Unemployment and personality: Are conscientiousness and agreeableness related to employability? *

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Abstract

This paper shows that unemployment and (some) personality traits are related. Individuals with low scores in the Big Five dimensions *conscientiousness* and *agreeableness* have a higher probability of being unemployed, longer unemployment durations, and experience more status changes between employment and unemployment. Results suggests that personality is an important determinant of women's risk of unemployment, but for men personality is more a matter of job keeping.

JEL Codes: H53, D31, J64, C38
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1 Introduction

There is a broad consensus that cognitive skills und labor market outcomes are closely connected (Heckman et al., 2006). Meanwhile, there is growing consensus that noncognitive skills are relevant, too. An increasing literature shows a relationship between noncognitive skills and different work related outcomes.[1].

Noncognitive skills have been shown to influence occupational choice (Barrick and Mount, 1991; Cobb-Clark and Tan, 2011; Wells et al., 2016), job performance and income (Barrick and Mount, 1991; Dohmen et al., 2009; Heineck and Anger, 2010; Mueller and Plug,

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[1]See Almlund et al. (2011); Borghans et al. (2008); Thiel and Thomsen (2013) for a review of the literature.

2006; Nyhus and Pons, 2005; Semykina and Linz, 2007), absence probability (Störmer and Fahr, 2013), the duration of unemployment spells (Caliendo et al., 2015; Cuesta and Budría, 2017; Egan et al., 2017; McGee, 2015; Uysal and Pohlmeier, 2011), and the probability of unemployment (Egan et al., 2017).

As it is often done in economics, the term 'noncognitive skills' is used synonymously to personality in this paper. Across disciplines, there are different ways to conceptualize a person's personality, but the most established model of personality is the 'Big Five' framework proposed by Costa and McCrae (1992). This framework is based on the finding that - for most purposes - five dimensions are enough to approximate an individual's personality. The five dimensions are extraversion, conscientiousness, agreeableness, openness to experience and neuroticism. See Almlund et al. (2011, Table 3) for an overview of the Big Five.

Why should personality traits influence labor market outcomes? The intuition is that individuals always have to exert some costly effort to achieve a certain outcome level.

The effort necessary to achieve a certain outcome level depends on personality traits. Sometimes the costs (of needed effort) exceed the utility of the resulting outcome level for some personality profiles. These individuals need additional extrinsic motivation to exert enough effort to achieve a certain outcome level. Job related tasks, for example, sometimes require some cooperation. Being a cooperative teamplayer demands less effort from an individual who is more *agreeable* as from someone who scores lower in the dimension *agreeableness*.

But not just the effort necessary might be different. Also intrinsic motivation (utility of the resulting outcome) might differ. This is consistent with the finding that high scorers in conscientiousness gain greater satisfaction from work. Their life satisfaction also responds more sensitively to the experience of unemployment. This finding suggests that conscientious individuals might be more (intrinsically) motivated to be a good employee (Boyce and Wood, 2011; Boyce et al., 2010; Judge et al., 2002).

The literature on personality and labor market outcomes generally agrees that conscientiousness is the most important personality trait for predicting several labor market outcomes (Cuesta and Budría, 2017; Egan et al., 2017; Fletcher, 2013, amongst others). This is quite intuitive, because individuals scoring low in conscientiousness are unconcerned and careless, while high scorers in this dimension are effective and organized.

A positive correlation between agreeableness, conscientiousness, and labor market outcomes also has been shown by the literature on organizational citizenship behavior (for a review see Podsakoff et al., 2000). While low scorers in agreeableness are competitve and antagonistic, high scorer are cooperative, friendly and sympathetic. Agreeableness is positively related to organisational citizenship which sum up behavioral aspects and social cohesion. Organisational citizenship behavior is not easy to measure and to compensate for. Nevertheless, it is crucial for an organisation to function. Employers value conscientious employees for consistently high level of work motivation. Thus, employees who score high in the dimensions conscientiousness and agreeableness are of special value for employers (Podsakoff et al., 2000).

Empirical evidence suggests that labor markets give an advantage to individuals with high

level of conscientiousness and agreeableness. Less conscious and agreeable individuals need to make more effort to find and keep a suitable employment. The question is, whether the welfare state lowers the extrinsic motivation for taking this effort. If this is true, the inhibition threshold of being unemployed for low scorers in conscientiousness and agreeableness is systematically lowered, and we should observe higher unemployment rates and unemployment durations.

Even if there is some literature which finds a significant correlation between the other Big Five dimensions and labor market outcomes like wages and occupational choice, we focus on the dimensions concientiousness and agreeableness, here. We do this, because studies investigating the association between Big Five personality traits and unemployment find significant associations between unemployment on the one side and conscientiousness and agreeableness on the other side only (Cuesta and Budría, 2017; Egan et al., 2017; Fletcher, 2013).

We assume that low levels of agreeableness are outweighed by a high level of conscientiousness or vice versa. Thus, individuals who score low in both dimensions are particularly disadvantaged at the labor market and have a higher risk of being permant or again and again unemployed. This is why we use a definition of personality which combines conscientiousness and agreeableness. This combined personality trait is called *AC-score* in the following. We will use the terms noncognitive skills, personality, and AC-score synonymously.

For investigating whether AC-scores and unemployment are correlated two types of unemployed are distinguished. First, individuals with long unemployment spells are of interest, and second, we are also interested in individuals who often switch between unemployment and employment. The risk of unemployment and educational attainment are negatively correlated, and educational achievements also depend on personality (Almlund et al., 2011; Cunha et al., 2010). Thus, the indirect influence of personality on welfare recipient status is well established. This paper will examine whether there is a direct effect of personality on welfare recipient status, too. This would mean that personality influences welfare recipient status beyond its effect through educational attainment. For measuring the direct effect an factor analytic approach is needed (see amongst others Almlund et al., 2011; Borghans et al., 2008; Heckman et al., 2006). Here, a latent structure model[2] is used to infer cognitive and noncognitive factor scores. We refer to this approach in more detail in section 3.2

The intuition that low scorers in concientiousness and agreeableness struggle at the labor market is not novel, but it is also a part of the Welfare Trait theory proposed by Perkins (2016). He underpins his argumentation with a number of evidence based on diverse methodologies. Brain injuries case studies show, that reductions in the levels of conscientiousness and agreeableness decrease employability (Blummer and Benson, 1975; Damasio, 1994). Perkins (2016) also presents longitudinal studies which show that personality measured in childhood predicts occupational outcomes in adulthood (Moffitt et al., 2011). Literature on troubled families shows that adults of the troubled families, on average, possess lower levels of conscientiousness and agreeableness than adults of control families. These differences in personality go hand in hand with significantly worse work records (Tonge et al., 1975, 1981). Perkins (2016) concludes that the methodological diverse evidence on the relationship be-

[2] Also known as confirmatory factor analysis.

tween agreeableness and conscientiousness on the one side and employability at the other side suggests that they are indeed connected. But an exhaustive empirical exploration of this hypothesis does - to the best of our knowledge - not exist, yet.

The paper is organized as follows: Section 2 reviews related literature. Section 3 presents the data and the factor analytic approach. Section 4 presents empirical strategies and results. Section 5 concludes.

2 Related literature

Egan et al. (2017) study the influence of pre-labor market measures of Big Five personality traits on the risk of unemployment. Their results show that conscientiousness - and no other Big Five personality trait - in adolescence indeed predict future unemployment. Even the inclusion of two additional education variables (academic motivation and educational assessment at age 26 and 30) to account for pausible pathways between the adolescent level of conscientiousness and the future risk of unemployment does not change results qualitatively. Their results also suggest that low levels of conscientiouness matter more for job keeping than for job finding.

Cuesta and Budría (2017) show that conscientiousness is negatively correlated with the probability of unemployment. Contrary to the hypothesis in this paper they find a positive link between the risk of unemployment and agreeableness, but an intuitive explaination for this result is not given. Interestingly, they find no significant role of the remaining Big Five personality traits[3] in explaining unemployment transition. Cuesta and Budría (2017) also find a negative correlation of positive reciprocity and risk of unemployment. As Dohmen et al. (2008) show, agreeableness and conscientiousness are important determinants of positive reciprocity.

Fletcher (2013) investigates the association between employment status at age 30 and the Big Five personality traits. He estimates a sibling fixed effects model to control for individual heterogeneity based on family background. After inclusion of family fixed effects he finds a positive association only between concientiousness and probability of being employed at age 30.

Evaluations of early childhood intervention programs find an indirect association between personality and unemployment. This interventions trained - amongst others - noncognitive skills related to agreeableness and conscientiousness. These improvements of noncognitive skills are longlasting and improve labor market outcomes. For an overview see Almlund et al. (2011) and Kautz et al. (2014). This kind of literature hints at a causal channel from personality to labor market outcomes. Nevertheless, it does not exclude that there is also a channel in the opposite direction. But Cobb-Clark and Schurer (2012) find little evidence that (economically meaningful) intra-individual personality change is related to adverse employment. Moreover, they show that Big Five personality traits seem to be relativly stable among working age adults.

[3] Namely neuroticism, extraversion, and openness.

All of this studies show that the Big Five dimensions concientiousness and agreeableness are important determinants of unemployment probability and unemployment duration. Different empirical strategies were used to identify the relationship between personality traits and unemployment. But none of these studies use a factor analytic approach to identify an association between unemployment and personality beyond the channel of cognitive skills.

We complement existing literature by using a combined measure of both trais (the *AC-score*) and by measuring the direct association between personality and unemployment- this means the association beyond the channel of educational attainment - by using the concept of factors. Economists adopt this approach from the psychological literature (Almlund et al., 2011; Borghans et al., 2008; Cattan, 2010; Heckman et al., 2010, 2006). The latent factor structure model used in this paper is described in Section 3.2. But first the data set and sample are introduced in Section 3.1.

3 Data and measurement of cognitive and noncognitve skills

3.1 Data and sample

To test whether or not there is an association between personality and unemployment several variables are necessary. First, the *AC-score* has to be determinend. Hence, measures for the Big Five dimensions concientiousness and agreeableness are needed. Moreover, we differentiate several aspects of unemployment: unemployment risk, the duration of unemployment, and status changes between employment and unemployment. This measures and socio-economic control variables are presented in the following.

Data is used from the German SOEP Panel[4] (G-SOEP, v.30). Questions on Big Five Items (BFI-S) were asked in waves 2005, 2009 and 2013. For each dimension there are three questions and the questions for the dimensions conscientiousness and agreeableness read as follows:

> 'I see myself as someone who: (c_1) is a thorough worker, (c_2) tends to be lazy, (c_3) carry out tasks efficiently, (a_1) is sometimes too coarse with others, (a_2) is able to forgive, and (a_3) is friendly with others.'

Here, (c_1) to (c_3) refer to the dimension conscientiousness, and (a_1) to (a_3) refer to agreeableness. The questions consist of positive and negative statements refering to the Big Five dimensions. Variables were constructed so that values still range from 1 to 7 but that higher values always indicate higher level of agreeableness or conscientiousness, repectively. Mean answers on these questions are about five. More detailed summary statistics can be found in Table A.1 in the appendix.

[4]The G-SOEP is a representative longitudinal study that contains a large set of socio-economic, attitudinal, and labor market characteristics of respondents.

The sample is not only restricted to years 2005, 2009, and 2013 but also to respondents aged between 18 and 65 years, because we are only interested in the population in working age. Students and trainees are dropped, too. Moreover, we exclude individuals with officially recognized reduction in earning capacity or severe disability. Thus, the sample consists of individuals who are generally capable to work only. All in all, for regressions a balanced panel is used which consists of 5163 individuals.

For cognitive skills three indicator variables were considered: school education (*educ_s*), vocational education (*educ_w*), and the variable *status*, which differentiates between non-working, blue-collar worker, white-collar worker, freelancer, and public servants. More detailed information and summary statistics can be found in Table A.1 in the appendix.

Several dependent variables were used to identify individuals who struggle with the labor market.

First, the length of unemployment spell is used as a dependent variable. Respondents were asked in each wave about their time spent unemployed in their lives up to this point. Of course, the spell of unemployment is highly autocorrelated and cannot decrease over time. Therefore, we use the difference between the spells of unemployment in 2013 and in 2009 as the dependent variable ($\Delta unemployment_{(13-09)}$). This is just a second best measure of unemployment duration, but if personality and unemployment duration are generally associated, they should also be an association in each arbitrary time intervall. To decrease autocorrelation the lagged dependent variable is included, too. For this, the difference between the spells of unemployment in 2009 and in 2005 is used. This lowers autocorrelation remarkably. A more detailed discussion can be found in Section 4.1.

Second, the probability of receiving welfare benefits[5] is used as a dependent variable. In style of the German social assistance system the variable is labeled as *ALGII* (see footnote 4 for an explanation).

Third, on-and-off welfare recipient status is used as dependent variable. The G-SOEP reports - for each year - whether respondents are employed or unemployed. We construct a variable which counts the number of status changes between 1984 and 2013. To achieve inter-individual comparability we divided an individual's total number of status changes by her number of years included in the G-SOEP. Because of the yearly base the number of status changes is underestimated.

Mean unemployment duration between 2009 and 2013 is two month. About 4 percent of the sample receive unemployment benefits in 2013, and the mean (standardized) number of status change is 0.05. More detailed information can be seen in Table A.1 in the appendix.

Table A.1 also shows summary statistics of our socio-economic control variables. The average age in the sample are 49.4 years and 45.3 percent of the sample is male. 94.7 percent of the sample are German citizens.

[5]In Germany, there is a system of social assistance for the case of unemployment. Individuals subject to social insurance contribution for at least 12 month within the last two years receive (contribution-dependent) *Arbeitslosengeld I*. *Arbeitslosengeld I* is payed for maximally 12 months, if available for the labor market. An individual who is not or not anymore entitled to *Arbeitslosengeld I* receives *Arbeitslosengeld II*. Strictly speaking, the second dependent variable is an indicator variable for receiving *Arbeitslosengeld II*.

3.2 Cognitive and noncognitive skills

It is not clear whether higher noncognitive ability causes lower probability of welfare dependece or whether higher cognitive skills cause both higher noncognitive skills and lower probability of welfare dependence. It might also be possible that higher noncognitive skills favor higher cognitive skills, which lower probability of welfare dependence. The construction of factors enables us to cut the association between cognitive and noncognitive skills.

Both, cognitive and noncognitive skills are hypothetical constructs which cannot be asked for directly. Therefore, measurement models were used to define relationships between observed phenomena (called indicators, items, or manifest variables) and unobservabel concepts (called factors or latent variables). The latent factor structure model (also called confirmatory factor analysis) is a common tool to test measurement models for hypothetical constructs. In contrast to explanatory factor analysis, latent factor structure models allow inference about the estimated latent factors (Thiel and Thomsen, 2013). See Brown (2014) for an introduction into latent factor structure mode. Explanations in this paper are based on Backhaus et al. (2015).

In this paper, noncognitive skills are presented by the *AC-score*. Individuals scoring low in both concientiousness and agreeableness are assumed to struggle at the labor market and have a higher risk of being unemployed. Thus, the indicators for the hypothetical construct *AC-score* are the indicator variables intended to map the Big Five dimension conscientiousness and agreeableness. For agreeableness these are variables a_1 to a_3 introduced in Section 3.1. For conscientiousness these are variable c_1 to c_3 introduced in Section 3.1, too.

Indicators of cognitive skills are school education, voacational education and the status of the current job (the distinction between non-working, blue-collar worker, white-collar worker, freelancer, and public servants).

The measurement model is assumend to be reflective. Thus, we assume a high correlation between indicator variables which is caused by the corresponding latent variable (=factor). That means that the *AC-score* is the driving force of the correlation between all indicator variables a_1 to c_3. Accordingly, the factor *cognitive* drives the correlation between the indicator variables school education, voacational education and the status of the current job.

The factor analysis now uses the correlations of indicator variables to estimates individual values (called factor scores) for the factors *AC-score* and *cognitive*. To disentangle the effects of cognitive and noncognitive skills it is common to assume both factors to be orthogonal (Heckman et al., 2006; Thiel and Thomsen, 2013).

Here, the measurement model for individual k is described by the following equations:

$$educ\_w_k = \lambda_{11} \cdot cognitive_k + \varepsilon_{1k} \quad (1)$$
$$educ\_s_k = \lambda_{21} \cdot cognitive_k + \varepsilon_{2k} \quad (2)$$
$$status_k = \lambda_{31} \cdot cognitive_k + \varepsilon_{3k} \quad (3)$$

$$a\_1_k = \lambda_{42} \cdot \text{AC-s}core_k + \varepsilon_{4k} \quad (4)$$
$$a\_2_k = \lambda_{52} \cdot \text{AC-s}core_k + \varepsilon_{5k} \quad (5)$$
$$a\_3_k = \lambda_{62} \cdot \text{AC-s}core_k + \varepsilon_{6k} \quad (6)$$
$$c\_1_k = \lambda_{72} \cdot \text{AC-s}core_k + \varepsilon_{7k} \quad (7)$$
$$c\_2_k = \lambda_{82} \cdot \text{AC-s}core_k + \varepsilon_{8k} \quad (8)$$
$$c\_3_k = \lambda_{92} \cdot \text{AC-s}core_k + \varepsilon_{9k} \quad (9)$$

where λ_{ij} ($i = 1,...,9$; $j = 1,2$) measures the correlation between the i-th indicator variable and factor j. This correlation is called factor loading.

The confirmatory factor analysis estimates coefficients of the theoretical variance-covariance matrix of the measurement model. Because standardized values of all variables are used (mean=0, sd=1) the variance-covariance matrix is equal to the correlation matrix.

It is assumed that factors, factors and disturbance terms ε_{ik}, and disturbance terms ε_{ik} are uncorrelated. The assumption of uncorrelated factors is what cuts the association between cognitive and noncognitive skills, here. A theoretical derivation of the correlation matrix can be found in the technical appendix.

In practice, measurement models are overidentified and an iterative algorithm is used to minimize the discrepancy function of empirical and theoretical correlation matrix. In this paper the Maximum-Likelihood-Method (ML) is used[6].

Correlation matrix estimation yields results for factor loadings λ_{ij} and disturbance terms ε_{ik}. Indicator variable values are given in the data set. Thus, rearranging equations (1) to (9) allow to estimate of individual factor scores $AC\text{-}score_k$ and $cognitive_k$. These individual factor score estimates[7] are used in Section 4 as noncognitive and cognitive skill measure.

Factor loadings and fit statistics for 2005, 2009 und 2013 can be seen in Table A.2 in the appendix. This estimation is not restricted to our main sample, but includes all available observations to increase model fit. The sample is restricted afterwards. All factor loadings are statistically significant on the 1% level. Estimated coefficients show that the factor *AC-score* is - as assumed - positively correlated with all indicator variables. Thus, higher level in conscientiousness and agreeableness indicate higher values of *AC-score*. Size of factor

[6]Results are not driven by Maximum-Likelihood assumptions. Asymptotic distribution free estimation (ADF) shows qualitatively similar results. ADF provides justifiable point estimates and standard errors under nonnormality of latent factors and/or indicator variables. But, if latent factors can be assumed to be normally distributed, ML is more efficient.

[7]STATA use a calculation analogue to regression scoring. As seen in Table A.1, few observations of item variables are missing in the sample. In this cases, stata conditions on items with observed values only.

loadings are all in all acceptable and indicate, that a higher share of variation in the dimension of conscientiousness is explained by the factor *AC-score* than of agreeableness[8].

The global fit statistics suggest that the model specification is good. The *Standardized Root Mean Square Residual (SRMR)* is a goodness-of-fit index which is independent from sample size and robust against voilation of the assumption of multinomial distribution. A value of *SRMR* less or equal than 0.08 indicates good model fit (Hu and Bentler, 1999). As can be seen in Table A.2 in the appendix values of *SRMR* range from 0.051 in 2005 and 2013 and 0.052 in 2009. The *Root-Mean-Square-Error of Approxiamtion (RMSEA)* is a statistical-inferences-index which is constructed to avoid common problems of the Chi-Squared-Test. Values of $RMSEA \geq 0.08$ and $RMSEA < 0.1$ indicates an acceptable model fit. Table A.2 in the appendix show that values range from 0.082 in 2013 and 0.087 in 2005. But in all specifications $pclose = 0.000$ apllies. This suggests that $H_0 : RMSEA \leq 0.05$ should not be rejected, which implies a good model fit (Browne et al., 1993).

Results of individual factor score estimations for *AC-score* are presented as box plots in Figure 1. Factor scores are estimated as deviations from the mean (of factor scores). Thus, they are a relative representation and it is not recommendable to interpret them quantitatively. What we can say is, that highly positive factor scores imply strinking above average combined value of agreeableness and conscientiousness, and that highly negative factor scores imply strinking below average combined value of agreeableness and conscientiousness.

Median factor scores are about 0.02 for all three years. Remember that values of personality indicator variables were standardized. As shown in Table A.1, the mean value of the sample is close to zero (about 0.002). The upper and the lower hinge (75th percentile and 25th percentile) range from about 0.25 to -0.20. A bit more variation is in upper and lower adjacent values which draw the border between inside and outside values. But in all three years there are just outside values at the lower end of the personality factor score distribution. This means, that there are no respondents with extraordinary high level of agreeableness and conscientiousness but some respondents with extraordinary low level.

There are no statistically significant mean-level change in factor scores of personality between 2005, 2009, and 2013. This conforms with Cobb-Clark and Schurer (2012), who show that Big Five personality traits are stable for working age adults.

4 Results

4.1 Personality and unemployment spells

Figure 2 shows box plots of years spent in unemployment over the life cycle. The median values are zero for all three years. The 75th percentiles are about 1. This means, that 75

[8]To evaluate whether concientiousness or agreeableness is the driving factor, I would prefer a regression including three factors - *cognitive skill*, *conscientiousness*, and *agreeableness* - into one regression. But, it is techniqually not feasible to estimate three orthogonal factors and get an acceptable model fit. Thus, this weakness has to be accepted.

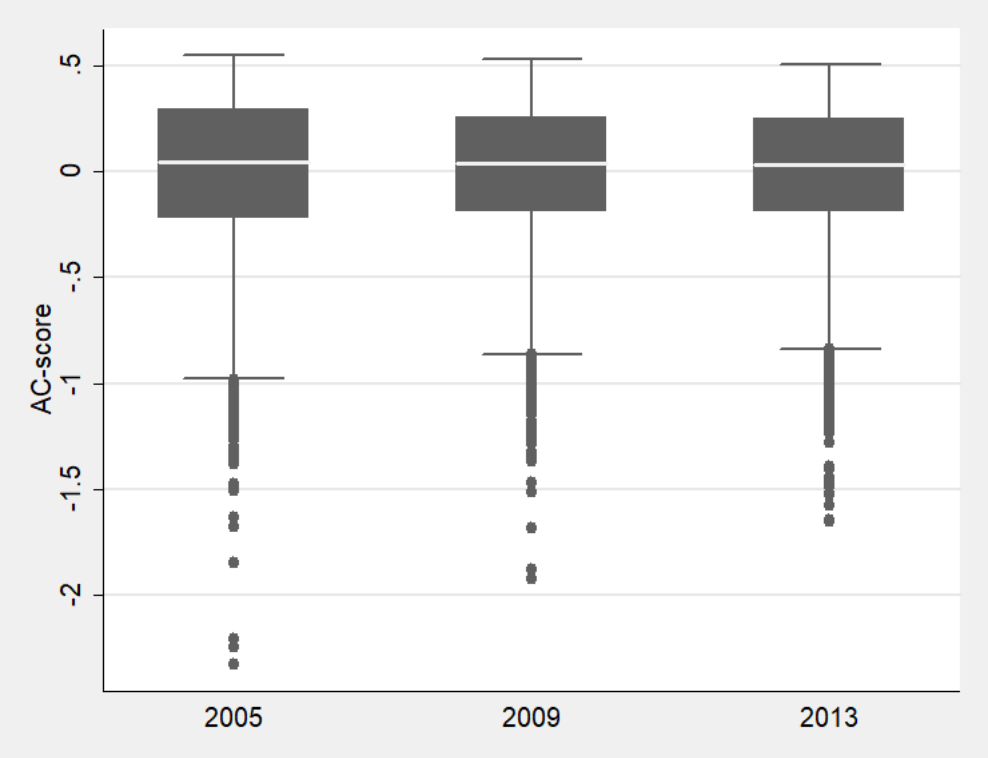

Figure 1: Boxplots for *AC-score*.

percent of respondents were unemployed for about one year or less up to the responding time period. Upper adjacent values are about 3 years. Outside values range from this lines up to 23 in 2005, 28.3 in 2009, and 29.3 in 2013. This means, that there are some respondents with extraordinarily high spells of unemployment over the life cycle.

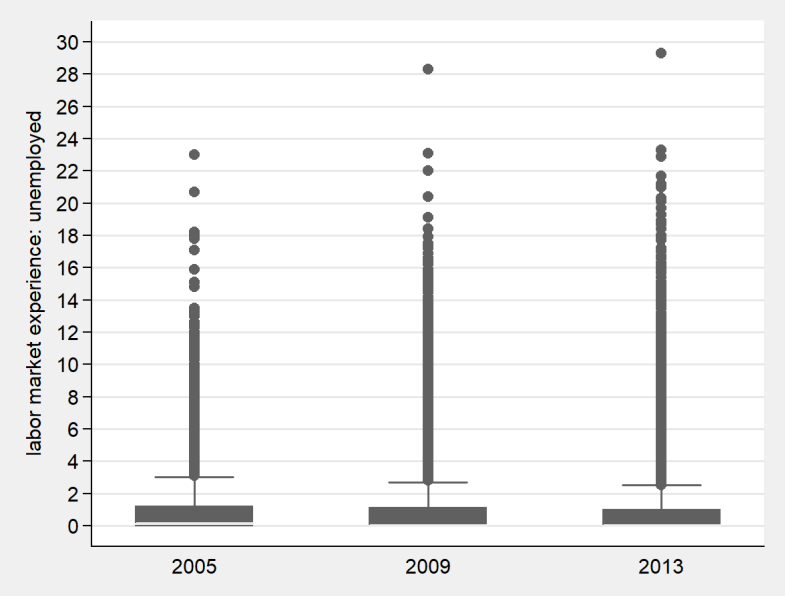

Figure 2: Boxplots for labor market experience unemployed.

The question is, whether or not these extraordinarily high spells of unemployment are related to the striking low levels of agreeableness and conscientiousness outlier show in Figure 1. This would suggest that are relationship between unemployment and personality exists.

As explained in Section 3.1, using total spell of unemployment as dependent variable for answering this question is inappropriate, because it is highly autocorrelated. If we regress spell of unemployment in 2013 on spell of unemployment in 2009 we get a coefficient of determination of $R^2 = 0.96$. In such a specification it is difficult to estimate the relationship to determinants other than the lagged dependent variable.

This is why I use the first difference of spell of unemployment as dependent and lagged dependent variable. For personality we use the *AC-scores* from 2009, because this should be the basis for behavior between 2009 and 2013.

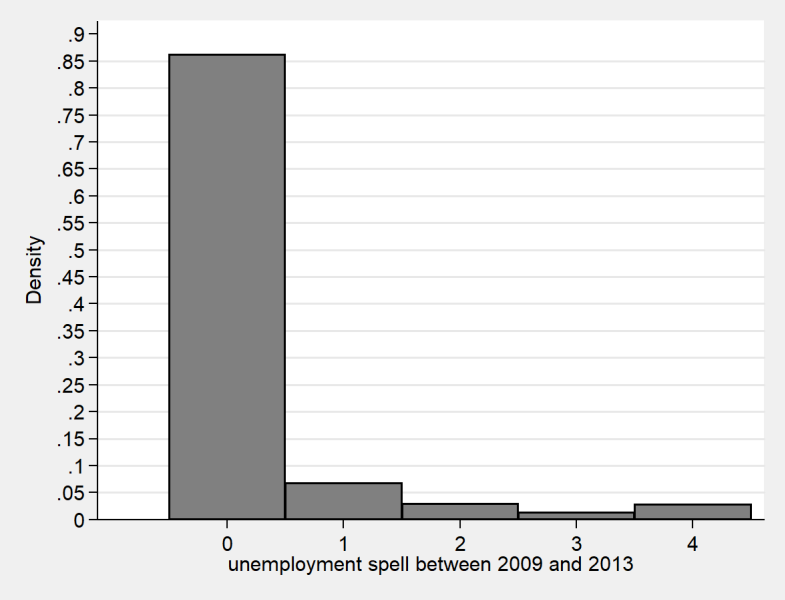

Figure 3: Unemployment between 2009 and 2013. Upper limit of years in unemployment on the x-axis.

Figure 3 gives an idea of how our dependent variable looks like. Respondents were grouped into five categories. Category 0 includes all who were not unemployed between 2009 and 2013. Category 1 includes respondents who were unemployed for one year or less in this time span. Category 2 covers respondents who were unemployed for more than one year, but not longer than two years. Category 3 covers respondents who were unemployed for more than two years, but not longer than three years. And category 4 covers respondents who were unemployed for more than three years, but not longer than four years. About 85 percent of our sample were not unemployed between 2009 and 2013, about 7 percent belong to category 1, about 3 percent belong to category 2, about 1.5 percent belong to category 3, and about 3 percent were unemployed for more than 3 years but not longer than 4 years.

To test whether there is an associaiton between unemployment duration and personality simple OLS regression were run on the following equation:

$$\Delta unemployment_{k,(13-09)} = \beta_0 + \beta_1 \cdot \Delta unemployment_{k,(09-05)} + \beta_2 \cdot \text{AC-s}core_{k,09} \quad (10)$$
$$+ \beta_3 \cdot cognitive_{k,09} + \beta_4 \cdot X_{k,09} + \mu_{k,(13-09)} \quad (11)$$

Control variables $X_{k,t}$ are *sex*, *age*, age^2, $family\ status$, *german*, and $state$. For region of residence ($state$) is controlled for to capture institutional differences - like different unemployment rates - in German states. To capture different entitlements for benefits it is controlled for $family\ status$ and german citizenship (*german*).

It is also standard to control for socio-economic status of parents and income. I refrain from doing that here. First, parents socio-economic status is one of the main driving factors of an individual's cognitive and noncognitive skills (Perkins, 2016). Second, income is highly correlated with the factor *cognitive*.

Table 1 presents results for the full sample. In column (1) *AC-score* has the assumed negative relationship to the change of time spend unemployed, which is highly statistically significant. Higher values of *AC-score* indicate higher level of agreeableness and conscientiousness. Respondents with low level of agreeableness and conscientiousness spend - on average - more time in unemployment.

Unemployment duration between 2009 and 2013 is - as expected - also negatively correlated with the factor *cognitive*.

Because of the use of factors I refrain from intepreting effect sizes quantitatively. But the pattern of coefficient sizes suggests that the association between unemployment duration and personality is relevant.

Men have on average higher unemployment durations than women. Unemployment duration firstly decreases in age but this effect diminishes over time. Married individuals living with their spouse have lower unemployment durations than divorced, unmarried or single individuals. German citizenship is not statistically significantly associated with unemployment duration. The region of residence seems not to be that important.

To explore potential heterogeneity of effects columns (2) and (3) split the sample into women and men. There are no indications for heterogenous effects. All in all, results do not change qualitatively, just the coefficient of state of residence lose statistical significance.

Because of the high share of individuals who never have been unemployed, the analysis is also restricted to individuals who experienced unemployed, yet. Table A.3 in the appendix reports results for these respondents. Again, specifications in columns (2) and (3) split the sample into women and men.

Here, results suggest that *AC-score* is more important for women than for men. The coefficient is not only somewhat higher, the association between unemployment duration and personality is merely statistically significant in the female subsample[9].

[9] In a subgroup analysis Fletcher (2013) also just find statistically significant effects of C and A in the female subsample. In contrast, Egan et al. (2017) and Cuesta and Budría (2017) find no differences between men and women.

Table 1: Personality and spell of unemployment between 2009 and 2013

	(1) full		(2) female		(3) male	
	coeff.	s.e.	coeff.	s.e.	coeff.	s.e.
$\Delta unemployment_{(09-05)}$	0.637***	(0.009)	0.585***	(0.011)	0.714***	(0.013)
$AC\text{-}score_{09}$	-0.058***	(0.020)	-0.062**	(0.027)	-0.055*	(0.028)
$cognitive_{09}$	-0.060***	(0.013)	-0.064***	(0.018)	-0.054***	(0.018)
men	0.040***	(0.013)				
age	-0.018***	(0.007)	-0.013	(0.009)	-0.019*	(0.010)
age^2	0.000***	(0.000)	0.000	(0.000)	0.000**	(0.000)
family status	0.025***	(0.006)	0.022***	(0.007)	0.036***	(0.009)
german	0.007	(0.030)	-0.005	(0.040)	0.030	(0.046)
state	0.003**	(0.001)	0.003	(0.002)	0.003	(0.002)
constant	0.354**	(0.161)	0.344	(0.218)	0.260	(0.237)
N	5,163		2,825		2,338	
R^2	0.549		0.524		0.592	

Robust standard errors in parentheses. ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$
Dependent variable: Spell of unemployment between 2009 and 2013.

4.2 Personality and unemployment benefits

Now, it should be investigated whether individuals scoring low in concientiousness and agreeableness have a higher probability of being welfare recipients.

In 2013, about 4 percent of the sample received unemployment benefits[10]. Figure 4 shows box plots of *AC-score* by subgroups 'no welfare recipient in 2013' and 'welfare recipient in 2013'. Mean values of *AC-score* vary from 0.004 for 'no welfare recipients in 2013' to -0.043 for 'welfare recipients in 2013'. This and the comparison of box plots suggest, that the distribution of individual factor scores of *AC-score* are more skewed to the right for individuals who receive unemployment benefits than for individuals which do not receive unemployment benefits in 2013. The dependent variable $ALGII_{k,t}$ is equal to one if individual k receives unemployment benefits in period t, and zero otherwise.

To test whether there is a statistically significant association between the probability of receiving unemployment benefits and *AC-score*, probit regressions were run on following equation:

$$\begin{aligned} ALGII_{k,13} = \beta_0 + \beta_1 \cdot ALGII_{k,05} + \beta_2 \cdot \text{AC-s}core_{k,09} \\ + \beta_3 \cdot cognitive_{k,09} + \beta_4 \cdot X_{k,13} + \mu_{k,13} \end{aligned}$$

As with unemployment duration, the probability of being a welfare benefit recipient is also path dependent. Therefore, its lag is included into regression. Control variables $X_{k,2013}$ are the same as in the previous section. Welfare recipient status today is caused by behavioral

[10]Strictly speaking, the term unemployment benefits means *Arbeitslosengeld II* (also called Hartz IV). See footnote 4 for an explanation of the German system of social assistance

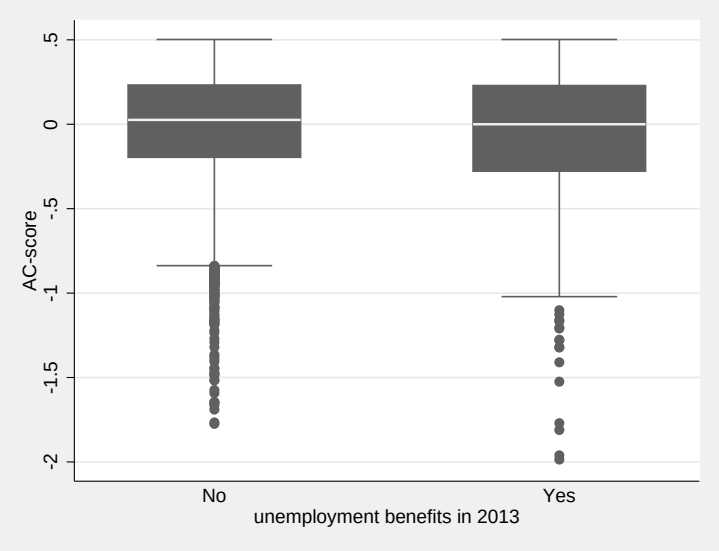

Figure 4: Boxplots of *AC-scores* for individuals who do and do not receive unemployment benefits in 2013.

patterns showed in the (recent) past. Intuitively, it is more convincing, that this behavioral patterns are grounded on personality traits exhibited in the (recent) past. Therefore, I include lagged individual factor scores into regressions[11].

Table 2 shows marginal effects. As in the previous section, column (1) refers to the overall sample and columns (2) and (3) split the sample into female and male. Results for the overall sample show a highly statistically significant negative association between the probability of receiving welfare benefits and personality. This means, that individuals with higher level in conscientiousness and agreeableness have a lower risk of welfare recipient status. Cognitive skills are also negatively correlated with the probability of welfare recipient status. Signs of socio-economic controls are similar to results shown in Section 4.1.

Again, results refering to *AC-score* seem to be driven by the female subsample, as can be seen in columns (2) and (3) of Table 2.

4.3 Personality and on-and-off welfare recipients

The probability and duration of unemployment might not be the only outcomes influenced by low levels of conscientiousness and agreeableness. Results of Egan et al. (2017) suggest that a low level of conscientiousness matters for job keeping. Perkins (2016) offer (rather anecdotical) evidence that individuals with a low level of both concientiousness and agreeableness have difficulties to keep their job. In this section we evaluate whether there is an association between *AC-score* and the number of status changes between employment and unemployment.

[11]It is also standard in the personality literature to use personality traits measured prior to the predicted outcomes to adress the potential reverse causality problem Heckman et al. (2006).

Table 2: Personality and probability of receiving unemployment benefits in 2013

	(1) full		(2) female		(3) male	
	mfx.	s.e.	mfx.	s.e.	mfx.	s.e.
$ALGII_{05}$	0.236***	(0.032)	0.201***	(0.038)	0.293***	(0.055)
$AC\text{-}score_{09}$	-0.011***	(0.004)	-0.013**	(0.005)	-0.008	(0.006)
$cognitive_{09}$	-0.028***	(0.004)	-0.032***	(0.005)	-0.023***	(0.005)
men	-0.000	(0.003)				
age	-0.003**	(0.001)	-0.00**	(0.002)	-0.002	(0.002)
age^2	0.000**	(0.000)	0.000*	(0.000)	0.000	(0.000)
family status	0.008***	(0.001)	0.008***	(0.002)	0.007***	(0.002)
german	-0.002	(0.006)	-0.002	(0.007)	-0.001	(0.01)
state	0.001***	(0.000)	0.001***	(0.000)	0.001***	(0.000)
N	5,163		2,825		2,338	
Pseudo R^2	0.325		0.327		0.342	

Robust standard errors in parentheses. ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$
Dependent variable: Indicator variable for receiving unemployment benefits in 2013.

The G-SOEP asks respondents about their employment status[12] on a yearly base. We construct a variable which counts all status changes between 1984 and 2013. To achieve inter-individual comparability we divided an individual's total number of status changes by the number of years she is included in the G-SOEP. If there is a missing value for employment status the year is skipped (it is also not accounted in the total number of observations for the specific respondent). For simplicity, this normalized variable is called *number of status changes* in the following. Because of the yearly base the number of status changes is underestimated.

About 70 percent of the sample experienced no status change between 1984 and 2013. In 2013, the mean of the whole sample is 0.050 status changes with a standard deviation of 0.097. The distribution of status changes experienced by respondents with values of status changes greater than zero can be seen in Figure 5.

With a mean of 0.167, a median of 0.143, and a maximum value of 0.750 this distribution is skewed to the right. Most individuals exhibit relatively low numbers of status changes, while there are some individuals with strinkingly large values.

To find out whether there is an association between the extraordinarily high values in status changes and extraordinarily low individual factor scores of *AC-score* (see Figure 1) OLS regressions were run on following equation:

$$\begin{aligned} \textit{Num. of status changes}_{k,13} = \beta_0 + \beta_1 \cdot \textit{Num. of status changes}_{k,05} + \beta_2 \cdot \text{AC-s}core_{k,09} \\ + \beta_3 \cdot cognitive_{k,09} + \beta_4 \cdot X_{k,13} + \mu_{k,13} \end{aligned}$$

As the dependent variable *number of status changes* is autocorrelated by construction its

[12] It is asked whether an individual is employed or unemployed. There is no differentiation between Arbeitslosengeld I and II.

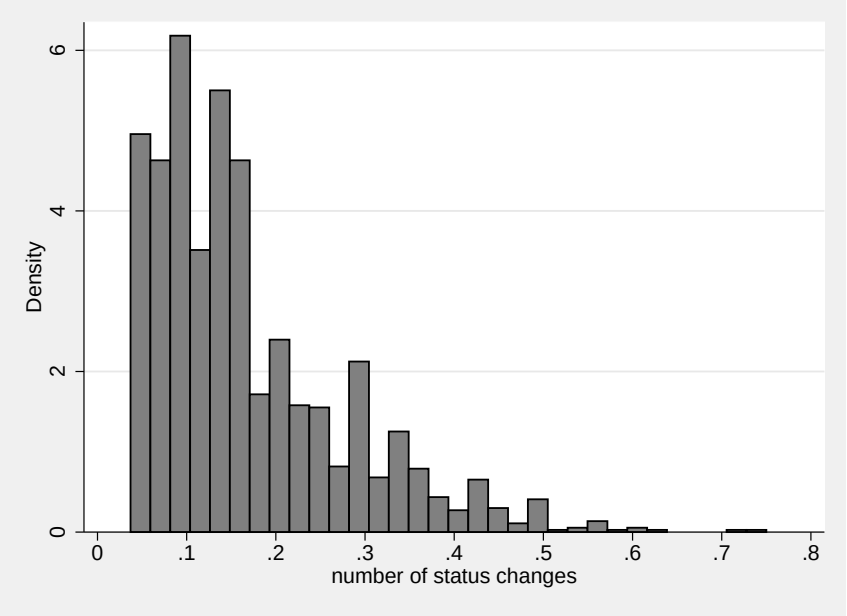

Figure 5: Distribution of status changes experienced by respondents with more than zero status changes (in 2013).

lag has to be included into regression. Control variables $X_{k,13}$ and individual factor scores *AC-score* and *cognitive* are the same as in the previous subsection.

Table 3 presents results. Again, column (1) refers to the whole sample and columns (2) and (3) refer to women and men, respectively. As can be seen in column (1) the sample decreases somewhat, but signs and significance of socio-economic control variables are as before. There is also a statistically significant, negative correlation between *AC-score* and *number of status changes*. Cognitive skills and *number of status changes* are statistically significantly correlated, too, and the coefficient has the expected negative sign. Up to this point no surprises: individuals with higher noncognitive and cognitive skills - on average - exhibit lower numbers of status changes, thus, have lower probabilties to be on and off welfare recipients.

But there is a surprise in columns (2) and (3). This time, the negative correlation between *AC-score* and the dependent variable is statistically significant for men only.

Results suggests that personality is an important determinant of women's risk of unemployment and unemployment duration, but for men personality is more a matter of job keeping.

5 Conclusion

Our results suggest that personality and unemployment are associated. Individuals with low levels of concientiousness and agreeableness have a higher risk of being welfare recipients, have longer unemployment durations, and change more frequently between employment and unemployment as more conscientious and agreeable individuals.

Table 3: Personality and on-and-off welfare recipients

	(1) full		(2) female		(3) male	
	coeff.	s.e.	coeff.	s.e.	coeff.	s.e.
Num. of status changes$_{05}$	1.272***	(0.015)	1.267***	(0.020)	1.279***	(0.022)
AC-score$_{09}$	-0.006**	(0.003)	-0.004	(0.004)	-0.009**	(0.004)
cognitive$_{09}$	-0.012***	(0.002)	-0.011***	(0.002)	-0.014***	(0.002)
men	-0.001	(0.002)				
age	-0.011***	(0.001)	-0.011***	(0.001)	-0.011***	(0.001)
age^2	0.000***	(0.000)	0.000***	(0.000)	0.000***	(0.000)
family status	0.004***	(0.001)	0.005***	(0.001)	0.004***	(0.001)
german	0.001	(0.004)	0.005	(0.005)	-0.006	(0.006)
state	0.000**	(0.000)	0.000	(0.000)	0.001***	(0.000)
constant	0.283***	(0.020)	0.274***	(0.029)	0.289***	(0.029)
N	5,163		2,825		2,338	
R^2	0.618		0.607		0.634	

Robust standard errors in parentheses. ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$
Dependent variable: Sum of unemployment status changes in 2013 (change is measured on a yearly base).

The association between receiving unemployment benefits and *AC-score* seems to be more important for women. In contrast, the association between *AC-score* and on-and-off welfare recipient status seems to be more important for men.

It would also be interesting to investigate the association between *AC-score* and attitudinal variables towards the welfare state. This would disentangle two possible pathways. First, it might be possible that low *AC-score* individuals have to exert more effort to find and keep a job. But secondly, it might also be possible that low *AC-score* individuals have a lower intrinsic motivation to find and keep a job because they think it is not necessary to live on their own expense. Unfortunately, the G-SOEP does not contain attended questions for such an analysis.

That we find a statistically significant correlation between personality and unemployment contributes to an socially controversial debate. The idea that welfare recipients differ in personality deepens ideological divides and leads to stigmatization of welfare recipients. Thus, we think it is important to remember that we just found an correlation. We cannot say anything about reasons and consequences.

Our results adds findings that low scorers in agreeableness and conscientiousness have a higher risk of being welfare recipients. Perkins (2016) even goes one step further. He claims in his 'Welfare Trait Theory' that the low *AC-score* parents raise low *AC-score* children and that this - in combination with head-dependent welfare benefits - might initiate a hazardous welfare state dynamic similar to that proposed by Lindbeck et al. (1999). That requires a transmission of the *AC-score* from parents to their children and a replicator dynamic change initiated by the rise of the welfare state. That would lead to an increasing proportion of welfare recipients in the long run.

The literature shows that personality traits indeed evolve in early childhood and are relatively constant over the life cycle (Cobb-Clark and Schurer, 2012; Roberts, 2009). Thus,

noncognitive skills are formed by childhood home and environment, where parents play an important role (Heckman et al., 2006). But - the good news is - empirical literature and evaluations of early cildhood intervention programs (like the Perry Preschool Program and the STAR Project) also show that it is possible to suppport children to develop reasonable levels of conscientiuoness and agreeableness

Results of this paper suggest that an association between unemployment and personality exists. Everything else is subject to future research.

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Appendix

Table A.1: Descriptive statistics for 2013

	Mean	Std. dev.	Min	Max	N
a_1: Am sometimes too coarse with others	4.882	(1.618)	1†	7‡	5,140
a_2: Able to forgive	5.375	(1.318)	1‡	7†	5,146
a_3: Friendly with others	5.781	(1.058)	1‡	7†	5,140
c_1: Thorough worker	6.235	(0.933)	1‡	7†	5,151
c_2: Tend to be lazy	5.635	(1.517)	1†	7‡	5,136
c_3: Carry out tasks efficiently	5.863	(1.033)	1‡	7†	5,140
educ_s[1]	4.191	(1.240)	1	6	5,104
educ_w[2]	2.304	(0.825)	1	4	5,163
status[3]	2.688	(1.061)	1	5	5,101
AC-score (factor score)	0.002	(0.326)	-1.650	0.502	5,163
cognitive (factor score)	0.002	(0.540)	-1.323	1.175	5,163
unemployment spell	1.217	(2.808)	0	29.3	5,163
$\Delta unemployment_{(13-09)}$	0.212	(0.703)	0	3.9	5,163
ALGII	0.041	(0.198)	0	1	5,163
Num. of status changes	0.050	(0.097)	0	0.750	5,163
men	0.453	(0.498)	0	1	5,163
age	49.4	(9.3)	25	65	5,163
family status	1.710	(1.200)	1	7	5,163
german	0.947	(0.225)	0	1	5,163

Source: G-SOEP.

† agree strongly

‡ disagree strongly

[1] (6) higher secondary education (Abitur), (5) higher secondary education (Fachhochschulreife), (4) secondary education, (3) lower secondary education, (2) other , (1) primary education.

[2] (1) no professional training, (2) professional training, (3) applied science university diploma, (4) University degree/PhD

[3] (1) non-working , (2) blue-collar worker, (3) white-collar worker, (4) self-employed, (5) public servants

Table A.2: Estimated coefficients of the cognitive and noncognitive factors

	2005		2009		2013	
	Coef.	SE	Coef.	SE	Coef.	SE
educ_w						
cognitive	0.772***	0.009	0.763***	0.009	0.754***	0.1
constant	2.664***	0.02	2.674***	0.02	2.681***	0.021
educ_s						
cognitive	0.742***	0.009	0.749***	0.009	0.779***	0.01
constant	3.158***	0.023	3.223***	0.023	3.220***	0.024
status						
cognitive	0.479***	0.009	0.482***	0.009	0.449***	0.01
constant	2.377***	0.019	2.481***	0.019	2.509***	0.02
c_1						
AC-score	0.659***	0.009	0.650***	0.009	0.659***	0.009
constant	6.961***	0.048	6.515***	0.045	6.642***	0.047
c_2						
AC-score	0.493***	0.01	0.433***	0.01	0.414***	0.011
constant	4.028***	0.029	3.625***	0.026	3.555***	0.027
c_3						
AC-score	0.648***	0.009	0.661***	0.009	0.677***	0.009
constant	5.714***	0.04	5.430***	0.037	5.775***	0.041
a_1						
AC-score	0.268***	0.012	0.253***	0.012	0.236***	0.012
constant	3.062***	0.023	2.989***	0.022	2.976***	0.023
a_2						
AC-score	0.328***	0.011	0.291***	0.011	0.272***	0.012
constant	4.249***	0.03	3.986***	0.028	4.101***	0.03
a_3						
AC-score	0.501***	0.01	0.448***	0.011	0.463***	0.011
constant	5.347***	0.01	5.094***	0.035	5.621***	0.04
N	11,012		11,210		10,361	
log likelihood	-147809.51		-153615.65		-140581.61	
R^2	0.925		0.92		0.925	
SRMR	0.051		0.052		0.051	
RMSEA	0.087		0.086		0.082	

Table A.3: Personality and spell of unemployment between 2009 and 2013 - subsample of individuals who experienced unemployment.

	(1) full		(2) female		(3) male	
	coeff.	s.e.	coeff.	s.e.	coeff.	s.e.
$\Delta unemployment_{(09-05)}$	0.601***	(0.014)	0.556***	(0.018)	0.666***	(0.022)
$AC\text{-}score_{09}$	-0.104**	(0.042)	-0.104*	(0.054)	-0.098	(0.063)
$cognitive_{09}$	-0.116***	(0.030)	-0.131***	(0.040)	-0.105**	(0.046)
men	0.089***	(0.029)				
age	-0.041***	(0.014)	-0.023	(0.018)	-0.061***	(0.022)
age^2	0.000***	(0.000)	0.000	(0.000)	0.001***	(0.000)
family status	0.048***	(0.012)	0.040***	(0.015)	0.077***	(0.019)
german	0.007	(0.061)	-0.004	(0.080)	0.040	(0.091)
state	0.005	(0.003)	0.005	(0.004)	0.006	(0.005)
constant	0.803**	(0.341)	0.597	(0.439)	1.009*	(0.530)
N	2,353		1,342		1,011	
R^2	0.505		0.479		0.553	

Robust standard errors in parentheses. ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$
Dependent variable: Spell of unemployment between 2009 and 2013.

Technical appendix

In this Section the theoretical correlation matrix used for the estimation of the latent factor structure model is derived. Explanations are on the basis of Backhaus et al. (2015), see Brown (2014) for an introduction into confirmatory analysis. The measurement model for standardized indicator variables x_{ik} with $i = 1,...,9$ and k individuals, and factors $f_1 = cognitive$ and $f_2 = AC\text{-}score$ looks as follows:

$$x_{1k} = \lambda_{11} \cdot f_{1k} + \varepsilon_{1k} \tag{12}$$
$$x_{2k} = \lambda_{21} \cdot f_{1k} + \varepsilon_{2k} \tag{13}$$
$$x_{3k} = \lambda_{31} \cdot f_{1k} + \varepsilon_{3k} \tag{14}$$

$$x_{4k} = \lambda_{42} \cdot f_{2k} + \varepsilon_{4k} \tag{15}$$
$$x_{5k} = \lambda_{52} \cdot f_{2k} + \varepsilon_{5k} \tag{16}$$
$$x_{6k} = \lambda_{62} \cdot f_{2k} + \varepsilon_{6k} \tag{17}$$
$$x_{7k} = \lambda_{72} \cdot f_{2k} + \varepsilon_{7k} \tag{18}$$
$$x_{8k} = \lambda_{82} \cdot f_{2k} + \varepsilon_{8k} \tag{19}$$
$$x_{9k} = \lambda_{92} \cdot f_{2k} + \varepsilon_{9k} \tag{20}$$

For the theoretical correlation matrix we correlate every indicator variable against every other.

$$r_{x_i,x_j} = \frac{1}{K} \sum_k x_{ik} \cdot x_{jk} \tag{21}$$

where $i = 1,...,9$ and $j = 1,...,9$.

There are three cases which might arise:

1. an indicator variable is correlated against itself ($i = j$),
2. two different indicator variables were correlated but both depend on the same factor ($i \neq j$),
3. two different indicator variables were correlated which do not depend on the same factor ($i \neq j$).

The covariances of the factors are defined as $Cov(f_1, f_1) = \Phi_{f_1,f_1} = 1$, $Cov(f_2, f_2) = \Phi_{f_2,f_2} = 1$, and $Cov(f_1, f_2) = \Phi_{f_1,f_2} = 0$.

Inserting equations (12) to (20) into equation (21) and assuming that disturbance terms are not correlated, and that factors and disturbance terms are uncorrelated, too, yields:

for case (i):

$$\begin{aligned}
r_{x_i,x_i} &= \frac{1}{K}\sum_k (\lambda_{i1} f_{1k} + \varepsilon_{ik})(\lambda_{i1} f_{1k} + \varepsilon_{ik}) \\
&= \frac{1}{K}\sum_k [(\lambda_{i1} \cdot f_{1k} \cdot \lambda_{i1} \cdot f_{1k}) + (\lambda_{i1} \cdot f_{1k} \cdot \varepsilon_{ik}) + (\varepsilon_{ik} \cdot \lambda_{i1} \cdot f_{1k}) + (\varepsilon_{ik} \cdot \varepsilon_{ik})] \\
&= \lambda_{i1} \cdot \lambda_{i1} \cdot \frac{1}{K}\sum_k f_{1k} \cdot f_{1k} + \lambda_{i1} \cdot \frac{1}{K}\sum_k f_{1k} \cdot \varepsilon_{ik} + \lambda_{i1} \cdot \frac{1}{K}\sum_k \varepsilon_{ik} \cdot f_{1k} + \frac{1}{K}\sum_k \varepsilon_{ik} \cdot \varepsilon_{ik} \\
&= \lambda_{i1} \cdot \lambda_{i1} \cdot \Phi_{f_1,f_1} + \lambda_{i1} \cdot r_{f_1,\varepsilon_i} + \lambda_{i1} \cdot r_{\varepsilon_i,f_1} + r_{\varepsilon_i,\varepsilon_i}. \\
&= \lambda_{i1}^2 + \varepsilon_i^2
\end{aligned}$$

for case (ii):

$$\begin{aligned}
r_{x_i,x_j} &= \frac{1}{K}\sum_k (\lambda_{i1} f_{1k} + \varepsilon_{ik})(\lambda_{j1} f_{1k} + \varepsilon_{jk}) \\
&\vdots \\
&= \lambda_{i1} \cdot \lambda_{j1} \cdot \Phi_{f_1,f_1} + \lambda_{i1} \cdot r_{f_1,\varepsilon_j} + \lambda_{j1} \cdot r_{\varepsilon_i,f_1} + r_{\varepsilon_i,\varepsilon_j}. \\
&= \lambda_{i1} \cdot \lambda_{j1}
\end{aligned}$$

and for case (iii):

$$\begin{aligned}
r_{x_i,x_j} &= \frac{1}{K}\sum_k (\lambda_{i1} f_{1k} + \varepsilon_{ik})(\lambda_{j2} f_{2k} + \varepsilon_{jk}) \\
&\vdots \\
&= \lambda_{i1} \cdot \lambda_{j2} \cdot \Phi_{f_1,f_2} + \lambda_{i1} \cdot r_{f_1,\varepsilon_j} + \lambda_{j2} \cdot r_{\varepsilon_i,f_2} + r_{\varepsilon_i,\varepsilon_j}. \\
&= 0
\end{aligned}$$

This leads to the theoretical correlation matrix $\hat{\Sigma}$:

$$\hat{\Sigma} = \begin{bmatrix}
\lambda_{11}^2 + \varepsilon_1^2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
\lambda_{11}\lambda_{21} & \lambda_{21}^2 + \varepsilon_2^2 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
\lambda_{11}\lambda_{31} & \lambda_{21}\lambda_{31} & \lambda_{31}^2 + \varepsilon_3^2 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & \lambda_{42}^2 + \varepsilon_4^2 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & \lambda_{42}\lambda_{52} & \lambda_{52}^2 + \varepsilon_5^2 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & \lambda_{42}\lambda_{62} & \lambda_{52}\lambda_{62} & \lambda_{62}^2 + \varepsilon_6^2 & 0 & 0 & 0 \\
0 & 0 & 0 & \lambda_{42}\lambda_{72} & \lambda_{52}\lambda_{72} & \lambda_{62}\lambda_{72} & \lambda_{72}^2 + \varepsilon_7^2 & 0 & 0 \\
0 & 0 & 0 & \lambda_{42}\lambda_{82} & \lambda_{52}\lambda_{82} & \lambda_{62}\lambda_{82} & \lambda_{72}\lambda_{82} & \lambda_{82}^2 + \varepsilon_8^2 & 0 \\
\lambda_{11}\lambda_{92}\Phi_{f_1,f_2} = 0 & 0 & 0 & \lambda_{42}\lambda_{92} & \lambda_{52}\lambda_{92} & \lambda_{62}\lambda_{92} & \lambda_{72}\lambda_{92} & \lambda_{82}\lambda_{92} & \lambda_{92}^2 + \varepsilon_9^2
\end{bmatrix}$$

Parameters are estimated to minimize the discrepancy function which is between $\hat{\Sigma}$ and the empirical correlation matrix.