Wage returns to job tasks and personality traits in Germany

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Abstract

Purpose – This article aims to examine whether specific job tasks measured at the individual level or personality traits are associated with wages and whether the relationship between personality traits and wages differs depending on the job tasks that individuals perform.

Design/methodology/approach – This study analyzes the association between job tasks and personality traits, and their interaction, with regard to wages using German employee data from 2017/2018.

Findings – Results suggest that nonroutine manual, interactive or analytic tasks are associated with significantly higher wages compared to routine manual tasks, and while extraversion and emotional stability are related to higher wages, agreeableness and openness tend to be associated with lower wages also within occupations. Moreover, the association between personality traits and wages varies depending on the job task requirements at the workplace. A high degree of extraversion in particular is associated with higher wages when the employee performs nonroutine manual, interactive or analytic tasks.

Originality/value – To date, especially the interaction between individual job tasks and personality traits on wages has not been extensively studied because data on both job tasks and personality at the employee level are scarce. This study contributes to the understanding of wage differences among employees.

Keywords Job task requirements, Routine tasks, Non-routine tasks, Analytic tasks, Interactive tasks, Social skills, Non-cognitive skills, Big-5 personality traits, Complementarity of skills, Wages, Germany

Paper type Research paper

1. Introduction

In Germany and other member states of the Organisation for Economic Co-operation and Development (OECD), there are pronounced wage gaps between employees, and wage inequality has increased in recent years (OECD, 2020). Labor market theories emphasize that the wage level is determined by both supply-side and demand-side factors. On the demand side, technological change and digitalization have had a significant impact on job profiles, such that wages for nonroutine, analytic and interactive task-intensive jobs have increased, while they have decreased for routine task-intensive jobs (Autor *et al.*, 2003; Acemoglu and Autor, 2011). On the supply side, studies frequently highlight the importance of individual human capital (Becker, 2009), but increasingly focus on the role of personality traits in labor market success and wages (see, e.g. Jackson, 2006; Almlund *et al.*, 2011).

Comparatively little research has been conducted on the *interplay* between labor supply and demand factors. In this context, personality traits may be important, because *combined* with tasks, they may exert significant effects on wages (e.g. Bowles *et al.*, 2001; Deming, 2017;

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Deming and Kahn, 2018; Palczyńska, 2021; Weinberger, 2014). Hence, our main research questions in this study are: Are specific job tasks measured at the individual level or personality traits associated with wages, and does the relationship between personality traits and wages differ depending on the job tasks that individuals perform? Routine and nonroutine jobs may not be equally suitable for all personality types. Therefore, we analyze possible task-personality complementarities with regard to wages.

The empirical analyses are based on data from 2017/2018 on 7,300 employees. The data include information on employees' personality traits (the Big-5), job tasks and a variety of other wage-relevant variables such as cognitive ability, firm size, economic sector and job complexity. This allows us to examine the relationship between personality traits, job tasks and wages in a large sample of the current German labor force. Germany is an interesting case to study because of its high vocational specificity (Shavit and Müller, 1998). In addition, labor market trends related to job tasks are already relatively well documented in Germany, which is also due to the good data availability (e.g. see Maier, 2022).

Using occupation fixed effects regression models, our findings suggest that nonroutine manual, interactive or analytic tasks yield economically meaningful wage returns compared to routine manual tasks, and while extraversion and emotional stability are related to higher wages, agreeableness and openness tend to be associated with lower wages also within occupations. Moreover, we find that the association between personality traits and wages varies depending on the job task requirements at the workplace. A high degree of extraversion in particular is associated with higher wages when the employee performs nonroutine manual, interactive or analytic tasks.

This study makes two main contributions to the literature: First, most previous studies cover only a reduced number of Big-5 personality traits and job tasks (e.g. Deming, 2017; Weinberger, 2014). In contrast, we analyze all Big-5 personality traits and crucial job task domains (Autor *et al.*, 2003) to investigate possible complementarities and mismatches. Second, we investigate variation in job tasks at the individual level, while most previous studies use task information aggregated at the occupational level. This is particularly important for the analysis of wages, because several studies suggest that job tasks differ significantly not only between, but also within occupations (Cassidy, 2017; Autor and Handel, 2013; Rohrbach-Schmidt, 2019).

The study is relevant from a policy perspective because it has implications for society, employers and employees. If the remuneration gap for job tasks in today's labor market is widening, this will affect the extent and structure of social inequality. Inequalities may also arise because employees with certain personality traits are more or less successful in the labor market. If wage returns to job tasks vary with personality traits, knowledge of these relations is important from both an education policy and a career choice perspective.

2. Previous research and hypotheses
Wages are determined by several factors attributed to the demand side (i.e. jobs) and the supply side (i.e. employees) of the labor market [1]. On the *demand side*, technological change has drastically affected jobs and, in particular, the tasks that employees are required to perform on the job (Autor *et al.*, 2003; Spitz-Oener, 2006). The task approach (Autor *et al.*, 2003) argues that advances in computer technology have complemented employees in so-called nonroutine cognitive tasks, left most nonroutine manual tasks unaffected and substituted for employees in routine tasks. Nonroutine cognitive tasks are analytic (sometimes also referred to as abstract) and interactive tasks. Analytic tasks require creativity, problem-solving skills, critical thinking and analytical reasoning. Interactive tasks are communicative tasks, such as negotiating and persuading. Nonroutine manual tasks are physical flexibility and adaptability, visual recognition and personal communication. By contrast, routine tasks

are repetitive cognitive tasks (e.g. bookkeeping, filling out documents) and repetitive manual tasks (operating machines, producing standardized products), which can, in principle, be automated and replaced by machines (Autor and Handel, 2013; Autor *et al.*, 2003). Studies in numerous countries have found that the demand and wage premia have increased for analytic and interactive tasks, but decreased for routine tasks (Acemoglu and Autor, 2011).

In addition, researchers suggest that job tasks also differ within occupations, and that these differences are important for wage levels. Autor and Handel (2013) used a representative sample of employees of the United States (US) and show that analytic tasks are positively associated with higher wages conditional on employee characteristics and occupation-mean task usage. Using German data, Cassidy (2017) shows that individual task usage predicts wages. In the case of Germany, Rohrbach-Schmidt (2019) confirms the wage effects of individual tasks with more recent data.

Regarding the *supply side* of the labor market, employees' human capital or skills (e.g. education level and work experience, but also cognitive abilities) have often been highlighted as factors explaining differences in remuneration (e.g. Becker, 2009; OECD, 2020). In addition, sociodemographic characteristics such as gender or migration background may also impact pay (e.g. Smith *et al.*, 2021). Several studies further show that personality traits (or more general so-called noncognitive skills) are important for individual labor market outcomes, such as job performance or wages (Almlund *et al.*, 2011; Borghans *et al.*, 2008a; Collischon, 2020; Heineck and Anger, 2010). In this context, the "Big-5" have probably become the most popular taxonomy for measuring individuals' personality. They include openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism (as opposed to emotional stability). Research primarily finds a positive relationship between openness, conscientiousness as well as emotional stability and wages, as individuals with these personality traits are likely to have better education outcomes and job performance, among other factors (Almlund *et al.*, 2011; Borghans *et al.*, 2008a; Heineck, 2011; Lundberg, 2013; Mueller and Plug, 2006; Nandi and Nicoletti, 2014). A number of studies report no relationship between extraversion and wages (Collischon, 2020; Heineck, 2011; Palczyńska, 2021) while others indicate a gendered effect, that is, a negative correlation for women only (Heineck and Anger, 2010; Nyhus and Pons, 2005). Agreeableness is related to wage penalties (Heineck, 2011; Nandi and Nicoletti, 2014).

Wage determination involves a complex *interplay between both sides of the labor market*. For example, employees with higher education are more likely to perform analytic tasks and are less likely to perform routine or manual tasks compared to employees with lower education. Additionally, job tasks within occupations vary by employee gender (Autor and Handel, 2013; Cassidy, 2017; Rohrbach-Schmidt, 2019).

A small strand of the literature examines sorting into tasks by noncognitive skills and their combined effects on wages. Borghans *et al.* (2008b) used British and German data and show that possessing more social skills is associated with a higher probability of working in interactive task-intensive occupations. Weinberger (2014) used US data to compare two high school cohorts from 1972 to 1988. She finds that students who participated in social activities were more likely to be employed in interactive task-intensive occupations. Her results also show that employment in and earnings premia to occupations requiring high levels of both cognitive and social skills grew substantially compared to occupations that require only one or neither type of skill. Deming (2017) confirms Weinberger's findings, and his empirical results show that most employment and wage growth have occurred in occupations that require both math and social skills.

Considering potential mechanisms, this research argues that employees with high social skills are more successful in interpersonal relations and teamwork. Therefore, they are more likely to be employed in interactive task-intensive jobs. Deming and Kahn (2018)

find evidence for a complementarity between cognitive and social skills with regard to pay and firm performance using a dataset of job openings in the US. Wehner *et al.* (2022) investigate whether recruiters preferred employees with different personality traits for different tasks using a discrete choice experimental setting. They find that recruiters preferred more open and conscientious applicants for analytic tasks, and more open, extraverted and agreeable employees for interactive tasks. Finally, using employee data from Poland, Palczyńska (2021) shows a complementarity between cognitive and noncognitive skills, that is, the more neurotic an individual is, the lower their returns to cognitive skills.

In sum, previous studies show that wages are affected by both the task requirements of jobs and the personalities of employees, among other factors. However, they usually cover only a limited set of personality traits, use aggregated task information at the occupational level, or do not explicitly focus on the interaction between personality traits and job tasks. The present study addresses this gap in the literature.

We first verify whether individual-level nonroutine manual, analytic, and interactive tasks are on average related to higher wages compared to routine tasks (H1). Second, we test our hypothesis that personality traits are associated with wages even within occupations (H2). Third, we examine whether the relationship between personality traits and wages differs depending on the job tasks that individuals perform. It is reasonable to expect that if employees' personality traits complement job tasks particularly well, these employees are likely to be more productive and better paid than otherwise comparable employees. Consequently, we hypothesize that the relationship between personality traits and wages differs across job tasks (H3).

3. Data and analytical strategy

3.1 Data

This study uses data from the 2018 Personality Traits and Employment Survey (Rohrbach-Schmidt and Ebner, 2020) which is a random subsample of 8,010 employees from the Bundesinstitut für Berufsbildung (BIBB)/Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (BAuA) Employment Survey (ES) 2018 (ES in the following; Hall *et al.*, 2020). The data are particularly suitable for this study because they contain information on both employee personality traits and individual job tasks. In addition, the dataset contains a large number of other wage-related variables that allowed us to control for potential confounding factors. The survey comprises employed individuals (dependent employees and self-employed persons) in Germany aged 15 and older with regular working hours of at least ten hours per week and with sufficient command of the German language (interviews were conducted in German). The analyses use data from individuals with complete information on all variables of interest and 37 2-digit occupations from the German Classification of Occupations (KldB, 2010 [2]) with at least 20 cases. The final sample size of the analyses was 7,300.

Our dependent variable in the multivariate models is gross hourly wages (logarithmized). The change in the independent variables can thus be interpreted approximately as a percentage change in hourly wage. The first central independent variable is the employees' main job task category. In the ES 2018, respondents were asked to indicate how often (frequently, sometimes or never) they performed 18 job task items. We exploit the task variance at the individual level because individual-level information is crucial for the assessment of individual wages (see Autor and Handel, 2013; Cassidy, 2017; Rohrbach-Schmidt, 2019 for comparison). Calculating wage regressions using individual and occupation-assigned job tasks, we once more show that wages vary significantly between individual and occupation-assigned job tasks. This result also holds when individual and occupation-assigned job tasks are added to the model separately or jointly

and when the full set of control variables is included (see Table A3 in the Supplementary File, SF in the following). This suggests that the individual deviation from occupation-level tasks is correlated with productivity.

To avoid measurement error in individual tasks, we follow earlier studies using the ES data by grouping the individual task items into broader task categories (Autor *et al.*, 2003; Rohrbach-Schmidt and Tiemann, 2013; see Table 1). To limit the influence of possible biases in the response for task items, we only consider individual task items that are performed "frequently" as opposed to "sometimes" or "never". To assess the main task category for each individual, the share of each task category j (e.g. analytic) among all task categories (nonroutine manual, interactive, analytic and routine manual) is calculated for each individual i. Thereby, we consider the different number of task items per task category (Alda, 2013; see Table 1):

$$Share\ of\ task\ category\ ji (e.g., analytic\ task) = \frac{Number\ of\ tasks\ performed\ in\ category\ ji}{Total\ number\ of\ tasks\ performed\ over\ all\ task\ categories}$$

These shares sum up to one (or 100%) for each individual, which is considered as an approximation of the share of working time that individuals use to perform each task category (Antonczyk *et al.*, 2009). For each individual, the main task then corresponds to the task category with the largest share of working time [3]. Table 2 shows the distribution of the main job tasks across the sample and occupations with high task shares in each category to illustrate the categorization.

The second group of important independent variables are the Big-5 personality traits. The follow-up survey contains personality trait information based on the Big Five Inventory short version (BFI-S) with 15 questions, three items per dimension (Gerlitz and Schupp, 2005; see Table 3). The validity and reliability of the BFI-S has been investigated in various studies and has proven to be a valid measure in large-scale surveys (Gerlitz and Schupp, 2005). As Rohrbach-Schmidt *et al.* (2020) show, the reliability of the Big-5 personality traits measured by Cronbach's alpha is comparable in the present study. The items are measured on a 5-point Likert scale from 1 (does not apply at all) to 5 (applies completely).

Each trait is based on the average value of the three related items. As shown in Table 4, conscientiousness has a high average value (mean = 4.16), which means that many employees consider themselves to be very conscientious. Agreeableness (mean = 3.99) scores were also high, followed by extraversion (mean = 3.65), openness (mean = 3.41) and emotional stability (mean = 3.38). All five factors showed substantial variation, and relatively high variation was evident for openness, emotional stability and extraversion.

Table 4 presents the descriptive statistics of our main variables and the control variables introduced in Section 3.2 together with information on the reference categories used in the models [4].

Task categories	Task items
Routine manual	Manufacturing, producing goods and commodities; supervising, controlling of machines; transporting, stocking, posting; cleaning, waste disposal, recycling
Non-routine manual	Measuring, testing, controlling the quality; repairing, maintenance; hosting, accommodating, preparing meals; caring, nursing, healing; securing, protecting, guarding, monitoring, regulating traffic
Interactive	Buying, providing, selling; promoting, marketing, public relations; training, teaching, instructing, educating; advising and informing
Analytic	Organizing, planning and preparing working processes (of others); developing, research and designing; gathering information, investigating, documenting

Main task category	Freq	Percent	Typical occupations (KldB, 2010, 2-digit)
Routine manual	982	13.45	Drivers and operators of vehicles and transport equipment (52), cleaning services (54)
Non-routine manual	685	9.38	Nonmedical healthcare, body care, wellness and medical technicians (82), building and civil engineering occupations (32)
Interactive	1,719	23.55	Purchasing, sales and trading (61), sales occupations in retail trade (62), Teaching and training (84), advertising and marketing, in commercial and editorial media design (92)
Analytic	3,914	53.62	Technical research and development, construction and production planning and scheduling (27), computer science, information and communication technology (43), business management and organization (71)
Total	7,300	100.00	

Table 2.
Distribution of task categories

Note(s): The typical occupations mentioned are given as examples
Source(s): BIBB/BAuA Employment Survey 2018 and follow-up survey to the BIBB/BAuA Employment Survey 2018, authors' calculations

Big-5 personality trait	Items "I see myself as someone who . . . "
Openness	is original, comes up with new ideas
	has an active imagination
	values artistic, esthetic experiences
Conscientiousness	does a thorough job
	tends to be lazy (−)*
	does things effectively and efficiently
Extraversion	is communicative, talkative
	is reserved (−)
	is outgoing, sociable
Agreeableness	is sometimes somewhat rude to others (−)
	is considerate and kind to others
	has a forgiving nature
Emotional stability	worries a lot (−)
	gets nervous easily (−)
	is relaxed, handles stress well

Table 3.
Big five inventory short version (BFI-S)

Note(s): *(−) negative polarity

3.2 Analytical strategy

The analysis proceeds as follows: First, to test hypotheses H1 and H2, we analyze the relationship between job tasks and wages as well as between the Big-5 personality traits and wages. To correct for the possible endogeneity between personality traits and wages, we follow the approach used by Heineck and Anger (2010) and others and regressed each Big-5 trait on age and age squared. These residuals are used in the estimations as age-effect-adjusted indicators of the Big-5 dimensions. To ease the interpretation of their effect sizes, the personality measures are mean-centered and standardized.

To control for differences in unobserved characteristics of the occupations, such as sorting of employees with different skills, we include occupation fixed effects (KldB, 2010, 2-digit level). To limit further confounding biases (Elwert and Winship, 2014), the wage regression also contains measures of employees' human capital and cognitive skills (highest qualification, labor market experience and its square, a measure of cognitive ability, state

	Mean	SD	Min	Max
Gross hourly wage (in Euros)[1]	22.47	17.887	0.575	396.552
Log of gross h. wage (in Euros)	2.97	0.521	−0.554	5.983
Main job task category				
Routine manual (base outcome resp. ref. cat.)	0.13			
Nonroutine manual	0.09			
Interactive	0.24			
Analytic	0.54			
Big-5 personality traits				
Openness (unstandardized)	3.41	0.822	1	5
Conscientiousness (unstandardized)	4.16	0.600	1	5
Extraversion (unstandardized)	3.65	0.805	1	5
Agreeableness (unstandardized)	3.99	0.665	1	5
Emotional stability (unstandardized)	3.38	0.803	1	5
Female	0.47			
Marital status				
Married (ref. cat.)	0.57			
Single	0.28			
Divorced	0.12			
Widowed	0.03			
Children under 18 in the household	0.32			
Migrant background	0.08			
Highest qualification				
No vocational degree	0.04			
Vocational training degree (ref. cat.)	0.44			
Advanced training degree	0.08			
College/University degree	0.43			
Labor market experience in years	23.55	11.741	0	57
Labor market entry cohorts				
Before 1970–1979	0.16			
1980–1989 (ref. cat.)	0.32			
1990–1999	0.23			
2000–2009	0.19			
2010–2018	0.10			
Cognitive ability (No. of animals named)	27.95	7.422	1	122
State of health	3.26	0.848	1	5
Existence of a works council in the firm	0.60			
Economic sector				
Public service (ref. cat.)	0.30			
Industry	0.18			
Craft trades	0.07			
Commerce	0.08			
Other services	0.29			
Other sectors	0.06			
Trade unions, interest groups, associations, chambers, private households	0.03			
Job complexity				
Unskilled/semiskilled tasks	0.04			
Skilled tasks (ref. cat.)	0.42			
Complex tasks	0.20			
Highly complex tasks	0.34			
N	7,300			

Note(s): The working sample includes both dependent employees and self-employed. Only 5.5% of them state a gross hourly wage below 8.84 Euros which equals the minimum wage applicable in 2017

Source(s): BIBB/BAuA Employment Survey 2018 and follow-up survey to the BIBB/BAuA Employment Survey 2018, authors' calculations

Table 4.
Summary statistics

of health [5]) and sociodemographic variables (gender, marital status, children under 18 in the household, migrant background). Moreover, we include firm-related, institutional and further controls (firm size, existence of a works council in the firm, economic sector, labor market entry cohorts, federal states). Finally, job complexity (KldB, 2010 5th digit) is controlled for. Our analytic strategy thus aims to study the associations between individual job tasks, personality and wages, conditional on educational attainment and occupational allocation. All continuous control variables are centered at their mean values.

Second, five extended models are used to examine whether the relationship between personality traits and wages differs depending on the job tasks that individuals perform (i.e. to test hypothesis H3). In doing so, we include interaction effects between the employees' main job task and their five personality traits on wages. The full wage model can be written as:

$$\ln(W_i) = \beta_0 + \beta_1 MT_i + \beta_2 PT_i + \beta_3 MT_i{}^*PT_i + \beta_4 X_i + \beta_5 OCC_i + \varepsilon_i, i = 1, \ldots, I$$

where $\ln(W_i)$ is the natural logarithm of the individual's gross hourly wage, β_0 is the intercept, MT_i is the individual's main job task (i.e. analytic, interactive or nonroutine manual tasks with routine task as reference category), PT_i is a vector of the individual's personality traits, $MT_i{}^*PT_i$ is the interaction between the individual's main task and the individual's personality, X_i is a vector of individual, firm, sectoral, and regional controls, OCC_i are the occupational dummies, and ε_i denotes the error term.

There is ample evidence in the literature of gender differences in personality traits, tasks or wage returns. Therefore, we conduct the analyses both for the full working sample and distinguishing between women and men.
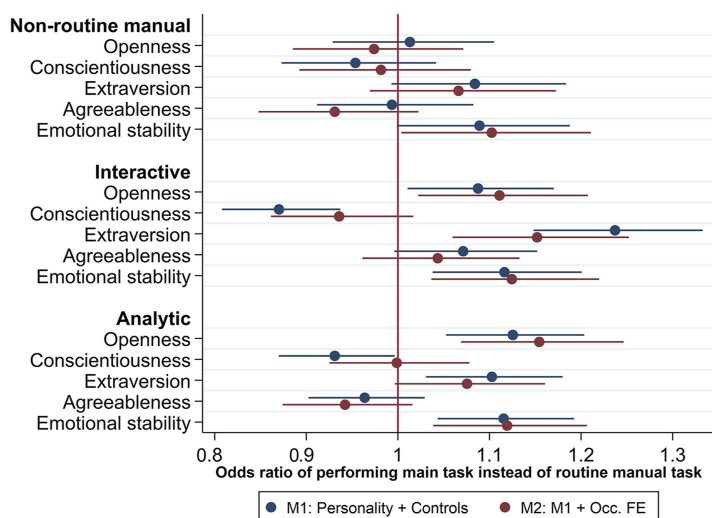
4. Results
4.1 Full working sample
Before we present the wage regressions, we briefly analyze the extent to which sorting into tasks by personality occurs between and within occupations. This procedure provides a more complete picture of the relationship between job tasks, personality and wages and helps us to adequately interpret our results. Figure 1 shows the results of the multinomial logit model M1 where the outcome variable is main task (with routine manual as the base outcome), and independent variables are the personality traits. We control for cognitive ability, gender, migrant background, highest qualification, labor market experience, labor market entry cohorts and size of firm. In an extended model M2 also shown in Figure 1, we then further add occupation controls to see how much within-occupation variation in tasks exists based on personality traits (see also SF, Table A1.1a).

These analyses reveal, first, that employees who are more open, more extraverted, more emotionally stable or less conscientious [6] are significantly more likely to sort into interactive occupations (such as advertising, marketing and media occupations or purchasing, sales and trade occupations) and analytic occupations (such as computer science, information and communication technology occupations or occupations in business management and organization). Second, after controlling for occupation (i.e. for within-job selection), we find that more open and more emotionally stable employees tend to sort into interactive and analytic tasks even within occupations. Also, more extraverted employees tend to perform more interactive tasks than others in their occupation.

Accordingly, the performance of job tasks in the German labor market seems to be related to some extent to the personality of employees (e.g. Borghans *et al.*, 2008b; Wehner *et al.*, 2022; Viinikainen *et al.*, 2020). This raises the question whether job tasks or specific combinations of personality traits and job tasks are rewarded differently on the labor market, which is the focus of our study.

Note(s): Figure 1 shows the results of two multinomial logit models where the
outcome variable is main task (with routine manual task as the base outcome),
and independent variables are the personality traits (see SF, Table A1.1a). M1
controls for cognitive ability, gender, migrant background, highest qualification,
labor market experience, labor market entry cohorts and size of firm. Big-5
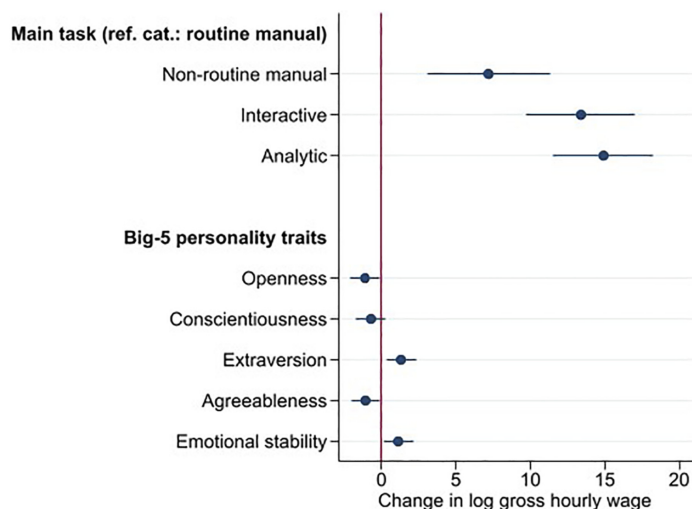personality traits are standardized. Model M2 further controls for Occupation
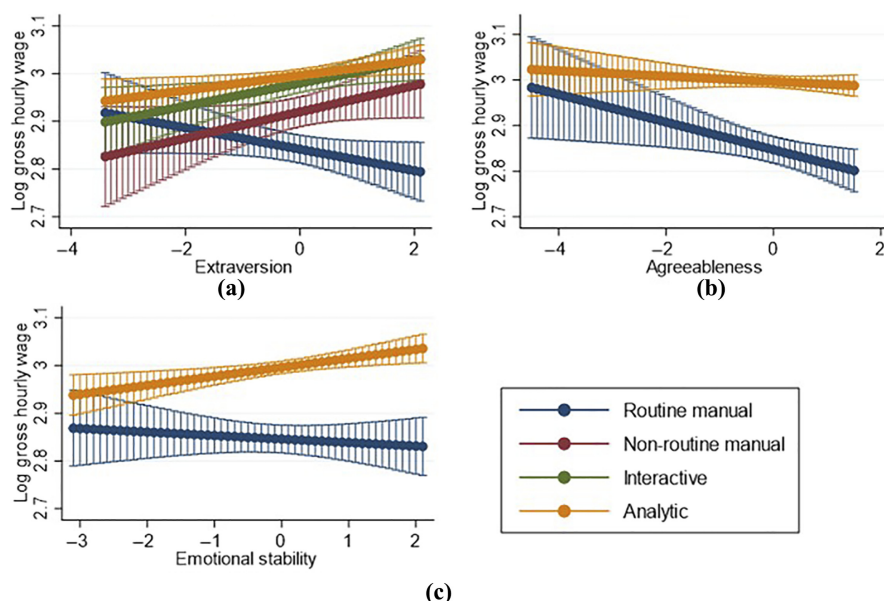Fixed Effects (Occ. FE)

Source(s): BIBB/BAuA Employment Survey 2018 and follow-up survey to the
BIBB/BAuA Employment Survey 2018, authors' calculations with $N = 7,300$

Figure 1.
Sorting into main task
by Big-5 personality
traits

Supporting hypothesis H1, Figure 2 (SF, Table A1.2a, Model M1) shows that employees
whose main tasks are nonroutine manual, interactive or analytic earn significantly higher
wages (on average $+ 7.2\%$, $+13.4\%$ and $+14.9\%$, respectively) compared to employees
working in routine manual tasks. These associations are substantial, especially since they are
adjusted for wage differences across occupations, differences in employees' human capital,
cognitive abilities and sociodemographic characteristics, as well as firm-related, institutional
and other controls. This again underscores the importance of individual job tasks in
understanding wages.

In addition, and supporting hypothesis H2, Figure 2 shows that wages vary significantly
with employees' Big-5 personality traits even within occupations, albeit to a smaller extent
than job tasks. A one standard deviation increase in extraversion and emotional stability is
related to 1.3% and 1.1% higher wages, respectively. While these traits are associated with
higher wages, agreeableness and openness tend to be associated with lower wages (both
−1.1%). The highly significant F-statistics (SF, Table A1.2a, Model M1) shows that both job
tasks and personality have a partial effect on wages and both groups of variables are jointly
significant.

The models depicted in Figure 3 test whether the relationship between personality traits
and wages differs depending on the job tasks that individuals perform (H3, also see SF,
Table A1.2a). Our results based on individual-level job tasks support this hypothesis: First,
extraversion is significantly related to higher wages in nonroutine manual, interactive and
analytic tasks, whereas extraversion is related to lower wages in routine tasks (see Figure 3a,

Note(s): Big-5 personality traits are mean-centered, standardized and age-effect-adjusted. The figure depicts the results from Model M1, see SF, Table A1.2a. The model controls for highest qualification, labor market experience and its square, cognitive ability, state of health, gender, marital status, children below 18 in the household, migrant background, size of firm, existence of a works council in the firm, economic sector, labor market entry cohorts, federal states, job complexity and 37 occupation dummies. The change in the independent variables can be interpreted approximately as a percentage change in gross hourly wage

Source(s): BIBB/BAuA Employment Survey 2018 and follow-up survey to the BIBB/BAuA Employment Survey 2018, authors' calculations with $N = 7,300$

Figure 2.
Main task, Big-5 personality traits and log gross hourly wages

and SF, Table A1.2a, Model M4). For instance, highly extraverted employees earn on average 2.8 Euros more per hour than highly introverted employees when performing nonroutine manual tasks, 2.5 Euros more when performing interactive tasks, and 1.7 Euros more when performing analytic tasks. In contrast, highly extraverted employees engaging in routine tasks earn 2.2 Euros less per hour than highly introverted employees. Second, being more agreeable is significantly associated with lower wages in all tasks; however, agreeableness is significantly more negatively associated with wages for employees with routine tasks than for those with analytic tasks (Figure 3b, and SF, Table A1.2a, Model M5). A highly agreeable employee earns on average 3.3 Euros less than a highly disagreeable one in routine tasks, but only 0.7 Euros less in analytic tasks. Third, Figure 3c (SF, Table A1.2a, Model M6) shows that highly emotionally stable employees are significantly more likely to earn an additional wage premium (1.9 Euros) if they perform analytic tasks, while being highly emotionally stable is associated with lower wages in routine tasks (−0.7 Euros).

4.2 Gender differences
Focusing on the sorting into tasks, our results show that particularly more extraverted women are more likely to work in interactive or analytic occupations, while more open and more emotionally stable men are more likely to sort into interactive and analytic occupations. After controlling for the employee's occupation – and thus looking at within-occupation selection – we find that these associations also show up for sorting into tasks within occupations. In addition, more conscientious women are not only less likely to sort into nonroutine manual, interactive

Note(s): Only significant interaction effects are shown. Big-5 personality traits are mean-centered, standardized and age-effect-adjusted. Figure 3 (a, b, c) depict the results from Model M4, M5 and M6, respectively, see SF, Table A1.2a). The models control for highest qualification, labor market experience and its square, cognitive ability, state of health, gender, marital status, children below 18 in the household, migrant background, size of firm, existence of a works council in the firm, economic sector, labor market entry cohorts, federal states, job complexity and 37 occupation dummies

Source(s): BIBB/BAuA Employment Survey 2018 and follow-up survey to the BIBB/BAuA Employment Survey 2018, authors' calculations with $N = 7,300$

and analytic occupations but are also less likely to perform these tasks within their occupations. Interestingly, while agreeableness seems to be unrelated to sorting into interactive occupations, more agreeable women perform more interactive tasks than others in their occupation (see SF, Tables A1.1b and A1.1c).

Focusing on the wage regressions (see Tables A1.2b and A1.2c), we find significant positive associations between wages and both interactive and analytic tasks for both genders. Nonroutine manual tasks are positively related to wages only for men (see models M1). Turning to personality, and to the question of whether the relationship between personality and wages differs across main tasks, we find some notable gender differences. First, openness is negatively related to wages for women, but not for men (see models M1). Model M2 for women shows that this negative relationship applies in particular for women in routine manual tasks, but less in other task categories [7]. Model M2 for men further reveals that there is no correlation between openness and wages among all task categories. Second, extraversion is especially negatively related to wages in routine manual tasks for women, but not for men (see models M3). In contrast, extraversion is positively related to wages in nonroutine manual and interactive tasks among both genders, as well as in analytic tasks among women (M3) [8]. Third, whereas agreeableness is negatively related to wages for men, there is no correlation between agreeableness and wages among women (M1). As model M5

for men shows, the negative relationship among men applies to the routine manual task category, but tends to be zero and even slightly positive in case of nonroutine manual and analytic tasks, respectively. On the contrary, the finding of no correlation between agreeableness and wages among women shows up in all task categories. Finally, emotional stability is positively related to wages for men in nonroutine manual, interactive and analytic tasks (M6), but not in routine manual tasks. For women, emotional stability and wages are not significantly related, and this applies to all task categories.

5. Robustness and sensitivity analyses

5.1 Alternative task operationalization

To reduce the complexity of our analyses, we have initially focused on the task category that the employee performs most frequently (see Section 3.2). We re-estimate our wage models using the working time of all task categories to analyze the robustness of our main results (see SF, Section A2.1.). This alternative task operationalization exploits more of the available task information, and considers that an employee's job might require a bundle of different task categories. Thus, whereas our main approach focuses on the main task category, this alternative approach takes greater account of the multidimensionality of the task requirements of jobs. However, the results based on the alternative operationalization for the overall sample and the gender-specific models are largely robust in comparison with our main findings. We find significant positive interaction effects on wages between extraversion and nonroutine tasks, and agreeableness as well as emotional stability and analytic tasks. In addition, we find significant positive interaction effects between openness as well as conscientiousness and analytic tasks, and conscientiousness as well as agreeableness and nonroutine manual tasks.

5.2 Specification of occupations

In addition, one could argue that the KldB 2010 2-digit level combined with the 5th digit requirement level is too broad to study within-occupation task variance. To rule out this possibility, we rerun the wage models with 3-digit occupation fixed effects (and the requirement level). The results are substantially similar to those reported in Section 4 for the overall sample and for the gender-specific models (see SF, Section A2.2.).

5.3 Age limit

Taking up the results of Lang et al. (2001), who show that the measurement quality of the BFI-S in telephone interviews is lower for respondents over 60 years of age, the analyses are also carried out for a sample of respondents up to 60 years of age to control for the possible effect of the interviewing technique on the outcomes. This exercise reveals no meaningful differences in the overall sample and in the gender-specific models (see SF, Section A2.3).

5.4 Controlling for motivation and persistence

In order to avoid multicollinearity problems, we do not control for alternative employee characteristics such as individual motivation or persistence. However, these characteristics might also influence the individual wage. To analyze a potential omitted variable bias, we include measures for the employee's motivation and persistence in our main wage models. To assess individual motivation, the employees in the ES were asked "How strongly do you pursue the goal of making a professional career? Very strongly, strongly, not much or not at all?" In addition, the dataset contains a measure for the employee's locus of control (Richter et al., 2017). Our robustness analyses show that the main associations of personality traits and tasks as well as their interaction on wages do not significantly differ from the results based on our main analyses (see SF, Section A2.4.).

5.5 Full model specification
Finally, in a full specification with all personality traits (see SF, Section A2.5.), the positive interaction effect between extraversion and nonroutine tasks is still significant, whereas the others are not. This suggests that the interaction between extraversion and nonroutine tasks is of particular importance. This also applies for the models for women, whereas for men, the positive interaction between emotional stability and interactive tasks as well as analytic tasks additionally remains significant.

6. Discussion and conclusion
Today's labor markets are undergoing profound change. A key trend is that demand is increasing for job tasks characterized by critical thinking, creativity and problem-solving requirements, as well as interactive communication tasks. Various studies show that personality traits are important for wages.

In this study, we target the following research questions: Are specific job tasks measured at the individual level or personality traits associated with wages, and does the relationship between personality traits and wages differs depending on the job tasks that individuals perform? We answer these questions by using a large sample of the current German labor force, which provides information about job tasks, employees' personality traits and wages. In contrast to earlier studies that mainly use task information at the occupational level, these data allow us to analyze these questions at the individual level.

First, the analyses show that job tasks are paid differently even within occupations, a finding that confirms earlier study results from the US and Germany (Autor and Handel, 2013; Cassidy, 2017; Rohrbach-Schmidt, 2019). Otherwise comparable employees who perform nonroutine manual, interactive or analytic job tasks as their main tasks are likely to earn more than those who perform routine tasks.

Second, the results show significant, albeit smaller associations between Big-5 personality traits and wages. Our results once more show that emotional stability is positively related to wages (e.g. Almlund *et al.*, 2011; Borghans *et al.*, 2008a), while agreeableness is negatively related to wages in some populations (Heineck, 2011; Nandi and Nicoletti, 2014). Additionally, we find that extraversion is positively associated with wages and openness is negatively related to wages.

Third, we find that the relationship between personality traits and wages differs depending on the job tasks that individuals perform. This result is in line with previous studies suggesting task-personality complementarities with regard to wages, especially among occupations that require nonroutine cognitive tasks and social skills (Borghans *et al.*, 2008b; Borghans *et al.*, 2014; Deming, 2017; Deming and Kahn, 2018; Weinberger, 2014). Our results contribute to these studies in that the wage returns to personality traits are likely to differ not only between occupations, but also within the same occupation across jobs with different task specialization. Extraversion is significantly related to higher wages in nonroutine manual, interactive and analytic tasks, whereas extraversion is related to lower wages in routine tasks. Similarly, highly emotionally stable employees are significantly more likely to earn higher wages if they perform analytic tasks, while being highly emotionally stable is associated with lower wages in routine tasks.

This suggests that more extraverted employees are more productive when they further specialize in nonroutine manual, interactive or analytic tasks and that more emotionally stable employees are more productive in analytic tasks. Nonroutine tasks, especially interactive ones, require complex communication and the ability to coordinate and communicate in teams (Autor *et al.*, 2003, p. 1284). Extraverted employees might be able to better accomplish these requirements than those with lower levels of this trait. This interpretation is consistent with the observation of sorting, in that more extraverted employees specialize in jobs with interactive tasks, even within occupations. Similarly, analytic tasks require problem-solving skills,

flexibility, intuition, conviction and creativity (Autor *et al.*, 2003, p. 1284). More extraverted or more emotionally stable employees may fulfill these requirements better than employees with lower levels of these traits. Consistent with this finding, more extraverted and emotionally stable employees are more likely to perform analytical tasks than routine tasks.

Moreover, we find that being more agreeable is significantly associated with lower wages in all tasks; however, agreeableness is significantly more negatively associated with wages for employees with routine tasks than for those with analytic tasks. This result is in line with the literature showing that agreeableness is negatively related to wages (Heineck, 2011; Nandi and Nicoletti, 2014). This is likely not due to lower productivity of more agreeable employees but to their lower assertiveness in the work environment. Routine tasks, on average, have higher risks of automation and job displacement than nonroutine tasks (Acemoglu and Autor, 2011), a process that increases competition for jobs and wages for routine workers. Consequently, highly agreeable employees might have particularly low chances to achieve decent wages in these jobs.

The central findings of wage differences between employees with different job tasks and personality traits also apply to the subsamples of female and male employees. However, consistent with the previous literature, gender-specific nuances are evident here (see, for example, Mueller and Plug (2006) with regards to agreeableness). The deeper investigation of these differences is an important field for future research.

Non-routine tasks are becoming more important. If the returns to tasks differ by personality even within occupations, this is important from an educational policy perspective. The educational system and further training in companies need to strengthen skills such as the interest in developing new ideas, and strong communication skills among (future) employees.

However, since the current study is based on cross-sectional data, we are not able to derive causal task-heterogeneous wage effects from personality traits. Future studies could address the question of sorting into tasks and task-personality complementarities with regards to wage returns. For example, this could be done with a movers design that observes both changes in job tasks and wages depending on the employee's personality traits. In addition, it would be interesting to investigate whether there are stronger or otherwise different personality effects for certain job tasks in less vocation-specific labor markets than Germany. Finally, it would also be worthwhile to uncover the mechanisms behind the finding that certain personality traits complement certain job tasks. For instance, qualitative studies on work and qualification processes in companies could be promising research.

Notes

1. Wages are also regulated to a large extent by institutional factors (e.g. collective bargaining agreements, minimum wages). In Germany, these factors are also reflected in differences in wage levels across the federal states. These institutional and regional factors are not the focus here, but corresponding influences are taken into account in the multivariate analyses by including, for instance, the control variables sector and region.

2. The KldB 2010, which is compatible with International Standard Classification of Occupations (ISCO 2008), is the most adequate classification for Germany, and it also offers the possibility of mapping the requirement level (see Paulus and Matthes, 2013).

3. If two or more tasks have the same shares, then the task with the lowest substitutability was chosen. Here, we assume the substitutability to be the lowest in analytic, followed by nonroutine manual, interactive and routine tasks. However, this was very rarely the case (only in about 3.3% of the working sample).

4. To make Table 4 clearer federal state and firm size variables are excluded, but are available on request.

5. Highest qualification is depicted as a dummy variable, which indicates whether a person has an apprenticeship or full-time school based vocational training degree (VET), an advanced training

certificate (Masters, technicians, business administrator and similar) or a university degree. Cognitive ability was collected as an animal-naming test (as in the German Socio-Economic Panel (SOEP), see Dohmen *et al.*, 2010). State of health ranges from poor (1) to excellent (5), and enters the models as a (quasi-)metric variable.

6. Similar findings concerning conscientiousness and occupational sorting in Germany can be found in the literature (see John and Thomsen, 2014).

7. For women, the net estimate for the association between openness and wages in interactive tasks is −0.005 (−0.055 + 0.050) and for analytic tasks −0.013 (−0.055 + 0.042). The differences in the estimates between the task categories interactive and routine manual (reference category) as well as between analytic and routine manual are statistically significant. In alternative specifications for women, with separate models for each main task, the correlation between openness and wages is significantly negative in case of routine manual tasks, but around zero and not significant in case of interactive and analytic tasks.

8. The net estimates for the association between extraversion and wages in nonroutine manual tasks for women is +0.017, in interactive tasks for women is +0.029 and in analytic tasks for women is +0.023, in nonroutine manual tasks for men it is +0.042, in interactive tasks for men it is +0.021.

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Supplementary material
The supplementary material for this article can be found online.

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