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Marta Palczyńska♦

Abstract

This paper provides evidence on the association between individuals' cognitive abilities, personality traits, and earnings. I find that cognitive skills and certain personality traits are complements. In particular, I find that cognitive skills and emotional stability are complementary, with neurotic individuals having significantly lower returns to their cognitive skills. Furthermore, my results indicate that agreeableness, neuroticism, and – surprisingly – grit are penalised significantly in the labour market; and that there is a positive relationship between conscientiousness and wages. Finally, I observe that, contrary to previous findings, women and men have similar returns to personality traits. I use well-established measures of cognitive skills and personality: namely, competence tests from the PIAAC survey to assess cognitive skills and the Big Five inventory and the Grit scale to assess personality traits.

Keywords: cognitive skills, personality traits, social skills, earnings

JEL: J16, J24, J31

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1. Introduction

The large impact of cognitive skills on labour market outcomes has long been recognised (Herrnstein & Murray, 1994; Murnane, Willett, & Levy, 1995), including at the international level (Leuven, Oosterbeek, & Van Ophem, 2004). However, even after cognitive skills are accounted for as determinants of individual wages, much of the variance in wages remains unexplained (Bowles, Gintis, and Osborne, 2001). Thus, economists became increasingly interested in investigating non-cognitive skills as potential predictors of life outcomes, and of wages in particular (for reviews, see Almlund, Duckworth, Heckman, & Kautz, 2011; Borghans, Duckworth, Heckman, & Ter Weel, 2008). Non-cognitive skills include a wide range of traits, such as personality traits,[1] values, motivations, and interests. Previous research has provided evidence that non-cognitive skills predict wages (Heckman & Kautz, 2012; Heineck, 2014), and that the variance in wages explained by non-cognitive skills is comparable to the variance explained by cognitive skills (Palczyńska & Świst, 2018).

At the same time, the recent economic literature has suggested that cognitive skills and selected personality traits, particularly social skills, are complements (Deming, 2017; Weinberger, 2014). Complementarity is understood here as an additional premium for having high levels of both skills at the same time. There are also reasons to expect emotional stability (the opposite of neuroticism) and cognitive skills to be complements. Motivation theory assumes that individuals have imperfect knowledge of their own abilities, and that ability and effort are complements. Higher levels of self-confidence may be expected to lead to higher levels of motivation and effort (Bénabou & Tirole, 2002). Accordingly, the more neurotic (so less self-confident[2]) an individual is, the lower his or her level of effort is expected to be; and, thus, the lower his or her use of skills and returns to cognitive skills are likely to be.

The main objective of this paper is to assess the degree of complementarity between cognitive skills and personality traits, and to evaluate their joint impact on individual wages. To date, this problem has been explored in the context of only one dimension of personality: i.e., social skills, which are often linked to extraversion from the Big Five model. In my article, I extend this research by analysing the complementarities between cognitive skills and the other Big Five traits and grit. To the best of my knowledge, this is the first study to provide evidence that neurotic individuals have lower returns to cognitive skills. Moreover, I replicate findings on the personality traits-wages relationships from high-income countries using well-established measures of cognitive skills and personality for Poland, and show the effects separately for women and men. For two reasons, Poland is an especially interesting case for analysis. First, the levels of earnings inequality in Poland are among the highest in Europe (Eurostat, 2016). Second, there is evidence that women in Poland have higher cognitive skills than men. In Poland, a gender gap in favour of women has been found for literacy, and no gender differences have been detected for numeracy; whereas men have been shown to have an advantage in numeracy in most other countries (OECD, 2016).

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[1] Some papers reserve the term "traits" for fixed characteristics, and "skills" for malleable characteristics. However, most of the economic literature uses these terms interchangeably. This paper follows the latter approach.

[2] Judge, Erez, Bono, & Thoresen (2002) showed that neuroticism, locus of control, self-esteem, and generalised self-efficacy are strongly related; and that a single factor explains this relationship. It was also argued that the locus of control, self-esteem, and neuroticism are indicators of a higher order trait: namely, core self-evaluation (Judge, Bono, Erez, & Locke, 2005; Judge & Hurst, 2007).

The paper is organised as follows. In the next section, I summarize the related literature. I then describe the dataset and the methodology used. In the following section, I investigate the relationship between cognitive and non-cognitive skills and wages. The last section concludes.

2. Related literature

This study contributes to four strands of literature: namely, to research on the returns to cognitive skills, the returns to non-cognitive skills, the complementarity between these skills, and the gender differences in the returns to skills. I limit my discussion of the literature to the studies that used the same concepts as this paper: i.e., achievement tests as measures of cognitive skills and personality traits (related to the Big Five traits and grit) as measures of non-cognitive skills.

Cognitive skills are considered a dimension of human capital that helps to explain workers' wage levels beyond their levels of educational attainment. Having strong cognitive skills enhances the productivity of workers, but it also enables them to learn new things and to adapt to changing work requirements. The most abundant evidence on the returns to cognitive skills are for early-career workers in the US (Chetty et al., 2011; Murnane et al., 1995). Additionally, the international competence surveys coordinated by the OECD (IALS, ALL, PIAAC) provided comparable cross-country data. For almost every country analysed, it has been shown that cognitive skills are rewarded among the working-age population (Hanushek, Schwerdt, Wiederhold, & Woessmann, 2015; Leuven et al., 2004).

There is extensive theoretical and empirical literature showing that personality affects wages via numerous channels other than education (Almlund et al., 2011). These non-cognitive skills may contribute to individual productivity analogically to human capital variables (Mueller & Plug, 2006), but they could also affect labour market outcomes via selection into occupations (Cobb-Clark & Tan, 2011) or wage negotiations (Nguyen et al., 2011). Personality traits are most commonly measured by the Big Five model, which organises personality according to five dimensions: openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism (emotional stability) (John & Srivastava, 1999; McCrae & Costa Jr, 1999). Conscientious individuals tend to be organised, responsible, and hardworking. Conscientiousness has been shown to be related to higher productivity (Cubel, Nuevo-Chiquero, Sanchez-Pages, & Vidal-Fernandez, 2016), to performance in on-the-job training (Barrick & Mount, 1991), and to supervisors' ratings of workers' performance (Caligiuri, 2000). Neuroticism has been found to be related to emotional instability, vulnerability to stress, and a lack of self-confidence. Traits associated with neuroticism, such as self-esteem and locus of control, have been shown to predict job search behaviour. For example, there is evidence that individuals with greater internal locus of control send out more job applications and have a higher reservation wage (Caliendo et al. 2015; McGee 2014). These results suggest that the wage gaps between neurotic and emotionally stable individuals may arise starting with the recruitment process.

Agreeableness, which is defined as the tendency to act in a cooperative, unselfish manner, may be valued in certain occupations that require client service or team work. However, there are channels other than productivity that operate in the opposite direction. Agreeableness has been shown to negatively affect selection into managerial and professional occupations (Cobb-Clark & Tan, 2011), as well as wage bargaining outcomes. Nguyen et al. (2011) and Hilbig et al. (2013) found experimentally that more agreeable individuals accepted unfair offers more often than their less agreeable counterparts. By contrast, openness to experience has been found to

positively affect selection into managerial and professional occupations (Cobb-Clark & Tan, 2011). Open individuals are typically curious, imaginative, and have a wide range interests – qualities that may be rewarded more in some occupations than in others. Extraversion is defined as the tendency to orient one's interests and energies towards the outer world of people and things, and is characterised by having a positive affect and high levels of sociability (Almlund et al. 2011). This trait might be beneficial in environments requiring team work. Extraverts typically have broader social networks, which might be an advantage in business.

Recently, the trait called "grit" has attracted a lot of attention among scientists and policy-makers. Grit is defined as perseverance and a passion for pursuing long-term goals. It has been observed that individuals who are "gritty" are able to sustain an interest in and a willingness to put effort into an activity, even when faced with challenges, failures, and a lack of positive feedback (Duckworth, Peterson, Matthews, & Kelly, 2007; Duckworth & Quinn, 2009). Grit is not part of the Big Five framework, but it is related to conscientiousness. Duckworth et al. (2007) have argued that grit is conceptually different from conscientiousness, as it emphasises stamina, or the ability to sustain effort and interest in long-term projects.

Previous empirical research has documented the relationship between personality and different aspects of labour market success. Barrick and Mount (1991) found that conscientiousness is positively related to job performance and training proficiency, whereas openness is related to training proficiency only. Many studies have shown that there are wage penalties for neuroticism and agreeableness (Mueller & Plug, 2006; Nyhus & Pons, 2005; O'Connell & Sheikh, 2011). Drago (2011) and Heineck and Anger (2010) also detected a negative relationship between wages and traits related to neuroticism. Studies on populations in the US and the UK reported that there is a wage premium for openness (Heineck, 2014; Mueller & Plug, 2006; O'Connell & Sheikh, 2011). However, research from other countries has suggested that there is a negative association between openness and earnings (Rammstedt, Danner, & Lechner, 2017; Risse, Farrell, & Fry, 2018). Most of the existing literature on this relationship has focused on the United States and Western Europe. The study by Cunningham et al. (2016) is one of the exceptions. Using Peruvian data, they found that openness is positively linked to wages, and that agreeableness is negatively linked to neuroticism. For Eastern Europe, Semykina and Linz (2007) showed that personality, as measured by locus of control and the need for challenge or for affiliation, affects earnings in Russia. Palczyńska and Świst (2018) evaluated this relationship in the context of the Polish labour market, and found that conscientious individuals earn more, while agreeable and neurotic individuals earn less. In the studies that controlled for individual and job differences, extraversion was not shown to be related to wages.

The recent literature has suggested that some non-cognitive skills can complement cognitive skills. Weinberger (2014) showed increasing complementarity between cognitive and social skills in the United States. Moreover, she demonstrated that the employment and wage premiums for occupations requiring both types of skills are substantially higher than those for occupations requiring just one or neither of these skills. Deming (2017) developed a team production model in which workers are assumed to exploit their comparative advantage by "trading tasks". According to this model, workers with high social skill levels have lower coordination costs when trading tasks, and are able to work with others more efficiently because they can specialise in their most productive tasks. His empirical analysis for the United States confirmed the model's prediction that there are complementarities between cognitive skills and social skills. The former study measured social skills by sports participation and other leadership roles in high school; while the latter study measured these skills by self-reported sociability or by assessments of extraversion based on the Big Five model, depending on data availability. Additionally, Deming (2017) constructed a measure of social skills based on four O*NET items.

Motivation theory gives reasons to expect that emotional stability and cognitive skills are complements. It assumes that individuals have imperfect knowledge of their own abilities, and that ability and effort are complements (Bénabou & Tirole, 2002). In addition, more self-confident individuals may be expected to put in more effort and to use their skills to a greater extent than their less self-confident counterparts. Accordingly, the more neurotic an individual is, the lower his or her use of skills is expected to be; and, thus, the lower his or her returns to cognitive skills are likely to be. Moreover, the results of experimental studies have suggested that neuroticism affects the use of skills. Müller and Schwieren (2012) and Cubel et al. (2016) examined the relationship between personality and productivity, as measured in the laboratory. Since the productivity task used was very simple, it was assumed that the level of performance of this task was unrelated to cognitive skills. Both studies found a negative association between neuroticism and productivity. Additionally, Müller and Schwieren (2012) investigated the relationship between personality traits and competitiveness, as measured experimentally through a classic paradigm based on Niederle and Vesterlund (2007). They found that neurotic individuals are less likely to compete than people who are not neurotic. There is also a growing body of literature showing that competitiveness is important for economic outcomes (Buser, Niederle, & Oosterbeek, 2014; Buser, Peter, Wolter, & others, 2017; Reuben, Sapienza, & Zingales, 2015). It may be expected that in a competitive environment, cognitive skills yield higher returns. In sum, the literature suggests that emotional stability is complementary to cognitive skills because of its impact on skill use and competitiveness.

Various studies have found heterogeneous effects of personality on wages for men and women, but the results differ across the analysed countries. Nyhus and Pons (2005) showed that agreeableness has a negative effect on earnings for women only; while Judge et al. (2012) found that agreeableness is significantly associated with lower wages for men. The findings on neuroticism are also not conclusive, as some studies have detected a relationship between neuroticism and earnings for men only (Mueller and Plug 2006), while other studies have found evidence of this relationship for both men and women (Nyhus and Pons, 2005). Judge et al. (2012) argued that gender differences in these personality traits-earnings relationships stem from the different social expectations for women and men. It has been shown that counter-stereotypic behaviour is often subject to social and economic sanctions (Rudman & Fairchild, 2004). These sanctions may include having more limited opportunities for promotion, reduced recognition (Rudman & Phelan, 2008), and worse interpersonal relations (Parks-Stamm, Heilman, & Hearns, 2008). For example, because men are expected to be more disagreeable than women, they are penalised more for agreeableness than women, who are expected to behave in this way.

This paper extends the limited existing research on the complementarities between cognitive skills and non-cognitive skills by providing evidence that emotional stability and cognitive skills are complements. Moreover, using well-established measures of cognitive skills and personality, I replicate for Poland previous findings on the relationships between personality traits and wages that are mostly for high-income countries, and show the effects separately for women and men.

3. Data and methods

This study employs data from the Polish follow-up to the Programme for the International Assessment of Adult Competencies (postPIAAC), conducted by the Educational Research Institute in 2014-2015. The dataset includes longitudinal information on PIAAC respondents in Poland and additional background information. The postPIAAC data is merged with cognitive skills measures from the OECD PIAAC study (Burski, Chłoń-Domińczak, Palczyńska, Rynko, & Śpiewanowski, 2013; OECD, 2013) conducted in 2011-2012. The combined database is representative of the Polish working-age population, and contains a number of measures of cognitive abilities, personality traits, and labour market outcomes (Palczyńska and Świst 2016).

The final sample is comprised of 1981 dependent employees aged 19-67. The natural logarithm of the gross hourly wage is used as the dependent variable. Summary statistics for the final sample are provided in Appendix Table A.2.

3.1. Measures of cognitive skills

The cognitive skills measured in the PIAAC are the basic information processing skills of literacy and numeracy.[3] Literacy is defined as "the ability to understand, evaluate, use and engage with written texts to participate in society, to achieve one's goals, and to develop one's knowledge and potential" (OECD, 2013). Numeracy refers to "the ability to access, use, interpret and communicate mathematical information and ideas in order to engage in and manage the mathematical demands of a range of situations in adult life" (OECD, 2013).

Both cognitive skills are measured on a 500-point scale in the PIAAC. In the subsequent analyses, I standardised the scores to have a mean of zero and a standard deviation of one. The PIAAC literacy and numeracy scales are intended to measure different skills, but they are strongly correlated (0.85). I focus on numeracy skills in this paper, but the results do not depend on the choice of the cognitive domain (the results for literacy are available from the author upon request).

I assume that among adults, literacy and numeracy do not change substantially over a three-year period. There is indirect evidence that the skills analysed here tend to be relatively stable over a period of this duration. Among schoolchildren, average annual gains in literacy and numeracy decline with age, and are already marginal by the age of 17 (Hill et al. (2008). Cross-sectional findings on adults show that proficiency peaks at around age 30, and then declines steadily (Paccagnella, 2016). However, longitudinal research on the development of literacy and numeracy skills has shown that the age profiles are less steep, or even that literacy is fixed early in life (Desjardins & Warnke, 2012).

3.2. Measures of personality

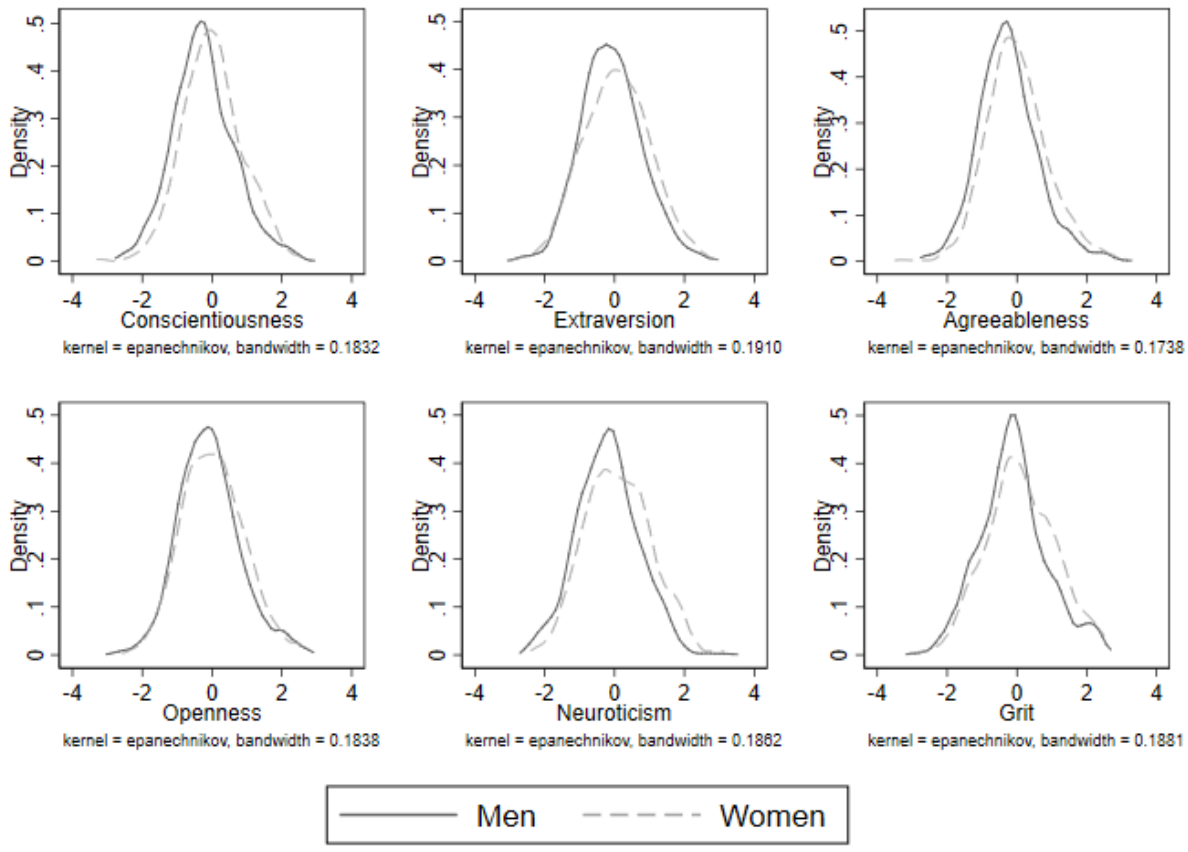
To measure personality, I use the Big Five model, which is the most widely used of the personality models. Here, personality traits are measured by the Polish version of the Big Five Inventory-Short (BFI-S) (Gerlitz & Schupp, 2005), which contains 15 self-reported items (see Appendix Table A.1 for the list of items). Respondents

[3] Also problem-solving in a technology-rich environment, but for a limited sample that included only respondents with basic computer skills who did not opt out from computer-based assessment.

answered on seven-point Likert type scales (1 – "disagree completely" to 7 – "agree completely"). The study also includes measurements from the short eight-item Grit scale (Grit-S) (Duckworth and Quinn 2009) (see Appendix Table A.2 for the list of items). The analysis uses the factor scores from the best fitted model obtained in the detailed psychometric analysis of the scale[4] (Palczyńska & Świst, 2016). The scores for the BFI-S and Grit-S subscales are standardised with a mean of zero and a standard deviation of one.

Figure 1 shows distributions of personality traits for males and females. Results from t-tests and Kolmogorov-Smirnov tests indicate that females have higher levels of conscientiousness, agreeableness, neuroticism, and grit than males; and these traits are differently distributed for males than for females.

Figure 1. Distribution of personality traits by gender



Notes: n = 1981.

Source: Own calculations based on postPIAAC data.

[4] The standardised Cronbach's alpha values range from 0.36 for extraversion to 0.61 for conscientiousness; and after the negative items are removed, they range from 0.45 for agreeableness to 0.66 for conscientiousness. In the analyses presented in the paper, I use a factor score from the six-factor oblique model with an additional factor loading the reverse-worded items for the Big Five data, and the unidimensional model for Grit-S.

3.3. Estimation method

I examine the returns to cognitive skills and personality traits using a semi-logarithmic model:

$$lnw_i = \beta \mathrm{COG}_i + \delta \mathrm{PT}_i + \alpha \mathrm{COG}_i * \mathrm{PT}_i + \theta \mathrm{X}_i + u_i,$$

where w_i is individual i's gross hourly wage, COG_i is the level of cognitive skills, PT_i is the vector of the respondent's personality traits and X_i is a vector of individual and job characteristics, and u_i denotes the error term. I include interactions between personality traits and cognitive skills in order to determine whether personality moderates the effect of cognitive skills on wages. I estimate models for men and women separately, in line with previous research that found substantial differences by gender.

Since wages are observed for employed individuals only, I use Heckman's selection model to account for sample selection bias (Heckman, 1979). The model is fitted with maximum likelihood; all of the models use weights that account for survey design. The selection equation includes variables that are distinct from the determinants of wages to serve as exclusion restrictions: namely, whether the respondent was living with a partner; whether the respondent's female and male parents or guardians were working when he or she was 16 years old; and whether the respondent had children aged six years or younger. There is no evidence of a sample selection problem in estimating the wage equation for women or for men (Table A. 3); thus, I focus on the results from the OLS estimation.

3.4. Alternative specifications

I include different sets of control variables. The baseline specification controls for age, age squared, years of education, experience, and experience squared. The second specification also includes a set of employment characteristics: a dummy on whether the respondent works for a public employer, tenure in the current job, the number of hours worked per week, nine occupation dummies (International Standard Classification of Occupations 2008, ISCO-08), and eight industry dummies (International Standard Industrial Classification, ISIC). The change in personality coefficients between specifications reflects the extent to which an individual's personality affects his or her selection into specific occupations (Filer, 1986; Heineck, 2014; e.g., Mueller & Plug, 2006).

Next, I account for the possible non-linear effects of personality. It has been argued that in the case of personality, "more" does not necessarily mean "better" (Lee et al. 2011). To test the possible non-linear associations between personality and wages, I estimate additional regressions with the quadratic term of each personality trait. Finally, as it has been argued that a worker's personality is revealed to the employer only after some time on the job (Heineck and Anger 2010; Nyhus and Pons 2005), I estimate models with interaction terms between an employee's tenure with the current employer and his or her personality traits.

4. Results

There are three main findings. First, conscientiousness is shown to be positively related to wages, while agreeableness, neuroticism, and grit are found to be negatively associated with wages. Second, there is no evidence of self-selection into occupations based on personality traits. Finally, complementarities are detected between some personality traits and cognitive skills: specifically, the analysis shows that the more emotionally stable an individual is, the higher his or her returns to cognitive skills are.

Table 1 Log-hourly wage estimates

	Men	Women	Men	Women	Men	Women
	(1)	(2)	(3)	(4)	(5)	(6)
Numeracy	0.101***	0.033	0.086**	0.044	0.050*	0.028
	(0.027)	(0.030)	(0.029)	(0.029)	(0.025)	(0.026)
Conscientiousness	0.141**	0.102+	0.148**	0.107+	0.143**	0.131**
	(0.051)	(0.060)	(0.051)	(0.061)	(0.048)	(0.047)
Extraversion	0.034	0.008	0.044	0.011	0.035	0.017
	(0.037)	(0.028)	(0.037)	(0.029)	(0.031)	(0.025)
Agreeableness	-0.159**	-0.090	-0.153**	-0.090	-0.167**	-0.135**
	(0.057)	(0.059)	(0.055)	(0.057)	(0.052)	(0.045)
Openness	0.001	-0.024	-0.021	-0.027	0.007	-0.032
	(0.044)	(0.035)	(0.042)	(0.033)	(0.037)	(0.030)
Neuroticism	-0.038*	-0.032	-0.031+	-0.032	-0.040*	-0.052*
	(0.017)	(0.022)	(0.016)	(0.023)	(0.017)	(0.020)
Grit	-0.019	-0.028	-0.024	-0.027	-0.035*	-0.028+
	(0.020)	(0.019)	(0.019)	(0.019)	(0.016)	(0.016)
Numeracy # Con			-0.056	-0.024	0.009	0.051
			(0.063)	(0.081)	(0.056)	(0.056)
Numeracy # Ext			-0.040	0.003	-0.053	-0.010
			(0.040)	(0.040)	(0.034)	(0.028)
Numeracy # Agr			-0.016	-0.003	-0.049	-0.059
			(0.075)	(0.072)	(0.062)	(0.053)
Numeracy # Opn			0.105+	-0.020	0.090+	0.018
			(0.059)	(0.041)	(0.049)	(0.030)
Numeracy # Neu			-0.035	-0.024	-0.049*	-0.040+
			(0.026)	(0.030)	(0.023)	(0.021)
Numeracy # Grit			0.025	-0.000	0.017	-0.026
			(0.030)	(0.029)	(0.027)	(0.023)
Individual controls	+	+	+	+	+	+
Job / Occupation controls					+	+
Observations	1065	916	1065	916	1065	916
R^2	0.305	0.306	0.318	0.314	0.468	0.507

*Notes: Standard errors in parentheses. Individual controls: age, age squared, years of education, experience, experience squared; job / occupation controls: tenure, hours worked per week, public sector dummy, 1-digit ISCO, industry (ISIC); ISCO=0 excluded; top and bottom 1% of wage distribution excluded. 10 PVs (plausible values) for numeracy. Logarithm of wages. Numeracy and non-cognitive skills are standardised. + p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001.*

Source: Own calculations based on postPIAAC data.

The findings on the associations between Big Five traits and wages are in line with those of the literature and my expectations (Table 1). A wage premium is observed for a one-standard-deviation increase in conscientiousness of 13-14% for both men and women. Agreeableness is found to be strongly related to wages: there is a wage penalty of about 14% for women and of almost 17% for men. A one-standard-deviation increase in neuroticism is shown to be associated with wages that are 4-5% lower. Openness and extraversion are found to be unrelated to wages. Contrary to my expectations, the analysis indicates that gritty individuals have lower wages. This finding could be partially explained by the results of Lucas et al. (2015), who experimentally showed that grittier individuals persist on a task even when they fail or face monetary losses. I find no gender differences in the relationships between personality traits and wages[5], which is not in line with the findings of earlier research showing that the effects of agreeableness and neuroticism on wages differ by gender (Judge et al., 2012; Nyhus & Pons, 2005).

There is no evidence of self-selection into occupations based on personality traits, as the coefficients actually increase, and some gain statistical significance, once job and occupation controls are included in the model[6] (columns 3 & 4 versus 5 & 6). This result may indicate that personality traits are related to wages only in certain occupations and industries in Poland.[7] However, I do observe self-selection into occupations based on cognitive skills. Once the job and occupation dummies are controlled for, the returns to cognitive skills are found to be smaller for an individual with average levels of personality traits.

Complementarities are observed for both women and men between emotional stability and cognitive skills, and between openness and cognitive skills for men only. Figure 2 illustrates the changes in wages with a one-standard-deviation change in numeracy at different values of neuroticism (emotional stability). The returns to numeracy are shown to be significantly different from zero for values of neuroticism around the mean or below. This result suggests that individuals with above-average neuroticism levels do not benefit from having higher cognitive skills.[8] A one-standard-deviation increase in numeracy is found to be related to having wages that are

[5] A comparison of regression coefficients between men and women for each of the 10 plausible values is available from the author upon request.

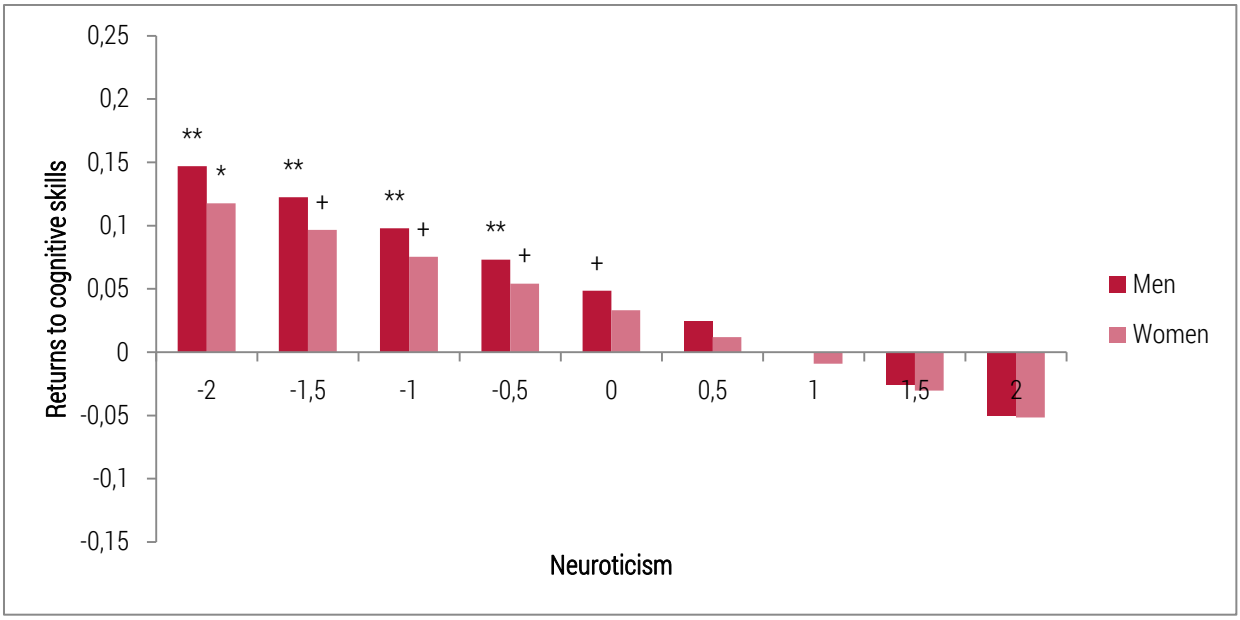
[6] Including job characteristics (tenure, hours worked per week, public sector dummy) does not change the coefficients; instead, the occupation and industry dummies drive the change.

[7] The sample size does not allow for analysis by occupation or industry.

[8] The earlier literature suggested that that the channels that might underlie this relationship include lower skill-use and self-selection into less competitive tasks even within occupations, which are related to neuroticism (Bénabou and Tirole 2002; Muller and Schwieren 2012). Additional analysis shows that after adjusting for the whole set of sociodemographic and job-specific controls, neuroticism is not related to the use of information-processing skills at work (reading, writing, numeracy, ICT), but is related to other generic skills and job characteristics among men, as neurotic men cooperate with others less

10% higher for men and 7% higher for women, assuming an equal level of neuroticism at one standard deviation below the average. However, there is no evidence for returns to social skills as measured by the level of extraversion, or for the complementarity of extraversion and cognitive skills.[9] I also find that openness enhances the returns to cognitive skills for men (Figure 3). A possible explanation for this finding is that being open (which means being curious and imaginative, and having a wide range of interests) is complementary to having high cognitive skills: individuals who are more open can put their cognitive skills to productive use more effectively than individuals who are less open.[10]

Figure 1 Average marginal effects of numeracy on wages by neuroticism level for men and women



*Notes: + p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001. Calculations on the first PV for numeracy, results for the other PVs are not qualitatively different.*

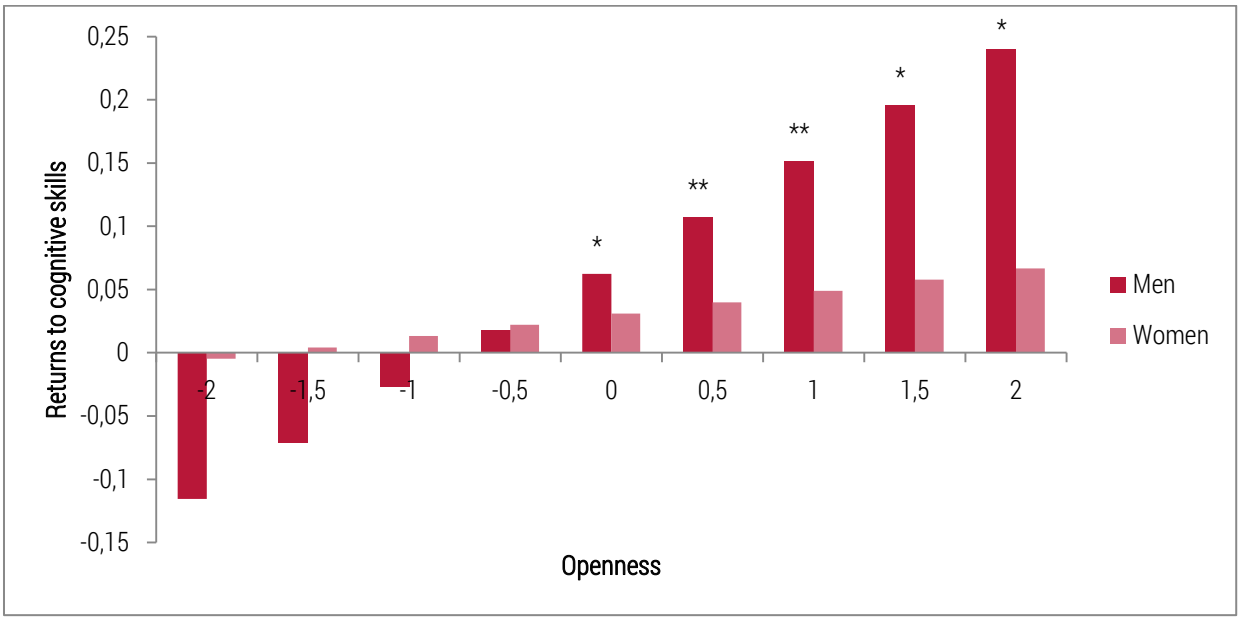
Source: Own calculations based on PIAAC and postPIAAC data.

often and spend more time planning their own work. However, after they are included in the wage regression, these characteristics are not found to be significant.

[9] As a robustness check, I estimated the models using an alternative measure of social skills based on the skill-use at work questions, as in Deming (2017). In this case, I observed a 3.3% premium for a one-standard-deviation increase in social skills for women only, but still found no complementarity with cognitive skills.

[10] Openness is related to the greater use of information-processing skills at work (reading, writing, and numeracy) for men. The reading and writing intensities are significantly related to wages for men.

Figure 2 Average marginal effects of numeracy on wages by openness level for men and women



*Notes: + p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001. Calculations on the first PV for numeracy, results for the other PVs are not qualitatively different.*

Source: Own calculations based on PIAAC and postPIAAC data.

4.1. Non-linearities

The results discussed so far are consistent with the expectations based on earlier research: namely, that there are wage penalties for agreeableness and neuroticism, while conscientiousness is positively linked to wages. However, as has been shown in previous research on the relationships between certain Big Five traits and economic outcomes (Le et al., 2011), it is possible that such relationships are non-linear. To account for possible non-linearities, I run additional models that include a quadratic term of each trait (Table 2, columns 1-2).

All of the relationships between personality traits and wages are found to be linear, except for a hump-shaped relationship between openness and wages detected for men, which was also observed by Rammstedt et al. (2017). Overall, my findings on non-linearities are in line with those of Mueller and Plug (2006), who found no convincing evidence of non-linearity in the personality traits-earnings relationship; and of Heineck and Anger (2010), who also found no support for a nonlinear association between personality traits and wages (except for extraversion for men).

4.2. Tenure Effect

It is possible that both the cognitive skills and the personality traits of employees are unobserved during the recruitment process, and that it therefore takes time for employers become aware of employees' traits, and to reward them accordingly (Heineck & Anger, 2010; Nyhus & Pons, 2005). Thus, tenure with a current employer could moderate the impact of personality traits on wages. This is also likely to be the case when the mechanism that underlies the personality traits-earnings relationship is not based strictly on productivity, but on other factors like success in bargaining, as is often argued in reference to the agreeableness-wages association

(Risse et al., 2018). With increasing tenure, there may be more occasions to negotiate wages, which could lead to a widening of the wage gap between agreeable and disagreeable individuals.

Table 2 Log hourly wages and non-linearity in cognitive skills and personality traits and the effects of tenure

	Men (1)	Women (2)	Men (3)	Women (4)
Numeracy	0.036	0.032	0.044+	0.044
	(0.023)	(0.027)	(0.026)	(0.031)
Conscientiousness	0.144**	0.135**	0.137*	0.124*
	(0.049)	(0.050)	(0.061)	(0.057)
Extraversion	0.033	0.014	0.070+	-0.009
	(0.031)	(0.025)	(0.039)	(0.032)
Agreeableness	-0.164***	-0.132**	-0.177**	-0.099+
	(0.050)	(0.045)	(0.063)	(0.055)
Openness	0.017	-0.024	0.017	-0.023
	(0.036)	(0.029)	(0.049)	(0.036)
Neuroticism	-0.039*	-0.047*	-0.049*	-0.069**
	(0.017)	(0.021)	(0.022)	(0.025)
Grit	-0.030+	-0.033*	-0.037	-0.033
	(0.016)	(0.016)	(0.024)	(0.021)
Numeracy # Con	0.001	0.058	0.006	0.069
	(0.058)	(0.057)	(0.056)	(0.051)
Numeracy # Ext	-0.045	-0.014	-0.058+	-0.009
	(0.035)	(0.028)	(0.035)	(0.026)
Numeracy # Agr	-0.034	-0.062	-0.044	-0.068
	(0.062)	(0.052)	(0.063)	(0.049)
Numeracy # Opn	0.074	0.009	0.089+	0.012
	(0.049)	(0.030)	(0.049)	(0.029)
Numeracy # Neu	-0.054*	-0.044*	-0.043+	-0.038+
	(0.023)	(0.022)	(0.023)	(0.020)
Numeracy # Grit	0.016	-0.023	0.021	-0.026
	(0.026)	(0.023)	(0.027)	(0.022)
Num # Num	0.019	-0.007		
	(0.020)	(0.019)		
Con # Con	-0.010	0.022		
	(0.036)	(0.026)		
Ext # Ext	0.025	-0.012		
	(0.018)	(0.015)		
Agr # Agr	0.020	-0.006		
	(0.027)	(0.022)		
Opn # Opn	-0.059**	-0.021		
	(0.021)	(0.019)		
Neu # Neu	-0.017	0.001		
	(0.014)	(0.016)		
Grit # Grit	-0.015	0.006		
	(0.012)	(0.012)		
Tenure in years	0.006**	0.006*	0.004+	0.008**
	(0.002)	(0.003)	(0.002)	(0.003)
Tenure # Num			0.002	-0.002
			(0.002)	(0.002)
Tenure # Con			0.001	-0.001
			(0.004)	(0.004)

Tenure # Ext			**-0.005***	0.003
			(0.002)	(0.002)
Tenure # Agr			0.000	-0.003
			(0.005)	(0.004)
Tenure # Opn			-0.000	-0.001
			(0.003)	(0.003)
Tenure # Neu			0.001	0.002
			(0.002)	(0.002)
Tenure # Grit			-0.000	0.000
			(0.003)	(0.002)
Individual controls	+	+	+	+
Job / Occupation controls	+	+	+	+
Observations	1065	916	1065	916
R^2	0.483	0.512	0.473	0.515

*Notes: Standard errors in parentheses. Individual controls: age, age squared, years of education, experience, experience squared; Occupation controls: 1-digit ISCO, industry (ISIC), public sector dummy, tenure, hours worked weekly; ISCO=0 excluded, top and bottom 1% of wage distribution excluded. First PV (plausible value) for numeracy. Logarithm of wages. Numeracy and non-cognitive skills are standardised. + p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001.*

Source: Own calculations based on PIAAC and postPIAAC data.

I find no moderating effects of tenure (Table 2, columns 3-4). Only the relationship of extraversion with wages for men is shown to change with tenure, whereby the initial premium for extraversion is found to decrease with tenure. There is limited and mixed empirical evidence of the moderating role of tenure. It has been shown that openness tends to be rewarded as tenure increases more among men, and that the premium for conscientiousness decreases with tenure (Nyhus and Pons 2005). However, consistent with my results, Heineck (2014) found no moderating effects of tenure.

5. Discussion and conclusions

This paper aimed to evaluate the impact of personality traits on wages and on the returns to cognitive skills. My analysis employed the Big Five personality model as a comprehensive framework for organising individuals' personality traits in five dimensions: openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism. Additionally, the role of grit was analysed. Cognitive skills were measured by a competence test used in the PIAAC survey.

I have thus extended the few existing studies that have investigated the complementarities between social skills and cognitive skills (Weinberger, 2014, Deming, 2017), adding evidence on new non-cognitive skills. I found that emotional stability and cognitive skills are complementary: i.e., neurotic individuals have lower wage returns to cognitive skills than their less neurotic counterparts. A possible theoretical explanation for this finding is that neurotic individuals tend to underestimate their abilities, as neuroticism is related to lower self-esteem; and that they expend less effort, which results in lower returns to cognitive skills. An alternative or complementary proposed mechanism predicts that neurotic individuals engage in less competitive tasks, which also yield lower returns to cognitive skills. This sorting into a preference for less competitive tasks can take place within occupations as well. Moreover, openness and cognitive skills were found to be complements, but only for men. An intuitive explanation for this finding is that more open individuals tend to find more efficient uses for their cognitive skills, as curiosity and imagination are facets of openness (Almlund et al. 2011). These results suggest that to obtain unbiased estimates of the returns to cognitive skills, it is necessary to account for personality traits. My findings also highlight the importance of including personality measures in large-scale competence surveys.

The incorporation of interaction effects between personality and cognitive skills into the wage determinants analysis helped to explain an additional share of the variance in individual wages, of about 1%. This is comparable to the additional variance explained by the inclusion of cognitive skills, and it accounts for 70% of the additional variance explained by the educational attainment both for men and women.

Social skills were not shown to be complementary to cognitive skills in Poland, as no additional wage premium for having high levels of social and cognitive skills was found. This result is robust to the measure of social skills used: i.e., to either the extraversion subscale of the Big Five model or an indicator based on skill use at work analogical to Deming (2017). Thus, we found that impact of social skills on earnings was different in Poland than in the United States, where previous analyses showed that social and cognitive skills are complementary. This discrepancy might be explained by the lower level of technology adoption in Poland,[11] as technological change has been driving the increased demand and rewards for social skills that are difficult to automate (Deming, 2017).

The analysis also showed that personality traits have an impact on labour market success in Poland when individual characteristics, including cognitive skills, are controlled for. In particular, the findings suggest that conscientiousness is rewarded, while agreeableness and neuroticism are penalised. These results are consistent with those of many of the previous studies cited earlier. Extraversion and openness were not found to be related to wages. However, once the non-linearities were allowed for, a significant hump-shaped relationship was

[11] The value of the ICT capital stock per worker in Poland was 14% of the ICT capital stock in the US in 2011 (Eden & Gaggl, 2015).

observed for men, which indicates that individuals with an intermediate level of openness have the highest average wages, all other things being equal. Although the positive impact of grit on educational attainment and performance has been well-documented (Angela Lee Duckworth & Quinn, 2009; Eskreis-Winkler, Shulman, Beal, & Duckworth, 2014), I found that grit is negatively related to wages in Poland. Eskreis-Winkler et al. (2014) showed that grittier individuals have fewer career changes, and thus have fewer opportunities to demand a pay rise. As the interests of gritty individuals are more consistent, these results may be seen as an indication of a negative compensating wage differential, whereby gritty individuals are willing to accept lower pay for a job that matches their interests.

My analysis found no systematic gender differences in how personality traits are remunerated in Poland. Thus, it appears that distributional differences in traits generate gender wage inequalities, rather than differences in wage premiums for a specific trait paid by employers. Among the traits correlated with higher wages, only conscientiousness was shown to advantage women. Together with emotional stability, conscientiousness has been found to be one of the two productivity-enhancing traits (Cubel et al., 2016).

This study is not without limitations. The data did not allow me to rule out endogeneity concerns. Nonetheless, I believe that exploratory studies like this one extend our knowledge on the psychological determinants of wages, and can thus be helpful in designing further research on the topic. Future studies could therefore concentrate on investigating the causal mechanisms between personality traits and wages. As there is only very limited evidence on the role of productivity, self-selection into occupations and tasks, and engagement in training, more research on these topics – including research that uses experimental methods – would be desirable. Moreover, further research could investigate whether the reported traits-wages associations are driven by a specific facet of a trait or by the whole trait, as each of Big Five traits is a multifaceted construct (Mõttus, 2016). Such analyses would also be helpful in identifying the mechanisms that underlie the observed relationships.

In sum, this paper's findings highlight the importance of non-cognitive skills in the labour market, not only as separate factors that influence wages, but as complements to cognitive skills. The results therefore suggest that efforts to foster cognitive skills may not bring about the expected results if individuals lack some crucial non-cognitive skills.

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Appendix

Table A1 BFI-S items

Agreeableness	sometimes a bit rude to others*
	forgiving
	considerate and kind to others
Conscientiousness	a thorough worker
	somewhat lazy*
	effective and efficient in completing tasks
Extraversion	communicative, talkative
	outgoing, sociable
	reserved*
Neuroticism	a worrier
	nervous
	relaxed, able to deal with stress*
Openness	original, someone who comes up with new ideas
	someone who values artistic, aesthetic experiences
	imaginative

*Notes: * reverse-worded item.*

Table A2 Grit-S items

Consistency of Interest	New ideas and projects sometimes distract me from previous ones*
	I often set a goal but later choose to pursue a different one*
	I have difficulty maintaining my focus on projects that take more than a few months to complete*
	I have been obsessed with a certain idea or project for a short time but later lost interest*
Perseverance of Effort	Setbacks don't discourage me.
	I finish whatever I begin.
	I am diligent.
	I am a hard worker.

*Notes: * reverse-worded item.*

Table A3 Summary statistics

	Men		Women	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
Hourly wages (in PLN)	18.26	10.90	16.45	9.77
B5: Conscientiousness	-0.11	0.94	0.15	0.95
B5: Extraversion	-0.06	0.93	0.01	1.01
B5: Agreeableness	-0.13	0.92	0.13	1.00
B5: Openness	-0.03	0.96	0.05	0.94
B5: Neuroticism	-0.22	0.91	0.03	0.99
Grit	-0.02	0.96	0.15	0.98
Numeracy	277.07	45.17	271.17	43.89

Literacy	277.97	42.34	282.24	42.15
Years of education	13.28	2.79	14.52	2.64
Age (in years)	37.98	11.89	39.50	11.57
Experience	16.11	12.12	16.03	11.65
Occupation (ISCO)				
ISCO: Managers	0.08	0.28	0.07	0.25
ISCO: Professionals	0.16	0.37	0.31	0.46
ISCO: Technicians and Associate Prof.	0.10	0.30	0.15	0.36
ISCO: Clerical Support Workers	0.05	0.22	0.11	0.31
ISCO: Services and Sales Workers	0.10	0.30	0.19	0.39
ISCO: Skilled Agric., Forestry, and Fishery Workers	0.01	0.07	0.00	0.06
ISCO: Craft and Related Trades Workers	0.22	0.42	0.02	0.14
ISCO: Plant and Machine Operators and Assemblers	0.18	0.39	0.04	0.19
ISCO: Elementary occupations	0.09	0.28	0.11	0.32
Industry (ISIC)				
ISIC: Agriculture	0.02	0.15	0.02	0.14
ISIC: Industry	0.48	0.50	0.19	0.39
ISIC: Traditional services	0.26	0.44	0.27	0.45
ISIC: Modern services	0.07	0.26	0.10	0.31
ISIC: Public administration	0.06	0.24	0.06	0.23
ISIC: Education	0.06	0.24	0.23	0.42
ISIC: Health	0.01	0.10	0.09	0.28
ISIC: Other	0.03	0.17	0.04	0.20
Public sector	0.23	0.42	0.42	0.49
Tenure with current company	8.16	9.29	9.11	9.55
Weekly hours worked	43.94	11.67	38.91	9.92
Living with a partner	0.68	0.47	0.68	0.47
Have children aged 0-6	0.24	0.43	0.23	0.42
Paid work of mother when age 16	0.76	0.43	0.75	0.43
Paid work of father when age 16	0.86	0.35	0.87	0.33
Observations	1065		916	

Notes: ISCO-08: The International Standard Classification of Occupations 2008; Armed Forces Occupations; self-employed excluded in the analysis resulting in a small proportion of Skilled Agric., Forestry, and Fishery Workers. Industry: grouping of the International Standard Industrial Classification (ISIC): Agriculture: A; Industry: B, C, D, E, F; Traditional services: G, H, I, N; Modern services: J, K, L, M; Public administration: O; Education: P; Health: Q; Other: R, S, T.

Source: Own calculations based on PIAAC and postPIAAC data.

Table A4 Heckman selection model

	Men (1)	Women (2)
Outcome equation (Hourly wages)		
Numeracy	0.053	0.049
Conscientiousness	0.144**	0.190**
Extraversion	0.033	0.004
Agreeableness	-0.166**	-0.174***
Openness	0.008	-0.020
Neuroticism	-0.040	-0.043+
Grit	-0.033*	-0.041*
Numeracy # Con	0.010	-0.028
Numeracy # Ext	-0.053	-0.004
Numeracy # Agr	-0.050	0.002

Numeracy # Opn	0.089	0.002
Numeracy # Neu	-0.048	-0.036
Numeracy # Grit	0.014	-0.008
Age	-0.006	-0.027
Age # Age	-0.000	0.000
Years of education	0.040	0.034**
Experience	0.032	0.024*
Experience # Experience	-0.000+	-0.000*
Occupation (ISCO)		
ISCO: Managers (ref. category)		
ISCO: Professionals	-0.196*	-0.207*
ISCO: Technicians and Associate Prof.	-0.425***	-0.488***
ISCO: Clerical Support Workers	-0.601***	-0.504***
ISCO: Services and Sales Workers	-0.612***	-0.710***
ISCO: Skilled Agric., Forestry, and Fishery Workers	-0.507	-1.243***
ISCO: Craft and Related Trades Workers	-0.485***	-0.620***
ISCO: Plant and Machine Operators and Assemblers	-0.421***	-0.645***
ISCO: Elementary occupations	-0.527***	-0.762***
Industry (ISIC)		
ISIC: Agriculture	-0.040	0.571**
ISIC: Industry	0.089*	0.002
ISIC: Traditional services (ref category)		
ISIC: Modern services	0.232**	-0.109
ISIC: Public administration	0.186+	-0.026
ISIC: Education	0.011	-0.032
ISIC: Health	-0.016	-0.088
ISIC: Other	-0.009	-0.220*
Public sector	-0.008	-0.031
Tenure	0.005+	0.005+
Hours worked weekly	-0.008*	-0.007**
Constant	2.829	3.226***
Selection equation (Employed of not)		
Have children aged 0-6	0.121	-0.689***
Work of mother when age 16	-0.376*	-0.059
Work of father when age 16	0.105	0.172
Living with partner	0.329	-0.152
Numeracy	0.267**	0.005
Conscientiousness	0.115	0.280+
Extraversion	-0.158+	0.163*
Agreeableness	-0.032	-0.197
Openness	0.125	-0.191*
Neuroticism	-0.025	-0.159**
Grit	-0.025	-0.034
Numeracy # Con	0.253	0.161
Numeracy # Ext	0.075	0.013
Numeracy # Agr	-0.117	-0.297
Numeracy # Opn	-0.133	-0.076
Numeracy # Neu	0.037	-0.003
Numeracy # Grit	0.022	0.010
Age	0.117*	0.166***
Age # Age	-0.003***	-0.003***

Years of education	0.081*	0.129***
Experience	0.107***	0.100***
Experience # Experience	-0.001	-0.000
Constant	-1.640+	-3.831***
athrho	0.081	-0.024
lnsigma	-0.988**	-1.006***
Observations	1456	1555
Selected	1065	916
Nonselected	391	639

*Notes: + p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001.*

Source: Own calculations based on PIAAC and postPIAAC data.

Table A5 Full results of the main specifications

Ln(wage)	Men (1)	Women (2)	Men (3)	Women (4)	Men (5)	Women (6)
Numeracy	0.101***	0.033	0.086**	0.044	0.050*	0.028
	(0.027)	(0.030)	(0.029)	(0.029)	(0.025)	(0.026)
Conscientiousness	0.141**	0.102+	0.148**	0.107+	0.143**	0.131**
	(0.051)	(0.060)	(0.051)	(0.061)	(0.048)	(0.047)
Extraversion	0.034	0.008	0.044	0.011	0.035	0.017
	(0.037)	(0.028)	(0.037)	(0.029)	(0.031)	(0.025)
Agreeableness	-0.159**	-0.090	-0.153**	-0.090	-0.167**	-0.135**
	(0.057)	(0.059)	(0.055)	(0.057)	(0.052)	(0.045)
Openness	0.001	-0.024	-0.021	-0.027	0.007	-0.032
	(0.044)	(0.035)	(0.042)	(0.033)	(0.037)	(0.030)
Neuroticism	-0.038*	-0.032	-0.031+	-0.032	-0.040*	-0.052*
	(0.017)	(0.022)	(0.016)	(0.023)	(0.017)	(0.020)
Grit	-0.019	-0.028	-0.024	-0.027	-0.035*	-0.028+
	(0.020)	(0.019)	(0.019)	(0.019)	(0.016)	(0.016)
Age	-0.003	-0.013	-0.003	-0.015	-0.008	-0.016
	(0.020)	(0.021)	(0.019)	(0.022)	(0.016)	(0.017)
Age # Age	-0.000	0.000	-0.000	0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Years of education	0.075***	0.092***	0.075***	0.093***	0.039***	0.031**
	(0.007)	(0.009)	(0.007)	(0.009)	(0.009)	(0.011)
Experience	0.027**	0.017+	0.028**	0.017+	0.031***	0.018*
	(0.011)	(0.010)	(0.011)	(0.010)	(0.009)	(0.008)
Experience # Experience	-0.000	-0.000	-0.000	-0.000	-0.000*	-0.000+
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Numeracy # Con			-0.056	-0.024	0.009	0.051
			(0.063)	(0.081)	(0.056)	(0.056)
Numeracy # Ext			-0.040	0.003	-0.053	-0.010
			(0.040)	(0.040)	(0.034)	(0.028)
Numeracy # Agr			-0.016	-0.003	-0.049	-0.059
			(0.075)	(0.072)	(0.062)	(0.053)
Numeracy # Opn			0.105+	-0.020	0.090+	0.018
			(0.059)	(0.041)	(0.049)	(0.030)
Numeracy # Neu			-0.035	-0.024	-0.049*	-0.040+
			(0.026)	(0.030)	(0.023)	(0.021)
Numeracy # Grit			0.025	-0.000	0.017	-0.026
			(0.030)	(0.029)	(0.027)	(0.023)

Occupation (ISCO)						
ISCO: Managers (ref. category)						
ISCO: Professionals					-0.195*	-0.197*
					(0.087)	(0.096)
ISCO: Technicians and Associate					-0.426***	-0.449***
Professionals					(0.092)	(0.082)
ISCO: Clerical Support Workers					-0.608***	-0.521***
					(0.095)	(0.077)
ISCO: Services and Sales Workers					-0.616***	-0.748***
					(0.097)	(0.073)
ISCO: Skilled Agric., Forestry, and Fishery					-0.397*	-1.307***
Workers					(0.173)	(0.223)
ISCO: Craft and Related Trades Workers					-0.489***	-0.643***
					(0.090)	(0.127)
ISCO: Plant and Machine Operators and					-0.425***	-0.638***
Assemblers					(0.087)	(0.102)
ISCO: Elementary Occupations					-0.533***	-0.753***
					(0.094)	(0.097)
Industry (ISIC)						
ISIC: Traditional services (ref. category)						
ISIC: Agriculture					-0.025	0.548**
					(0.147)	(0.207)
ISIC: Industry					0.090*	-0.037
					(0.045)	(0.064)
ISIC: Modern services					0.232**	-0.181+
					(0.080)	(0.095)
ISIC: Public administration					0.187+	-0.087
					(0.098)	(0.110)
ISIC: Education					0.010	-0.089
					(0.103)	(0.089)
ISIC: Health					-0.021	-0.150+
					(0.099)	(0.081)
ISIC: Other					-0.010	-0.272**
					(0.137)	(0.086)
Public sector					-0.007	-0.039
					(0.057)	(0.072)
Tenure					0.005*	0.006*
					(0.002)	(0.003)
Weekly working hours					-0.008***	-0.010***
					(0.002)	(0.003)
Constant	1.641***	1.352***	1.636***	1.368***	2.891***	3.233***
	(0.335)	(0.349)	(0.328)	(0.350)	(0.310)	(0.300)
Observations	1065	916	1065	916	1065	916
R2	0.305	0.306	0.318	0.314	0.468	0.507

Notes: Standard errors in parentheses; $^{+}$ p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001.

Source: Own calculations based on PIAAC and postPIAAC data.

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