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Abstract: Increased wages and productivity associated with performance pay can be beneficial to both employers and employees. However, performance pay can also entail unintended consequences for workers' well-being. This study is the first to systematically examine the association between performance pay and loneliness, a significant social well-being concern. Using representative survey data from Germany, I find that performance pay is positively associated with incidence, dimensions, and intensity of loneliness. Correspondingly, performance pay is negatively associated with social life satisfaction of the workers. The findings also hold in sensible instrumental variable estimations addressing the potential endogeneity of performance pay and in various robustness checks. Investigating the potential role of moderating factors reveals that the association between performance pay and loneliness is particularly large for private sector employees. Finally, implications are discussed.

Keywords: Performance Pay, Loneliness, Social Life, Well-Being, SOEP.

JEL: J33, I31, J32, I10.

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1. Introduction

Theoretical and empirical evidence show that performance pay aligns objectives of workers and firms. Performance pay is linked with both increased wages and productivity.[1] However, recent studies motivated by Adam Smith's (1776) discussion of piece rates demonstrate that performance pay can have unintended costs for workers' health (see Bender and Skåtun 2022). Nonetheless, the unintended costs of performance pay may go far beyond health concerns and encompass social life and well-being of the workers. This study uniquely examines the social well-being consequences of performance pay by investigating the following question: *Does performance pay increase the risk of worker loneliness?*

Investigating whether performance pay leads to loneliness stands as an important policy issue due to several reasons. First, the feeling of loneliness is on the rise globally and is acknowledged as a rising public health and well-being concern (e.g., Sirois and Owens 2023).[2] Second, loneliness is associated with numerous negative consequences for individual health and well-being (Hakulinen et al. 2018; Hawkley et al. 2010; James et al. 2011; Cacioppo et al. 2002, 2006; Holt-Lunstad et al. 2010, 2015; Fawaz and Mira 2023; Horigian et al. 2021; Matthews et al. 2017). Third, in addition to its detrimental consequences for individuals, loneliness also entails negative consequences for the firms, families, society, and economy as a whole (Bowers et al. 2022; Firoz and Chaudhary 2022; Gerst-Emerson and Jayawardhana 2015; Mihalopoulos et al. 2020; Ozcelik and Barsade 2018; Putnam 2000; Valtorta et al. 2018).

Accordingly, the rapid growth and recognition of numerous negative consequences of loneliness have triggered governments to develop strategies against loneliness. Thus, tackling loneliness and developing social participation is in line with the "leave no on behind" commitment of the United Nation's 2030 Agenda for Sustainable Development. In

2018, the UK government was first to build a strategy to reduce loneliness with a funding of 20 million pounds (Department of Digital, Culture, Media and Sport 2018). In 2023, German Federal Government launched the *Strategy Against Loneliness* as part of the German Sustainability Strategy (Federal Ministry for Family Affairs, Senior Citizens, Women and Youth 2023). In 2023, US Senator Murphy also introduced legislation to the *National Strategy for Social Connection Act* in order to combat the loneliness epidemic in the US. Likewise, the European Commission's *Loneliness Project* is aiming to provide intervention policies for loneliness across EU-27 since 2023 (Casabianca et al. 2023).

Nonetheless, despite the broad literature on the rapid rise and the negative consequences of loneliness, economists have paid less attention to establish a relationship between different job designs and worker loneliness. Considering the spread of performance pay among firms in Europe and the United States over the last decades (Bender and Skåtun 2022; Lemieux et al. 2009; Zwysen 2021), it becomes increasingly crucial and timely to investigate whether and how performance pay increases the risk of worker loneliness. The present study is the first to examine this question.

There are at least three channels through which performance pay may increase the risk of worker loneliness. First, workers receiving performance pay are less likely to be cooperative and exert helping effort to colleagues (Drago and Garvey 1998). This in turn, may decrease the probability of building social capital with colleagues, and hence, increase the risk of loneliness. Second, performance pay is associated with an increased mental focus on work (Hur et al. 2021). This may not allow workers to psychologically detach from work during non-work time, and hence, enjoy quality time with family and friends. A heightened mental focus on work also suggests prioritization of work over private life, which in turn, limits workers' opportunities to participate in activities involving interaction with others and building new connections outside the workplace. Thus, leading to an increased risk of

loneliness. Third, performance pay causes higher stress by increasing worker effort, expectations, and workload pressure (Baktash et al. 2022a). This could further increase the probability of feeling lonely. Overall, all these channels hint at a positive association between performance pay and loneliness.

I use the German Socio-Economic Panel (SOEP) to investigate the association between performance pay and loneliness directly. First, I examine whether workers receiving performance pay are more likely to *feel lonely*. I also use alternative measures of loneliness to study the effect of performance pay on dimensions and intensity of loneliness. Second, I account for a possible omitted variable bias, and hence, address the potential endogeneity of performance pay variable using instrumental variable (IV) strategy. I also provide sensible and intuitive justifications increasing confidence in the credibility of the IV. Third, I analyze factors that may potentially moderate the relationship between performance pay and loneliness. Finally, I perform several robustness checks such as using *social life satisfaction* as a proxy for loneliness, examining whether the results are robust after excluding workers who switched their jobs in between observed waves, investigating whether performance pay intensity matters for the association between performance pay and loneliness, and exploring whether the association exists when workers receive collective performance pay.

2. Setting the Stage

2.1. Performance Pay and Physical Well-being

An extensive body of literature study the consequences of performance pay on physical well-being based on Adam Smith's (1776) concern that piece rates incentivize workers to "ruin their health". The initial case studies indicate that performance pay increases accidents and injuries at workplace (e.g., Freeman and Kleiner 2005; Johansson et al. 2010; Saha et al. 2004). Recent

studies using survey data also match with case studies and show a positive association between performance pay and workplace injuries (e.g., Bender et al. 2012; Artz and Heywood 2015).

Moreover, the negative consequences of performance pay on physical well-being extend beyond the elevated risk of accidents and injuries at the workplace. There exists evidence that performance-related pay deteriorates physical health (Bender and Theodossiou 2014; Foster and Rosenzweig 1994), increases sickness-related absences (DeVaro and Heywood; Frick et al. 2013), and increases the probability of higher blood pressure (Andelic et al. 2023).

2.2. Performance Pay and Mental Well-being

Available evidence points not only at negative consequences of performance pay on physical health and well-being, but also on mental well-being. Habel et al. (2021) show that relative importance of commissions increases the emotional exhaustion of sales workers. Davis (2016) indicates that piece rates negatively impact the emotional health of garment workers in Vietnam. Using laboratory experiments, Cadsby et al. (2016) find a positive association between performance pay and self-reported stress. In recent laboratory experiments, Allan et al. (2020, 2021) also show that performance pay increases the stress level measured by cortisol hormone levels. These findings are also complemented by survey evidence. Baktash et al. (2022a) show that performance pay increases the stress level of workers using representative survey data from Germany. Consecutively, the stress associated with performance pay can lead to the use of medication. Workers increase the usage of prescribed anti-anxiety and anti-depressant drugs when the employer adopts performance pay (Dahl and Pierce 2020). Accordingly, workers receiving performance pay are even more likely to consume illicit drugs and different types of alcohol as a coping mechanism (Artz et al. 2021, Baktash et al. 2022b).

2.3. Performance Pay and Loneliness

The World Health Organization (WHO) suggests that well-being has three dimensions: "physical, mental and social well-being" (WHO 1948). While the literature on adverse consequences of performance pay for workers' physical and mental well-being is ample, almost no attention has been paid on social well-being consequences of performance pay. This study is the first to examine whether and how performance pay affects the social well-being of workers by focusing on loneliness. Loneliness is a dimension of social well-being that corresponds to the "subjective psychological discomfort people experience when their network of social relationships is significantly deficient in either quality or quantity" (Perlman and Peplau 1998: p.571).

Principally, work and workplace are often considered as the main mechanisms to achieve such social relationships (Ferris et al. 2009; Wright and Silard 2021). In their conceptual theoretical model of loneliness in the workplace, Wright and Silard (2021: p. 1071) argue that developing social relationships is more likely in "organizations with a mastery climate compared to organizations with a performance culture." Organizations using time-rate and seniority-based pay may encourage collaboration and learning, while organizations using performance-related pay may encourage competitiveness and social comparison (Bunderson and Sutcliffe 2003). Thus, workers receiving performance pay have a lower probability of cooperation and engaging in helping-efforts to their coworkers (e.g., Burks et al. 2009; Encinosa et al. 2007; Lombardi et al. 2020). Drago and Garvey (1998) show that promotion incentives are negatively related with worker helping-efforts and positively related with individual worker effort. Indeed, Gläser et al. (2017) argue that performance pay can even induce interpersonal deviance such as harming behavior toward coworkers. Thus, performance pay has been shown to trigger detrimental and aggressive facets of competitiveness (Lazear 1989; Gläser et al. 2022). Against this background, the uncooperativeness associated with

performance pay reduces the likelihood of creating strong bonds with colleagues, and hence, opens doors to the feeling of loneliness.

Moreover, performance pay is also associated with increased working hours both in cross sectional and worker fixed effects estimations (Artz and Heywood 2022; Baktash et al. 2024b; DeVaro 2022; Green and Heywood 2023). Greater working hours associated with performance pay, in turn, reduces the available time and energy for leisure activities, sleep, physical activities, and household activities (Andelic et al. 2022). The increased work-related mental focus of workers receiving performance pay even suggests that performance pay entails a higher willingness to prioritize work over family and friends (Hur et al. 2021). Thus, workers receiving performance pay increase their work commitment to a level that it induces "over-work."[3] The higher commitment to the job can even adversely affect workers' family life. Baktash et al. (2024a) provide evidence that performance pay is associated with increased risk of marital instability.

Therefore, increased mental focus on work associated with performance pay may further contribute to an increased risk of loneliness. An increased work-related mental focus suggests that performance pay may not allow the workers to psychologically detach from work during non-work time and to enjoy quality time socializing with family and friends. At the same time, it suggests prioritization of work over private life. This would result in limited opportunities to get involved in social and leisure activities outside the workplace, which may possibly allow the workers to meet and bond with new people who share similar interests as themselves (see Pagan 2021).

Finally, performance pay leads to higher stress by increasing worker effort, expectations, and workload pressure (e.g., Allan et al. 2020, 2021; Baktash et al. 2022a). A series of studies have shown that loneliness has a biological and stress-related origin (Campagne 2019; Glaser et al. 1985; Moshtael et al. 2024; Wang et al. 2024). Accordingly,

elevated stress associated with performance pay can be another important channel through which the risk of worker loneliness can be increased. Overall, all these channels hint at a positive association between performance pay and loneliness.

To summarize, previous studies have shown that performance pay not only harms workers' physical and mental well-being, but also impacts their relationships with coworkers, commitment to work, work-life balance, and activities outside the workplace. Therefore, these studies build the theoretical framework of the present study and raises the important question of whether and how performance pay increases the risk of worker loneliness.

3. Data and Variables

3.1. Dataset

I use the SOEP to empirically test the relationship between performance pay and loneliness. The SOEP is a broad representative longitudinal survey of private households in Germany and one of the largest and enduring multidisciplinary survey across the globe (Goebel et al. 2019). Thus, 30,000 individuals from around 15,000 households are annually interviewed. The questionnaire consists of routine demographic and socio-economic questions every year and asks 'special' topic questions in specific waves. Information on performance pay comes from the waves 2011 and 2016. I pool the data so independent variables are taken from these waves. The analysis focuses on employees aged 20 to 65 years, as it reflects the typical working age population in Germany. Moreover, I exclude apprentices and marginally employed individuals, as they do not face a choice of sorting into performance pay. Thus, the empirical analysis uses an unbalanced sample with 12,224 observations from 10,008 employees.

The explanatory variables in the respective period t ($t = 2011, 2016$) are used to explain a feeling of loneliness in the subsequent period for which the data is available (i.e., either in $t + 1$ or in $t + 2$). This not only considers that performance pay may not immediately

lead to the feeling of loneliness, but also mitigates the risk of any reverse causation. Thus, predetermined explanatory variables reduce the problem of endogeneity. Nevertheless, I still address the potential endogeneity of receiving performance pay using an IV approach. As a further robustness check, I use a subjective score of social life satisfaction, which is available for the same waves as the explanatory variables, as the outcome variable instead of the loneliness variables that come from the subsequent waves.

3.2. Performance Pay

The performance-related pay indicator is constructed from a two-stage question. It first asks whether the employee is facing a regular and formalized performance appraisal by a superior by asking: "Is your performance regularly assessed by a superior as part of a formalized procedure?" In the next step, if the employee responds positively, then he or she is asked if the performance appraisal impacts their earnings (i.e., consequences for monthly gross wage, annual bonus, future wage growth, and/or potential promotion). Thus, following the literature, I build a broad indicator of performance-related pay (e.g., Baktash et al. 2022a; Cornelissen et al. 2011; Grund and Sliwka 2010). The performance pay indicator equals 1 if the employee faces a performance appraisal and the appraisal has any consequences for their earnings. It equals zero if otherwise. In this study, 28 percent of the employees categorize themselves as subject to performance pay.[4]

3.3. Loneliness

The outcome variable, loneliness, is based on the following three items: (1) "How often do you miss the company of other people?" (2) "How often do you feel socially isolated?" (3) "How often do you feel left out?" For each item, interviewees respond on a five-point scale with categories "never," "seldom," "sometimes," "often," and "very often." It is important to note that feeling of loneliness is not equivalent to feeling alone. However, it involves feelings of

"disconnectedness," "isolation," and "not belonging" (Hughes et al. 2004). These feelings are consequently considered to demonstrate the gap between an individual's desired and actual social relationships (Peplau and Perlman 1982).

As the measures of the three loneliness items are self-reported, it may lead to a possible issue of self-reporting bias. Thus, in order to diminish the risk of any measurement error, I build a broad indicator of the *incidence of loneliness* equal to 1 if the worker feels any of the three dimensions of loneliness, i.e., lack companionship, feel isolated, or feel left out. The indicator is equal to zero if the worker never feels any of the three types of loneliness. It is possible that workers underreport their frequency of feeling loneliness (see Richard et al. 2017; Richardson 2004; Tomstad et al. 2017), but it is less likely to misreport whether they feel loneliness at all.

While I initially focus on the dummy outcome variable for the incidence of loneliness, in extensions I also use alternative measures of loneliness. First, I build the following three binary variables: (1) Lack companionship, (2) feel isolated, and (3) feel left out. *Lack companionship* is equal to one if the worker misses the company of other people seldom, sometimes, often, or very often. *Feel isolated* equals 1 if the worker feels seldom, sometimes, often, or very often socially isolated. *Feel left out* is equal to 1 if the worker feels seldom, sometimes, often, or very often left out. The dummy variables are equal to zero if the worker never feels the respective type of loneliness.

Subsequently, I also build two additional variables to capture the intensity of loneliness. The first variable is the *number of types of loneliness*, which is constructed by summing the three dummy variables for each type of loneliness. The second variable is a short-scale *loneliness index* developed by Hughes et al. (2004). Thus, following the procedure of Hughes et al. (2004), I first rearrange the five-point scale of the three items to three-point Likert scale as follows: "never," "seldom/sometimes," and "often/very often." Next, the loneliness index is

constructed by summing the three rearranged items, with larger scores demonstrating higher loneliness level. The intercorrelation of the items is suitably high with a Cronbach's alpha of 0.75. The mean loneliness score on the single combined index is 2.05 with 1.26 standard deviation. Table 1 presents the definitions and descriptive statistics of the key variables.

3.4. Social Life Satisfaction

The social life satisfaction score is asked in the same waves as the performance pay variable (i.e., 2011 and 2016). The score is based on the following questions: "How satisfied are you today with the following areas of your life? - How satisfied are you with your social life?" Thus, the social life satisfaction is scored on an eleven-point Likert scale ranging from 0 "completely dissatisfied" to 10 "completely satisfied." As the feeling of loneliness and satisfaction with social life are very closely related, I exploit this advantage and use the social life satisfaction score as a further outcome. This allows me to examine whether performance pay has a direct impact on the social life satisfaction of the workers within the same wave, or the results are driven by the predetermined nature of explanatory variables. Additionally, it also sheds light in the overall association between performance pay and social well-being. The mean social life satisfaction score of the estimation sample is 7.67 with 1.70 standard deviation.

3.5. Control Variables

The richness of the SOEP allows including a comprehensive selection of control variables for worker and job characteristics that may potentially influence the worker loneliness and sorting into performance pay. Table A1 presents the definition and descriptive statistics of the control variables. I control for a recent death in the family as well as marital status, migration background, the presence of children in household, the number of individuals in household, whether the worker has a religious affiliation, and whether the worker feels the size of their dwelling is appropriate for their household. General financial problems are taken into account

by adding a binary variable equal to 1 if the worker is concerned about their economic situation. The uniqueness of the data also allows the inclusion of controls for the number of close friends, and presence of siblings and parents.

Work-related factors are also likely to play a role in shaping worker loneliness. Thus, I include variables for job insecurity, working hours, part time employment, having a permanent contract, number of years with current employer, years of work experience, and whether a works council is present at the workplace. Moreover, I control for the worker's monthly earnings and total household earnings. On the one hand, highly paid jobs may involve higher responsibilities, and hence, may limit the worker's establishment of meaningful relationships. On the other hand, previous studies show that performance pay is positively associated with higher earnings (e.g., Booth and Frank 1999; Green and Heywood 2016; Heywood and Parent 2012; Jirjahn and Stephan 2004). By controlling for income, the analysis rules out the possibility that the relationship between performance pay and loneliness reflects an income effect. Correspondingly, the years of attained education are kept constant.

Worker personality traits are also taken into account by controlling for the classical Big Five personality traits (conscientiousness, extraversion, agreeableness, openness, and neuroticism), risk tolerance, and locus of control. The Big Five model is one of the most commonly used taxonomy of personality traits that is able to predict various life outcomes including labor market performance and health (Almlund et al. 2011). The Big Five personality traits have also predictive power in determining loneliness levels (De Jong-Gierveld et al. 2016; Wilt et al. 2017). Controlling for locus of control takes into account that internal workers, those who believe their own actions determine the outcomes, are more likely to sort into performance pay jobs (Heywood et al. 2017). Subsequently, locus of control can also play an important role in determining loneliness levels (Hojat 1982). Risk preferences are captured by an experimentally validated indicator of risk tolerance (Dohmen et al. 2011). On the one hand,

risk tolerant workers have a higher probability of sorting into performance pay (Bandiera et al. 2011; Cornelissen et al. 2011; Grund and Sliwka 2010). On the other hand, risk tolerance may also predict the loneliness of individuals.

Furthermore, controls for age and gender are also added (Barreto et al. 2021; Lepinteur et al. 2022). Gender can play a role in shaping loneliness. People can also experience different levels of loneliness at different points over their life course and coping mechanisms may be influenced by age. Finally, I also add the state of residence, industry, occupation, and year of survey fixed effects.

4. Results

4.1. Initial Estimates

Table 2 presents the initial key estimates for the incidence of loneliness. The determinants of feeling lonely are estimated using pooled and random-effects (RE) linear probability models, as well as probit and RE probit models, which take into account the binary nature of the outcome variable. The cross-period correlation of worker-specific error terms are taken into account using RE models. Moreover, the standard errors are clustered at the worker level. All the four estimation strategies yield highly similar results.

According to all the four models, performance pay emerges as a statistically significant determinant of feeling lonely. Workers receiving performance pay are 2.6 percentage points more likely to have an incidence of loneliness. As the mean incidence of loneliness equals 0.86, this could be viewed as a 3 percent increase. Thus, the initial findings conform to the hypothesis that the lower helping effort, higher pressure and stress, reduced interaction with family, and prioritization of work associated with performance pay could lead to worker loneliness.

Most of the explanatory variables also emerge as significant determinants of feeling lonely. Having a stable partner, migration background, size of household, and residing in a

dwelling with appropriate size are negative determinants of feeling lonely. Workers' years of education and net income are positive determinants of loneliness, while the household net income emerges as a negative determinant of feeling lonely. Moreover, job insecurity, financial insecurity, presence of siblings, and part-time contract are positively associated with loneliness. Personality traits of the workers also play an important role in determining the feeling of loneliness. On the one hand, risk tolerant workers and those high on neuroticism are more likely to experience loneliness. On the other hand, conscientiousness, extraversion, agreeableness, and internal locus of control scores are significant negative determinants of feeling lonely.

Appendix Table A1 additionally presents the estimates on performance pay for alternative specifications of the control variables. Specification (1) excludes controls for family characteristics, number of close friends, working hours, income, personality traits, industry and occupation. Specifications (2) to (6) add controls for family characteristics, close friends, working hours and income, personality traits, industry and occupation, respectively. The results indicate a significant relationship between performance pay and loneliness incidence irrespective of the specification of the control variables. The estimated magnitude is slightly higher when working hours and income are controlled for and marginally higher when personality traits are controlled for.

4.2. Alternative Measures of Loneliness

The study showed a significant association between performance pay and the incidence of loneliness so far. At issue is whether performance pay influences all the three dimensions of loneliness. As individuals may feel lonely for different reasons, investigating the dimensions of loneliness separately stands as an important question. Another crucial question is whether performance pay also increases the intensity of loneliness. The negative impact of performance

pay on workers' health and well-being would be particularly concerning if performance pay not only increases the incidence, but also the intensity of loneliness.

4.2.1. Dimensions of Loneliness

Table 3 presents the key estimates for the three dimensions of loneliness, i.e., lack companionship, feel isolated, and feel left out. The determinants of feeling the three types of loneliness are estimated using a multivariate probit model with standard errors clustered at the worker level. This model is a generalization of bivariate model, and hence, allows for correlated error terms between different probit equations. Thus, the probit equations are jointly estimated using maximum simulated likelihood to address a likely correlation of the error terms (Capellari and Jenkins 2003). The correlation of the error terms in Table 3 shows that all the error terms are positively correlated. This implies that there exist unobserved factors affecting the feeling of the three types of loneliness in the same direction.[5]

The results indicate that workers receiving performance pay are more likely to feel two out of the three dimensions of the loneliness. While the regression does not show a statistically significant effect on the probability of feeling isolated, performance pay emerges as a statistically significant positive determinant of lacking companionship and feeling left out. The average marginal effects indicate that performance pay is associated with 1.8 and 2.1 percentage points increase in the probability of lacking companionship and feeling left out, respectively. As the original share of workers lacking companionship and feeling left out equals 81 and 70 percent, respectively, this implies a 2.2 and 3 percent increase in lacking companionship and feeling left out. Thus, the findings conform to the hypothesis that the lower helping effort, higher pressure and stress, and prioritization of work over family and private life associated with performance pay leads workers to lack companionship and feel left out.

Moreover, most of the control variables continue emerging similar effects as in initial estimates. Married workers, those having a stable partner, and those reporting appropriate size of dwelling are less likely to feel all the three dimensions of loneliness. First-generation immigrants are less likely to feel left out and second-generation immigrants are less likely to lack companionship in comparison to the natives. Female workers are more likely to feel left out. Size of household have a negative influence on lacking companionship, but a positive influence on feeling isolated. Highly educated workers are less likely to feel isolated and more likely to feel left out. As expected, workers with more close friends are less likely to feel isolated. The presence of siblings has a positive influence on feelings of loneliness. However, the presence of mother has a negative effect on feeling isolated. The workers' net income is a positive determinant of lacking companionship and feeling isolated, whereas the household net income emerges to be a negative determinant of feeling any of the three types of loneliness. Those who stay longer with the same employer are less likely to lack companionship and feel isolated. Working hours have only a positive influence on feeling isolated. Job insecurity and financial insecurity have strong positive effect on all the three types of loneliness. Finally, the personality traits of workers continue having significant effect on all the three dimensions of loneliness. Risk tolerance and neuroticism are positively associated with all the three types of loneliness, while conscientiousness, extraversion, and internal locus of control are negatively associated.

4.2.2. Intensity of Loneliness

While the study so far focused on dummy outcome variables and established a positive association between performance pay and these variables, in the following step, I focus on two additional measures of loneliness that capture its intensity. First, I estimate the determinants of the number of types of loneliness felt by workers. Table 4 shows the key results of OLS, RE,

and Poisson model that accounts for the count nature of the outcome variable, zero to three. All the three methods reflect each other and yield similar results. Workers receiving performance pay are significantly feeling more types of loneliness. Specifically, performance pay is associated with a statistically significant but small additional .04 types of loneliness. This provides additional evidence that performance pay also impacts the intensity of loneliness. Moreover, most of the control variables also continue to demonstrate a similar effect to that in the previous estimates.

Second, I estimate the determinants of loneliness index. Table 5 presents the main results of OLS, RE, ordered probit, and RE ordered probit that account for the ordered category of the loneliness index, zero to six. Again, all the four strategies yield similar results and continue to support the hypothesis of the present study by indicating that performance pay is significantly associated with increased score of loneliness index. Workers receiving performance pay score on average .05 higher on loneliness index than the workers receiving time-rate. The control variables again continue indicating similar effects to those found in previous regressions. Overall, the findings suggest that performance pay not only influences the incidence of loneliness, but also increases the intensity of loneliness.

4.3. The Issue of Endogeneity

While the study so far showed a consistent and significant positive effect of performance pay on loneliness, the performance pay variable may nonetheless suffer from endogeneity. Including a long list of other determining factors of loneliness may reduce the risk of endogeneity. However, there may still exist unobservable factors impacting both sorting into jobs with performance pay and feeling of loneliness. The estimated effect of performance pay on feeling of loneliness is overestimated if the unobservable factors impact both performance pay and loneliness in the same direction. Alternatively, the estimated effect of performance pay

on feelings of loneliness is underestimated if the unobservable factors impact performance pay and loneliness in opposite directions.

One approach to address endogeneity could be using a fixed-effects model. However, I refrain from using this approach due to the following reasons. First, this study uses an unbalanced panel containing a large number of singleton observations that are not possible to be used for estimating within-worker effects. Dropping the singleton observations largely diminishes the number of observation as the singleton observations account for more than half of the original observations (64 percent). Second, the fixed effects model only tackles the issue of unobserved time-invariant effects. However, it does not address the issue of unobserved time-varying effects. Plümper and Troeger (2019) indicate that a fixed effects method is likely to intensify the bias caused by omitted time-varying factors as dropping the between variation enlarges the impact of time-varying misspecification on parameter estimates.

Instead, an IV approach is used to address the issue of endogeneity. This approach has the advantage of not only addressing the unobservable time-invariant effects, but also the unobservable time-varying effects. The essential condition of IV approach is the exclusion restriction, which implies that IVs do not influence the outcome variable directly, but only indirectly through the key explanatory variable. Nonetheless, it has been always challenging to find convincing exclusion restrictions. Just-identifying exclusion restrictions are based on conditions, which cannot be justified empirically (Heckman 2000, Keane 2010). Their justification relies solely on reasoning and an appeal to intuition. Section 4.4 examines the credibility of the IV in detail and shows the exclusion restrictions imposed by the model are likely plausible in the context of performance pay and loneliness.

I follow an IV strategy grounded on aggregation (for examples see Andelic et al. 2023; Baktash et al. 2022a; Baktash 2023; 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). Thus, the IV is the share of workers receiving performance pay calculated for 257 detailed 4-digit occupations. When the share of those receiving performance pay for each worker's occupation is calculated, I exclude the respective worker. The performance pay share by occupation demonstrates the general tendency within a narrowly determined job that workers are on performance pay. For instance, a high performance pay share by occupation may show that worker output is monitored without difficulty in that job, and consecutively, raises the individual worker's likelihood of receiving performance pay (BayoMoriones et al. 2013).

Table 6 shows a series of regressions tackling the endogeneity issue in the context of loneliness incidence. Column (1) presents the two-stage least squares (2SLS) results using linear probability regressions. The first-stage estimates the individual worker's likelihood of receiving performance pay. The IV, performance pay share by occupation, emerges as statistically significant positive determinant of the individual worker's likelihood of receiving performance pay. Both, the robust *F* test and the Anderson-Rubin test statistic reject the hypothesis of weak instrument. Moreover, the Wooldridge's (2010) robust score test rejects the hypothesis that performance pay variable is exogenous. Next, performance pay variable is replaced in the second-stage with the predicted values obtained from the first-stage estimation to address the endogeneity issue. The 2SLS regression confirms the key pattern of results. However, the magnitude of the impact is 4 times larger when the endogeneity issue is addressed. The results suggest that workers receiving performance pay are 11 percentage points more likely to feel loneliness. Given the share of workers feeling lonely equals 86 percent, this would imply a 13 percent increase. Column (2) of Table 7 presents the RE IV results. While the RE IV follows the same procedure as in 2SLS regression, it additionally takes into account the cross-period correlation of worker-specific error terms. Nonetheless, this approach also yields similar results as the simple 2SLS regression.

Column (3) presents the findings of the treatment effects model (Maddala 1983; Vella and Verbeek 1999). This approach takes into account that the endogenous variable, performance pay, is binary. It jointly estimates a probit equation explaining performance pay and a linear probability equation explaining the incidence of loneliness using maximum likelihood. The correlation of the error terms (ρ) shows that the error terms of the two equations are negatively correlated. This indicates that there are unobservable factors that impact receiving performance pay and incidence of loneliness in opposite directions, and hence, the performance pay effect is underestimated when endogeneity is not addressed. For example, one unobservable factor could be physical attractiveness inducing the negative correlation. More attractive workers have a higher likelihood of sorting into jobs with performance pay. Simultaneously, more attractive individuals have a lower probability of feeling lonely.[6] Another unobservable factor could be health consciousness. The likelihood of sorting into performance pay jobs could be higher for health-conscious workers who have an initially good health status. Concurrently, the healthy lifestyle of health-conscious workers would reduce the probability of feeling lonely.[7] Thus, addressing the endogeneity issue using treatment effects model elicits again a much larger influence of performance pay on the incidence of loneliness. This approach also supports the key pattern of the results and shows that the magnitude of the impact is around 3 times larger than the regressions of Table 2.

Column (4) of Table 7 presents the recursive bivariate probit results (Greene 1998). This approach takes into account that both performance pay and incidence of loneliness variables are binary. Thus, the determinants of receiving performance pay are jointly estimated with the determinants of feeling lonely. Again, recursive bivariate probit model also supports the key findings and shows that workers receiving performance pay are 9 percentage points more likely to feel lonely. Overall, according to all the four models, performance pay is a statistically significant positive determinant of the incidence of loneliness. Workers subject to

performance pay are 7-11 percentage points more likely to feel lonely. Considering the mean incidence of loneliness, this can be viewed as an 8-13 percent increase.

In the next step, I also address the issue of endogeneity when the alternative measures of loneliness are used as outcome variables. Table 7 presents the recursive multivariate probit regression results. The determinants of the three dimensions of loneliness are jointly estimated with the determinants of receiving performance pay. The recursive model provides significant positive associations between performance pay and all the three dimensions of loneliness. The average marginal effects show that performance pay is associated with a 4.7, 4.8, and 5.5 percentage points increase in the probability of feeling left out, feeling isolated, and lacking companionship, respectively. This can be viewed as a 5.8, 12.3, and 7.9 percent increase, respectively. Thus, the findings suggests that performance pay not only increases the overall incidence of loneliness, but also affects each three dimensions of loneliness independently.

Table 8 addresses the endogeneity of performance pay in the context of the number of types of loneliness using a series of regressions. I use again 2SLS, RE IV, and treatment effects models. Additionally, an IV Poisson model is used to account for the count nature of the outcome variable. According to all four models, performance pay emerges as a statistically significant determinant of the number of types of loneliness felt by the workers. Workers who receive performance pay feel an additional 0.30 types of loneliness. This is a substantial increase. As the mean number of types of loneliness equals 1.9, it implies a 16 percent increase.

Finally, I also address the issue of endogeneity in the context of loneliness index by using 2SLS, RE IV, treatment effects, and ordered probit IV models. While the first three models follow the same procedure as described above, the last model, ordered probit IV, jointly estimates a probit equation explaining performance pay and an ordered probit equation explaining the loneliness index using maximum likelihood. Table 9 presents the key results. According to all four methods, workers who receive performance pay score half point higher

loneliness index on average. As the mean loneliness index equals 2, this implies as a substantial increase of 25 percent. Therefore, it can be concluded that performance pay not only entails the prevalence of loneliness, but it is also associated with increased loneliness intensity. This further increases the concerns about adverse effects of performance pay on workers' social well-being and health.

4.4. Credibility of the Instrumental Variable

The study used performance pay share by occupation (excluding own contribution of the respective worker) as an IV to account for the endogeneity of performance pay variable. The validity of the IV requires that performance pay share by occupation has no direct effect on the individual worker's loneliness, but only an indirect effect through the individual worker's likelihood of receiving performance pay. However, one may argue that the performance pay share by occupation may also directly influence the loneliness level of the individual workers.

This study takes the exclusion restriction imposed by the model to be plausible for several reasons. First, the credibility of an IV can depend on the covariates included (Angrist and Pischke 2009). An instrument may lack validity per se but may only be valid after conditioning on covariates. The richness of the SOEP enables including a long list of control variables. Particularly, it still allows the inclusion of 11 broadly defined two-digit occupation dummies. As the included covariates capture significant aspects of the working conditions, it increases confidence in the credibility of the IV. Therefore, as long as important controls for working conditions are included, no direct effect but only an indirect effect of the IV through the individual worker's probability of receiving performance pay should be expected.

Second, I calculate loneliness share by occupation and include it as an additional covariate in the IV estimations. By conditioning on loneliness share by occupation, I switch off all the channels through which the IV may affect worker loneliness. Table A3 shows the results.

In the first-stage regression, loneliness share by occupation emerges as an insignificant determinant of an individual worker's likelihood of receiving performance pay. While performance pay share by occupation emerges as a positive and highly significant determinant. The second-stage regression shows that performance pay increases the probability of feeling lonely by 11.5 percentage points even when the loneliness share by occupation is controlled for. The coefficient is very similar to the one found in Table 7. Therefore, switching off all the channels through which the IV may affect worker loneliness does not change the key findings and increases the confidence in the validity of the IV.

Third, I perform placebo tests to assess the credibility of the IV. I test whether the performance pay share by occupation is correlated with chronic diseases such as cancer, and cardiovascular diseases. Assuming that performance pay does not lead to cancer or cardiovascular diseases (at least in the short run), a significant correlation between the IV and these outcome variables would violate the exclusion restriction.[8] The placebo tests show no significant effect of the IV on cancer and cardiac diseases.[9] These tests add further support for the credibility of the IV.

4.5. Heterogeneous Effect of Performance Pay

The study also performed a series of heterogeneity examinations to explore whether the association between performance pay and loneliness depends on moderating factors. I examined whether results differ between East and West Germany and whether marital status plays a moderating role. In both cases, an interaction of performance pay with these variables did not emerge as statistically significant. Moreover, I examined the moderating role of gender and part-time work. Again, neither gender nor part-time work emerged as significant moderating factors.

Nonetheless, I also investigated the moderating role of private sector employment, and the findings are more informative here. Previous research shows that the level of competition and commitment may differ among public and private sector employees (e.g., Bryson and Freeman 2014; Bryson et al. 2017; Lyons et al. 2006; Zeffane 1994). Boyne (2002) states that in public sector, "policies such as performance-related pay, or promises of financial bonuses and other perquisites, are unlikely to enhance staff commitment or improve organizational performance." Therefore, the association between performance pay and loneliness may be stronger and larger in private sector due to higher competition and commitment.

Table 10 presents the key results. In column (1), an interaction between performance pay and public sector employment is included. Performance pay variable continues to take a significant positive coefficient, while its interaction with public sector emerges with a significantly negative coefficient. This suggests that performance pay in private sector increases the risk of feeling lonely to a larger degree compared to performance pay in public sector. Performance pay is associated with a 3.6 and 0.3 percentage points increase in the risk of loneliness in private and public sectors, respectively. Columns (2) and (3) present the results for workers in public and private sectors separately. In line with the interaction term, the influence of performance pay on loneliness is positive, large, and statistically significant for private sector employees, while the effect is not significantly different from zero for public sector employees. According to the equality of coefficients test, this difference across sectors is also statistically significant. Thus, the finding is in line with the notion that policies such as performance pay induces high competition in private sector, and hence, impact the loneliness of the workers to a larger extent.[10]

4.6. Performance Pay and Social Life Satisfaction

The study used explanatory variables from the respective period t, to explain the feeling of loneliness in the subsequent closest wave that information is available (i.e., either in $t+1$ or in $t+2$). At issue is whether performance pay has a direct impact on the social well-being of the workers within the same wave, or the results are driven by the predetermined nature of explanatory variables. The SOEP asks a question about the social life satisfaction of the respondents in the respective period t ($t = 2011, 2016$) that explanatory variables come from. Thus, this gives the opportunity to exploit the social life satisfaction score as a proxy for the feeling of loneliness and examine the robustness of the findings. Indeed, Peplau and Perlman (1982) argue that the feeling of loneliness indicates the gap between a person's desired and actual social relationships. Accordingly, workers who are satisfied with their social relationships and social life are less likely to experience the feeling of loneliness, and vice versa. Additionally, investigating the association between performance pay and social life satisfaction presents a broader understanding of the social well-being consequences of performance pay.

Table 11 presents the estimates for social life satisfaction. Columns (1) and (3) use ordered probit and RE ordered probit models. The two regressions demonstrate a significant negative effect of performance pay on the social life satisfaction. Next, columns (2) and (4) use ordered probit IV and RE IV to consider the endogeneity of performance pay. Both estimation strategies yield very similar results and indicate that performance pay is significantly associated with a lower score of social life satisfaction. The estimate is roughly one-half lower social life satisfaction score. The average score in the estimation sample equals 7.7, and hence, this implies a 6 percent reduction in overall social life satisfaction. Therefore, these findings are also in line with the notion that workers who receive performance pay are less cooperative,

prioritize work over private life, experience higher stress, and subsequently, they are less likely to be satisfied with their social life.

4.7. Robustness Checks

As a first robustness check, I return to the loneliness measure as outcome variable and rerun the key regressions excluding workers who changed their jobs in 2012, 2013, or 2017. As the performance pay variable is predetermined, it may raise the question whether workers in the subsequent years that loneliness measures are available still received performance pay or not. Keeping only the workers who have not changed their jobs in between these periods allows addressing this problem. Table A4 shows the estimates for the incidence of loneliness excluding switchers. The results are very similar to the ones presented before. Excluding switchers even leads to slightly higher coefficients and statistically significance levels. Altogether, the additional estimates suggest robustness of the key findings.

A further question is whether the association between performance pay and loneliness depends on the intensity of performance pay. Bender et al. (2012) show that physical well-being consequences of performance pay depend on performance pay types. The SOEP allows distinguishing between four types of performance pay by the financial consequences of performance appraisal. Thus, I build an intensity measure of performance pay that ranges from 0 (do not receive any of the 4 types) to 4 (receive all 4 types simultaneously). Table A5 provides the results. In the uncorrected estimates, an additional type of performance pay is associated with one percentage point increase in the probability of feeling lonely. In the endogeneity corrected estimates, receiving one additional type of performance pay increases the probability of feeling lonely by 5 percentage points. This indicates that performance pay intensity matters for the feeling of loneliness and increases the likelihood significantly.

Finally, at issue is whether individual-based performance pay has a larger effect on the risk of loneliness than the team- or organizational-based performance pay. On the one hand, team- and organizational-based performance pay may increase the risk of loneliness due to higher stress and peer pressure (Kandel and Lazear 1992). On the other hand, these collective types of performance pay may mitigate the risk of loneliness as they are associated with increased teamwork and cooperativeness as well as decreased worker conflict (Heywood et al. 2005a, 2005b; Wageman and Baker 1997). No direct information on these aspects of performance pay is available in the SOEP. However, there is an indirect question asking whether the employees received any profit-sharing, premiums or bonuses as extra pay from their employers. I use this variable as a proxy for collective performance pay and rerun the initial estimates by additionally including this variable.[11] While the initial measure of performance pay remains unchanged and continues to take a significantly positive coefficient ($\beta = 0.177;\ standard\ error = 0.054;\ average\ marginal\ effect = 0.025$), the proxy for collective performance pay takes a small positive but insignificant coefficient ($\beta = 0.063;\ standard\ error = 0.063;\ average\ marginal\ effect = 0.009$). This finding supports the theoretical expectations that the two facets of collective performance pay – cooperation and stress/peer pressure – work in opposite directions.[12]

5. Discussion and Conclusions

Performance pay aligns the interests of employers with those of the employees by improving profits and earnings. However, performance pay can also entail negative consequences that affect employees, employers and society as a whole. These negative consequences can be particularly crucial when they affect factors that are external to employment relations, such as families, social circles, and civil societies. Thus, performance pay may cause such externalities if it leads to increased risk of worker loneliness.

I used German survey data to investigate the association between performance pay and loneliness. The key findings showed that performance pay not only increases the incidence of loneliness, but it also influences all the three dimensions of loneliness as well as the intensity of loneliness. Interestingly, private sector employment played a significant moderating role in the relationship between performance pay and loneliness. IV estimations addressing the potential endogeneity of performance pay supported these findings with even larger magnitudes.

This study was motivated by the extensive findings that performance pay has unintended costs for workers' physical and mental well-being. The association between performance pay and workers' social well-being was not previously studied. Thus, the finding that performance pay increases the risk of worker loneliness contributes an additional factor to be considered in any assessment of performance pay. As performance pay has spread among firms worldwide, especially, in the United States and Europe, mitigating the loneliness level of workers receiving performance pay becomes crucial for the employers, organizations, and policymakers.

Of course, at issues is what kind of interventions may help mitigate loneliness level of such workers. To diminish the loneliness level of employees receiving performance pay, interventions by managers and organizations, for instance, may play an important role (Knight et al. 2022; Sullivan and Bendell 2023). On the one hand, managers and organizations may encourage socializing in the office and set up peer buddy systems (e.g., mentorship opportunities) for those receiving performance pay. This would help workers receiving performance pay to cultivate meaningful bonds among colleagues and coworkers, which in turn, would diminish their loneliness level. On the other hand, managers and organizations may also provide better job autonomy to those receiving performance pay. This would not only allow workers receiving performance pay to align their workplace activities to those of their

colleagues, but also allow them to align their free time to those of their families and friends outside the workplace. Thus, resulting in lower risk of loneliness. Future research may empirically investigate whether these interventions could be beneficial in reducing loneliness level of those receiving performance pay.

Thus, the finding that performance pay increases the risk of loneliness has several implications. First, intervention programs may be organized to reduce the loneliness level of workers receiving performance pay. This is crucial not only for the employees, but also for the employer and economy as a whole. Second, as the costs of loneliness is not fully borne by firms, public intervention to monitor the performance pay intensity may be warranted. Third, documenting the link between performance pay and loneliness not only shed light on the mechanisms through which performance pay deteriorates health and well-being, but it also emphasizes that economists should pay more attention to the unexplored dimensions of worker loneliness.

Finally, I propose avenues for future research. While loneliness remains an issue globally, the degree of loneliness varies by countries (European Commission 2023; Ipsos 2021). Thus, studying the association between performance pay and loneliness for different countries with different degrees of loneliness stands as a crucial future research. Furthermore, while the present study used a broad indicator of performance-related pay, future studies may distinguish between different types of performance pay in detail (e.g., piece rates, commissions, individual-based performance pay, team-based performance pay, organizational-based performance pay).

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Tables

Table 1: Definition and Descriptive Statistics of the Key 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.	0.28	0.45
Performance pay share by occupation	The share of workers receiving performance pay calculated for 257 detailed four-digit occupations excluding the worker's own contribution to the share of each survey year.	0.25	0.19
Incidence of loneliness	Dummy equals 1 if the worker misses the company of other people, feels socially isolated, or feels left out.	0.86	0.35
Lack companionship	Dummy equals 1 if the worker misses the company of other people.	0.81	0.39
Feel isolated	Dummy equals 1 if the worker feels socially isolated.	0.39	0.49
Feel left out	Dummy equals 1 if the worker feels left out.	0.70	0.46
Number of types of loneliness	Number of different types of loneliness (lack companionship, feel isolated, feel left out) the worker feels.	1.91	1.05
Loneliness index	Sum of the three ordered variables (with each variable ranging from 0 "never" to "2" often/very often) for the frequency of feeling lonely for each type of loneliness (lack companionship, feel isolated, feel left out). The index ranges from 0 "never feel lonely" to 6 "often/very often lack companionship, feel isolated and feel left out."	2.05	1.26
Social life satisfaction	Overall social life satisfaction scored on an eleven-point Likert scale ranging from 0 "completely dissatisfied" to 10 "completely satisfied."	7.67	1.70

Number of observations = 12224. For the performance pay share by occupation and social life satisfaction, the number of observations equal to 12198 and 12219, respectively.

Table 2: Determinants of Loneliness Incidence

	(1) *LPM*	*(2)* *RE*	*(3)* *Probit*	*(4)* *RE Probit*
Performance pay	0.025 (0.008)***	0.026 (0.008)***	0.123 [0.024] (0.038)***	0.178 [0.025] (0.053)***
Control variables	Included	Included	Included	Included
R^2/Pseudo R^2	0.076	0.076	0.099	0.091
Number of observations	12224	12224	12224	12224
Number of employees	10008	10008	10008	10008

Dependent variable: Incidence of loneliness. The table shows estimated coefficients. Standard errors in parentheses are clustered at the individual level. Average marginal effects are in square brackets. *** Statistically significant at the 1% level.

Table 3: Determinants of Feeling Different Types of Loneliness

	(1) *Lack companionship*	*(2)* *Feel isolated*	*(3)* *Feel left out*
Performance pay	0.071 [0.018] (0.034)**	0.012 [0.004] (0.031)	0.068 [0.021] (0.031)**
Control variables	Included	Included	Included
Log-likelihood	-17209.07		
	Correlation of error terms		
Feel isolated	0.546 (0.015)***	---	---
Feel left out	0.669 (0.012)***	0.715 (0.011)***	---
Number of observations	12224		
Number of employees	10008		

Method: Multivariate probit. The table shows estimated coefficients. Standard errors in parentheses are clustered at the individual level. Average marginal effects are in square brackets. ** Statistically significant at the 5% level; *** at the 1% level.

Table 4: Determinants of Number of Types of Loneliness

	(1) *OLS*	*(2)* *RE*	*(3)* *Poisson*
Performance pay	0.043 (0.022)**	0.043 (0.021)**	0.022 [0.043] (0.012)*
Control variables	Included	Included	Included
R^2/Pseudo R^2	0.166	0.165	0.031
Number of observations	12224	12224	12224
Number of employees	10008	10008	10008

Dependent variable: Number of types of loneliness. The table shows estimated coefficients. Standard errors in parentheses are clustered at the individual level. Average marginal effects are in square brackets. * Statistically significant at the 10% level; ** at the 5% level.

Table 5: Determinants of Loneliness Index

	(1) *OLS*	*(2)* *RE*	*(3)* *Ordered Probit*	*(4)* *RE Ordered Probit*
Performance pay	0.055 (0.026)**	0.050 (0.025)**	0.049 (0.024)**	0.063 (0.032)**
Control variables	Included	Included	Included	Included
R^2/Pseudo R^2	0.190	0.190	0.067	0.060
Number of observations	12224	12224	12224	12224
Number of employees	10008	10008	10008	10008

Dependent variable: Loneliness index. The table shows estimated coefficients. Standard errors in parentheses are clustered at the individual level. Average marginal effects are in square brackets. ** Statistically significant at the 5% level.

Table 6: Determinants of Loneliness Incidence; the Issue of Endogeneity

	(1) *2SLS*	*(2)* *RE IV*	*(3)* *Treatment effects; ML*	*(4)* *Recursive Bivariate Probit*
	Incidence of loneliness			
Performance pay	0.110 (0.043)**	0.111 (0.044)**	0.067 (0.023)***	0.387 [0.090] (0.190)**
	Performance pay			
Performance pay share by occupation	0.506 (0.028)***	0.494 (0.028)***	1.527 (0.087)***	1.526 (0.087)***
Wooldridge robust score test	4.04**	---	---	---
Robust F	329.96***	---	---	---
Anderson-Rubin test statistic	6.54**	---	---	---
ρ	---	---	-0.076 (0.038)**	-0.163 (0.115)
Number of observations	12198	12198	12198	12198
Number of employees	9990	9990	9990	9990

Dependent variable: Incidence of loneliness. The table shows estimated coefficients. Standard errors in parentheses are clustered at the individual level. Average marginal effects are in square brackets. * Statistically significant at the 10% level; ** at the 5% level; *** at the 1% level. Control variables are included, but suppressed to save space.

Table 7: Determinants of Feeling Different Types of Loneliness; the Issue of Endogeneity

	(1) *Lack companionship*	*(2)* *Feel isolated*	*(3)* *Feel left out*	*(4)* *Performance pay*
Performance pay	0.226 [0.055] (0.080)***	0.142 [0.048] (0.080)*	0.153 [0.047] (0.074)**	---
Performance pay share by occupation	---	---	---	1.526 (0.088)***
Log-likelihood	-23011.46			
	Correlation of error terms			
Feel isolated	0.546 (0.015)***	---	---	---
Feel left out	0.676 (0.011)***	0.722 (0.011)***	---	---
Performance pay	-0.100 (0.045)**	-0.081 (0.045)*	-0.056 (0.042)	---
Number of observations	12198			
Number of employees	9990			

Method: Recursive multivariate probit. The table shows estimated coefficients. Standard errors in parentheses are clustered at the individual level. Average marginal effects are in square brackets. * Statistically significant at the 10% level; ** at the 5% level; *** at the 1% level. Control variables are included, but suppressed to save space.

Table 8: Determinants of Number of Types of Loneliness; the Issue of Endogeneity

	(1) *2SLS*	*(2)* *RE IV*	*(2)* *Treatment effects; ML*	*(4)* *IV Poisson; CF*
	Number of types of loneliness			
Performance pay	0.237 (0.120)**	0.237 (0.121)**	0.212 (0.086)**	0.155 [0.296] (0.073)**
	Performance pay			
Performance pay share by occupation	0.506 (0.028)***	0.506 (0.028)***	1.523 (0.087)***	0.506 (0.028)***
Wooldridge robust score test	2.68	---	---	---
First-stage residual	---	---	---	-0.134 (0.074)*
Robust F	329.96***	---	---	---
Anderson-Rubin test statistic	3.90**	---	---	---
ρ	---	---	-0.107 (0.052)**	---
Number of observations	12198	12198	12198	12198
Number of employees	9990	9990	9990	9990

Dependent variable: Number of types of loneliness. The table shows estimated coefficients. Standard errors in parentheses are clustered at the individual level. Average marginal effects are in square brackets. * Statistically significant at the 10% level; ** at the 5% level; *** at the 1% level. Control variables are included, but suppressed to save space.

Table 9: Determinants of Loneliness Index; the Issue of Endogeneity

	(1) *2SLS*	*(2)* *RE IV*	*(3)* *Treatment effects; ML*	*(4)* *Ordered Probit IV*
	Loneliness index			
Performance pay	0.286 (0.141)**	0.286 (0.142)**	0.492 (0.162)***	0.394 (0.125)***
	Performance pay			
Performance pay share by occupation	0.506 (0.028)***	0.506 (0.028)***	1.495 (0.092)***	1.504 (0.090)***
Wooldridge robust score test	2.74*	---	---	---
Robust F	329.96***	---	---	---
Anderson-Rubin test statistic	4.11**	---	---	---
ρ	---	---	-0.231 (0.083)***	-0.210 (0.075)***
Number of observations	12198	12198	12198	12198
Number of employees	9990	9990	9990	9990

Dependent variable: Loneliness index. The table shows estimated coefficients. Standard errors in parentheses are clustered at the individual level. Average marginal effects are in square brackets. * Statistically significant at the 10% level; ** at the 5% level; *** at the 1% level. Control variables are included, but suppressed to save space.

Table 10: Determinants of Loneliness Incidence; Moderating Role of Sector

	(1) *All*	*(2)* *Public*	*(3)* *Private*
Performance pay	0.036 (0.009)***	-0.004 (0.014)	0.036 (0.009)***
Performance pay x public sector	-0.033 (0.016)**	---	---
Public sector	0.023 (0.010)**	---	---
Equality of coefficients test	---	0.011**	
Control variables	Included	Included	Included
R^2	0.077	0.091	0.079
Number of observations	12224	3508	8716
Number of employees	10008	2891	7293

Dependent variable: Incidence of loneliness. Method: OLS. The table shows estimated coefficients. Standard errors in parentheses 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 suppressed to save space.

Table 11: Determinants of Social Life Satisfaction

	(1) *Ordered Probit*	*(2)* *Ordered Probit IV*	*(3)* *RE Ordered Probit*	*(4)* *RE IV*
	Social life satisfaction			
Performance pay	-0.044 (0.023)*	-0.434 (0.138)***	-0.059 (0.032)*	-0.452 (0.205)**
	Performance pay			
Performance pay share by occupation	---	1.503 (0.091)***	---	0.492 (0.028)***
ρ	---	0.239 (0.083)***	---	---
Number of observations	12219	12172	12219	12172
Number of employees	10008	9972	10008	9972

Dependent variable: Social life satisfaction. The table shows estimated coefficients. Z-statistics in parentheses 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 suppressed to save space.

Appendix

Table A1: Definition and Descriptive Statistics of Control Variables

Variable	*Definition*	*Mean*	*Std. dev.*
Age	The worker's age by years ranging from 20 to 65.	44.98	10.26
Female worker	Dummy equals 1 if the worker is a woman.	0.50	0.50
Married	Dummy equals 1 if the worker is married.	0.64	0.48
Partner	Dummy equals 1 if the worker has a partner, but is not married.	0.21	0.41
First-generation immigrant	Dummy equals 1 if the worker is a first-generation immigrant.	0.15	0.35
Second-generation immigrant	Dummy equals 1 if the worker is a second-generation immigrant.	0.05	0.22
Children in HH	Dummy equals 1 if there are children under 16 years in the household.	0.45	0.50
Size of HH	The number of persons in the household.	2.93	1.30
Fit dwelling	Dummy equals 1 if the worker thinks that the total size of their dwelling is just right for their household.	0.70	0.46
Bereaved	Dummy equals 1 if the worker's partner/spouse, father, mother, child or a household member died recently.	0.03	0.17
Religious	Dummy equals 1 if the worker has any religious affiliation.	0.63	0.48
Number of close friends	The total number of close friends the worker has.	4.11	3.48
Sister	Dummy equals 1 if the worker has sister.	0.57	0.50
Brother	Dummy equals 1 if the worker has brother.	0.57	0.50
Mother	Dummy equals 1 if the worker has mother.	0.75	0.44
Father	Dummy equals 1 if the worker has father.	0.55	0.50
Education	The worker's years of education ranging from 7 to 18 years.	12.95	2.76
Public sector	Dummy equals 1 if the worker is employed in the public sector.	0.29	0.45
Tenure	The number of years the worker is with their current firm.	11.99	10.47
Works council	Dummy equals 1 if a works council is present in the firm.	0.61	0.49
Actual working hours	The number of weekly hours the worker actually works including possible over-time.	38.64	10.40
Log of income	Natural log of net income received last month.	7.42	0.58
Log of HH income	Natural log of net household monthly income.	8.08	0.48
Work experience	The worker's total length of full-time and part-time employment experience in years.	20.79	10.83
Permanent	Dummy equals 1 if the worker has a permanent contract.	0.90	0.30
Part time	Dummy equals 1 if the worker is employed part-time.	0.28	0.45
Job insecurity	Dummy equals 1 if the worker is somewhat concerned or very concerned about his or her job security.	0.38	0.49
Financial insecurity	Dummy equals 1 if the worker is somewhat concerned or very concerned about his or her own economic situation.	0.63	0.48
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".	4.91	2.21

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.	5.84	0.86
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.	4.88	1.14
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.	5.32	0.94
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”.	4.58	1.14
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.	3.69	1.20
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.	4.98	0.79
State dummies	Fifteen federal state dummies for Hamburg, Lower Saxony, Bremen, North Rhine-Westphalia, Hesse, Rhineland-Palatinate, Baden-Württemberg, Bavaria, Saarland, Berlin, Brandenburg, Mecklenburg-West Pomerania, Saxony, Saxony-Anhalt and Thuringia (reference federal state: Schleswig-Holstein).		
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 dummy	One dummy for the year 2016 (reference year: 2011).

Number of observations = 12224.

Table A2: Determinants of Loneliness Incidence; Alternative Specifications

	(1) Without controls for family characteristics, close friends, working hours, income, personality traits, industry and occupation		*(2) Specification (1) plus controls for family characteristics*	
	RE	*RE Probit*	*RE*	*RE Probit*
Performance pay	0.022 (0.008)***	0.142 [0.020] (0.053)***	0.022 (0.007)***	0.141 [0.020] (0.053)***
Control variables	Included	Included	Included	Included
R^2	0.031		0.034	
Number of observations	12224	12224	12224	12224
Number of employees	10008	10008	10008	10008
	(3) Specification (1) plus control for close friends		*(4) Specification (1) plus controls for working hours and income*	
	RE	*RE Probit*	*RE*	*RE Probit*
Performance pay	0.022 (0.008)***	0.142 [0.020] (0.053)***	0.023 (0.008)***	0.151 [0.021] (0.054)***
Control variables	Included	Included	Included	Included
R^2	0.031		0.032	
Number of observations	12224	12224	12224	12224
Number of employees	10008	10008	10008	10008
	(5) Specification (1) plus controls for personality traits		*(6) Specification (1) plus controls for industry and occupation*	
	RE	*RE Probit*	*RE*	*RE Probit*
Performance pay	0.027 (0.007)***	0.186 [0.026] (0.052)***	0.022 (0.008)***	0.143 [0.020] (0.055)***
Control variables	Included	Included	Included	Included
R^2	0.071		0.032	
Number of observations	12224	12224	12224	12224
Number of employees	10008	10008	10008	10008

Dependent variable: Incidence of loneliness. The table shows estimated coefficients. Standard errors in parentheses are clustered at the individual level. Average marginal effects are in square brackets. *** Statistically significant at the 1% level.

Table A3: Determinants of Loneliness Incidence; Credibility of the Instrumental Variable

	(1) *2SLS*	*(2)* *RE IV*	*(3)* *Treatment effects; ML*	*(4)* *Recursive Bivariate Probit*
	Incidence of loneliness			
Performance pay	0.115 (0.043)***	0.118 (0.044)***	0.067 (0.023)***	0.384 (0.192)**
Loneliness share by occupation	-0.100 (0.038)***	-0.098 (0.038)***	-0.096 (0.038)**	-0.458 (0.200)**
	Performance pay			
Performance pay share by occupation	0.509 (0.028)***	0.493 (0.028)***	1.536 (0.088)***	1.535 (0.088)***
Loneliness share by occupation	0.027 (0.048)	0.031 (0.046)	0.163 (0.175)	0.165 (0.175)
Wooldridge robust score test	4.46**	---	---	---
Robust F	325.55***	---	---	---
Anderson-Rubin test statistic	7.13***	---	---	---
ρ	---	---	-0.075 (0.038)**	-0.159 (0.117)
Number of observations	12155	12155	12155	12155
Number of employees	9963	9963	9963	9963

Dependent variable: Incidence of loneliness. The table shows estimated coefficients. Standard errors in parentheses are clustered at the individual level. Average marginal effects are in square brackets. ** Statistically significant at the 5% level; *** at the 1% level. Control variables are included, but suppressed to save space.

Table A4: Robustness Check: Excluding Switchers

	(1) *RE Probit*	*(2)* *Recursive bivariate probit*
	Incidence of loneliness	
Performance pay	0.183 (0.055)***	0.413 (0.189)**
	Performance pay	
Performance pay share by occupation	---	1.520 (0.089)***
ρ	---	-0.178 (0.115)
Number of observations	11578	11554
Number of employees	9586	9568

Dependent variables: Incidence of loneliness. The table shows estimated coefficients. Z-statistics in parentheses are clustered at the individual level. ** Statistically significant at the 5% level; *** at the 10% level.

Table A5: Determinants of Loneliness Incidence: Performance Pay Intensity

	(1) *RE*	*(2)* *RE Probit*	*(3)* *RE IV*	*(4)* *Probit IV*
	Incidence of loneliness			
Performance pay intensity	0.009 (0.003)***	0.062 [0.009] (0.023)***	0.053 (0.021)**	0.243 [0.051] (0.097)**
	Performance pay intensity			
Performance pay share by occupation	---	---	1.028 (0.066)***	1.044 (0.066)***
Wooldridge robust score test/ Wald exogeneity test	---	---	4.73**	4.24**
Robust F	---	---	246.27***	---
Anderson-Rubin test statistic	---	---	6.54**	---
Number of observations	12224	12224	12198	12198
Number of employees	10008	10008	9990	9990

Dependent variable: Incidence of loneliness. The table shows estimated coefficients. Standard errors in parentheses are clustered at the individual level. Average marginal effects are in square brackets. ** Statistically significant at the 5% level; *** at the 10% level.

Endnotes

[1] It has been shown that performance pay raises the performance of the firm by attracting highly talented workers and fostering increased 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). Abundant evidence also exists on the link between performance pay and increased 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] According to the Google Trends data, the Google worldwide search for the following statements has been risen dramatically in the last 20 years and reached its peak level in the recent years: (1) "Where to meet people," (2) "How to make friends," (3) "Where to make friends" (see Google Trends, http://www.google.com/trends).

[3] This idea goes back to Adam Smith (1776) who argued that piece rates incentivize workers to "ruin their health."

[4] This is in line with other studies using German data.

[5] Even though the significant correlation of the error terms and the dichotomous nature of the dependent variables suggest the usage of a multivariate probit model, I also test whether the results are robust to different estimation strategies by using linear probability, RE linear probability, probit, and RE probit models. These models also confirm the key findings of multivariate probit regression, while not being able to consider the correlation of the error terms.

[6] There exists empirical evidence on the positive association between attractiveness and receiving better performance evaluations as well as earning higher amount of performance pay (Ahmed et al. 2023; Hosoda et al. 2003; Tu et al. 2022). This implies a higher incentive of sorting into performance pay jobs for more attractive individuals. At the same time, there exists several studies showing a negative association between attractiveness and loneliness (see D'Alessandro 2023; Feingold 1992; Jones et al. 1981; Lamm and Stephan 1987; Reis et al. 1982; Stephan et al. 1988; Zakahi and Duran 1988).

[7] There exists a positive association between physical exercise or sports and sorting into jobs with performance pay (Zhang et al. 2016). At the same time, there is a negative association between healthy lifestyle and loneliness (Richard et al. 2017).

[8] Medical evidence suggests that it takes several years for cancer to develop. For example, it takes 10-15 years for colon cancer to develop (Muto et al. 1975). Similarly, the latency period for breast, lung, and stomach cancer are

17.2, 13.6, and 22.9 years (Nadler and Zurbenko 2014). Therefore, an immediate effect of performance pay on cancer is unlikely.

[9] The results are available upon request.

[10] I also address the issue of endogeneity in the context of heterogeneous effect of performance pay on loneliness. The IV estimations are in line with those presented in Table 10. Like the initial IV estimations, the effect of performance pay on loneliness is larger for both subsamples with the private sector having much larger and statistically significant influence (β=0.163; standard error=0.074) compared to the public sector (β=0.039; standard error=0.057). The results are available upon request.

[11] Note that this variable may also capture any other kinds of non-performance related bonuses and premiums.

[12] The results are available upon request.