay strongly associate with the use of alcohol and drugs and with the intensity of use (see Artz et al. 2021, for US evidence and Baktash et al. 2021, for German evidence). Again, the untested notion is that such self-medication reflects the greater stress of jobs with performance pay.

Thus, stress sits behind much of the literature linking performance pay and employee health deterioration. Not surprisingly, there have been efforts to directly examine the link between performance pay and stress. Many of these have, again, focused on piece rates and have used experimental methods. Thus, in laboratory tests Cadsby et al. (2016) present experiments showing that piece rates increase self-reported stress among risk averse individuals. Allan et al. (2021) circumvent both self-selection and self-reporting problems with laboratory evidence showing that those on piece rates suffer higher stress as measured objectively by cortisol hormone levels. This mirrors an early field experiment in which Timio and Gentili (1976) randomly assigned confectioner workers to four days on either piece rates or hourly wages. They found elevated hormone levels among the piece rate workers.

While experimental studies provide valuable insights into the relationship between performance pay and stress, the results from stylized laboratory settings need to be complemented by survey studies examining performance pay in the real world. Experimental evidence is usually based on short-term settings. This gives rise to the question of how performance pay influences stress among long-term workers. On the one hand, workers may experience higher stress in their real working life as they receive performance pay over a much longer time. On the other hand, workers in real world settings may develop coping mechanisms

mitigating the influence of performance pay on stress. While we cannot identify such coping mechanisms, we do examine a representative sample of workers reflecting typical coping mechanisms. The purpose of our examination is not to measure the success of coping mechanisms, but to emphasize that – in contrast to laboratory settings – these mechanisms are reflected in real-world stress. Thus, it is important to examine the link between performance pay and stress using survey data.

However, survey studies so far have presented mixed evidence. Indeed, in their review of the organizational behavior literature, Ganster et al. (2007) call for more research citing studies indicating that worker well-being is both helped and hurt by performance pay. The apparent link to stress seems more firmly established for piece rates than that for other forms of performance pay. Yet, those working for piece rates are only a small share of those receiving some form of performance pay (see Jirjahn, 2002 and Parent, 2002). Moreover, broad measures of performance pay have been routinely associated with greater worker job satisfaction (Green and Heywood, 2008). Finally, the role of moderating factors such as risk preferences influencing the relationship between performance pay and stress remains an under-researched issue. Given the centrality of stress (often unmeasured) as the conduit through which performance pay damages health, further study is warranted.

Using the SOEP, we develop a measure of stress to be used as a dependent variable. We use a very broad measure of performance pay to test the association and include a wide variety of other known determinants of stress. We find a routine role for performance pay that survives a variety of alternative specifications as well as exploratory IV estimations to account for endogeneity.

Critically, we find risk tolerance has an important moderating influence. The stress associated with performance pay is greater for those who are risk tolerant. This goes to suggest that the uncertainty of performance pay helps create stress.

## 3. Data and Variables

### *3.1 Dataset*

We draw our data from the SOEP (Goebel et al. 2019). The SOEP is a large representative longitudinal survey of private households in Germany. Routine socio-economic and demographic questions are asked annually. Different 'special' topic questions appear in specific waves. For the empirical analysis, we use data from the waves 2004, 2008 and 2016 as they contain information on both performance pay and stress. We focus on employees aged 18 to 60 years. This reflects the typical working age population in Germany. We exclude apprentices, interviewees reporting zero working hours and marginally employed individuals (monthly earnings of below 450 Euros). These employees are unlikely to face a choice of sorting into performance pay. After retaining observations for which full information is available, the analysis is based on an unbalanced sample with 20,696 observations from 14,848 employees.

### *3.2 Stress*

Our measure of stress is built from seven relevant questions on the interviewee's feelings during the last four weeks. Four ask for worker introspection: (1) Feeling rushed or pressed for time (2) Feeling down and gloomy (3) Feeling calm and relaxed (4) Feeling energetic. Three require reflection on daily activities that may have been limited because of mental health or emotional problems: (5) Achieving

less at work or in everyday activities than planned (6) Carrying out work or everyday tasks less thoroughly than usual (7) Being in less contact with friends or relatives. The measure is consciously not based on questions focused on work as a work focus may identify work characteristics that play a small role in overall stress and so health. The questions and their mean responses are shown in Table 1 and, when necessary, are reordered so that greater stress is identified with a larger number. All measures reflect a five-point Likert scale from 0 to 4. These were summed and divided by seven to create a single scale of stress. The intercorrelation of the items is suitably high with a Cronbach's alpha of 0.83. The average stress level on the single combined scale is 1.22.

*3.3 Performance Pay*

The critical measure of performance pay follows from a two-stage question asking first if the worker is subject to regular and formalized performance appraisals. The specific question is: “Is your own performance regularly assessed by a superior as part of a formalized procedure?” Second, if the worker answers yes, he or she is asked whether the performance appraisal has consequences for his or her earnings; i.e., consequences for monthly gross wage, annual bonus, future wage growth and/or potential promotion. Building from Cornelissen et al. (2011) and Grund and Sliwka (2010), we use a broad indicator of performance-related pay. The dummy variable for performance pay equals 1 if a worker is subject to performance appraisal and the performance appraisal has any consequences for their earnings. Otherwise, it equals zero. In our sample, 26 percent of workers are subject to performance pay.

*3.4 Control Variables*

The data allows including a rich set of control variables for worker and job characteristics which may be potential determinants of stress. Table 2 provides the definitions and descriptive statistics of the explanatory variables. A recent death in the family is controlled for as is marital status, migration background, the presence of children, the number of people in the household, and whether the worker feels the current housing is appropriate for his or her household. We also control for job insecurity, a well known source of stress. Similarly, we control for the actual hours worked including overtime. We also account for general financial problems (e.g., poor retirement planning or debt problems) by including a dummy equal to 1 if the worker is concerned about his or her economic situation.

Furthermore, the regressions include an income measure to control for the fact that more highly paid jobs may involve greater responsibility and stress while recognizing that performance pay is typically associated with higher earnings (e.g., Booth and Frank 1999). Similarly, the years of education are controlled for. We also account for years of tenure and part-time status. Both variables may be associated with increased stress, but for very different reasons. Higher tenure usually involves greater rents for employees because of deferred compensation schemes or firm-specific human capital (Hutchens 1986). Thus, high tenured employees have more to lose. Part-time employees are often segregated into peripheral jobs with little prospect for advancement (Heywood et al. 2011). Moreover, variables for full-time, part-time and unemployment experience help capture the worker's labor market history.

We also include controls for age and gender. Age can play a role in stress as people face different stress-related situations over the life course and coping mechanisms also depend on age (Blanchflower 2021, Chen et al. 2018). Indeed, in their review of past studies, Griffiths et al. (2008) indicate that stress follows an inverse u-shape and peaks for workers in late middle-age. Women frequently report greater workplace stress (Gllysten and Palmer 2005). On the one hand, this may reflect discrimination or stereotyping at work. On the other hand, it may be due to higher conflicts with family responsibilities. Women often remain disproportionately responsible for family even when they work (Heywood and Jirjahn 2002).

Furthermore, we include a variety of personality indicators as control variables. We account for the classical Big Five personality traits – conscientiousness, extraversion, agreeableness, openness and neuroticism. The Big Five model is one of the most widely shared taxonomy of personality traits with predictive power for a series of life outcomes including labor market performance and health (Almlund et al. 2011). The Big Five personality traits have also been shown to play a consistent role in determining stress levels (Xin et al. 2017).

We also include a measure of locus of control. Past work has shown that those with an internal locus of control believe that they will benefit from performance appraisal. They sort into situations in which pay depends on their performance (Heywood et al. 2017). This same internal locus has also been associated with reduced stress as such workers feel they are in control of their own outcomes and much of stress is generated by feeling out of control (Bollini et al. 2004).

Risk preference is captured by an experimentally validated indicator of risk tolerance. It measures the willingness to take risks on an eleven-point Likert scale that ranges from "not at all willing to take risks" to "very willing to take risks" (Dohmen et al. 2011). Risk tolerant workers are more likely to sort into performance pay (Bandiera et al. 2015; Cornelissen et al. 2011; Grund and Sliwka 2010). We will examine whether risk tolerant workers have lower stress and whether risk tolerance plays a moderating role in the face of performance pay.

We also account for the region of the country, employment in the public sector, the two-digit occupation of the worker and the broad industry in which they work. Dummies are included to account for the three years of the survey included in our sample.

## 4. Results

### *4.1 Initial Estimates*

Table 3 provides initial estimates from two regression models. Column 1 presents an OLS estimation with errors clustered at the individual level. Column 2 presents a random effects estimation that helps control for unobserved heterogeneity when that heterogeneity is constant over time and not correlated with independent variables.

The results across the two regressions largely mirror each other with indicators of a recent death in the family and financial insecurity taking very large and statistically significant coefficients. By comparison, the receipt of performance pay has a smaller coefficient. It is associated with a statically significant increase in stress by 0.03 of a point in the stress scale. This magnitude

can be interpreted, in part, by comparing it to the significant coefficient on hours worked of 0.007. It suggests that the stress associated with our very broad measure of performance pay is equivalent to working an extra 4 to 5 hours a week. Alternatively, performance pay adds approximately the same stress as having children in the household. Thus, while not as major a statistical determinant as a recent death of a loved one, the role of performance pay is far from trivial.

The other controls indicate that skilled craftspeople and those working in services have greater stress. Confirming past evidence, stress follows an inverse u-shape in age peaking in the late 40s. Furthermore, stress is significantly higher for women. Education, tenure, part-time work and job insecurity are also positively associated with stress. By contrast, having a partner or spouse, migration background, the number of persons in household and a housing with appropriate size are negatively associated with stress. Personality also plays an important role. Neuroticism is a positive determinant of stress whereas conscientiousness, extraversion, agreeableness, internal locus of control and risk tolerance are negative determinants.

In Appendix Table A1, we provide the estimates on our key indicator of performance pay for different specifications of the control variables. In specification (1), we exclude the controls for industry, occupation, personality, working hours and income. In specifications (2) to (6), we respectively add controls for industry, occupation, personality, working hours and income to specification (1). The results show a significant association of performance pay and stress regardless of the specification of the control variables. The estimated

magnitude of that association is somewhat higher when personality traits are controlled for and somewhat lower when actual working hours are controlled for.

*4.2 The Issue of Endogeneity*

So far we have shown that the finding of a significant link between performance and stress is remarkably robust to different specifications and also holds in regressions which include a rich set of control variables. We recognize that the evidence on the role of performance pay may nonetheless suffer from endogeneity of performance pay. Despite the large set of control variables, there still may be unobserved factors influencing both stress levels and sorting into performance. The influence of performance pay on stress will be overestimated if the unobserved factors influence performance pay and stress positively or negatively in the same direction. The influence will be underestimated if the unobserved factors influence performance pay and stress in opposite directions.

A fixed effects model might stand as one approach to account for endogeneity. We do not pursue this approach for two reasons. First, our unbalanced data include a larger number of singleton observations which cannot be used for estimating within-person effects. Dropping the singleton observation substantially reduces the number of observations. Second, the fixed effects model can only address the problem of unobserved time-invariant influences, but not the problem of unobserved time-varying influences. Plümper and Troeger (2019) show that fixed effects estimates may even aggravate the bias due to omitted time-varying variables as dropping the between variation increases the influence of time-varying misspecification on parameter estimates.

Instead we use an IV approach to address the issue of endogeneity. The IV approach has the advantage that it accounts for both time-invariant and time-varying unobserved variables. A crucial requirement of IV estimations is an exclusion restriction; i.e., at least one variable that influences the key explanatory variable, but not the outcome variable. Finding convincing exclusion restrictions is always a matter of debate. Just-identifying exclusion restrictions are based on assumptions that cannot be formally tested (Heckman 2000, Keane 2010). They can only be justified by reasoning and an appeal to intuition. Hence, attempts to account for endogeneity should be largely viewed as exploratory and perhaps seen largely as robustness tests. We follow an instrumental variable strategy based on aggregation (for examples see Bilanakos et al. 2018; Cornelissen et al. 2011; Fisman and Svensson 2007; Lai and Ng 2014; Lee 2004; Machin and Wadhwani 1991, Woessman and West 2006 among others). We use the share of workers receiving performance pay calculated for 266 detailed 4-digit occupations as instrument. When calculating the share of those receiving performance pay for a worker's occupation, we exclude that worker. The share of workers receiving performance pay reflects the general propensity within a narrowly defined occupation that workers are on performance pay. For example, a high share of workers receiving performance pay within an occupation may indicate that worker output can be easily monitored for that occupation. This, in turn, increases the individual worker's probability of receiving performance pay (Bayo-Moriones et al. 2013).

The validity of the instrument requires that the share of workers with performance pay in the detailed occupation has no direct influence on the individual worker's stress level. Importantly, the validity of an instrument can

depend on the control variables included (Angrist and Pischke 2009). An instrument may be not valid per se but may be valid only after conditioning on covariates. The dataset enables us to include a rich set of controls. In particular note that our instrument allows us to still include the eleven broadly defined two-digit occupation dummies. Our control variables capture important aspects of the working conditions increasing confidence in the validity of the instrument. Thus, to the extent that we control for critical working conditions, we do not expect a direct influence of the instrument, but only an indirect influence through the individual worker's likelihood of receiving performance pay.

Table 4 shows the key results of a two-stage least squares (2SLS) and a random effects IV estimation. Both models show very similar results. In the first stage, the determinants of performance pay are estimated by a linear probability model. The first-stage estimations in columns (1) and (3) show that our instrumental variable is significantly associated with performance pay. The share of workers on performance pay within an occupation is a positive determinant of an individual worker's propensity of receiving performance pay. As shown by the robust *F* test and the Anderson-Rubin test, the hypothesis of a weak instrument is rejected.

In order to test for the exogeneity of performance pay, we added the residuals of the first-stage estimations as a further explanatory variable to specification in our initial stress regressions. The residuals took a significantly negative coefficient (-0.104 with a standard error of 0.054 in the OLS regression and -0.122 with a standard error of 0.053 in the random effects regression). Thus, the hypothesis of exogeneity is rejected and performance pay has to be considered as endogenous.[2] The negative sign of the coefficient suggests that the

unobserved factors influencing performance pay and stress are negatively correlated. For example, healthy and resilient workers may be more likely to sort into performance pay and, at the same time, healthy and resilient workers have lower stress levels.[3] If health and resilience are not sufficiently accounted for, our initial regressions underestimates the influence of performance pay on stress. The estimated coefficient on performance pay captures not only the true effect on stress, but also the effect of health and resilience which works in the opposite direction.

Thus, to account for the endogeneity of performance pay in the stress regression, we replace the variable for performance pay by the predicted values of performance pay obtained from the first-stage regression. As shown in columns (2) and (4), the estimated influence of performance pay on stress remains statistically significant and the magnitude of that influence is much larger when taking the issue of endogeneity into account. The 2SLS regression suggests an increase by 0.132 of a point in the stress scale and the random effects IV regression indicates an increase by 0.154 of a point in the stress scale. Comparing magnitudes, the estimated influence of performance on stress is now similar to the influence of the death of a loved one. Considering that the mean stress score in our sample is 1.223, performance pay is associated with an increase in stress of nearly 13 percent.

*4.3 The Moderating Role of Risk Tolerance*

We recognize that the relationship between performance pay and stress may vary with workers' circumstances and characteristics. In particular, a worker's risk attitude may play a moderating role. Performance pay brings with it various types

of risk for workers (Milgrom and Roberts 1992: pp. 207–208). First, workers' performance can be stochastic reflecting markets, production technology, health or weather. Second, performance measurement itself can be stochastic as subjective performance appraisals depend on superiors' idiosyncratic perceptions. Against this background, we hypothesize that the positive link between performance and stress should be stronger for workers with a lower degree of risk tolerance.

In order to test this hypothesis, we include a variable for the interaction of performance pay and risk attitude in our regressions. Table 5 shows the key results of OLS and random effects regressions. Performance pay emerges with a significantly positive coefficient whereas the interaction variable takes a significantly negative coefficient. This result fits our hypothesis that the income risk associated with performance pay is particularly stressful for workers with low risk tolerance.

Table 6 presents 2SLS and random effects IV regressions in which we not only instrument performance pay, but also the interaction variable. The regressions confirm the key pattern of results. The variable for performance pay continues to take a significantly positive coefficient and the interaction variable a significantly negative coefficient. Using the random effects IV estimates, we can illustrate the results quantitatively. For a worker with zero risk tolerance (a highly risk-averse worker), performance pay is associated with an increase in stress by 0.257 of a point in the stress scale. This is a very substantial influence. Given that the mean stress score is 1.223, this is an increase in stress by more than 20 percent. For a worker with maximum risk tolerance (the highest point of the scale is 10), performance pay involves a much smaller increase in stress by

only 0.047 of point in the stress scale. Taking again the mean stress score into account, this is an increase by roughly 4 percent.

Finally, we examine whether the influence of performance pay and its interaction with risk attitude depends on the type of performance pay. We distinguish between two types of performance pay – performance pay with shorter term financial consequences (consequences for monthly gross wage or annual bonus) and performance pay with longer term financial consequences (consequences for future wage growth or potential promotion). We estimate the influences of the two types one at a time relative to the reference group of workers without any performance pay (and respectively exclude observations with the other type).

Table A2 shows the results of OLS and random effects estimations. The estimations show similar results for both types of performance pay. The variable for the respective type of performance pay takes a significantly positive coefficient and the variable for the interaction with risk tolerance takes a significantly negative coefficient. Table A3 provides the results of 2SLS and random effects IV regressions. This exercise confirms the key pattern of results. While the coefficient on the interaction of risk tolerance and performance pay with short-term consequences is no longer significant in these regressions, this simply reflects increased standard errors – a problem that often arises in IV estimations. Altogether, we find a similar pattern of results when distinguishing between performance pay with short-term and long-term financial consequences.

## 5. Conclusions

We use unique data to examine the role of performance pay in generating stress among workers. Both OLS and random effect estimates confirm an important role as the broad measure of performance pay is associated with substantially elevated stress levels. This persists in regressions including a long list of detailed controls. It also persists in IV robustness checks. Both the endogeneity test and the IV estimates suggest that the OLS and random effect estimates were too small. The actual influence emerges as larger in the IV estimates with a double-digit percentage increase in the stress index associated with performance pay.

Importantly, we uniquely show that risk tolerance mediates the relationship between performance pay and stress. For the least risk tolerant, performance pay clearly ranks as among the very most important determinants of stress. This indicates that performance pay generates stress not just by increasing expectations, effort, and work speed but also by placing earnings at risk.

Isolating this role of financial risk deserves more emphasis. Future work using other data might try to introduce specific measures of the extent of financial risk associated with various types of performance pay. This could allow a direct measure of stress cost of the financial risk of performance pay that is separate from the influence of effort and work speed.

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**Table 1:** Components of Stress

| *Item* | *Definition (mean, std. dev.)* |
|---|---|
| Item 1 | Feel rushed or pressed for time (2.146, 0.936). |
| Item 2 | Feel down and gloomy (1.356, 0.938). |
| Item 3 | Feel calm and relaxed (2.370, 0.811). |
| Item 4 | Feel energetic (2.159, 0.836). |
| Item 5 | Feel that due to mental health or emotional problems, you achieved less than you wanted to at work or in everyday activities (0.582, 0.851). |
| Item 6 | Feel that due to mental health or emotional problems you carried out your work or everyday tasks less thoroughly than usual (0.485, 0.755). |
| Item 7 | Feel that due to physical or mental health problems you were limited socially, that is, in contact with friends, acquaintances, or relatives (0.521, 0.827). |
| Stress | Score of emotional/mental stress constructed by adding up items 1–7. Items 3 and 4 are recoded in inverse order before adding up. The sum of items is divided by 7. (1.223, 0.594). |

*N* = 20696. The introduction to items 1-7 is "During the last four weeks, how often did you feel the following?" Interviewees respond to each statement on a five-point Likert scale ranging from 0 "never" to 4 "always".

**Table 2:** Definitions and Descriptive Statistics of the Explanatory Variables

| *Variable* | *Definition (mean, std. dev.)* |
|---|---|
| Performance pay | Dummy equals 1 if the worker faces a regular performance appraisal that has consequences for his or her earnings (0.2595, 0.438). |
| Performance pay share by occupation | The share of workers receiving performance pay calculated for 266 detailed four-digit occupations excluding the worker's own contribution to the share for each survey year (0.2597, 0.193). |
| Age | The worker's age by years ranging from 18 to 60 (43.024, 9.725). |
| Female worker | Dummy equals 1 if the worker is a woman (0.484, 0.500). |
| Married | Dummy equals 1 if the worker is married (0.645, 0.479). |
| Partner | Dummy equals 1 if the worker has a partner, but is not married (0.211, 0.408). |
| Migration background | Dummy equals 1 if the worker is a first-generation or second-generation immigrant (0.185, 0.389). |
| Children in HH | Dummy equals 1 if there are children under 16 years in the household (0.426, 0.494). |
| Size of HH | The number of persons in the household (2.965, 1.283). |
| Bereaved | Dummy equals 1 if the worker's partner/spouse, father, mother, child or a household member died recently (0.027, 0.162). |
| Fit dwelling | Dummy equals 1 if the worker thinks that the total size of their dwelling is just right for their household (0.718, 0.450). |
| Education | The worker's years of education ranging from 7 to 18 years (12.825, 2.718). |
| Job insecurity | Dummy equals 1 if the worker is somewhat concerned or very concerned about his or her job security (0.503, 0.500). |
| Financial insecurity | Dummy equals 1 if the worker is somewhat concerned or very concerned about his or her own economic situation (0.698, 0.459). |
| Public sector | Dummy equals 1 if the worker is employed in the public sector (0.293, 0.455). |
| Tenure | The number of years the worker is with their current firm (11.263, 9.806). |
| Log of income | Natural log of net income received last month (7.339, 0.589). |
| Working hours | The number of weekly hours the worker actually works including possible over-time (38.951, 10.683). |
| Full time experience | The worker's total length of full-time employment experience in years (16.019, 10.740). |
| Part time experience | The worker's total length of part-time employment experience in years (3.227, 5.656). |
| Unemployment experience | The worker's total length of unemployment experience in years (0.573, 1.559). |
| Part time | Dummy equals 1 if the worker is employed part-time (0.250, 0.433). |
| East Germany | Dummy equals 1 if the worker resides in one of the federal states located in East Germany (Berlin, Brandenburg, Mecklenburg-West Pomerania, Saxony, Saxony-Anhalt, Thuringia) (0.245, 0.430). |
| Southern West Germany | Dummy equals 1 if the worker resides in one of the Southern federal states located in West Germany (Bavaria, Baden-Wuerttemberg) (0.280, 0.449). |
| Northern West Germany | Dummy equals 1 if the worker resides in one of the Northern federal states located in West Germany (Schleswig-Holstein, Hamburg, Lower Saxony, Bremen) (0.143, 0.350). |
| Risk tolerance | Score of risk tolerance. The interviewee answers the question: "Are you generally willing to take risks or do you try to avoid taking risks?" on an eleven-point Likert scale. The scale ranges from 0 "not at all willing to take risks" to 10 "very willing to take risks" (4.810, 2.217). |
| Conscientiousness | Score of conscientiousness constructed from adding up three survey items measured on a seven-point Likert scale ranging from 1 "does not apply to me at all" to 7 "applies to me perfectly". The sum of items is divided by 3. The items are: I see myself as someone who… "does a thorough job", "does things effectively and efficiently", "tends to be lazy". The last item was recoded in inverse order before adding up. (5.919, 0.857). |

| | |
|---|---|
| Extraversion | Score of extraversion constructed from adding up three survey items measured on a seven-point Likert scale ranging from 1 “does not apply to me at all” to 7 “applies to me perfectly”. The sum of items is divided by 3. The items are: I see myself as someone who… “is communicative”, “is sociable”, “is reserved”. The last item was recoded in inverse order before adding up. (4.862, 1.133). |
| Agreeableness | Score of agreeableness constructed from adding up three survey items measured on a seven-point Likert scale ranging from 1 “does not apply to me at all” to 7 “applies to me perfectly”. The sum of items is divided by 3. The items are: I see myself as someone who… “is sometimes somewhat rude to others”, “has a forgiving nature”, “is considerate and kind to others”. The first item was recoded in inverse order before adding up. (5.344, 0.957). |
| Openness | Score of openness constructed from adding up three survey items measured on a seven-point Likert scale ranging from 1 “does not apply to me at all” to 7 “applies to me perfectly”. The sum of items is divided by 3. The items are: I see myself as someone who… “is original ”, values artistic experiences”, “has an active imagination”. (4.514, 1.150). |
| Neuroticism | Score of neuroticism constructed from adding up three survey items measured on a seven-point Likert scale ranging from 1 “does not apply to me at all” to 7 “applies to me perfectly”. The sum of items is divided by 3. The items are: I see myself as someone who… “worries a lot”, “gets nervous easily”, “deals well with stress”. The last item was recoded in inverse order before adding up. (3.763, 1.200). |
| Locus of control | Score of locus of control constructed from adding up eight items measured on a seven-point Likert scale ranging from 1 “disagree completely” to 7 “agree completely”. The sum of items is divided by 8. The items are “How my life takes course is dependent on me”, “Success is gained through hard work”, “Compared to others, I have not achieved what I deserve”, “What one achieves in life is, in the first instance, a question of destiny or luck”, “I often experience that others have a controlling influence over my life”, “When I encounter difficulties in my life, I often doubt my own abilities”, “The opportunities that I have in life are determined by the social conditions” and “I have little control over things that happen in my life”. Items 4–8 are recoded in inverse order before adding up (4.958, 0.800). |
| Industry dummies | Six broad industry dummies for manufacturing, construction, trade, transport, banking/insurance and services (reference group: agriculture, energy and mining) |
| Occupation dummies | Eleven broad two-digit occupation dummies for semi-skilled blue-collar, skilled blue-collar, blue-collar foreman/forewoman, blue- and white-collar master craftsperson, semi-skilled white-collar, skilled white-collar, highly skilled white-collar, white-collar with extensive managerial duties, middle-level civil servant, upper-level civil servant and executive-level civil servant (reference group: unskilled blue-collar, unskilled-white-collar and lower-level civil servant). |
| Year dummies | Two dummies for the years 2008 and 2016 (reference year: 2004). |

N = 20696. For the performance pay share by occupation, the number of observations is equal to 20606.

**Table 3:** Determinants of Stress

| | *(1)*<br>*OLS* | *(2)*<br>*RE* |
|---|---|---|
| Performance pay | 0.030*** | 0.028*** |
| | (0.009) | (0.009) |
| Age | 0.009** | 0.008** |
| | (0.004) | (0.003) |
| Age-squared | -0.0001*** | -0.0001** |
| | (0.00004) | (0.00004) |
| Female worker | 0.107*** | 0.112*** |
| | (0.011) | (0.011) |
| Married | -0.048*** | -0.054*** |
| | (0.013) | (0.013) |
| Partner | -0.028** | -0.038*** |
| | (0.014) | (0.013) |
| Migration background | -0.081*** | -0.085*** |
| | (0.011) | (0.011) |
| Children in HH | 0.036*** | 0.035*** |
| | (0.011) | (0.011) |
| Size of HH | -0.010** | -0.008** |
| | (0.004) | (0.004) |
| Bereaved | 0.130*** | 0.121*** |
| | (0.024) | (0.023) |
| Fit dwelling | -0.072*** | -0.065*** |
| | (0.008) | (0.008) |
| Education | 0.004* | 0.004** |
| | (0.002) | (0.002) |
| Job insecurity | 0.084*** | 0.085*** |
| | (0.009) | (0.009) |
| Financial insecurity | 0.175*** | 0.167*** |
| | (0.009) | (0.009) |
| Tenure | 0.002*** | 0.002*** |
| | (0.001) | (0.001) |
| Log of income | -0.013 | -0.016 |
| | (0.013) | (0.013) |
| Working hours | 0.007*** | 0.007*** |
| | (0.001) | (0.001) |
| Full time experience | 0.001 | 0.001 |
| | (0.001) | (0.001) |
| Part time experience | 0.002 | 0.002 |
| | (0.001) | (0.001) |
| Unemployment experience | 0.002 | 0.002 |
| | (0.003) | (0.003) |
| Part time | 0.072*** | 0.072*** |
| | (0.016) | (0.016) |
| East Germany | -0.022** | -0.026** |
| | (0.011) | (0.011) |
| Southern West Germany | 0.012 | 0.008 |
| | (0.010) | (0.010) |
| Northern West Germany | -0.036*** | -0.035*** |
| | (0.013) | (0.012) |
| Risk tolerance | -0.004* | -0.005*** |
| | (0.002) | (0.002) |
| Conscientiousness | -0.037*** | -0.038*** |
| | (0.005) | (0.005) |

| | | |
|---|---|---|
| Extraversion | -0.012*** | -0.012*** |
| | (0.004) | (0.004) |
| Agreeableness | -0.028*** | -0.027*** |
| | (0.004) | (0.004) |
| Openness | 0.004 | 0.005 |
| | (0.004) | (0.004) |
| Neuroticism | 0.142*** | 0.133*** |
| | (0.004) | (0.004) |
| Locus of control | -0.101*** | -0.096*** |
| | (0.006) | (0.005) |
| Public sector | 0.021* | 0.024** |
| | (0.011) | (0.011) |
| Manufacturing | 0.031 | 0.030 |
| | (0.026) | (0.025) |
| Construction | -0.017 | -0.019 |
| | (0.030) | (0.029) |
| Trade | 0.026 | 0.028 |
| | (0.027) | (0.027) |
| Transport | 0.026 | 0.021 |
| | (0.030) | (0.029) |
| Banking/Insurance | 0.045 | 0.044 |
| | (0.030) | (0.030) |
| Services | 0.045* | 0.047* |
| | (0.026) | (0.025) |
| Semi-skilled blue-collar | -0.030* | -0.022 |
| | (0.018) | (0.018) |
| Skilled blue-collar | -0.024 | -0.017 |
| | (0.017) | (0.017) |
| Blue-collar foreman/forewoman | 0.024 | 0.016 |
| | (0.031) | (0.030) |
| Blue- and white-collar master craftsperson | 0.112*** | 0.096*** |
| | (0.036) | (0.035) |
| Semi-skilled white-collar | -0.011 | -0.009 |
| | (0.023) | (0.022) |
| Skilled white-collar | -0.007 | -0.010 |
| | (0.014) | (0.014) |
| Highly skilled white-collar | 0.031* | 0.029 |
| | (0.018) | (0.018) |
| White-collar with managerial duties | 0.043 | 0.040 |
| | (0.030) | (0.030) |
| Middle-level civil servant | 0.019 | 0.032 |
| | (0.033) | (0.032) |
| Upper-level civil servant | 0.043* | 0.039 |
| | (0.026) | (0.026) |
| Executive-level civil servant | 0.009 | -0.001 |
| | (0.031) | (0.030) |
| Year 2008 | 0.012 | 0.011 |
| | (0.009) | (0.008) |
| Year 2016 | -0.036*** | -0.031*** |
| | (0.009) | (0.009) |
| $R^2$ | 0.2420 | 0.2416 |
| Number of observations | 20696 | 20696 |
| Number of employees | 14891 | 14891 |

The table shows the estimated coefficients. Standard errors in parenthesis are clustered at the individual level. * Statistically significant at the 10% level; ** at the 5% level; *** at the 1% level.

**Table 4:** Determinants of Stress; the Issue of Endogeneity

| | *2SLS* | | *RE IV* | |
|---|---|---|---|---|
| | *(1) Performance pay* | *(2) Stress* | *(3) Performance pay* | *(4) Stress* |
| Performance pay | --- | 0.132** (0.054) | --- | 0.154*** (0.057) |
| Performance pay share by occupation | 0.460*** (0.021) | --- | 0.430*** (0.021) | --- |
| $R^2$ | 0.1925 | 0.2376 | 0.1922 | 0.2347 |
| Robust F test | 470.713*** | --- | --- | --- |
| Anderson-Rubin test statistic | 5.97 ** | --- | --- | --- |
| Number of observations | 20606 | 20606 | 20606 | 20606 |
| Number of employees | 14848 | 14848 | 14848 | 14848 |

The table indicates the estimated coefficients. Standard errors in parenthesis are clustered at the individual level. ** Statistically significant at the 5% level; *** at the 1% level. Control variables are included, but suppressed to save space.

**Table 5:** Determinants of Stress; Interaction of Performance Pay and Risk Tolerance

| | *(1)*<br>*OLS* | *(2)*<br>*RE* |
|---|---|---|
| Performance pay | 0.085*** | 0.079*** |
| | (0.023) | (0.022) |
| Performance pay x risk tolerance | -0.011*** | -0.010*** |
| | (0.004) | (0.004) |
| Risk tolerance | -0.001 | -0.003 |
| | (0.002) | (0.002) |
| $R^2$ | 0.2423 | 0.2419 |
| Number of observations | 20696 | 20696 |
| Number of employees | 14891 | 14891 |

The table shows the estimated coefficients. Standard errors in parenthesis are clustered at the individual level. *** Statistically significant at the 1% level. Control variables are included, but suppressed to save space.

**Table 6:** Determinants of Stress; Interaction of Performance Pay and Risk Tolerance; the Issue of Endogeneity

| | *(1)*<br>*2SLS* | *(2)*<br>*RE IV* |
|---|---|---|
| | *Stress* | |
| Performance pay | 0.237*** | 0.257*** |
| | (0.086) | (0.087) |
| Performance pay x risk tolerance | -0.022* | -0.021* |
| | (0.012) | (0.012) |
| Risk tolerance | 0.001 | -0.0004 |
| | (0.004) | (0.004) |
| $R^2$ | 0.2378 | 0.2349 |
| | *Performance pay* | |
| Performance pay share by occupation | 0.436*** | 0.422*** |
| | (0.043) | (0.041) |
| Performance pay share by occupation x risk tolerance | 0.005 | 0.002 |
| | (0.008) | (0.007) |
| $R^2$ | 0.1925 | 0.1923 |
| Robust F test | 235.50*** | --- |
| | *Performance pay x risk tolerance* | |
| Performance pay share by occupation | -1.703*** | -1.694*** |
| | (0.184) | (0.180) |
| Performance pay share by occupation x risk tolerance | 0.795*** | 0.759*** |
| | (0.044) | (0.043) |
| $R^2$ | 0.2335 | 0.2333 |
| Robust F test | 226.74*** | --- |
| Number of observations | 20606 | 20606 |
| Number of employees | 14848 | 14848 |

The table shows the estimated coefficients. Standard errors in parenthesis are clustered at the individual level. * Statistically significant at the 10% level; *** at the 1% level. Control variables are included, but suppressed to save space.

## Appendix

**Table A1:** Alternative Specifications

| | *(1) Without controls for industry, occupation, personality traits, working hours and log of income* | | *(2) Specification (1) plus controls for industry* | | *(3) Specification (1) plus controls for occupation* | |
|---|---|---|---|---|---|---|
| | *OLS* | *RE* | *OLS* | *RE* | *OLS* | *RE* |
| Performance pay | 0.027*** (0.010) | 0.023** (0.009) | 0.028*** (0.010) | 0.023** (0.009) | 0.023** (0.010) | 0.019** (0.009) |
| $R^2$ | 0.1017 | 0.1012 | 0.1022 | 0.1017 | 0.1027 | 0.1022 |
| Number of observations | 20696 | 20696 | 20696 | 20696 | 20696 | 20696 |
| Number of employees | 14891 | 14891 | 14891 | 14891 | 14891 | 14891 |
| | *(4) Specification (1) plus controls for personality* | | *(5) Specification (1) plus control variable for working hours* | | *(6) Specification (1) plus control variable for log of income* | |
| | *OLS* | *RE* | *OLS* | *RE* | *OLS* | *RE* |
| Performance pay | 0.040*** (0.009) | 0.036*** (0.009) | 0.022** (0.010) | 0.018** (0.009) | 0.023** (0.010) | 0.020** (0.009) |
| $R^2$ | 0.2333 | 0.2329 | 0.1078 | 0.1074 | 0.1019 | 0.1015 |
| Number of observations | 20696 | 20696 | 20696 | 20696 | 20696 | 20696 |
| Number of employees | 14891 | 14891 | 14891 | 14891 | 14891 | 14891 |

The table shows the estimated coefficients. Standard errors in parenthesis are clustered at the individual level. ** Statistically significant at the 5% level; *** at the 1% level. Control variables are included, but suppressed to save space.

**Table A2:** Determinants of Stress; Types of Performance Pay and Risk Tolerance

| | *(1)*<br>*OLS* | *(2)*<br>*RE* | *(3)*<br>*OLS* | *(4)*<br>*RE* |
|---|---|---|---|---|
| Performance pay with short-term consequences | 0.095*** | 0.082*** | --- | --- |
| | (0.028) | (0.026) | | |
| Performance pay with short-term consequences x risk tolerance | -0.012** | -0.010** | --- | --- |
| | (0.005) | (0.005) | | |
| Performance pay with long-term consequences | --- | --- | 0.077*** | 0.073*** |
| | | | (0.027) | (0.025) |
| Performance pay with long-term consequences x risk tolerance | --- | --- | -0.011** | -0.011** |
| | | | (0.005) | (0.004) |
| Risk tolerance | -0.001 | -0.003 | -0.001 | -0.003 |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| $R^2$ | 0.2416 | 0.2412 | 0.2436 | 0.2432 |
| Number of observations | 18908 | 18908 | 19381 | 19381 |
| Number of employees | 13913 | 13913 | 14260 | 14260 |

The table shows the estimated coefficients. Standard errors in parenthesis are clustered at the individual level. ** Statistically significant at the 5% level; *** at the 1% level. Control variables are included, but are suppressed to save space. The dummy for performance pay with short-term consequences equals 1 if performance appraisals have consequences for annual bonus or monthly gross wage. The dummy for performance pay with long-term financial consequences equals 1 if performance appraisals have consequences for future wage growth or promotion. For each dummy, the reference group consists of workers who are not subject to performance appraisals with financial consequences. The influences of the two types are estimated one at a time. Observations with the other type are respectively excluded from the regressions.

**Table A3:** Determinants of Stress; Types of Performance Pay and Risk Tolerance; the Issue of Endogeneity

| | *(1)*<br>*2SLS* | *(2)*<br>*RE IV* | *(3)*<br>*2SLS* | *(4)*<br>*RE IV* |
|---|---|---|---|---|
| Performance pay with short-term consequences | 0.278** | 0.284** | --- | --- |
| | (0.119) | (0.118) | | |
| Performance pay with short-term consequences x risk tolerance | -0.015 | -0.014 | --- | --- |
| | (0.017) | (0.017) | | |
| Performance pay with long-term consequences | --- | --- | 0.306*** | 0.325*** |
| | | | (0.095) | (0.095) |
| Performance pay with long-term consequences x risk tolerance | --- | --- | -0.030** | -0.029** |
| | | | (0.013) | (0.013) |
| Risk tolerance | -0.001 | -0.002 | 0.002 | 0.001 |
| | (0.004) | (0.004) | (0.003) | (0.003) |
| $R^2$ | 0.2311 | 0.2301 | 0.2362 | 0.2331 |
| | *First-stage regression of performance pay with short-term consequences* | | | |
| Performance pay share by occupation | 0.326*** | 0.316*** | --- | --- |
| | (0.045) | (0.043) | | |
| Performance pay share by occupation x risk tolerance | 0.008 | 0.005 | --- | --- |
| | (0.008) | (0.008) | | |
| $R^2$ | 0.1694 | 0.1691 | --- | --- |
| Robust F test | 149.44*** | --- | --- | --- |
| | *First-stage regression of performance pay with short-term consequences x risk tolerance* | | | |
| Performance pay share by occupation | -1.464*** | -1.419*** | --- | --- |
| | (0.195) | (0.190) | | |
| Performance pay share by occupation x risk tolerance | 0.651*** | 0.615*** | --- | --- |
| | (0.047) | (0.046) | | |
| $R^2$ | 0.1978 | 0.1976 | --- | --- |
| Robust F test | 135.69*** | --- | --- | --- |
| | *First-stage regression of performance pay with long-term consequences* | | | |
| Performance pay share by occupation | --- | --- | 0.391*** | 0.373*** |
| | | | (0.042) | (0.040) |
| Performance pay share by occupation x risk tolerance | --- | --- | 0.010 | 0.007 |
| | | | (0.007) | (0.007) |
| $R^2$ | --- | --- | 0.2192 | 0.2189 |
| Robust F test | --- | --- | 224.22*** | --- |
| | *First-stage regression of performance pay with long-term consequences x risk tolerance* | | | |
| Performance pay share by occupation | --- | --- | -1.807*** | -1.803*** |
| | | | (0.184) | (0.180) |
| Performance pay share by occupation x risk tolerance | --- | --- | 0.802*** | 0.768*** |
| | | | (0.044) | (0.043) |
| $R^2$ | --- | --- | 0.2459 | 0.2456 |
| Robust F test | --- | --- | 226.05*** | --- |
| Anderson-Rubin test statistic | 8.38** | --- | 10.93*** | --- |
| Wooldridge Robust F | 2.844* | --- | 3.435** | --- |
| Number of observations | 18824 | 18824 | 19298 | 19298 |
| Number of employees | 13871 | 13871 | 14219 | 14219 |

The table shows the estimated coefficients. Standard errors in parenthesis are clustered at the individual level. * Statistically significant at the 10% level; ** at the 5% level; *** at the 1% level. Control variables are included, but are suppressed to save space. The dummy for performance pay with short-term consequences equals 1 if performance appraisals have consequences for annual bonus or monthly gross wage. The dummy for performance pay with long-term financial consequences equals 1 if performance appraisals have consequences for future wage growth or promotion. For each dummy, the reference group consists of workers who are not subject to performance appraisals with financial consequences. The influences of the two types are estimated one at a time. Observations with the other type are respectively excluded from the regressions.

**Endnotes**

[1] Survey and experimental studies have found that performance pay increases firm performance by attracting more talented workers and inducing higher worker effort (Bandiera et al. 2005; Banker et al. 1996; Cadsby et al. 2007; Dohmen and Falk 2011; Gielen et al. 2010; Heywood et al. 2011; Jirjahn 2016; Lazear 2000; Paarsch and Shearer 2000; Shaw 2015; Shearer 2004). There is also ample evidence that performance pay is linked to higher wages (Booth and Frank 1999; Green and Heywood 2016; Heywood and Parent 2012; Jirjahn and Stephan 2004; Parent 1999; Pekkarinen and Ridell 2008; Seiler 1984).

[2] Wooldridge's robust score test also rejects the hypothesis of exogeneity ($F = 3.617$).

[3] Zhang et al. (2016) provide experimental evidence showing that individuals who like physical exercise or sports are more likely to prefer performance pay over fixed pay. This evidence supports the view that individuals with initially better health tend to sort into performance pay jobs.