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2020

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Please cite as:

Palczyńska, M. (2021), "Wage premia for skills: the complementarity of cognitive and non-cognitive skills", *International Journal of Manpower*, Vol. 42 No. 4, pp. 556-580. https://doi.org/10.1108/IJM-08-2019-0379

Previous version:

IBS Working Papers 09/2018

Wage premia for skills: the complementarity of cognitive and non-cognitive skills*

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Abstract

Purpose - The main purpose of this paper is to assess the degree of complementarity between cognitive skills and non-cognitive skills, and to evaluate their joint impact on individual wages.

Design/methodology/approach – The author uses a survey representative of the Polish working-age population with well-established measures of cognitive and non-cognitive skills.

Findings - Non-cognitive skills are important in the labour market, not only as separate factors that influence wages, but as complements to cognitive skills. Specifically, the analysis showed that the more neurotic an individual is, the lower his or her returns to cognitive skills are. Social skills were not shown to be complementary to cognitive skills in Poland, unlike the recent results in the United States.

Originality/value - To the best of author's knowledge, this is the first study to provide evidence that neurotic individuals have lower returns to cognitive skills. It also tests the existence of the complementarity between social and cognitive skills.

Keywords: earnings, cognitive skills, non-cognitive skills, social skills, gender differences

Paper type: Research paper

JEL: J16, J24, J31

* The author would like to thank three anonymous referees for their useful comments and suggestions. The author also wishes to thank Iga Magda, Piotr Lewandowski and participants of the IZA World Labor Conference 2018, the 2018 WIEM conference and the 4th PIAAC International Conference for helpful comments.

Funding: This work was supported by the National Science Centre, Poland (grant number 2017/27/B/HS4/01201).

1. Introduction

The large impact of cognitive skills on labour market outcomes has long been recognised (Leuven et al., 2004; Murnane et al., 1995). However, even after cognitive skills are accounted for as determinants of individual wages, much of the variance in wages remains unexplained (Bowles et al., 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 et al., 2011; Borghans et al., 2008; Heckman and Kautz, 2012). Non-cognitive skills include a wide range of character skills, such as personality traits, values, motivations, and preferences. Previous research has provided evidence that non-cognitive skills predict wages (Goldsmith et al., 1997; Heckman and Kautz, 2012), and that the variance in wages and job performance explained by non-cognitive skills is comparable to the variance explained by cognitive skills (Kautz et al., 2014; Palczyńska and Świst, 2018).

The dominant framework for analysing wage determination is the human capital model (Becker, 1964) where human capital consists of skills that contribute to production. Non-cognitive skills may enhance worker's productivity and act as traditional measures of human capital such as years of schooling or experience. A behavioural model proposed by Bowles et al. (2001) offers a framework for considering the relationship between non-cognitive skills and wages beyond the productivity factors. First, they argue that employers value incentive-enhancing preferences of workers which allow to lower the costs of labour contract enforcement. Second, they stress that some non-cognitive skills facilitate benefiting from labour market disequilibria e.g. by decisions to migrate in case of spatial disequilibria or by enhancing job search effort.

At the same time, the recent economic literature has suggested that cognitive skills and selected non-cognitive skills, particularly social skills, are complements (Deming, 2017; Weinberger, 2014). Complementarity is understood here as an additional premium for having high levels of both types of skills at the same time. 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. There are also reasons to expect emotional stability (the opposite of neuroticism) and cognitive skills to be complements. Bénabou & Tirole's (2002) work on motivation assumes that ability and effort are complements. As individuals have imperfect knowledge of their own abilities, higher levels of self-confidence may be expected to lead to higher levels of motivation and effort. Accordingly, the less self-confident 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. Judge et al. (2002) showed that emotional stability, locus of control, self-esteem, and generalised self-efficacy are strongly correlated; and that they are indicators of a higher order trait: namely, core self-evaluation. Thus, it might be expected that both social skills and emotional stability are complementary to cognitive skills.

The main objective of this paper is to assess the degree of complementarity between cognitive skills and non-cognitive skills, and to evaluate their joint impact on individual wages. Non-cognitive skills are measured by grit and the Big Five personality inventory referred to by Kautz et al. (2014, p. 9) as "the longitude and latitude of non-cognitive skills, by which all more narrowly defined skills may be categorized". The Big Five model organises personality according to five dimensions: openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism (the opposite of emotional stability) (McCrae and Costa Jr, 1999). To date, the problem of complementarity between skills has been explored in the context of only one dimension of non-cognitive skills: i.e., social skills, which are linked to extraversion from the Big Five model by its facet

of sociability (Almlund et al., 2011). This article extends this research by analysing the complementarities between cognitive skills and all the Big Five traits and grit. To the best of author's knowledge, this is the first study to provide evidence that neurotic individuals have lower returns to cognitive skills and to verify the existence of the complementarity between social and cognitive skills outside the US. Moreover, it replicates findings on the relationships between non-cognitive skills and wages from high-income countries using well-established measures of cognitive and non-cognitive skills for Poland, and shows 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) and it would be important to know how much of it could be explained by the individual heterogeneity. 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; which is in contrast to trends in most other countries where men have been shown to have an advantage in numeracy and no gender differences were found in literacy (OECD, 2013a).

It is an exploratory study which cannot eliminate reverse causality problem between skills and wages. Yet, it can inspire potential further studies using better data and more advanced methods to establish pure causal effects. Moreover, the evidence gathered on the stability of personality traits over time (Cobb-Clark and Schurer, 2012) and on very limited or temporary impact of a major work-related life event such as an involuntary job loss on personality (Anger et al., 2017; Preuss and Hennecke, 2018) gives reasons to expect the observed relationships to be causal.

The paper is organised as follows. Next section summarizes the related literature. Then the dataset and the methodology used is described. The following section investigates the relationship between cognitive and non-cognitive skills and wages in Polish data spanning 2011-2015. 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. The discussion of the literature is limited to the studies that used the same concepts as this paper: i.e., achievement tests as measures of cognitive skills and character skills related to the Big Five dimensions 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 et al., 2015; Leuven et al., 2004).

Non-cognitive skills may contribute to individual productivity analogically to human capital variables (Mueller and Plug, 2006), but they could also affect labour market outcomes via wage negotiations (Nguyen et al., 2011) or, indirectly, through the type of occupation (Cobb-Clark and Tan, 2011) or education (Lundberg, 2013) chosen. Non-cognitive skills are most commonly measured by the Big Five model. Conscientious individuals tend to be organised, responsible, and hardworking. Conscientiousness has been shown to be related to higher productivity (Cubel et al., 2016), to performance in on-the-job training (Barrick and Mount, 1991), and to supervisors' ratings of workers' performance (Caligiuri, 2000). Bowles et al. (2001) name conscientiousness as one of

the incentive-enhancing characteristics. Neuroticism is characterised by emotional instability, vulnerability to stress, and a lack of self-confidence (Almlund et al., 2011). 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). 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 and Tan, 2011), as well as wage bargaining outcomes. Nguyen et al. (2011) 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 and 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 (Heineck and Anger, 2010).

Recently, the trait called "grit" has attracted a lot of attention among scientists and policy-makers (Alan et al., 2019; Credé et al., 2017). 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 et al., 2007; Duckworth and Quinn, 2009). Grit is not part of the Big Five framework, but grit and conscientiousness correlate strongly (e.g. Duckworth and Quinn, 2009; Ivcevic and Brackett, 2014).

Previous empirical research has documented the relationship between non-cognitive skills and wages. Conscientiousness is predominantly positively related to wages (Heineck and Anger, 2010; Mueller and Plug, 2006) while there are sometimes wage penalties for agreeableness (Mueller and Plug, 2006; Nyhus and Pons, 2005). Many studies also detected a negative relationship between wages and neuroticism (Mueller and Plug, 2006; Nyhus and Pons, 2005) or traits related to neuroticism (Drago, 2011; Heineck and Anger, 2010). The results on openness are more mixed. Studies on populations in the US and the UK reported that there is a wage premium for openness (Heineck, 2014; Mueller and Plug, 2006). However, research from other countries has suggested that there is a negative association between openness and earnings (Rammstedt et al., 2017; Risse et al., 2018). In the studies that controlled for individual and job differences, extraversion was not shown to be related to wages (Heineck, 2014; Mueller and Plug, 2006; Nyhus and Pons, 2005). Most of the existing literature on these relationships has focused on the United States and Western Europe. For post-socialist economies, personality, as measured by locus of control and the need for challenge or for affiliation, has been shown to affect earnings (Semykina and Linz, 2007) and the probability of being in a supervisory position (Chu and Linz, 2017). 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. There is less evidence on the relationship between grit and wages. Albandea and Giret (2018) found positive returns to grit among French graduates.

The recent literature has suggested that some non-cognitive skills can complement cognitive skills (Deming, 2017; Weinberger, 2014). 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's (2017) empirical analysis for the United States confirmed his team production 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 and participation in clubs and sports. Additionally, Deming (2017) constructed a measure of social skills based on job tasks items.

Bénabou and Tirole's (2002) work on motivation 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 true ability and effort are complements. It seems reasonable to assume that more self-confident individuals may put in more effort and use their skills to a greater extent than their less self-confident counterparts with the same ability. Accordingly, I expect that the more neurotic an individual is, the lower his or her use of skills is; and, thus, the lower his or her returns to cognitive skills are likely to be. Moreover, the results of experimental studies have also 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 and found a negative association between neuroticism and productivity. Müller and Schwieren (2012) investigated the relationship between personality traits and competitiveness and found that neurotic individuals are less likely to compete than people who are not neurotic. It may be expected that in a competitive environment, cognitive skills yield higher returns. In sum, the literature suggests that emotional stability may be 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 such as having more limited opportunities for promotion, reduced recognition, and worse interpersonal relations (Parks-Stamm et al., 2008; Rudman and Phelan, 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. It also verifies the hypothesis about the complementarity between social skills and cognitive skills. Moreover, using well-established measures of skills, it replicates for Poland previous findings on the relationships between non-cognitive skills 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 (OECD, 2013a) conducted in 2011-2012. The combined database is representative of the Polish working-age population[1], and contains a number of measures of cognitive abilities, personality traits, and labour market outcomes (Palczyńska and Świst, 2018).

The final sample is comprised of 1981 workers aged 19-67, excluding self-employed. 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 A3.

3.1 Measures of cognitive skills

The cognitive skills measured in the PIAAC are the information processing skills of literacy and numeracy[2]. 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, 2013a: 59). 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, 2013a: 59).

Both cognitive skills are measured on a 500-point scale in the PIAAC. In the subsequent analyses, the scores are standardised 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). The analysis focuses on numeracy but the results for literacy are qualitatively similar. PIAAC uses multiple imputations (plausible values—PVs) to increase the accuracy of the cognitive measures (for details see OECD, 2013b). Ten PVs are drawn for each respondent per domain. If not stated otherwise, the regression analyses are run separately for each of the ten PVs and the average results are reported with the imputation error added to the variance estimator.

The analysis assumes that among adults literacy and numeracy do not change substantially over a three-year period. There is indirect evidence that the cognitive 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 and Warnke, 2012).

3.2 Measures of non-cognitive skills

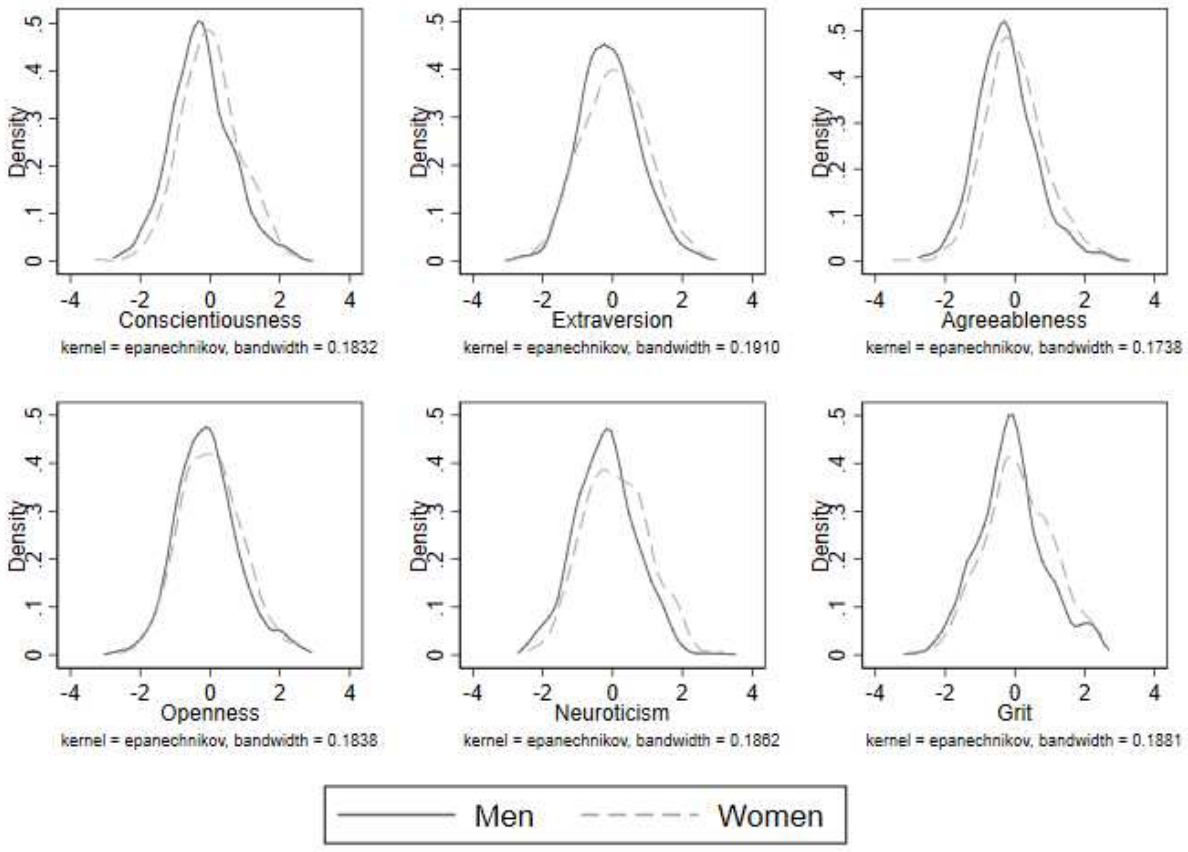
Non-cognitive skills are measured by the Polish version of the Big Five Inventory-Short (BFI-S) (Gerlitz and Schupp, 2005), which contains 15 self-reported items. Respondents answered on seven-point Likert type scales (1 — "disagree completely" to 7 — "agree completely"). The comparison of this short measure to the longer, more robust NEO-PI-R which contains 240 items showed that BFI-S provides reliable and valid data to investigate research questions in social surveys (Hahn et al., 2012). The study also includes measurements from the short eight-item Grit scale (Grit-S) (Duckworth and Quinn, 2009) (see Appendix Table A1 for the list of BFI-S and Grit-S items). The analysis uses the factor scores from the six-factor oblique model with an additional factor loading the reverse-worded items for the Big Five data as it is the best fitted model obtained in the detailed psychometric analysis of the scale (Palczyńska and Świst, 2016) and the factor scores from the

unidimensional model for Grit-S as researchers have often used Grit-S as a single factor (Eskreis-Winkler et al., 2014)[3]. The scores for the BFI-S subscales and Grit-S are standardised with a mean of zero and a standard deviation of one within the total working-age population.

Social skills are measured by extraversion subscale of the Big Five. As an alternative, I construct a measure of social skills using three job tasks questions from the same survey: (i) In your job what proportion of your time do you usually spend cooperating or collaborating with co-workers? (ii) How often does your job usually involve persuading or influencing people? (iii) How often does your job usually involve negotiating with people either inside or outside your firm or organisation? I standardise each variable to have a mean of 0 and a standard deviation of 1. Then, I take the average across three items and standardise it. This measure is similar to the social skill task intensity of occupations used in Deming (2017) based on O*NET (Occupational Information Network) questions on coordination, negotiation, persuasion, and social perceptiveness.

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.

3.3 Estimation method

The paper examines the returns to cognitive and non-cognitive skills using a semi-logarithmic model:

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

where w_i is individual i's gross hourly wage, COG_i is the level of cognitive skills, $NCOG_i$ is the vector of the respondent's non-cognitive skills and X_i is a vector of individual and job characteristics, and u_i denotes the error term. Interactions between non-cognitive and cognitive skills are included in order to determine whether character skills moderate the effect of cognitive skills on wages. Models are estimated for men and women separately, in line with previous research that found substantial differences by gender.

Since wages are observed for employed individuals only, Heckman's selection model is used 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 A4); thus, the rest of the paper focuses on the results from the OLS estimation.

3.4 Alternative specifications

Different sets of control variables are included. The baseline specification controls for age and age squared. The second specification adds interactions between non-cognitive and cognitive skills with no additional controls. The third specification adds controls for years of education. The full 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 higher paid occupations (Heineck, 2014; Mueller and Plug, 2006).

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 higher paid occupations based on personality traits. Finally, complementarities are detected between some non-cognitive 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 conditional on education and job characteristics.

The estimation results are in Table 1. Columns (1) – (2) show the relationship between cognitive and non-cognitive skills and wages conditional only on age. Columns (3) – (4) add interactions between non-cognitive and cognitive skills which are statistically insignificant. In both specification cognitive skills are highly related to wages and there is a wage penalty for agreeableness and a premium for conscientiousness for men only. Columns (5) – (6) add controls for years of completed education. This causes the coefficients on cognitive skills to decrease by over 50%, while the coefficients on conscientiousness and agreeableness increase and gain statistical significance also for women. Columns (7) and (8) show results conditional on age, education and job characteristics. The coefficients on conscientiousness and agreeableness remain statistically

significant and even increase slightly while the coefficients on neuroticism and grit gain statistical significance. The findings on the associations between Big Five traits and wages from the full specification are in line with those of the literature. 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[4]. Contrary to the 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. No gender differences in the relationships between personality traits and wages were found[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 and Pons, 2005).

Table 1 Log-hourly wage estimates

	Men	Women	Men	Women	Men	Women	Men	Women
Ln(wage)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Numeracy	**0.203*** **	**0.148*** **	**0.187*** **	**0.152*** **	**0.089** **	**0.048+**	**0.054***	0.029
	(0.027)	(0.031)	(0.028)	(0.031)	(0.029)	(0.029)	(0.025)	(0.025)
Conscientiousness	0.087	0.040	**0.094+**	0.041	**0.145** **	**0.110+**	**0.143** **	**0.130** **
	(0.055)	(0.067)	(0.056)	(0.068)	(0.052)	(0.063)	(0.047)	(0.046)
Extraversion	0.015	-0.018	0.021	-0.019	0.043	0.011	0.034	0.015
	(0.041)	(0.034)	(0.041)	(0.035)	(0.039)	(0.029)	(0.033)	(0.025)
Agreeableness	**-0.146***	-0.086	**-0.140***	-0.088	**-0.150** **	**-0.098+**	**-0.167*** **	**-0.140** **
	(0.059)	(0.063)	(0.058)	(0.061)	(0.054)	(0.058)	(0.050)	(0.044)
Openness	0.024	0.039	0.006	0.041	-0.019	-0.024	0.007	-0.029
	(0.048)	(0.038)	(0.046)	(0.038)	(0.044)	(0.034)	(0.040)	(0.030)
Neuroticism	-0.029	**-0.039+**	-0.022	**-0.039+**	**-0.030+**	-0.031	**-0.040***	**-0.051***
	(0.021)	(0.021)	(0.020)	(0.021)	(0.017)	(0.023)	(0.018)	(0.020)
Grit	0.003	0.015	-0.005	0.011	-0.019	-0.026	**-0.031+**	**-0.027+**
	(0.023)	(0.023)	(0.022)	(0.023)	(0.018)	(0.019)	(0.017)	(0.016)
Numeracy # Con			-0.064	0.009	-0.051	-0.034	0.011	0.050
			(0.064)	(0.074)	(0.063)	(0.084)	(0.054)	(0.054)
Numeracy # Ext			-0.026	0.009	-0.028	0.007	-0.042	-0.005
			(0.041)	(0.047)	(0.039)	(0.039)	(0.034)	(0.028)
Numeracy # Agr			-0.020	-0.001	-0.022	0.010	-0.054	-0.056
			(0.077)	(0.074)	(0.072)	(0.073)	(0.059)	(0.052)
Numeracy # Opn			0.082	-0.038	0.093	-0.022	0.078	0.013
			(0.060)	(0.053)	(0.057)	(0.040)	(0.049)	(0.032)
Numeracy # Neu			-0.035	-0.018	-0.040	-0.023	**-0.053***	**-0.042***
			(0.030)	(0.028)	(0.026)	(0.029)	(0.023)	(0.020)
Numeracy # Grit			0.040	0.005	0.033	0.002	0.022	-0.025
			(0.032)	(0.026)	(0.029)	(0.029)	(0.026)	(0.022)
Age	+	+	+	+	+	+	+	+
Education					+	+	+	+
Job / Occupation controls							+	+
Observations	1065	916	1065	916	1065	916	1065	916
R2	0.173	0.114	0.187	0.118	0.300	0.306	0.451	0.502

Notes: Standard errors in parentheses. Individual controls: age, age squared, years of education; 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. + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

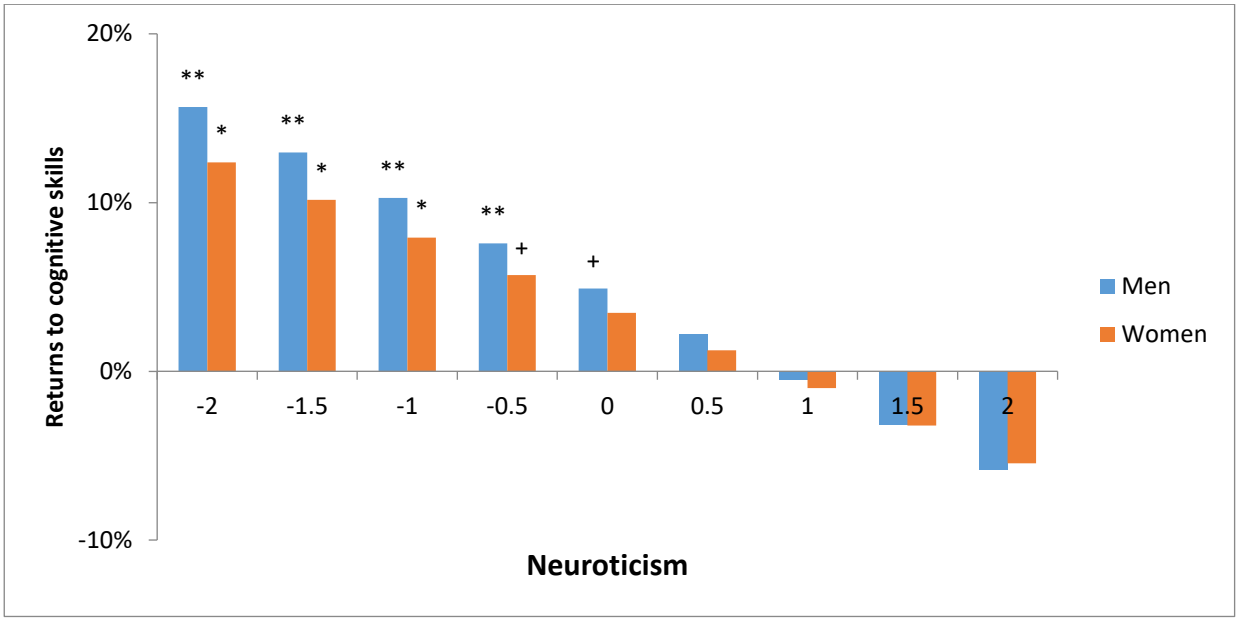
Source: Own calculations based on postPIAAC data.

Self-selection into occupations. There is no evidence of self-selection into higher paid occupations based on non-cognitive skills, as the coefficients actually increase, and some gain statistical significance, once job and occupation controls are included in the model[6] (columns 5 & 6 versus 7 & 8). Nonetheless, self-selection into occupations based on cognitive skills is observed. When including controls for age and education only, the returns to one standard deviation of cognitive skills are equal to 8.9% for men and 4.8% for women (columns 5 & 6). Once the occupation and industry dummies are controlled for, the returns to cognitive skills decrease by over 45% to 5.4% for men and become insignificant for women; however, in the full models conditional on job characteristics, the gender differences in returns to cognitive skills are not statistically significant.

Complementarities. Complementarities are observed for both women and men between emotional stability and cognitive skills. Figure 2 illustrates the changes in wages with a one-standard-deviation change in numeracy at different values of neuroticism (the opposite of emotional stability) conditional on individual and job characteristics[7]. 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. A one-standard-deviation increase in numeracy is found to be related to having wages that are 10% higher for men and 8% higher for women, assuming an equal level of neuroticism at one standard deviation below the average. An additional analysis investigated if neuroticism is related to lower skill-use and self-selection into less competitive tasks. This analysis uses job tasks module from the same survey. Models with skill-use indicators as dependent variables and the same set of control variables as specifications 7 & 8 are estimated. The results indicate that neuroticism is not related to the use of information-processing skills at work (reading, writing, numeracy, and information and communication technologies (ICT) skills), but is related to some other generic skills and job characteristics. Neurotic men cooperate with others less often and both, neurotic men and women, spend more time planning their own work than their less neurotic colleagues. Neuroticism is not related to the frequency of working to tight deadlines.

There is no evidence for returns to social skills as measured by the level of extraversion, or for the complementarity of social and cognitive skills. As a robustness check, the models are estimated using an alternative measure of social skills constructed from the job-tasks questions. Using this measure, a 3.6 % premium for a one-standard-deviation increase in social skills is observed for women only, but still no complementarity with cognitive skills is found.

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



Notes: The models (specifications 7 & 8 from Table 1) control for: age, age squared, years of education, tenure, hours worked per week, public sector dummy, 1-digit ISCO, industry (ISIC); ISCO=0 excluded; top and bottom 1% of wage distribution excluded. Logarithm of wages. Numeracy and non-cognitive skills are standardised. + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. 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.

5. Discussion and conclusions

This paper aimed to evaluate the impact of non-cognitive skills on wages and on the returns to cognitive skills. The analysis employed the Big Five personality model as a comprehensive framework for organising individuals' non-cognitive skills 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.

The paper thus extended the few existing studies that have investigated the complementarities between social skills and cognitive skills (Weinberger, 2014; Deming, 2017), adding evidence on other non-cognitive skills. It 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 less competitive tasks can take place within occupations as well. On the whole, these results suggest that to obtain unbiased estimates of the returns to cognitive skills, it is necessary to account for non-cognitive skills. My findings also highlight the importance of including non-cognitive measures in large-scale competence surveys.

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 job tasks. Thus, the result is different than in the United States, where previous analyses showed that social and cognitive skills are complementary. This discrepancy might be

explained either by the differences in the measures of social skills available or by the difference in the relationship. However, the data at my disposal do not allow me to distinguish between these two explanations. Both Weinberger (2014) and Deming (2017) use participation in sports and clubs during high school, and the former study also leadership roles, as indicators of social skills which measures are not available in my data set. Extraversion subscale measures sociability but in a general context and does not capture the leadership aspect. However, if the relationship between social skills and earnings differs between the countries, the lower level of technology adoption in Poland[8] could be a potential reason, 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 non-cognitive skills 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. Although the positive impact of grit on educational attainment and other life outcomes has been documented (Duckworth and Quinn, 2009; Eskreis-Winkler et al., 2014), this study found that grit is negatively related to wages once education and other non-cognitive skills are controlled for. 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 also 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.

This study is not without limitations. The data did not allow to rule out endogeneity concerns as the non-cognitive skills and wages measures are contemporaneous. Nonetheless, 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 non-cognitive skills 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 to identify the mechanisms that underlie the observed relationships. Moreover, future studies with bigger samples could investigate the selection to jobs in more detail. The open question is if workers with certain non-cognitive skills are more likely to work in specific occupations within broader occupational categories analysed in this study.

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. They also suggest that more research exploring the interrelations of economics with psychology is needed.

Notes

1. A comparison of postPIAAC and Polish LFS structures in terms of age, gender, education, firm size and occupation (ISCO classification) is available in the Appendix (Table A2).
2. Also problem-solving in a technology-rich environment was assessed, but for a limited sample that included only respondents with basic computer skills who did not opt out from computer-based assessment.
3. 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. A six-factor oblique model for BFI-S provides good fit with the data (RMSEA = 0.077, TLI = 0.860, CFI = 0.905) while the unidimensional model for Grit-S has poorer fit to the data (RMSEA = 0.135, CFI = 0.804, TLI = 0.726).
4. To account for possible non-linearities additional models including a quadratic term of each skill are run. All of the relationships between non-cognitive skills and wages are found to be linear, except for a hump-shaped relationship between openness and wages detected only for men (also observed by Rammstedt et al. (2017)).
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. As a robustness check the specifications 7 & 8 were run with occupation-industry fixed effects. The estimates for neuroticism and neuroticism-numeracy interaction have not changed for women and have decreased for men but they are still jointly significant.
8. The value of the ICT capital stock per worker in Poland was 14% of the ICT capital stock in the US in 2011 (Eden and Gaggl, 2020).

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Appendix

Table A1 BFI-S and Grit-S items

BFI-S	
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
Grit-S	
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 A2 Structures of the postPIAAC sample and the Polish LFS 2014 data

	postPIAAC	LFS 2014
Age		
20-24	10%	7%
25-34	34%	30%
35-44	25%	28%
45-54	20%	21%
55-64	12%	14%
N	1961	105200
Gender		
Male	51%	53%
Female	49%	47%
N	1961	105200
Education		
ISCED 0-2	4%	5%
ISCED 3-4	54%	60%
ISCED 5-6	42%	35%
N	1961	105200
Firm size*		
1-10	25%	18%
11-19	12%	12%
20-50	22%	18%

51-250	22%	28%
>250	19%	25%
N	1950	91504
ISCO		
Managers	7%	6%
Professionals	23%	21%
Technicians and Associate Prof.	13%	14%
Clerical Support Workers	8%	8%
Services and Sales Workers	14%	14%
Skilled Agric., Forestry, and Fishery Workers	0%	0%
Craft and Related Trades Workers	13%	16%
Plant and Machine Operators and Assemblers	11%	12%
Elementary occupations	10%	8%
N	1961	105025

** The questions about the firm size differ between the surveys. In LFS it is: "How many persons are employed in your institution (company)?", in postPIAAC: "How many people work for your employer at the place where you work?" with additional clarification to interviewer: "This question refers to the geographical location where the job is mainly carried out or based." Therefore, in case of postPIAAC, the question informs about the size of local branch not the whole company which explains smaller reported firm size. Possible answers in LFS after aggregation differ slightly: 1-10, 11-19, 20-49, 50-250, >250.*

Notes: Samples restricted to employees aged 20-64, excluding self-employed and helping family members. In case of postPIAAC, sample is additionally restricted to respondents without any missing values in variables of interest (working sample of the article).

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
Social skills (job tasks measure)	0.10	1.02	0.09	0.95
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
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 (in years)	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	0.045	0.051+
Conscientiousness	0.139**	0.192***
Extraversion	0.030	0.002
Agreeableness	-0.163**	-0.182***
Openness	0.008	-0.019
Neuroticism	-0.034+	-0.043+
Grit	-0.031+	-0.040*
Numeracy # Con	0.002	-0.028
Numeracy # Ext	-0.037	0.001
Numeracy # Agr	-0.056	0.005
Numeracy # Opn	0.084	-0.006
Numeracy # Neu	-0.060**	-0.039
Numeracy # Grit	0.022	-0.007
Age	0.021	0.007
Age # Age	-0.000	-0.000
Years of education	0.033**	0.034+
Occupation (ISCO)		
ISCO: Managers (ref. category)	0.000	0.000
ISCO: Professionals	-0.211*	-0.212*
ISCO: Technicians and Associate Prof.	-0.410***	-0.481***
ISCO: Clerical Support Workers	-0.604***	-0.510***
ISCO: Services and Sales Workers	-0.616***	-0.701***
ISCO: Skilled Agric., Forestry, and Fishery Workers	-0.560*	-1.177***
ISCO: Craft and Related Trades Workers	-0.482***	-0.619***
ISCO: Plant and Machine Operators and Assemblers	-0.435***	-0.643***
ISCO: Elementary occupations	-0.548***	-0.782***
Industry (ISIC)		
ISIC: Agriculture	-0.028	0.509*
ISIC: Industry	0.092*	-0.001
ISIC: Traditional services (ref category)	0.000	0.000

ISIC: Modern services	0.223**	-0.102
ISIC: Public administration	0.189+	-0.045
ISIC: Education	0.035	-0.029
ISIC: Health	-0.040	-0.093
ISIC: Other	-0.016	-0.225*
Public sector	0.002	-0.024
Tenure	0.005**	0.006*
Hours worked weekly	-0.008***	-0.008**
Constant	2.504***	2.691**
Selection equation (Employed or not)		
Have children aged 0-6	0.234	-0.610***
Work of mother when age 16	-0.214	0.021
Work of father when age 16	0.138	0.102
Living with partner	0.578***	-0.040
Numeracy	0.249***	0.049
Conscientiousness	0.277+	0.338**
Extraversion	-0.120	0.124
Agreeableness	-0.135	-0.224+
Openness	0.018	-0.128
Neuroticism	-0.040	-0.164**
Grit	0.028	-0.015
Numeracy # Con	0.189+	0.102
Numeracy # Ext	0.129+	0.039
Numeracy # Agr	-0.131	-0.176
Numeracy # Opn	-0.121	-0.096
Numeracy # Neu	-0.023	0.003
Numeracy # Grit	0.056	0.053
Age	0.202***	0.230***
Age # Age	-0.003***	-0.003***
Years of education	0.075**	0.152***
Constant	-3.755***	-5.852***
athrho	-0.161	0.001
lnsigma	-0.979***	-0.996***
Observations	1601	1755
Selected	1065	916
Nonselected	536	839

Notes: $^{+}$ p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001.

Source: Own calculations based on PIAAC and postPIAAC data.

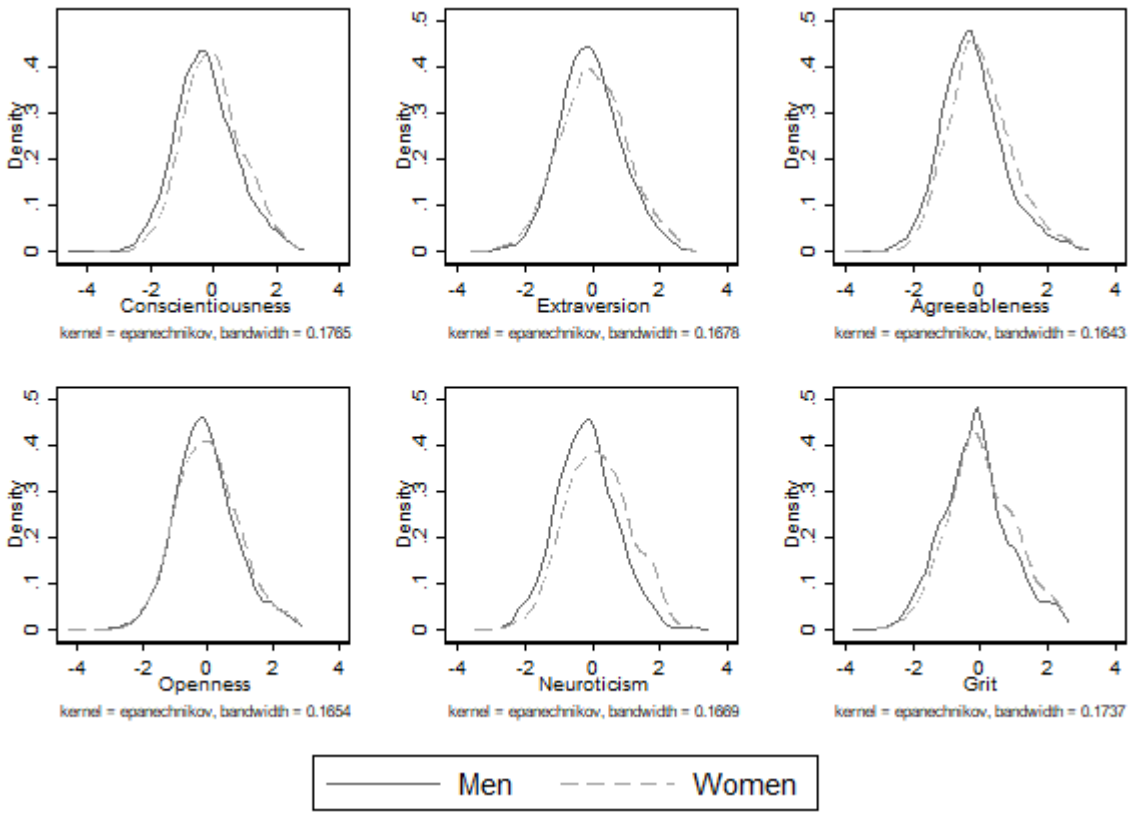
Table A5 Full results of the main specifications

Ln(wage)	Men (1)	Women (2)	Men (3)	Women (4)	Men (5)	Women (6)	Men (7)	Women (8)
Numeracy	0.203***	0.148***	0.187***	0.152***	0.089**	0.048+	0.054*	0.029
	(0.027)	(0.031)	(0.028)	(0.031)	(0.029)	(0.029)	(0.025)	(0.025)
Conscientiousness	0.087	0.040	0.094+	0.041	0.145**	0.110+	0.143**	0.130**
	(0.055)	(0.067)	(0.056)	(0.068)	(0.052)	(0.063)	(0.047)	(0.046)
Extraversion	0.015	-0.018	0.021	-0.019	0.043	0.011	0.034	0.015
	(0.041)	(0.034)	(0.041)	(0.035)	(0.039)	(0.029)	(0.033)	(0.025)
Agreeableness	-0.146*	-0.086	-0.140*	-0.088	-0.150**	-0.098+	-0.167***	-0.140**
	(0.059)	(0.063)	(0.058)	(0.061)	(0.054)	(0.058)	(0.050)	(0.044)
Openness	0.024	0.039	0.006	0.041	-0.019	-0.024	0.007	-0.029
	(0.048)	(0.038)	(0.046)	(0.038)	(0.044)	(0.034)	(0.040)	(0.030)
Neuroticism	-0.029	-0.039+	-0.022	-0.039+	-0.030+	-0.031	-0.040*	-0.051*
	(0.021)	(0.021)	(0.020)	(0.021)	(0.017)	(0.023)	(0.018)	(0.020)
Grit	0.003	0.015	-0.005	0.011	-0.019	-0.026	-0.031+	-0.027+
	(0.023)	(0.023)	(0.022)	(0.023)	(0.018)	(0.019)	(0.017)	(0.016)
Age	0.037**	0.025+	0.038**	0.024	0.027*	0.004	0.027**	0.007
	(0.013)	(0.014)	(0.013)	(0.015)	(0.012)	(0.013)	(0.010)	(0.012)
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)	(0.000)	(0.000)	(0.000)	(0.000)
Years of education					0.071***	0.095***	0.034***	0.030**
					(0.007)	(0.009)	(0.009)	(0.011)
Numeracy # Con			-0.064	0.009	-0.051	-0.034	0.011	0.050
			(0.064)	(0.074)	(0.063)	(0.084)	(0.054)	(0.054)
Numeracy # Ext			-0.026	0.009	-0.028	0.007	-0.042	-0.005
			(0.041)	(0.047)	(0.039)	(0.039)	(0.034)	(0.028)
Numeracy # Agr			-0.020	-0.001	-0.022	0.010	-0.054	-0.056
			(0.077)	(0.074)	(0.072)	(0.073)	(0.059)	(0.052)
Numeracy # Opn			0.082	-0.038	0.093	-0.022	0.078	0.013
			(0.060)	(0.053)	(0.057)	(0.040)	(0.049)	(0.032)
Numeracy # Neu			-0.035	-0.018	-0.040	-0.023	-0.053*	-0.042*
			(0.030)	(0.028)	(0.026)	(0.029)	(0.023)	(0.020)
Numeracy # Grit			0.040	0.005	0.033	0.002	0.022	-0.025
			(0.032)	(0.026)	(0.029)	(0.029)	(0.026)	(0.022)
Occupation (ISCO)								
ISCO: Managers (ref. category)								
ISCO:Professionals							-0.211*	-0.203*
							(0.089)	(0.095)
ISCO: Technicians and Associate Professionals							-0.411***	-0.445***
							(0.096)	(0.083)
ISCO: Clerical Support Workers							-0.608***	-0.528***
							(0.097)	(0.076)
ISCO: Services and Sales Workers							-0.619***	-0.747***
							(0.095)	(0.070)
ISCO: Skilled Agric., Forestry, and Fishery Workers							-0.412*	-1.253***
							(0.188)	(0.224)
ISCO: Craft and Related Trades Workers							-0.485***	-0.644***
							(0.093)	(0.123)
ISCO: Plant and Machine Operators and Assemblers							-0.438***	-0.638***
							(0.088)	(0.101)
ISCO: Elementary Occupations							-0.553***	-0.774***
							(0.097)	(0.094)
Industry (ISIC)								

ISIC: Traditional services (ref. category)								
ISIC: Agriculture							-0.054	0.491*
							(0.148)	(0.203)
ISIC: Industry							0.093*	-0.041
							(0.045)	(0.064)
ISIC: Modern services							0.227**	-0.180+
							(0.078)	(0.095)
ISIC: Public administration							0.187+	-0.098
							(0.098)	(0.110)
ISIC: Education							0.034	-0.088
							(0.105)	(0.088)
ISIC: Health							-0.051	-0.153+
							(0.100)	(0.080)
ISIC: Other							-0.017	-0.277**
							(0.118)	(0.092)
Public sector							0.005	-0.035
							(0.059)	(0.072)
Tenure							0.006**	0.007**
							(0.002)	(0.002)
Weekly working hours							-0.008***	-0.010***
							(0.002)	(0.003)
Constant	1.923***	2.029***	1.894***	2.048***	1.170***	1.028***	2.358***	2.871***
	(0.239)	(0.255)	(0.232)	(0.259)	(0.222)	(0.234)	(0.228)	(0.244)
Observations	1065	916	1065	916	1065	916	1065	916
R2	0.173	0.114	0.187	0.118	0.300	0.306	0.451	0.502

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.

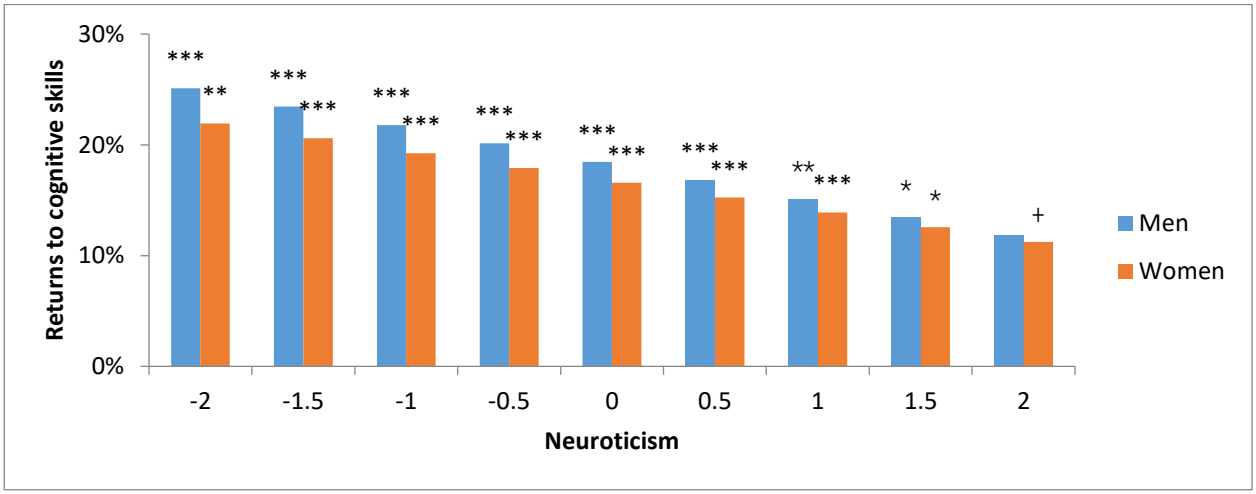
Figure A1 Distribution of personality traits by gender among the total population



Notes: n = 4551.

Source: Own calculations based on postPIAAC data.

Figure A2 Average marginal effects of numeracy on wages by neuroticism level for men and women (unconditional analysis)



Notes: The models (specifications 3 & 4 from Table 1) control for: age and age squared; ISCO=0 excluded; top and bottom 1% of wage distribution excluded. Logarithm of wages. Numeracy and non-cognitive skills are standardised. + p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001. Calculations on the first PV for numeracy, results for 7 out of 10 PVs are not qualitatively different.

Source: Own calculations based on PIAAC and postPIAAC data.