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Overeducation, Performance Pay and Wages: Evidence from Germany

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Abstract: Overeducated workers are more productive and have higher wages in comparison to their adequately educated coworkers in the same jobs. However, they face a series of challenges in the labor market, including lower wages in comparison to their similarly educated peers who are in correctly matched jobs. Yet, less consensus exists over the adjustment mechanisms to overcome the negative consequences of overeducation. This study examines the hypotheses that overeducated workers sort into performance pay jobs as an adjustment mechanism and that performance pay moderates their wages. Using German Socio-Economic Panel, I show that overeducation associates with a higher likelihood of sorting into performance pay jobs and that performance pay moderates the wages of overeducated workers positively. It also holds in endogenous switching regressions accounting for the potential endogeneity of performance pay. Importantly, the positive role of performance pay is particularly larger for the wages of overeducated women.

Keywords: Performance Pay; Overeducation; Wages; Educational Mismatch; Sorting.

JEL Classification: I21; J24; J31; J33; M52.

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1. Introduction

An extensive body of literature shows that overeducated workers, those with a surplus level of education than is required in their job, are more productive and earn higher in comparison to their adequately educated colleagues in the same jobs (Duncan & Hoffman 1981; Hartog 1985; Rumberger 1987; Alba-Ramirez 1993; Daly et al. 2000; Galasi 2008). Yet, overeducated workers also encounter a series of challenges and problems in the labor market (see Freeman 1976; Rumberger 1981; Groot & van den Brink 2000). First, overeducated workers have lower wages in comparison to their correctly allocated peers who are similarly educated (Bauer 2002; Hartog 2000; McGuiness 2006; Bender & Heywood 2011; Marioni 2021). Second, overeducated workers are less likely to be satisfied with their jobs (Hersch 1991; Belfield & Harris 2002; Moshavi & Terborg 2002; Bender & Heywood 2006). Third, overeducation is also associated with a higher probability of job turnover (Allen & van der Velden 2001; Wolbers 2003; Verhaest & Omey 2006), which in turn may deteriorate the labor market stability of the overeducated workers.

Despite the known negative labor market consequences of overeducation, developed countries still implement policies to expand the educational attainment of their labor force.[1] Besides financial support from the government, individual students also have to invest enormously in resources and time to successfully increase the share of highly educated labor force (Sloane 2020). Yet, ample evidence shows that a large share of workers are educationally mismatched: 258 million workers worldwide (Gammarano 2020) and around 17 percent of the workers in OECD (Organization for Economic Cooperation and Development) countries as well as in Germany are overeducated (OECD 2016). Therefore, it is crucial to investigate how the overeducated workers enhance their labor market positions to overcome the negative consequences of being overqualified.

This study contributes to the literature by investigating the link between overeducation, performance pay and wages. In a first step, I study whether overeducated workers, as an adjustment mechanism, are more likely to sort into jobs where they get financial rewards according to their productivity and performance, i.e., sort into performance pay jobs. In the next step, I examine whether the wages of overeducated workers subject to performance pay systematically differ from the wages of overeducated workers receiving no performance pay.

Performance pay aligns the objectives of worker and firm. It attracts more talented and highly productive workers (Lazear 1986, 2000). Moreover, there is abundant evidence showing that performance pay is associated with higher wages (Booth & Frank 1999; Green & Heywood 2016; Heywood & Parent 2012; Jirjahn & Stephan 2004; Parent 1999; Pekkarinen & Riddell 2008). As the wages of workers with performance pay are tied to their productivity, highly qualified workers may earn more in such jobs. Thus, overeducated workers may have an incentive to sort into performance pay jobs not only because they are more productive and qualified but also because they can utilize their surplus qualifications and skills to be rewarded accordingly, and hence, improve their wages.

Overeducated workers have at least three reasons to sort into performance pay jobs. First, they are more productive in comparison to their adequately educated counterparts in the same jobs but still earn less than the similarly educated workers who are in correctly matched jobs. Second, overeducated workers may become frustrated easily in jobs in which they are not able to make full use of their surplus education. As a consequence of frustration, these workers are less satisfied with their jobs (Tsang et al. 1991). Thus, this may provide another incentive to simply sort into performance pay jobs, where their surplus education and productivity could be tied to their pay. Third, overeducated workers may have less or even no incentive to be extra productive in the time rate sector as there are no returns for their extra effort, and hence, may not use their surplus education when they are not awarded and appraised accordingly.

Not surprisingly, a large number of studies examine the labor market consequences of overeducation as I will review. Far less studied is the adjustment mechanisms overeducated workers use to improve their labor market positions. This study is the first to examine whether overeducated workers are more likely to sort into performance pay jobs and whether performance pay moderates their wages. Few studies already examine the role of worker education on sorting into different job types. Spence (1973) shows that education has a role in sorting workers with higher productivity into jobs where they can be more productive. It is also argued that the overqualified workers are more likely to sort into jobs where their likelihood of being promoted later are higher (Sicherman & Galor 1990). Gottschalk and Hansen (2003) provide evidence that some workers with college degrees sort voluntarily into the non-college sector due to their idiosyncratic preferences. Moreover, some recent studies argue that the lower wages of overeducated workers may partially reflect a compensating wage differential for more favorable job characteristics (McGuinness & Sloane 2011; Verhaest & Verhofstadt 2016). However, the sorting probability of overqualified workers into performance pay jobs and the moderating effect of performance pay on their wages have not been studied yet.

Using unique data from the German Socio-Economic Panel (SOEP), this study shows that overeducation is strongly associated with higher likelihood of sorting into performance pay jobs. Despite including a wide variety of determinants of sorting into performance pay, worker preferences and worker characteristics, I find overeducation consistently and significantly associates with sorting into performance pay jobs. Importantly, I also show that performance pay moderates the wages of overeducated workers positively. In comparison to their correctly allocated peers with similar levels of education, overeducated workers subject to performance pay have significantly lower wage penalties than overeducated workers receiving no performance pay. In comparison to their correctly allocated coworkers in the same jobs, overeducated workers subject to performance pay have significantly higher wage

premiums than overeducated workers receiving no performance pay. These also remain true even when accounting for the potential endogeneity of performance pay.

Interestingly, the moderating role of performance pay on the wages of overeducated workers is larger for women than for the men. Overeducated women receiving performance pay are subject to no wage penalty, while the wage penalty of overeducated men receiving performance pay is almost half the wage penalty of overeducated men with no performance pay. This indicates that sorting of overeducated workers into performance pay jobs can be an effective adjustment mechanism, especially, for the overeducated women.

The overall findings shed light on models arguing that workers with higher productivity sort into performance pay jobs (Lazear 1986, 2000). It also indicates that employing overqualified workers is understandable and clarifies the firms' motives of tolerating continuous overeducation in the workforce. Notably, this study compares overeducated workers with two kinds of adequately educated workers: (1) those who are similarly educated but are in higher level jobs and (2) those who are in the same jobs but have lower educational attainment. The first comparison is relevant from the employees' viewpoint in particular, as it evaluates the effects of accepting a job below the educational level. The second comparison is more relevant from the employers' perspective, as it assesses the difference between overeducated workers and their adequately educated coworkers. Consequently, the findings of this study also bring two strands of literature, personnel and education economics, together.

In what follows, I first set the context by summarizing the previous evidences on the relationship between overeducation, performance pay and wages. Section 3 presents the data and variables. Section 4 provides the empirical analyses including heterogeneity and robustness checks. Section 5 concludes.

2. Background

Overeducation (undereducation) is associated with higher (lower) productivity. Empirical evidence using cross-sectional and panel data across different countries and time periods provides that overeducated (undereducated) workers have higher (lower) wages in comparison to their adequately educated coworkers in the same job (Battu et al. 1999; Büchel 2002; Dolton & Vignoles 2000; Frenette 2004; Green et al. 2007; van der Meer 2006). Moreover, taking into account the firm-level productivity, various empirical studies show that overeducation (undereducation) increases (diminishes) the productivity of the firms. Kampelmann and Rycx (2012) provide evidence that overeducation (undereducation) is associated with higher (lower) establishment level productivity using Belgian establishment data. Using a broader dataset with a longer time period from Belgium, Mahy et al. (2015) confirm these findings. Haugrund (1990) studies the link between educational mismatch and productivity on an establishment-level for Germany. Focusing on six German establishments in industrial R&D, Haugrund indicates that overqualified employees have better performance than their correctly allocated colleagues do.[2]

Yet, despite being more productive, overeducated workers suffer from a number of negative labor market consequences. First, available evidence shows that overeducation is associated with lower job satisfaction. In his preliminary study, Tsang (1984) shows that overeducation is associated with a 3.3 percent decrease in job satisfaction. Moreover, using unique data from manufacturing and warehouse firms, Hersch (1991) provides evidence that overqualified workers have significantly lower job satisfaction. Using the US Survey of Doctorate Recipients, Bender and Heywood (2006) show that among highly educated workers, those who report that their job closely match their education have significantly better job satisfaction. Focusing on workers with Ph.D.s in science, Bender and Heywood (2009) find a

negative relationship between educational mismatch and job satisfaction. They show that mismatched workers have a 20 percent lower job satisfaction.

Second, besides the lower job satisfaction, it is also well known that overeducation is associated with a higher probability of job turnover and quits. Using the Survey of Working Conditions, Tsang et al. (1991) argue that overeducation is associated with both lower job satisfaction and higher turnover. They also show that this effect is stronger specifically for workers with higher years of overeducation. Wolbers (2003) studies the consequences of educational mismatch among school leavers in the Europe. He shows that mismatched workers, as an adjustment mechanism, are more likely to look actively for new jobs and quit than those with matched jobs. Moreover, using the Dutch data, Allen and van der Velden (2001) show a strong positive relationship between mismatch and turnover rates. Bender and Heywood (2009) indicate that overeducation is associated with around 30 percent higher likelihood of job turnover among workers with Ph.D.s in science. Further, Verhaest and Omey (2006) show a positive link between overeducation and turnover rates using Flemish data.

Third, and most importantly, overeducated workers have lower wages in comparison to their adequately educated peers with the same levels of education. Verdugo and Verdugo (1989) show that overeducated workers earn around 14 to 32 percent lower in comparison to similarly educated workers who are in matched jobs using 1980 census data. Using the same specifications, Santos (1995) finds similar outcomes for Portugal. Bauer (2002) studies the wage effects of educational mismatch in Germany between 1984 and 1998 using the SOEP. Supporting the empirical literature, he shows that overeducation is associated with lower earnings for both male and female workers. In a survey of empirical studies from different sources and time periods, Hartog (2000) indicates that overeducated workers indeed have lower earnings in comparison to matched workers with same levels of education. Similarly, in his review of the literature on overeducation, McGuinness (2006) shows that overeducation is

associated with an average wage penalty of 15.3 percent. He concludes that overeducation is not only nocuous for the individual workers and firms, but also for the economy as a whole. These findings imply that despite being more productive and earning more than their correctly matched coworkers in the same jobs, overeducated workers do not earn the potential wage that their qualification levels enable them to earn.

Against this background, overeducated workers may have a motive to improve their labor market positions by sorting into specific types of jobs. One possible adjustment mechanism could be sorting into jobs where good performance and productivity is rewarded. Overeducated workers are highly productive in comparison to their coworkers in the same jobs and hence, as a response to the negative signals of being overeducated, they may be more likely and more motivated to sort into performance pay jobs.

It is well known that performance pay attracts more talented and highly productive workers (e.g., Lazear 1986, 2000; Booth & Frank 1999; Dohmen & Falk 2011) by tying their performance with their pay. In his seminal windshield study, Lazear (2000) shows that after a shift into performance pay, half of the productivity gains originated from highly productive and talented workers being attracted to this scheme. Using Norwegian physicians' data, Sørensen and Grytten (2003) indicate that one third of the productivity gains associated with performance pay is because of the selection effect. Moreover, workers who are subject to performance pay have better general intelligence (AFQT score) and a higher self-esteem (Curme & Stefanec 2007). These characteristics in turn, are highly associated with better effort and earnings (Bowles et al. 2001). Similarly, experimental studies also show that more talented, productive and confident workers tend to sort into jobs with performance pay (e.g., Dohmen & Falk 2011). Additionally, the evidence on the link between performance pay and wages is clear. It has been consistently shown that performance pay is associated with higher wages (Green &

Heywood 2016; Heywood & Parent 2012; Jirjahn & Stephan 2004; Parent 1999; Pekkarinen & Riddell 2008; Seiler 1984).[3]

This study adds to the self-sorting model by introducing the issue of educational mismatch. Literature that focuses on the role of education on worker sorting does not consider the relationship between educational mismatch and performance pay. Signaling theory (Spence 1973) indicates that education as a signal has an impact in sorting workers who have a higher productivity into jobs where they can be more productive. The theory of career mobility (Sicherman & Galor 1990) indicates that overeducated workers are more probable to sort into jobs where their probability of being promoted later is higher. There is also evidence showing that due to heterogeneous preferences, some workers with college degrees sort voluntarily into non-college sector (Gottschalk & Hansen 2003). Furthermore, McGuinness and Sloane (2011) examine the relationship between overeducation and different job attributes arguing that the lower wages of overeducated workers might be partially driven by a compensating wage differential for more favorable job attributes. Thus, they emphasize a trade-off between being adequately educated and being overeducated in a job with more favorable attributes such as jobs with higher job security or better family life balance.

Building on the above mentioned literature, this study first examines whether overeducated workers, as a response to negative overeducation signals, are more likely to sort into performance pay jobs. Next, as the effectiveness of receiving performance pay depends on whether performance pay increases the wages of overeducated workers, I additionally investigate whether performance pay moderates the relationship between overeducation and wages.

3. Data and Variables

3.1.Dataset

The data stems from the SOEP (Goebel et al. 2019). The SOEP is a broad representative longitudinal survey of private households in Germany. Demographic and socio-economic information is collected annually, while 'special' topic information is collected in different waves. I focus on the data from waves 2004, 2008, 2011, and 2016. They are the only waves that cover information on both performance pay and educational mismatch. The empirical analysis comprises employees aged 25 to 65, which reflects the typical working age population.[4] Apprentices and marginally employed individuals are excluded as they are not likely to face a choice of sorting into performance pay. Following the literature on educational mismatch, I also exclude workers with a migration background. The acquired education of workers with a migration background may differ from the education system in Germany, and hence, excluding them lets the study focus on workers who attained their education in a comparable education system. Moreover, individuals with no formal qualifications are excluded as they are unlikely to face the problem of being overqualified. After retaining observations for which full information is available, the analysis makes use of an unbalanced sample with 20,126 observations from 11,376 employees.

3.2.Performance Pay

The performance pay variable is constructed using a two-stage question. First, it is asked if the worker is facing a regular and formalized performance appraisal by a superior. Next, if the worker responds positive, they are subsequently asked if the performance appraisal influences their earnings; i.e., influences on monthly gross wage, annual bonus, future wage growth and/or potential promotion. Building from the literature, the analysis makes use of a broad indicator

of performance-related pay (e.g., Baktash et al. 2022a; Cornelissen et al. 2011; Grund & Sliwka 2010). The performance pay indicator equals 1 if the employee faces a regular and formalized performance appraisal that influences their earnings and equals zero if otherwise. In this study, 28 percent of the employees classify themselves as being subject to performance pay.

3.3. Overeducation

The realized matches approach was used to identify overeducation and undereducation.[5] It measures years of required education in an occupation using the mean years of attained education of all the workers in that occupation (Verdugo & Verdugo 1989).[6] Workers are considered to be overeducated (undereducated) if their attained years of education are one standard deviation higher (lower) than the mean years of schooling in their occupation.[7] Table 1 provides descriptive statistics of the key variables for employees with and without performance pay. The mean years of overeducation is significantly higher in performance pay sector than in time rate sector. This shows a first indication that overeducation is indeed associated positively with receiving performance pay. Significant differences can also be found if the years of undereducation, years of attained education, and years of required education are considered.

3.4. Wages

The SOEP asks the following questions related to gross hourly wages of the workers: (1) "What did you earn from your work last month? Please state both: gross income, which means income before deduction of taxes and social security and net income…" (2) "How many hours do you generally work per week, including any overtime?" Therefore, monthly gross income in Euros is divided by actual working hours in a month (actual working hours in a month = actual working hours in a week x 4.33). The wage variable is also initially deflated using the SOEP-

provided consumer price index. Finally, a natural logarithm of the gross hourly wages is taken. As shown in Table 1, the mean log of gross hourly wages is significantly higher for workers subject to performance pay than for those receiving no performance pay.

3.5.Control Variables

Overeducation may differ across individuals with different personal characteristics. These characteristics may also be associated with performance pay and/or wages. Therefore, in an effort to isolate the effect of overeducation it is crucial to control for a broad set of other determining factors of sorting into performance pay jobs and wages. Table A1 shows the definition and descriptive statistics of the explanatory variables.

Demographic characteristics are taken into account by controlling for age, gender, region of residence, presence of young children in the household and household size (see Büchel & Weißhuhn 1997; Dohmen & Falk 2011). Moreover, work and income related factors and job complexity are taken into account by adding controls for the years of tenure with the current firm, firm size, public sector employees, part-time employees, broad industries and occupations (see Brown & Heywood 2005; Jirjahn & Poutsma 2013). In order to hold employment history constant, controls for full-time work experience, part-time work experience and unemployment experience are added (see Daly et al. 2000). I also control for different personality traits by including variables for the Big Five (conscientiousness, extraversion, agreeableness, openness, and neuroticism), locus of control and risk tolerance (see Blázquez & Budria 2012; Heywood et al. 2017). Finally, by holding the demographic characteristics, work and income related factors, job complexity, employment history and personality traits constant, this study diminishes any probability of omitted variable bias to the minimum possible level.[8]

4. Results

4.1. Overeducation and Performance Pay

Table 2 presents the estimates of the determinants of sorting into performance pay jobs using random effects linear and random effects probit regressions. The cross-period correlation of individual specific error terms are taken into consideration using random effects model. Moreover, the standard errors are clustered at the individual level. The first two columns compare overeducated workers to their similarly educated peers who are in matched jobs by keeping the years of attained education constant. The latter two columns compare overeducated workers to their coworkers in the same jobs who are correctly matched by keeping the years of required education constant.

When the years of attained education is controlled for, according to both random effects linear and random effects probit regressions, overeducation is statistically significantly associated with a higher likelihood of sorting into performance pay jobs. A two-year increase in the years of overeducation is significantly associated with a 2.2 percentage points higher likelihood of sorting into performance pay jobs. As the original share of employees with performance pay is 28 percent, this denotes a 7.8 percent higher probability of sorting into performance pay jobs. Thus, in comparison to their similarly educated peers, overeducated workers are more likely to sort into jobs with performance pay to enhance their labor market positions.

Similarly, when the years of required education is controlled for, both random effects linear and random effects probit regressions show a statistically significant positive relationship between overeducation and performance pay. A two-year increase in the years of overeducation is associated with 4.4 percentage points higher probability of sorting into performance pay jobs. This represents a 15.7 percent higher probability of sorting into jobs

with performance pay. Thus, in comparison to their adequately educated coworkers who are in the same jobs, overeducated workers are more probable to receive performance pay.

The findings are consistent with the notion that overqualified workers are more productive than their coworkers and hence, to improve their positions in the labor market and to eliminate negative consequences associated with overeducation, they are more likely to sort into jobs where they are rewarded for good performance. These results shed light on the models arguing that higher productivity workers sort into performance pay jobs.[9]

4.2.Overeducation, Performance Pay and Wages

4.2.1. Initial Estimates

Table 3 presents the initial estimates of the wage regression using random effects linear model, which takes into account the cross-period correlation of worker specific error terms. Again, the first two columns compare the overeducated workers to their similarly educated peers who are in matched jobs and the latter two columns compare them to their coworkers in the same jobs who are correctly allocated.

Column 1 shows that overeducated workers have lower wages in comparison to their correctly matched peers with similar level of education confirming the findings of previous studies. Column 2 includes performance pay variable and its interactions with years of overeducation, undereducation and attained education to investigate how performance pay contributes to the relationship between overeducation and wages. Overeducated workers with no performance pay face around 5 percent wage penalty. However, overeducated workers with performance pay face only 1.8 percent wage penalty. Thus, performance pay moderates the wages of overeducated workers positively by rewarding them according to their productivity and performance, and hence, can be used as a partially successful adjustment mechanism.

Interestingly, the interaction between performance pay and years of undereducation is also statistically significantly negative. While undereducated workers with no performance pay jobs have on average 5.3 percent higher wages than their similarly educated peers who are in matched jobs, the same is not true for undereducated workers with performance pay. As performance pay ties the productivity of workers to their pay, the wage premium of undereducated workers decreases to only 1.4 percent when they are subject to performance pay.

Column 3 shows that overeducated workers have higher wages in comparison to their adequately educated coworkers in the same jobs confirming the findings of previous studies. Column 4 includes again the performance pay variable and its interactions with educational mismatch variables. The interaction between years of overeducation and performance pay takes a statistically significant positive coefficient. Thus, overeducated workers with no performance pay have on average 4.7 percent wage premium, while those subject to performance pay have 7 percent. Moreover, while the interaction between years of undereducation and performance pay takes a negative coefficient, it is not statistically significant.

4.2.2. The Issue of Endogeneity

The study so far shows a significant and consistent positive role of performance pay on the relationship between overeducation and wages. However, the evidence on the role of performance pay may nonetheless suffer from endogeneity of performance pay. Despite including a long list of control variables, there still may be unobserved factors influencing both wages and sorting into performance pay. Thus, the endogeneity of performance pay variable would also result in biased estimates of the interaction of performance pay with educational mismatch variables.

One approach to account for endogeneity could be to use a fixed effects model. However, the study does not pursue this method for several reasons. First, the unbalanced panel data used in this study includes a large number of singleton observations that may not be used for estimating within-individual effects. Dropping the singleton observations decreases the number of observations substantially. Second, the fixed effects model drops out all the details comprised in the cross-sectional variation of the data and considers only the within variation of variables. Hence, inclusion of time-invariant variables are not possible. The within variations of educational mismatch variables and performance pay variable are quite small in estimation sample.[10] Variables with a small within variation may be included in the fixed effects models. However, the inclusion of these variables may lead to highly inefficient estimates (Jirjahn and Ottenbacher 2023). Third, a fixed effects model only tackles the issue of unobserved time-invariant effects, but not the issue of unobserved time-varying effects. Plümper and Troeger (2019) indicate that a fixed effects model is likely to intensify the bias caused by omitted time-varying variables as dropping the between variation raises the effect of time-varying misspecification on parameter estimates. Moreover, attenuation bias caused by measurement errors also tends to be more intense in fixed effects models (Swaffield 2001). While a possible weakness of the random effects model is the condition which does not allow any correlation of the random effects with the independent variables, Clark and Linzer (2015) provide evidence indicating that despite violation of this condition, random effects may still be preferred over the fixed effects model. Provided that the relationship between random effects and independent variables is not large and consequently the subsequent bias is sufficiently mild, then the smaller variance of the random effects model generates smaller root mean square errors compared to the fixed effects model. Particularly, this is important when variables with low within variations are included in the regression.[11]

Instead, this study uses an endogenous switching regression approach to address the potential omitted variable issue. This approach has the advantage of accounting not only for time-invariant, but also for time-varying unobserved variables. Running a switching regression has the further advantage of analyzing whether the link between overeducation and wages differ between workers with and without performance pay. This provides an alternative approach to analyze the interactions of performance pay and educational mismatch variables. Table 4 indicates the results. The determinants of sorting into performance pay and the determinants of workers' wage with and without performance pay are jointly estimated using full information maximum likelihood (FIML).[12] This method provides consistent standard errors by fitting binary and continuous parts of the model at the same time. Theoretically, the inherent nonlinearity of the endogenous switching model ensures the identification of the model. Besides previously used identifiers, I additionally use the share of workers receiving performance pay calculated for 162 detailed 4-digit occupations as instrument for performance pay (for instrumental variable strategy based on aggregation see for example Andelic et al. 2023, Baktash et al. 2022b, 2023, Lee 2004, Machin and Wadhwani 1991, Woessman and West 2006). When calculating the share of those receiving performance pay for a worker's occupation, I exclude that worker and focus only on occupations with more than 5 observations in a year. 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 (Bayo-Moriones et al. 2013). Indeed, 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). Hence, efforts to address the endogeneity should be mainly seen as exploratory and robustness checks.

The analysis reveals four intriguing findings. First, the likelihood ratio (LR) tests of independent equations (χ^2) reject the hypothesis of exogeneity, and hence, performance pay has to be treated as endogenous. Second, the performance pay share by occupation is a significant positive determinant of an individual worker's likelihood of receiving performance pay, fulfilling the relevance assumption. Third, the correlation between error terms (ρ) of the performance pay equation (selection equation) and the wage equations (outcome equations) take negative coefficients. However, the correlation coefficient is significant only for the correlation between performance pay equation and time rate sector wage equation. This suggests that workers who choose to work in time rate sector have lower wages than a random worker in the sample.

Fourth, and most importantly, the endogenous switching regression approves the key results. When the years of attained education is controlled for, a year increase in the years of overeducation is associated with 5.5 percent wage penalty in time rate sector. While for workers receiving performance pay, this penalty is substantially lower and equals 3.4 percent. Similarly, when the years of required education is controlled for, a year increase in the years of overeducation is associated with 3.8 percent wage premium in the time rate sector. However, for workers receiving performance pay, this premium equals 5.2 percent. Overall, the endogenous switching regression accounting for endogeneity of performance pay also supports the notion that performance pay moderates the wages of overeducated workers positively and reduces the wage penalty associated with overeducation.

4.2.3. Gender Differences

I also examine whether the role of performance pay on the wages of overeducated workers differ between women and men. Therefore, I stratify the sample by gender and run separate wage regressions for women and men. Table 5 shows the results. In comparison to their

similarly educated peers who are in matched jobs, overeducated women receiving no performance pay have on average 5 percent wage penalty. However, overeducated women receiving performance pay have no wage penalty. This implies that performance pay reduces the wage discrimination against the women and enables them to earn according to their productivity (Jirjahn & Stephan 2004; Gunderson 1975). Overeducated men receiving no performance pay have on average 4.5 percent wage penalty, while those receiving performance pay have only 2.6 percent. Moreover, in comparison to their adequately educated coworkers in the same jobs, overeducated women with no performance pay have on average 5.4 percent wage premium, while those with performance pay have 8.7 percent. Overeducated men receiving no performance pay have on average 3.3 percent wage premium, while those with performance pay have 5 percent.

In a further step, endogenous switching regression models are used to address the potential endogeneity of performance pay in the subsamples of women and men. Table 6 shows the results. In comparison to their similarly educated peers who are adequately educated, overeducated women receiving no performance pay have on average 5.8 percent wage penalty. However, those receiving performance pay have no statistically significant wage penalty. This supports the notion that performance pay moderates the wages of overeducated women positively, and eliminates the wage penalty associated with overeducation even when the endogeneity of performance pay is taken into account. Moreover, the results also indicate that in comparison to their correctly matched coworkers in the same jobs, overeducated women with no performance pay have a 4.4 percent and overeducated women with performance pay have a 7.2 percent wage premium.

In comparison to their similarly educated peers who are adequately educated, overeducated men receiving no performance pay have on average 5.1 percent wage penalty (similar to the overeducated women receiving no performance pay). However, those receiving

performance pay have a much lower wage penalty of 3.9 percent, indicating that performance pay only partially eliminates this penalty for overeducated men. Further, in comparison to their adequately educated coworkers in the same jobs, overeducated men receiving no performance pay have on average 2.6 percent and those receiving performance pay have 3.6 percent wage premium. Overall, the findings indicate that performance pay moderates the wages of both overeducated women and men positively. However, the effect is relatively larger for the women, which can be due to elimination of wage discrimination against the women.

4.3. Robustness Checks

While initially the random effects model is preferred over the fixed effects model due to previously mentioned various reasons. Nevertheless, for a matter of comparison, Table A2 indicates the results of fixed effects estimations. As stated earlier, the fixed effects method drops the singleton observations, which accounts for almost half the original observations. Therefore, Table A2 also indicates the random effects estimations. Again, excluding the singleton observations causes smaller coefficients and significance levels for the years of overeducation and its interaction with performance pay in the random effects estimations. This occurs due to having lower statistical power after losing half observations (Hill et al. 2020). However, even in this case, performance pay plays a significant positive role in shaping the wages of overeducated workers. According to the random effects estimation, in comparison to their similarly educated peers who are in matched jobs, overeducated workers with no performance pay are subject to a 3.8 percent wage penalty while overeducated workers with performance pay are subject to only 1.4 percent wage penalty.

The fixed effects estimation shows even a stronger finding that performance pay alters the negative effect of overeducation on wages to a positive one. According to the fixed effects model, overeducated workers receiving no performance pay are subject to a 1.6 percent wage

penalty while overeducated workers receiving performance pay are subject to a small wage premium of 0.3 percent. This provides further evidence that performance pay allows workers to make up for wage losses caused by working in jobs where they are overqualified by tying their performance to their pay. Moreover, when overeducated workers are being compared to their adequately educated coworkers in the same jobs, the interaction of years of overeducation and performance pay continues taking a positive and similar coefficient in both random effects ($\beta = 0.014; z = 1.77$) and fixed effects ($\beta = 0.011; z = 1.24$) methods. Altogether, the findings of Table A2 suggests that the smaller z-statistics in the fixed effects regressions is not due to the specific estimation method solely, but instead due to the substantial reduction in estimation sample. Finally, these findings also imply that the positive moderating role of performance pay on the wages of overqualified workers persists even when including worker fixed effects.

While the fixed effects model also supports the key finding of this study, I proceed further and take into account that the effect of overeducation on wages may vary across workers. Artz and Welsch (2020) suggest the usage of random slopes models to allow a heterogeneous impact of educational mismatch on wages across workers. Thus, following Artz and Welsch, I use a random slopes model and a random slopes model with Mundlak terms. The first takes into account that the influence of educational mismatch differs across workers. The latter additionally controls for the influence of time invariant factors. Table A3 presents the results. Again, both models conform to the hypothesis that performance pay positively moderates the relationship between overeducation and wages. Altogether, even the usage of different estimation strategies support the key finding of the present study and suggest that performance pay substantially reduces the wage penalty associated with overeducation.

A further question is whether the moderating role of performance pay depends on the type of performance pay. The data allows to distinguish between two types of performance

pay: (1) performance pay with short-term financial consequences (consequences for monthly gross wage or annual bonus) and (2) performance pay with long-term financial consequences (consequences for future wage growth or potential promotion). Thus, I estimate the effect of the two types by including the two variables and their interactions with educational mismatch variables in wage regression. Table A4 demonstrate the results. Performance pay with long-term financial consequences emerges to play a more important role in moderating the wages of overeducated workers than the performance pay with short-term financial consequences. Thus, the positive moderating role of performance pay on the wages of overeducated workers is mainly driven by performance pay with long-term financial consequences.

As a final robustness check, the study uses the mode approach to measure overeducation instead of the so far used mean approach. Thus, according to the mode approach, a worker is considered to be overeducated (undereducated) if the worker's attained years of education is higher (lower) than the mode years of education in their occupation (Kiker et al. 1997). Therefore, I rerun the main regressions using an alternative measure of educational mismatch to check the robustness of the results. Table A5 shows the results. Years of overeducation is statistically significantly associated with higher likelihood of sorting into performance pay jobs in both regressions controlling for years of attained education and years of required education, respectively. Moreover, columns 3 and 4 show that performance pay significantly moderates the wages of overeducated workers positively in comparison to both their similarly educated peers who are adequately educated and their coworkers in the same jobs, respectively. The endogenous switching regressions addressing the potential endogeneity of performance pay variable also confirm these results.[13] Hence, the mode approach supports the key findings of this study and implies that the positive influence of performance pay on the wages of overqualified workers also persists using a different measurement strategy.

5. Conclusions

This study examined the sorting probability of overqualified workers into performance pay jobs and investigated how performance pay contributes to the relationship between overeducation and wages. Overeducated workers are more productive and earn more than their coworkers who are adequately educated. Yet, they earn much lower than their peers with similar levels of education who are in jobs that correctly match their qualifications, are less satisfied with their jobs and are more likely to quit jobs. Therefore, as an adjustment mechanism to overcome the negative consequences, overqualified workers may be more likely to sort into jobs where they are rewarded for their good performance and productivity. Consequently, performance pay may improve their wages.

Using German survey data the study indicated that overeducated workers are more likely to sort into performance pay jobs. This likelihood holds true despite controlling for a long list of demographic characteristics, work and income related factors, job complexity, employment history and personality traits. Additionally, the study showed that performance pay significantly moderates the wages of overeducated workers positively. The moderation effect of performance pay is particularly larger for overeducated women than men, reflecting that performance pay also reduces gender wage discrimination. The findings also remained true in endogenous switching regressions addressing the potential endogeneity of performance pay. Therefore, it is shown that performance pay can improve the labor market success of overeducated workers by substantially reducing the wage penalty associated with overeducation, especially for the women. Finally, the results also shed light on the models arguing that highly productive workers sort into jobs with performance pay.

This study also provides valuable recommendations for both employees and employers. In terms of wages, overeducated workers receiving performance pay are better off compared to overeducated workers receiving time rate. Therefore, if workers are willing to accept jobs

below their qualification levels, then they are better off (or less worse off) when they receive performance-related pay instead of time rate. On the other hand, offering performance pay contracts to overeducated workers should be also beneficial to the employers. Considering wages as a proxy for productivity, overeducated workers subject to performance pay are more productive, and hence, more beneficial to the firm. Therefore, offering performance pay to overeducated workers is a win-win situation for both employees and employers.

I end this paper with remarks for further research. The present study already showed that the moderating role of performance pay on the wages of overeducated workers is mainly driven by performance pay with long-term financial consequences. Exploring the role of different types of performance pay (e.g., piece rates, commissions, individual-based performance pay, team-based performance pay, etc.) in detail stands as important future research. Finally, while overeducation remains a concern worldwide, the prevalence of overeducation differs by countries. Thus, future research could also investigate how performance pay contributes to the association between overeducation and wages across countries with distinct levels of overeducation.

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Tables

Table 1: Descriptive Statistics of the Key Variables

Variable	*(1)* *Performance pay* *Mean* *(Std. dev.)*	*(2)* *No performance pay* *Mean* *(Std. dev.)*	*(3)* *Difference* *(t-statistic)*
Years of overeducation	0.225 (0.652)	0.184 (0.638)	0.041 (4.08)***
Years of undereducation	0.078 (0.343)	0.058 (0.301)	0.021 (4.21)***
Years of attained education	13.914 (2.726)	13.070 (2.625)	0.844 (20.24)***
Years of required education	13.525 (1.825)	12.820 (1.955)	0.705 (23.38)***
Ln (wage)	2.845 (0.450)	2.548 (0.493)	0.297 (39.26)***
Number of observations	5624	14502	20126

*** Statistically significant at the 1% level.

Table 2: Overeducation and Performance Pay

	Comparison to similarly educated peers		*Comparison to coworkers in the same job*	
	(1)	*(2)*	*(3)*	*(4)*
	RE	*RE Probit*	*RE*	*RE Probit*
Years of overeducation	0.011 (2.11)**	0.061 [0.011] (2.08)**	0.020 (4.07)***	0.118 [0.022] (4.27)***
Years of undereducation	0.010 (0.95)	0.055 [0.010] (1.04)	-0.004 (0.38)	-0.031 [-0.006] (0.56)
Years of attained education	0.005 (2.20)**	0.029 [0.005] (2.63)***	---	---
Years of required education	---	---	0.007 (2.73)***	0.045 [0.008] (3.13)***
Control Variables	Included	Included	Included	Included
R^2	0.1878	0.1268	0.1878	0.1269
Number of observations	20126	20126	20126	20126
Number of employees	11376	11376	11376	11376

Dependent variable: Performance pay. The table shows the estimated coefficients. Z-statistics in parentheses are based on robust standard errors clustered at the individual level. Average marginal effects are in square brackets. ** Statistically significant at the 5% level; *** at the 1% level.

Table 3: Overeducation, Performance Pay and Wages

	Comparison to similarly educated peers		*Comparison to coworkers in the same job*	
	(1)	*(2)*	*(3)*	*(4)*
Years of overeducation	-0.038 (8.07)***	-0.048 (8.56)***	0.055 (12.27)***	0.047 (9.14)***
Years of undereducation	0.040 (5.64)***	0.053 (6.25)***	-0.093 (11.60)***	-0.085 (8.93)***
Years of attained education	0.055 (31.94)***	0.057 (30.39)***	---	---
Years of required education	---	---	0.067 (30.10)***	0.069 (29.11)***
Performance pay	---	0.118 (4.29)***	---	0.145 (4.04)***
Years of overeducation x performance pay	---	0.030 (3.86)***	---	0.023 (3.23)***
Years of undereducation x performance pay	---	-0.039 (2.74)***	---	-0.020 (1.41)
Years of attained education x performance pay	---	-0.006 (3.11)***	---	---
Years of required education x performance pay	---	---	---	-0.009 (3.18)***
Control Variables	Included	Included	Included	Included
R^2	0.6066	0.6087	0.6099	0.6121
Number of observations	20126	20126	20126	20126
Number of employees	11376	11376	11376	11376

Dependent variable: Ln (wage). Method: Random effects. The table shows the estimated coefficients. Z-statistics in parentheses are based on robust standard errors clustered at the individual level. *** Statistically significant at the 1% level.

Table 4: Overeducation, Performance Pay and Wages; Endogenous Switching Regression

	Comparison to similarly educated peers			*Comparison to coworkers in the same job*		
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
	PP	*Ln (wage) (PP = 0)*	*Ln (wage) (PP = 1)*	*PP*	*Ln (wage) (PP = 0)*	*Ln (wage) (PP = 1)*
Years of overeducation	0.075 (3.54)***	-0.055 (8.52)***	-0.034 (3.94)***	0.069 (3.48)***	0.038 (6.56)***	0.052 (5.98)***
Years of undereducation	-0.064 (1.56)	0.065 (5.88)***	0.023 (1.48)	-0.043 (1.03)	-0.079 (6.94)***	-0.098 (6.31)***
Years of attained education	0.002 (0.20)	0.049 (22.04)***	0.042 (14.42)***	---	---	---
Years of required education	---	---	---	-0.018 (1.65)*	0.071 (24.18)***	0.060 (14.24)***
Performance pay share by occupation	1.638 (22.36)***	---	---	1.631 (21.72)***	---	---
Control Variables	Included			Included		
ρ	---	-0.352 (2.85)***	-0.193 (1.05)	---	-0.284 (1.90)*	-0.154 (0.94)
Log pseudo-likelihood	-13261.215			-13227.961		
χ^2	64.15***			32.68***		
Number of observations	18895			18895		
Number of employees	10871			10871		

Dependent variable: Performance pay in columns (1), and (4); Ln (wage) in columns (2), (3), (5), and (6). Method: Endogenous switching regression. The table shows the estimated coefficients. Z-statistics in parentheses are based on robust standard errors clustered at the individual level. * Statistically significant at the 10% level; *** at the 1% level.

Table 5: Overeducation, Performance Pay and Wages; Gender Splits

	Comparison to similarly educated peers		*Comparison to coworkers in the same job*	
	(1)	*(2)*	*(3)*	*(4)*
	Female	*Male*	*Female*	*Male*
Years of overeducation	-0.050 (6.60)***	-0.045 (5.41)***	0.054 (8.16)***	0.033 (4.17)***
Years of undereducation	0.077 (6.58)***	0.026 (2.10)**	-0.068 (5.52)***	-0.094 (6.96)***
Years of attained education	0.060 (23.37)***	0.051 (17.45)***	---	---
Years of required education	---	---	0.081 (23.55)***	0.053 (15.41)***
Performance pay	0.160 (3.52)***	0.098 (2.84)***	0.212 (3.48)***	0.099 (2.24)**
Years of overeducation x performance pay	0.050 (4.14)***	0.019 (1.88)*	0.033 (3.01)***	0.017 (1.84)*
Years of undereducation x performance pay	-0.035 (1.32)	-0.028 (1.72)*	-0.014 (0.52)	-0.008 (0.48)
Years of attained education x performance pay	-0.010 (3.11)***	-0.004 (1.67)*	---	---
Years of required education x performance pay	---	---	-0.014 (3.14)***	-0.005 (1.37)
Control Variables	Included	Included	Included	Included
R^2	0.5495	0.6347	0.5574	0.6350
Number of observations	9671	10455	9671	10455
Number of employees	5641	5735	5641	5735

Dependent variable: Ln (wage). Method: Random effects. The table shows the estimated coefficients. Z-statistics in parentheses are based on robust standard errors clustered at the individual level. * Statistically significant at the 10% level; ** at the 5% level; *** at the 1% level.

Table 6: Overeducation, Performance Pay and Wages; Gender Splits - Endogenous Switching Regression

	Comparison to similarly educated peers			*Comparison to coworkers in the same job*			*Comparison to similarly educated peers*			*Comparison to coworkers in the same job*		
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
	Female						*Male*					
	PP	*Ln (wage) (PP = 0)*	*Ln (wage) (PP = 1)*	*PP*	*Ln (wage) (PP = 0)*	*Ln (wage) (PP = 1)*	*PP*	*Ln (wage) (PP = 0)*	*Ln (wage) (PP = 1)*	*PP*	*Ln (wage) (PP = 0)*	*Ln (wage) (PP = 1)*
Years of overeducation	0.091 (2.94)***	-0.058 (6.97)***	-0.025 (1.61)	0.035 (1.26)	0.044 (6.28)***	0.072 (5.10)***	0.070 (2.36)**	-0.051 (4.93)***	-0.039 (3.61)***	0.114 (3.93)***	0.026 (2.13)**	0.036 (3.25)***
Years of undereducation	-0.017 (0.29)	0.090 (6.28)***	0.074 (2.30)**	0.085 (1.40)	-0.059 (4.09)***	-0.064 (1.96)**	-0.083 (1.58)	0.027 (1.66)*	-0.011 (0.77)	-0.142 (2.55)**	-0.098 (5.75)***	-0.116 (7.35)***
Years of attained education	-0.023 (1.98)**	0.054 (18.60)***	0.048 (10.51)***	---	---	---	0.026 (2.24)**	0.041 (9.80)***	0.037 (9.44)***	---	---	---
Years of required education	---	---	---	-0.064 (3.78)***	0.081 (20.52)***	0.072 (9.91)***	---	---	---	0.024 (1.58)	0.055 (9.16)***	0.050 (8.98)***
Performance pay share by occupation	1.798 (11.61)***	---	---	1.822 (11.54)***	---	---	1.514 (14.70)***	---	---	1.477 (12.73)***	---	---
Control Variables	Included			Included			Included			Included		
ρ	---	-0.315 (2.44)**	-0.332 (0.64)	---	-0.267 (1.92)*	-0.310 (0.58)	---	-0.434 (1.66)	-0.133 (0.73)	---	-0.379 (1.04)	-0.089 (0.60)
Log pseudo-likelihood	-6322.625			-6270.964			-6659.054			-6667.649		
χ^2	37.97***			26.47***			31.43***			15.05***		
Number of observations	9239			9239			9656			9656		
Number of employees	5449			5449			5422			5422		

Dependent variable: Performance pay in columns (1), (4), (7), and (10); Ln (wage) in columns (2), (3), (5), (6), (8), (9), (11), and (12). Method: Endogenous switching regression. The table shows the estimated coefficients. Z-statistics in parentheses are based on robust standard errors clustered at the individual level. * Statistically significant at the 10% level; ** at the 5% level; *** at the 1% level.

Appendix

Table A1: Definition and Descriptive Statistics of Explanatory Variables

Variable	*Definition (Mean, std. dev.)*
Age	The age of worker in years (45.316, 9.658).
Female worker	Dummy equals 1 if the worker is a woman (0.481, 0.500).
Married	Dummy equals 1 if the worker is married (0.657, 0.475).
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) (0.295, 0.456).
Southern West German	Dummy equals 1 if the worker resides in one of the Southern federal states located in West Germany (Bavaria, Baden-Wuerttemberg) (0.262, 0.440).
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) (0.138, 0.345).
Children in HH	Dummy equals 1 if there are any children under 16 years old in the household (0.377, 0.485).
Size of HH	The number of people living in the household (2.833, 1.221).
Public sector	Dummy equals 1 if the worker is employed in the public sector (0.326, 0.469).
Tenure	The worker's tenure with the frim in years (13.113, 10.590).
Full-time work experience	The worker's full-time work experience in years (18.092, 11.200).
Part-time work experience	The worker's part-time work experience in years (3.453, 6.035).
Unemployment experience	The worker's unemployment experience in years (0.515, 1.409).
Part-time worker	Dummy equals 1 if the worker holds a part-time contract (0.245, 0.430).
Firm size 20-199	Dummy equals 1 if the worker is employed in a firm with 20-199 employees (0.291, 0.454).
Firm size 200-1999	Dummy equals 1 if the worker is employed in a firm with 200-1999 employees (0.229, 0.420).
Firm size ≥ 2000	Dummy equals 1 if the worker is employed in a firm with more than 1999 employees (0.279, 0.448).
Risk tolerance	The score of risk tolerance. The interviewee answers the question: "Are you generally willing to take risks or do you try to avoid taking risk?" 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" (4.742, 2.108).
Conscientiousness	The 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 (5.902, 0.850).
Extraversion	The 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 (4.829, 1.125).

Agreeableness	The 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 (5.316, 0.947).
Openness	The 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” (4.510, 1.133).
Neuroticism	The 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 (3.715, 1.191).
Locus of control	The score of locus of control constructed from adding up nine 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 3–8 are recoded in inverse order before adding up (4.974, 0.785).
Industry dummies	Six broad industry dummies.
Occupation dummies	Six broad occupation dummies.
Year dummies	Three year dummies for the years 2008, 2011 and 2016.

Number of observations = 20126.

Table A2: Overeducation, Performance Pay and Wages; Excluding Singleton Observations

	Comparison to similarly educated peers		*Comparison to coworkers in the same job*	
	(1)	*(2)*	*(3)*	*(4)*
	RE	*FE*	*RE*	*FE*
Years of overeducation	-0.038 (5.55)***	-0.016 (1.99)**	0.057 (8.55)***	0.005 (0.50)
Years of undereducation	0.045 (4.99)***	0.024 (2.48)**	-0.088 (8.12)***	-0.004 (0.28)
Years of attained education	0.061 (24.99)***	0.073 (3.87)***	---	---
Years of required education	---	---	0.068 (22.74)***	0.014 (3.00)***
Performance pay	0.119 (3.77)***	0.078 (2.07)**	0.145 (3.52)***	0.071 (1.46)
Years of overeducation x performance pay	0.024 (2.81)***	0.019 (2.04)**	0.014 (1.77)*	0.011 (1.24)
Years of undereducation x performance pay	-0.036 (2.35)**	-0.031 (1.83)*	-0.017 (1.05)	-0.018 (1.02)
Years of attained education x performance pay	-0.007 (3.10)***	-0.006 (1.98)**	---	---
Years of required education x performance pay	---	---	-0.009 (3.03)***	-0.005 (1.39)
Control Variables	Included	Included	Included	Included
Overall/Within R^2	0.6121	0.4624	0.6180	0.4605
Number of observations	13544	13544	13544	13544
Number of employees	4794	4794	4794	4794

Dependent variable: Ln (wage). The table shows the estimated coefficients. Z-statistics in parentheses are based on robust standard errors clustered at the individual level. * Statistically significant at the 10% level; ** at the 5% level; *** at the 1% level.

Table A3: Overeducation, Performance Pay and Wages; Random Slopes Models

	Comparison to similarly educated peers		*Comparison to coworkers in the same job*	
	(1)	*(2)*	*(3)*	*(4)*
	RS	*Mundlak and RS*	*RS*	*Mundlak and RS*
Years of overeducation	-0.041 (6.41)***	-0.016 (2.17)**	0.063 (9.97)***	0.004 (0.47)
Years of undereducation	0.045 (4.89)***	0.022 (2.18)**	-0.091 (8.79)***	-0.006 (0.50)
Years of attained education	0.062 (27.78)***	0.050 (17.53)***	---	---
Years of required education	---	---	0.069 (26.17)***	0.016 (3.85)***
Performance pay	0.121 (3.97)***	0.074 (2.14)**	0.148 (3.73)***	0.145 (3.46)***
Years of overeducation x performance pay	0.024 (2.54)**	0.019 (1.92)*	0.011 (1.27)	0.008 (0.86)
Years of undereducation x performance pay	-0.036 (2.50)**	-0.030 (1.91)*	-0.016 (1.02)	-0.009 (0.57)
Years of attained education x performance pay	-0.007 (3.35)***	-0.005 (2.10)**	---	---
Years of required education x performance pay	---	---	-0.010 (3.27)***	-0.011 (3.45)***
Control Variables	Included	Included	Included	Included
Number of observations	13544	13544	13544	13544
Number of employees	4794	4794	4794	4794

Dependent variable: Ln (wage). Equations (2) and (4) additionally include Mundlak terms. The table shows the estimated coefficients. Z-statistics in parentheses are based on robust standard errors clustered at the individual level. * Statistically significant at the 10% level; ** at the 5% level; *** at the 1% level.

Table A4: Overeducation, Performance Pay and Wages; Types of Performance Pay

	Comparison to similarly educated peers			*Comparison to coworkers in the same job*		
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Years of overeducation	-0.043 (8.10)***	-0.046 (8.77)***	-0.046 (8.49)***	0.050 (10.03)***	0.049 (10.12)***	0.048 (9.46)***
Years of undereducation	0.042 (5.32)***	0.050 (6.34)***	0.049 (5.98)***	-0.089 (10.11)***	-0.089 (9.87)***	-0.087 (9.31)***
Years of attained education	0.055 (30.40)***	0.057 (31.13)***	0.056 (30.32)***	---	---	---
Years of required education	---	---	---	0.066 (28.91)***	0.069 (29.62)***	0.068 (28.88)***
Performance pay (short)	0.068 (2.38)**	---	0.018 (0.56)	0.054 (1.42)	---	-0.007 (0.16)
Performance pay (long)	---	0.123 (4.10)***	0.113 (3.38)***	---	0.151 (3.72)***	0.144 (3.21)***
Years of overeducation x performance pay (short)	0.020 (2.55)**	---	0.006 (0.64)	0.020 (2.81)***	---	0.012 (1.44)
Years of undereducation x performance pay (short)	-0.012 (0.73)	---	0.005 (0.28)	-0.016 (0.99)	---	-0.012 (0.73)
Years of attained education x performance pay (short)	-0.002 (0.81)	---	0.002 (0.82)	---	---	---
Years of required education x performance pay (short)	---	---	---	-0.001 (0.23)	---	0.004 (1.20)
Years of overeducation x performance pay (long)	---	0.031 (3.89)***	0.027 (2.82)***	---	0.020 (2.73)***	0.013 (1.55)
Years of undereducation x performance pay (long)	---	-0.038 (2.53)**	-0.039 (2.46)**	---	-0.014 (0.94)	-0.010 (0.63)
Years of attained education x performance pay (long)	---	-0.008 (3.42)***	-0.008 (3.24)***	---	---	---
Years of required education x performance pay (long)	---	---	---	---	-0.010 (3.21)***	-0.010 (3.11)***
Control Variables	Included	Included	Included	Included	Included	Included
R^2	0.6093	0.6079	0.6097	0.6127	0.6113	0.6132
Number of observations	20126	20126	20126	20126	20126	20126
Number of employees	11376	11376	11376	11376	11376	11376

Dependent variable: Ln (wage). Method: Random effects. The table shows the estimated coefficients. Z-statistics in parentheses are based on robust standard errors clustered at the individual level. ** Statistically significant at the 5% level; *** at the 1% level.

Table A5: Robustness Check; Mode Approach

	(1)	*(2)*	*(3)*	*(4)*
	Performance pay	*Performance pay*	*Ln (wage)*	*Ln (wage)*
	RE Probit	*RE Probit*	*RE*	*RE*
Years of overeducation	0.054 (4.17)***	0.091 (6.49)***	-0.024 (9.17)***	0.034 (13.21)***
Years of undereducation	0.059 (5.93)***	0.021 (1.65)	0.012 (6.80)***	-0.046 (18.43)***
Years of attained education	0.038 (3.52)***	---	0.058 (31.57)***	---
Years of required education	---	0.038 (3.52)***	---	0.058 (31.57)***
Performance pay	---	---	0.085 (3.28)***	0.085 (3.28)***
Years of overeducation x performance pay	---	---	0.012 (3.80)***	0.008 (2.43)**
Years of undereducation x performance pay	---	---	-0.002 (0.74)	0.003 (0.80)
Years of attained education x performance pay	---	---	-0.004 (2.24)**	---
Years of required education x performance pay	---	---	---	-0.004 (2.24)**
Control Variables	Included	Included	Included	Included
R^2	0.1287	0.1287	0.6119	0.6119
Number of observations	20126	20126	20126	20126
Number of employees	11376	11376	11376	11376

Dependent variable: Performance pay in columns (1), and (2), Ln (wage) in columns (3), and (4). The table shows the estimated coefficients. Z-statistics in parentheses are based on robust standard errors clustered at the individual level. ** Statistically significant at the 5% level; *** at the 1% level.

Endnotes

[1] For example, one of the main aims of the European Union (EU) in 2002 was to improve the higher education participation rates of 30-34 years olds to 40 percent by 2020. This EU goal indicates that there would be excess demand for higher qualified labor or that the firms employing highly qualified individuals would develop their production style to capitalize on the extra skills (McGuinness 2006). Nevertheless, if the labor demand changes or if the developments are not fulfilled by firms, then workers may end up in jobs that require less education, or in other words, overeducation arises.

[2] Grunau (2016) finds a significant negative association between undereducation and establishment-level productivity in Germany.

[3] Workers receiving performance pay are also more likely to have a higher job satisfaction (e.g., see Green and Heywood 2008).

[4] As the average age of completing a degree in Germany is 24, the study focuses on individuals older than 24 (Statistisches Bundesamt 2022).

[5] The advantages and disadvantages of different identification strategies of overeducation and undereducation are discussed in detail by Sicherman (1991), Kiker et al. (1997), Hartog (2000) and Leuven and Oosterbeek (2011).

[6] I use three-digit occupation dummies based on International Standard Classification of Occupations (ISCO) to measure required years of education in an occupation.

[7] The years of attained education variable is constructed by SOEP measuring the number of years usually required to obtain one's highest qualification. Thus, years of education is the sum of years of schooling and any occupational training including universities (SOEP Group 2021, pp. 48-49).

[8] The estimation results for the control variables are not shown to save space. The full results are available upon request.

[9] The results also confirm the role of most of the independent variables in the anticipated directions.

[10] The workers' attained years of education is mostly constant in the sample, especially, after the age of 30.

[11] See Hill et al. (2020) for a critical discussion of fixed effects model limitations.

[12] The study uses a Stata program written by Lokshin and Sajaia (2004).

[13] The results are available upon request.