Non-Cognitive Skills and
the Economics of Entrepreneurial Decision Making

Marco Caliendo1  Frank Fossen2  Alexander Kritikos3
IZA Bonn          FU Berlin          DIW Berlin

Abstract:
Based on a large, representative German household panel, this paper investigates whether non-cognitive skills influence entrepreneurial decision making, in particular the entry and exit decision, the latter one thus capturing entrepreneurial survival. The analysis reveals that there are some variables that affect the economic decision of becoming an entrepreneur and different ones or different parameter values of the same variable affecting the life span as an entrepreneur. The explanatory power of non-cognitive skills among all observable variables amounts to almost 30%, with risk tolerance, locus of control and openness to experience being overall the most important variables.

JEL classification: D81, J23, M13, L26
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1 Marco Caliendo is Director of Research at the Institute for the Study of Labor (IZA) in Bonn, Research Fellow of the IAB in Nuremberg and Research Affiliate of DIW Berlin, e-mail: caliendo@iza.org.

2 Frank Fossen is Assistant Professor of Economics at Freie Universität Berlin, Research Associate of DIW Berlin and Research Fellow of the IZA, Bonn, e-mail: frank.fossen@fu-berlin.de

3 Alexander Kritikos (corresponding author) is Research Director at the German Institute for Economic Research (DIW Berlin), Professor of Economics at the University of Potsdam and Research Fellow of the IZA, Bonn and of the IAB, Nuremberg, e-mail: akritikos@diw.de. Address. DIW Berlin, 10108 Berlin, Germany. Phone: +49.30.89789.157, Fax: +49.30.89789.104
1 Introduction

Entrepreneurs, often claimed to be important for economic growth and performance (see Schumpeter, 1911, Acs and Audretsch, 2003), are a rare species: in innovation driven economies like the US, Sweden or Germany, only one in ten employed individuals are self-employed and every year typically only 1% to 2% of the total employment population start a new business (see Kelly et al., 2010). Scientists are, therefore, left wondering, whether there are any reliable factors or variables related to the human personality that affect the probability of becoming and of succeeding as an entrepreneur.

Personality variables, traditionally studied by psychologists and incorporated only more recently by economists as non-cognitive skills, are a potential source to explain entrepreneurial status. We know from psychological analysis that the personality is, in general, an important determinant of occupational choices (see e.g. Holland, 1997). Further, there is a large body of empirical evidence revealing that non-cognitive skills are important in explaining entrepreneurship. For instance, Zhao and Seibert (2006) show that entrepreneurs are different when their personality structure is compared to the one of managers.

Given that the personality plays a role when focusing on entrepreneurship, previous research tried to construct an average entrepreneurial profile, but failed to do so, as Aldrich (1999) made clear. He claimed that this kind of research had reached an empirical dead end.\(^4\) In this paper we follow a different approach. In line with Rauch and Frese (2007, p.1) who plea that the “person should be put back into entrepreneurship research”, we analyze to what extent non-cognitive skills influence entrepreneurial decision making at certain points of time. We pick out the two most prominent decisions, namely the entry decision into entrepreneurship and the exit decision from entrepreneurship which in turn is capturing

\(^4\) Claims in a similar direction were made by Blanchflower and Oswald (1998) who conclude that “psychology apparently does not play a key role” and by Gartner (1988) who explained that it is the wrong question to ask “who is an entrepreneur”.
entrepreneurial survival. By doing so we are able to contribute to the questions of how personality influences the selection into entrepreneurship as well as the subsequent survival in entrepreneurship where survival can be used as a proxy for entrepreneurial success.

Our approach allows the addressing of another central debate as well: which set of personality variables is relevant: fundamental traits or specific personality characteristics? Zhao and Seibert (2006), for instance, advocate that general personality traits, in particular the Big Five construct, for reasons of reliability and validity are better able to identify the relevant relationships between personality and entrepreneurial processes than more specific personality characteristics. However, there are also those arguing that this general traits approach is not sufficiently related to entrepreneurial tasks (Dudley et al., 2006). As Barrick and Mount (2005, p. 367) point out, specific “traits rely on explicit description of entrepreneurial activities that may be situated in time, place and role,” which is why specific personality characteristics are more useful in predicting entrepreneurial performance than the Big Five.

Risk attitudes – being the most often studied specific personality characteristic, at least in economic sciences in this context – serve as an example of the debate. Research finds that entrepreneurs seem to be more risk tolerant than employed persons (Hartog et al., 2002) or managers (Stewart and Roth, 2001) and that the decision to become an entrepreneur is positively related with an increased willingness to take risks (Caliendo et al., 2009). Other researchers agree with these findings, but believe that it is not necessary to explicitly examine risk tolerance as it is a compound personality characteristic reflected by a specific combination of scores within the Big Five personality construct (see for instance Nicholson et al., 2005). In contrast, Paunonen and Ashton (2001) suggest that risk attitudes form a separate dimension of personality outside of the Big Five. Thus, while personality is assigned a crucial role to explain entrepreneurship, there is conflicting evidence whether personality is best measured in terms of fundamental traits or whether specific personality characteristics should
be used in the context of entrepreneurship. As we have information on both kinds of personality variables, we are able to provide a first answer on this question.

For our analysis we make use of a unique data set, the German Socio-Economic Panel (GSOEP). In this annual panel more than 20,000 individuals are surveyed and are asked various questions about their socio-economic situation and for some years also about their personality, eliciting both the Big Five traits and several specific personality characteristics. We differentiate throughout the rest of the paper between the Big Five model, which we will abbreviate as ‘traits’, and ‘personality characteristics’, which are related to entrepreneurial activities. We test to what extent all non-cognitive skills, which we describe (similar to Borghans et al, 2008) as personality variables (being the sum of all observed traits and personality characteristics), have a statistical and economic impact on entrepreneurial decision making and we provide information on their explanatory power for entrepreneurship. When conducting these tests, we are able to control not only for a large set of socio-demographic characteristics but also for cognitive skills. We further make various robustness checks.

We show that personality variables are important. The explanatory power of all observed personality variables amounts to 30% among all observed variables and is comparable to prominent determinants of entrepreneurship like age, work experience and education together. Interestingly, factors of the Big Five approach rather influence the entry decision, while specific personality characteristics add substantial information also to the exit decision.

The rest of the paper is organized as follows. Based on existing heuristics and empirical evidence we present in Section 2 several hypotheses how traits and personality characteristics may influence entrepreneurial decision making. In Section 3, we describe the representative data used in our analysis. Section 4 is devoted to the econometric approach and the presentation of the results as well as of several sensitivity tests and robustness checks. Section 5 provides a discussion based on the presented hypotheses. Section 6 concludes the analysis.
2 Personality and Entrepreneurial Status: Theory and Evidence

2.1 Personality Variables and Their Relation to Entrepreneurial Activities

Similar to earlier research (see e.g. Brandstätter, 1997), we define those persons as entrepreneurs who are (mostly) the founders, owners and managers of a business under their own liability. In these mostly small firms success depends on the decisions made by the entrepreneur (Van Gelderen et al. 2000). Decisions are driven by the strategies and goals of the entrepreneurs that are directly influenced by traits and other variables such as human capital and cognitive abilities. Personality theory generally suggests that the influence of personality variables on entrepreneurial success is mediated by the strategies and goals of the decision maker (see e.g. Baum and Locke, 2004). In order to identify which traits and personality characteristics may influence entrepreneurship, we discuss what kind of tasks entrepreneurs face and how personality variables influence the accomplishment of such tasks.

Entrepreneurs should be able to produce a good or service that involves some form of innovation. However, entrepreneurs must do more: the decisions they make, at every step of the process, will determine whether their new business succeeds or fails. These steps range from the basic quality and quantity of production, determining investments in the business, its marketing strategy, understanding the competition and, ultimately, delivery of the goods or service to the end user: the client that the entrepreneur has successfully sold their product to. Thus, entrepreneurs need to do many things, or, as Lazear (2004) notes, they need to be “jacks-of-all-trades”. Entrepreneurs need to be able to identify and exploit opportunities. In this process entrepreneurs make a large number of sometimes rapid decisions under risk or uncertainty. And once decisions are made, they need to be able to tolerate risk – the uncertain situation existing until the goods and services are actually sold. Thus entrepreneurs need not just knowledge, expertise and professional competencies, but also a variety of skills and abilities that are influenced by personality characteristics. Besides these internal variables, external factors, including economic, specific sector related issues, governmental regulation, and political events, influence the entrepreneur’s business goals and success. According to this heuristic, all influences of traits and personality characteristics, and other internal and
external influences on entrepreneurial success, are mediated by entrepreneurial decisions and actions (see e.g. Baum and Locke, 2004).\(^5\)

Therefore, we need to select the traits and characteristics that influence entrepreneurial decision making (Tett et al., 2003). This means that personality characteristics related to entrepreneurial tasks need to be identified in order to be able to estimate the true effects of personality on entrepreneurship. Typical examples of personality characteristics matching entrepreneurial tasks are, \textit{inter alia}, locus of control (Rotter, 1966) or need for autonomy (Brandstätter, 1997). In the following Section, we conceptualize the links between traits, personality characteristics, and the decision for a business start-up and entrepreneurial survival. Based on previous research, we derive, for each trait and personality characteristic, expectations about its influences on the probability to decide to start an own business, the probability of business survival and on the probability to be an entrepreneur.\(^6\)

\section*{2.2 The Broad Approach: The Five-Factor Model of Personality}

One way of matching traits with the tasks of running a business is to use the Big Five taxonomy, as developed by Costa and McCrae (1992), which organizes a vast variety of personality traits into a concise personality construct. We shortly describe how each of the five factors, named \textit{extraversion}, \textit{emotional stability}, \textit{agreeableness}, \textit{openness to experience}, and \textit{conscientiousness}, relate to entrepreneurial decision making and derive hypotheses mostly in line with previous research of Ciavarella et al. (2004) and Zhao and Seibert (2006).

The first factor, \textit{extraversion}, consists of variables that describe the extent that individuals are assertive, dominant, ambitious, energetic, and seek leadership roles (see Judge et al., 1999). Moreover, extraverted individuals tend to be sociable, thus enabling them to develop social networks more easily, which may result in stronger partnerships with clients and suppliers. All parts of the factor – being assertive, seeking leadership and developing networks – are positively related to entrepreneurial development in terms of the entry decision

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\(^5\) Another strand of literature focuses on the influence of cognitive skills on entrepreneurial decisions (see e.g., Baron, 1998, 2004, or Hartog et al., 2008). In our analysis, we also control for cognitive skills.

\(^6\) In this context, we should clarify that exits from entrepreneurship comprise both business failure and business closure (see also Bates, 2005).
and in terms of entrepreneurial success. This holds true for different roles, both internally when building teams and assigning responsibilities, and externally when client and supplier networks have to be developed (see Costa et al., 1984). Therefore, we hypothesize (H1a) that the higher individuals score on extraversion, the higher the probability (i) that they will decide to become an entrepreneur, (ii) of a longer life span as an entrepreneur, (iii) that they will be an entrepreneur.

The second factor, emotional stability, or neuroticism in its negative specification, should have similar effects on entrepreneurship. Emotionally stable individuals are characterized as self-confident, relaxed, and able to tolerate stressful situations (see Jugde et al., 1999). They can manage day-to-day performance pressure, remain optimistic and maintain relationships toward others (Hurtz and Donovan, 2000). At the beginning of the process, individuals in entrepreneurial environments must manage stress and uncertainty while working in an unstructured environment with uncertain outcomes. Moreover, entrepreneurs usually have personal and financial stakes in the enterprise. Being stress resistant is helpful for bearing uncertainty. Therefore, we hypothesize (H1b) that the higher individuals score on emotional stability, the higher the probability (i) that they will decide to become an entrepreneur, (ii) of a longer life span as an entrepreneur, (iii) that they will be an entrepreneur.

The third factor is openness to experience. Openness to experience describes an individual’s ability to seek new experiences and explore novel ideas. Persons scoring high on this factor should be creative, innovative, and curious (McCrae, 1987). Furthermore, this factor contains cognitive aspects (see Barrick and Mount, 1991). Persons scoring high on this factor should be intelligent, in particular when intelligence is related to their originality and broad-mindedness. The attributes of exploring new ideas, being creative and taking novel approaches to the complete entrepreneurial process are crucial for starting a new venture and should have a positive influence on the entry decision to entrepreneurship. With respect to survival there are less clear expectations. On the one hand, entrepreneurs should be constantly open for changing markets, which is why this factor could influence entrepreneurial survival in a positive way (see Ciavarella et al., 2004). On the other hand, it can be argued that after the entry period a calm manager is more necessary than a creative entrepreneur (see
Sarasvathy, 2004). We hypothesize (H1c) that the higher individuals score on openness to experience, the higher the probability (i) that they will decide to become an entrepreneur, and (ii) that they will be an entrepreneur. However, we also expect that openness to experience has no influence on the life span as an entrepreneur.

*Conscientiousness* contains two components. On the one hand, conscientious individuals are achievement oriented; on the other hand they can be described as hard workers, efficient and dutiful. Need for achievement expresses the motivation of individuals to search for new and better solutions than those given in the actual environment (see McClelland 1961). It is expected that achievement oriented persons will become successful entrepreneurs. With respect to the other aspects of this factor, being a hard worker or being dutiful, there is less awareness in the entrepreneurship literature. There are considerations that entrepreneurs have to work harder than most employees (see Barrick and Mount, 1991) while, with respect to dutifulness, it is negatively linked to entrepreneurial development (see Rauch and Frese, 2007). Thus, there are two contradictory effects within the construct of conscientiousness. When is not possible to sufficiently separate between the aspects of this factor (which is the case for our data), (H1d) conscientiousness should not influence entrepreneurial decisions.

Persons scoring high on *agreeableness* are described as having a forgiving and trusting nature, as being altruistic and flexible. High values of agreeableness suggest that individuals are cooperative, while low values indicate self-centered and hard bargaining individuals. With respect to entrepreneurship both extremes of this factor seem to have positive and negative effects on starting a business. With respect to survival, high ends of agreeableness relate to interpersonal reactivity and should help to develop positive relationships with clients, suppliers, and investors, which is why high scores on agreeableness could increase the probability of entrepreneurial survival (see Ciavarella et al., 2004). On the other hand, it is argued that there are negative effects on survival if entrepreneurs show high levels of agreeableness as it might inhibit their bargaining abilities. Zhao and Seibert (2006) expect entrepreneurs to suffer more from bargaining disadvantages than managers, which is why they (similar to Chell, et al., 1991 and to Schmitt-Rodermund, 2004) hypothesize that lower scores in agreeableness should increase entrepreneurial survival. Therefore, we hypothesize (H1e)
that (i) differing scores in agreeableness do not influence the entry decision, (ii) but that the lower individuals score on agreeableness the higher the probability of a longer life span as an entrepreneur.

A growing body of evidence suggests that entrepreneurs differ from employees and managers with regard to the Big Five. For instance, Brandstaetter (1997) finds differences for emotional stability, Herrmann (1989) for extraversion, Howard et al. (1996) for agreeableness and openness for experience, Jackson (1994) for conscientiousness. The most related study to the present approach is the meta-analytical review of Zhao and Seibert (2006). They put together a large set of single variable studies capturing the “Big Five” personality construct and analyze to what extent entrepreneurs differ from managers in these personality dimensions. They find that distinctions exist for four of the five personality factors. In accordance with their hypotheses, entrepreneurs score significantly higher than managers on conscientiousness, openness to experience, emotional stability and lower on agreeableness. Interestingly, Zhao and Seibert (2006, p. 266) conclude that “exploring the role of narrow traits in the attainment of entrepreneurial status may be a productive avenue for future research. But to add theoretical value, the burden of proof is to demonstrate that the narrow traits explain variance beyond the Big Five approach”.

2.3 Specific Personality Characteristics in the Context of Entrepreneurship

Proponents of the specific personality characteristics approach argue that some of the Big Five factors include sub-factors with contradicting effects, resulting in information lost for individual personality traits. The examples given above, with respect to conscientiousness and agreeableness, illustrate the extent that the effects of sub-factors may cancel each other out. Further discussions exist to what extent the Big Five factors are able to capture all personality characteristics relevant for entrepreneurship. Therefore, inter alia, Vinchur et al. (1998) argue

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7 Schmitt-Rodermund (2004) finds e.g. similar results on a data set based on the “Terman Life Cycle Study”.
8 Ciavarella et al. (2004) analyze the relationship between personality and venture survival. They find that among the Big Five taxonomy conscientiousness positively influences and openness to experience negatively influences the probability of venture survival. However, their analysis is based on a very small sample and on an ex-post measure of the Big Five factors once the survival of the venture was determined. Thus, the study faces severe limitations.
that specific characteristics exactly matching the entrepreneurial personality are better predictors than broad trait taxonomies.

Accordingly, there is a list of specific personality characteristics related to the tasks of entrepreneurial activities (see *inter alia* Rauch and Frese, 2007). In our data set, we have information on several specific personality characteristics; among them the two most often reviewed variables, namely *locus of control* and *risk attitudes.*

*Locus of control* (based on a concept of Rotter, 1966) measures generalized expectations about internal and external control of reinforcement. People with an internal locus of control believe that they determine their future outcomes through their own actions. Persons with an external locus of control believe that their future outcomes in terms of success and failure are determined randomly or by the external environment, but not by their own actions. As entrepreneurs must continuously make decisions related to their business outcomes, it is assumed that locus of control is a highly relevant personality characteristic for all entrepreneurial states. This is confirmed by empirical research: Begley and Boyd (1987), Evans and Leighton (1989), Bonnet and Furnham (1991), and Mueller and Thomas (2000) deliver evidence that there is a positive relationship between internal locus of control and entrepreneurial status.

We hypothesize (H2a) that the higher (lower) individuals score on internal (external) locus of control the higher the probability (i) that they will decide to become an entrepreneur, (ii) of a longer life span as an entrepreneur, (iii) that they will be an entrepreneur.

Every entrepreneurial decision includes risk taking. As the outcome of each investment is unpredictable, related decisions are risky. Therefore, there is no unidirectional relationship between *risk attitudes* and entrepreneurial survival. While it is expected that risk attitudes positively influence the decision to become an entrepreneur (see *inter alia* Cramer et al., 2002; Caliendo et al., 2009), the probability of entrepreneurial success is not correlated in a strictly positive way with risk attitudes. Instead, there should be an inverse U-shaped

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9 For a complete list of personality characteristics related to entrepreneurship, see Rauch and Frese (2007).

10 Moreover, Brockhaus (1980) reports significant differences between successful and unsuccessful entrepreneurs with respect to locus of control. And van Praag et al. (2009) report that locus of control, when controlled for education, strongly influences entrepreneurial income and that entrepreneurs with high internal locus of control scores are more successful at generating high incomes than employees.
influence of risk attitudes on entrepreneurial survival as riskier investments should also lead to an increasing probability of large losses with the consequence of bankruptcy and entrepreneurial failure or closure (see Chell et al., 1991). Caliendo et al. (2010) show that individuals with medium risk attitude scores are more likely to remain entrepreneurs than individuals with either low or high scores. Therefore, we hypothesize (H2b) that the higher individuals score on risk attitudes, the higher the probability that they (i) will become an entrepreneur and (ii) be an entrepreneur. Additionally, (iii) among all entrepreneurs those with low or high risk attitudes have a shorter life span as an entrepreneur than persons whose risk attitudes fall within the medium range.

There are several additional variables that have been partly analyzed in the entrepreneurial context. These are, on the one hand, variables of social cognition such as the willingness to trust others and to reciprocate, and variables that deal with emotional aspects of entrepreneurial decisions, such as impatience and impulsivity.

Trust relates to the extent that people believe that they can trust and rely on others, and to what extent they can deal with strangers. Being able to trust other people seems to be an important prerequisite for realizing exchange processes when opening a business. It begins with selecting and delegating tasks to trustworthy persons before the entrepreneurial life starts (Logan, 2009) and turns into trusting other people in a network. We, therefore, suggest that people who are unable to rely on anyone will be less able to successfully start a business (see Caliendo et al., 2011). On the other hand, high levels of trust may also contain the risk of exploitation. Entrepreneurs unboundedly trusting others may face an increasing probability of losses leading with higher probability to entrepreneurial closure or failure when compared to less trustful persons. Thus, we hypothesize (H2c) that high levels of trust will particularly increase the probability to decide to start entrepreneurial activities.

Focusing on impulsivity and impatience, it is important to note that both characteristics are included in the Big Five factor “emotional stability” (Costa and McCrae, 1992). Based on the analysis of the factor “emotional stability” we should expect that both variables are negatively associated with entrepreneurial entry and survival, as they are on the low end of the factor while entrepreneurs should be more successful when they score high on emotional
stability. However, there is initial evidence that impulsivity might positively influence entrepreneurial decisions, in particular when “the risky business opportunity is a hot decision” where emotions influence the decision in contrast to “cold decisions” where emotions do not play any role (Sahakian et al., 2008, p. 168f). Similarly, there is differing evidence with respect to “impatience”. In an occupational choice model, Vereshchagina and Hopenhayn (2009) suggest that entrepreneurial risk taking will only occur if agents are sufficiently impatient and that these two variables are positively correlated. Thus, we hypothesize (H2d) that the probability for an entry decision into entrepreneurial activities should increase the more impulsive and impatient individuals are.

In the context of previous empirical research, we should also highlight the meta-analytical study of Rauch and Frese (2007), who make use of the narrow approach and discuss to what extent entrepreneurs are different from managers in those personality characteristics that are specifically matched to the tasks of entrepreneurship. Without taking the Big Five approach into account, they find that entrepreneurs score higher than managers with respect to the characteristics of innovativeness, stress tolerance, proactive personality, need for autonomy, and – interestingly – lower with respect to locus of control. The lower score of entrepreneurs in locus of control when compared to managers is explained by the fact that this variable might be even more important for managers.11

The empirical studies of both Zhao and Seibert (2006) as well as Rauch and Frese (2007) are important benchmarks in analyzing the influence of traits and personality characteristics on entrepreneurial status. However, although they observe differences between certain populations, they are not able to answer the question of which traits and which personality characteristics influence the decision of individuals to become and remain entrepreneurs when the Big Five approach and further personality characteristics are simultaneously considered.

11 There is a long list of single variable studies where the effect of further specific personality characteristics on entrepreneurial status is studied. Stewart et al. (1998) find differences for the variables achievement motivation and innovativeness between managers and entrepreneurs, Chen et al. (1998) for entrepreneurial self-efficacy, Müller and Gappisch (2005) for problem solving orientation, Koellinger et al. (2007) for overconfidence. As we are not focussing in this study on all personality variables related to entrepreneurial development, we do not review the complete literature with respect to the question where entrepreneurs differ from others.
2.4 The Big Five Approach versus Specific Personality Characteristics

We should also describe how specific personality characteristics could be compound variables within the Big Five construct. The proponents of the Big Five approach argue with respect to the above analyzed specific personality characteristics, that

- risk attitudes are a specific combination of all five factors of the Big Five approach, namely that persons scoring high on risk attitudes, also score high on extraversion, openness to experience, and emotional stability, and low on agreeableness and conscientiousness (see Nicholson et al., 2005);

- internal (external) locus of control are positively (negatively) related to the factors emotional stability (Levenson, 1973) and conscientiousness (DeNeve and Cooper, 1998) and should be covered by them;

- trust is positively correlated with agreeableness and should be covered by this factor (DeNeve and Cooper, 1998);

- impulsivity and impatience are covered by the factor neuroticism, with impulsive and impatient persons scoring low on emotional stability (Costa and McCrae, 1992).

Proponents of the Big Five approach hypothesize (H3) that the above mentioned traits and personality characteristics are correlated as just presented and that no explanatory power is added when these specific characteristics are analyzed in addition to the Big Five factors. As counter-hypothesis (H4) it is stated that explanatory power is added when personality characteristics related to entrepreneurial tasks are analyzed in addition to the Big Five.

Beyond the test of hypotheses H3 and H4 we test in Section 3.3 to what extent the expected correlations (see Table 1) between traits and personality characteristics are observed, providing information about the validity of the empirical measures of all personality variables.

INSERT TABLE 1 ABOUT HERE
3 Data Description

3.1 Representative Household Panel Data

In our analysis we use the German Socio-Economic Panel (SOEP). The SOEP is an annual representative panel survey covering detailed information about the socio-economic situation of about 22,000 individuals living in 12,000 households across Germany. Our analysis draws on ten sequential waves of the SOEP starting in 2000, when the sample was substantially enlarged, through the 2009 wave. Our sample includes individuals between 19 and 59 years of age. Given the statutory retirement age of 65 in Germany, we exclude individuals older than 59 years in order to avoid early retirement issues. We also exclude farmers, civil servants and those currently in education, vocational training or military service as they have a limited occupational choice set or different determinants of occupational choices that could distort our analysis. Family members working for a self-employed relative are also excluded from the sample because they are not entrepreneurs in the sense that they run their own business.

Similarly to earlier studies, we focus on self-employment as an indicator of entrepreneurship. The concept of entrepreneurship partly differs from self-employment, as the former usually implies the risk bearing of innovation, whereas the latter goes along with income risk but not necessarily with technological innovation. Working individuals are classified as self-employed when they report self-employment as their primary activity. A transition into or out of self-employment can be identified in the data when a person is observed in different employment states in two consecutive years, $t$ and $t+1$. Therefore, the observations of 2009 do not enter the estimations of entries and exits, but serve to identify

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12 The SOEP is similar to the PSID (Panel Study of Income Dynamics) in the US and the BHPS (British Household Panel Survey) in the UK. A stable set of core questions appears every year, covering the most essential areas, such as: population and demography; education, training, and qualification; labor market and occupational dynamics; earnings, income, and social security; housing; health; and basic orientation. Other questions - like the ones about personality variables which we will use and describe later on - are asked in rotating intervals. Respondents also provide biographical background information like lifetime work, unemployment experience and parents’ occupation. For a detailed data description, see Wagner et al. (2007).

13 The actual average retirement age in Germany was 63 years in 2004 (Radl, 2007).
transitions in 2008. In the estimation of the probability of being self-employed, the observations of 2009 are included.

3.2 Measurement of Personality Variables

In several survey waves the SOEP included short versions of established psychological personality inventories. This addition allows us to explicitly study traits and personality characteristics and their consequences on a large, representative sample of the population, and to relate them to a rich set of socio-economic variables. Specifically, in 2005 and 2009, the SOEP included identical special personality questionnaires that measured respondent’s Big Five personality factors. In 2005, additional questions measured locus of control and reciprocity. The respondents were asked how much they agreed with different statements about themselves (on 7-point Likert scales). Fifteen items assessed the Big Five personality traits (3 items for each trait), plus internal and external locus of control were measured by 10 items, while 6 items addressed reciprocity. Similarly, in 2003 and 2008, the same respondents answered three questions measuring trust. The survey waves of 2004, 2006, 2008, and 2009 include a question about the general willingness to take risks, using identical wording each year, and the 2008 questionnaire included questions about patience and impulsivity. Table A 1 in the Appendix shows the translated wording of all the statements measuring traits and personality characteristics. We obtain a respondent’s score for a personality characteristic by averaging the scores from the different statements referring to that characteristic. For some items, the scale is inverted (see also Table A 1).

A factor analysis as an ex-post validation of the personality variables confirms that the items used in the analysis load on distinct factors, which generally correspond very well to the Big Five traits and personality characteristics identified ex-ante. This is noteworthy because it shows that the personality characteristics used in addition to the Big Five, such as locus of

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14 The SOEP waves of 2004 and 2009 additionally included a measure of risk attitudes using lottery choices. This paper uses the question about the general willingness to take risks, as this is the only risk question also available in 2006 and 2008. Furthermore, the experiment by Dohmen et al. (2011) showed that this measure performs better than the lottery measure in predicting behavior.

15 Detailed results are available in Table S 1 in the supplementary appendix.
control and trust, are independent variables and are not reflected by the Big Five traits. It is therefore important to add these variables when analyzing the effects of personality on outcomes such as entrepreneurship, instead of relying solely on the Big Five.\textsuperscript{16}

Since we only observe traits and personality characteristics in selected survey waves, we impute a respondent’s answers to the personality questions into the observations of the same respondent in the other survey years, assuming that traits are stable within a few years.\textsuperscript{17} For those traits and personality characteristics that are elicited in more than one survey wave, we impute values from the past where possible. For example, for 2004 through 2007, we impute information on the trust variable from 2003 and not from 2008.\textsuperscript{18}

3.3 Correlations and Validity Checks

We start our empirical analysis with an examination of the observed correlations between the various personality traits and relate them to the hypothesized correlations. Table 2 presents the pair-wise correlation coefficients in the pooled sample for the 2000-2009 waves. The correlation coefficients are shown only if they are significantly different from zero at a significance level of 10%; those also significant at the 1% level are marked with a star. Obviously, almost all personality variables are correlated, but most correlation coefficients are below 0.2 in absolute terms.

\textbf{INSERT TABLE 2 ABOUT HERE}

The signs of the observed correlations confirm 19 out of the 21 hypothesized correlations summarized in Table 1; the correlation between impulsivity and neuroticism has the sign opposite to the expectation, but is weak, and one correlation (risk attitude and

\textsuperscript{16} Only for the ten items intended to measure locus of control the results from the factor analysis are somewhat more mixed. We therefore do not use two of these items (indicated in Table A 1) for the construction of internal and external locus of control. The item “Inborn abilities are more important than any efforts one can make” loads on factor 9, which seems to represent internal locus of control, but we stick with the \textit{ex-ante} concept and use it for external locus of control. We repeated the main estimations without using this item and obtained very similar results (available from the authors on request).

\textsuperscript{17} In fact, the correlation coefficients between the Big Five personality variables in the sample, as measured in 2005 and 2009, are 0.60 for openness, 0.53 for conscientiousness, 0.66 for extraversion, 0.55 for agreeableness, and 0.59 for neuroticism (all are significant at the 1% level). Given these quite high correlations, it seems plausible that the deviations represent (random) noise in the survey response.

\textsuperscript{18} Section 4.4 further assesses the stability of personality traits for entrepreneurs.
conscientiousness) is not significant at the 10% level. This also means that almost all relevant correlations between the Big Five and specific personality characteristics (Section 2.4) are confirmed, thus, increasing the confidence that the measures of all personality variables available in the data are closely related to the theoretical concepts.

This finding is important from another point of view. For instance, for risk tolerance four out of the five hypothesized correlations are observed, confirming the expectations of Nicholson et al. (2005). As mentioned in the introduction, literature finds a positive effect of risk tolerance on entrepreneurial choice. As the Big Five construct is unobserved in these studies, it is possible that the estimated effect of risk tolerance is spurious and actually reflects effects of the omitted personality traits. By controlling for the Big Five in our estimation, we will show that risk tolerance has an effect on entrepreneurship (see Section 4.2).

Another result should be highlighted: the trust variable has low correlation coefficients to other variables, making clear that having additional information on this variable might be important. The overall correlation matrix suggests however, that all personality variables used in this study measure concepts that are correlated but clearly distinct, allowing for the conclusion that, a priori, all variables should be included in the analysis of entrepreneurship.

3.4 Group Means of Personality Variables

Table 3 shows the weighted means of the personality traits before standardization for the full sample and by employment state, based on the pooled sample. We conducted \( t \)-tests of equal means in the sub-samples of the self-employed and those not self-employed. Stars in the column for the self-employed indicate the results of the tests. For most traits and personality characteristics we find significant differences.

19 A new result in this context is that individuals tending to external locus of control also trust other people less.

20 We conducted additional tests on the validity and on the internal consistency of the questionnaire, e.g. by analysing correlations between the single items behind the personality variables, by analyzing correlations between the Big Five factors confirming hypotheses of Digman (1997), and also by relating personality variables to other information available in the SOEP such as the number of friends. All tests show that the questionnaire is valid and internally consistent. The tests are available from the authors on request.

21 Table A 2 in the Appendix provides the definitions of the variables.
The results show that, compared to others, the self-employed are more risk-tolerant. Concerning the Big Five, the self-employed have higher average scores in openness and extraversion, and lower scores in agreeableness and neuroticism, than the full sample. They also exhibit a higher internal and a lower external locus of control, score higher on trust, and are less patient and more impulsive than the remainder of the population.

The means of the socio-demographic variables confirm known facts. The share of women among the self-employed is low; self-employed are more likely to have a university degree in comparison to the full sample and a higher share of them had a self-employed father at the age of 15. The self-employed have less prior unemployment experience\(^{22}\) and receive much higher real income from interests, dividends, and house rents on average, indicating greater financial wealth. These differences highlight the importance of controlling for these variables in order to identify the partial effects of traits and personality characteristics, *ceteris paribus*.

4 Empirical Results

4.1 Econometric Approach

We model the probabilities of transition into and out of self-employment as discrete time hazard rate models. We use annual data because interviews occur once a year and the covariates are not available for higher frequencies. The probability of entry into self-employment is estimated conditional on the tenure in dependent employment or the duration of non-employment, based on the sample of those in dependent employment and those not working. The probability of exit from self-employment is estimated conditional on the duration of the current spell in self-employment, based on the sample of the self-employed.

Applying discrete time hazard rate models allows consistently taking into account state dependence and avoids survivorship bias. The estimation equation is a logit model of the transition probability conditional on the duration of the current state, estimated on the data in person-year format (cf. Jenkins, 1995; Caliendo et al., 2010). The baseline hazard, which

\(^{22}\) To avoid endogeneity, work experience (in decades) and unemployment experience (in years) accumulate until the year before the observation year. We use retrospective information about a respondents’ employment history to recover the work and unemployment experience before the respondent enters the panel.
captures duration dependence, is specified flexibly as a third degree polynomial of the duration in the current state. In the model of exit from self-employment, we expect the probability of exit to be high in the first years of self-employment and to decline with longer duration, after initial hurdles are passed (Caliendo et al., 2010). The model of entry into self-employment allows the baseline hazards to differ between those in dependent employment and those not working. This is achieved by an interaction of the variables capturing the spell duration with a dummy variable indicating the current state. For example, for those in dependent employment, the probability of switching to self-employment may decrease with tenure. Apart from the duration in the current state, we include the personality variables described in Section 3.2 and known determinants of entrepreneurship (e.g. Parker, 2009) as additional control variables, which we list in Table A 2.23

The interplay between entry and exit rates determines the stock of self-employment. Therefore, we also estimate a logit model of the probability of being self-employed, based on the full sample of the self-employed, those in dependent employment and those not working. We use the same vector of explanatory variables as in the transition models, excluding tenure, which would be endogenous in this model. In all estimations, we report standard errors robust to heteroscedasticity and correlation between repeated observations of the same individuals in different years (clusters).

4.2 Main Estimation Results

Table 4 presents the estimated marginal effects for the personality variables on the yearly transition probabilities into and out of self-employment and on the probability of being self-employed. For each of these three outcomes, two specifications are displayed. Besides the control variables, specification A includes the Big Five personality dimensions only; the other contains all the personality variables (specification B). Given that Caliendo et al. (2010) find a U-shaped relationship between risk tolerance and the probability of exit from self-

23 These are: age, prior working experience and prior unemployment experience, the number of children, real income from interests, dividends, and rents as an indicator of wealth, and dummy variables indicating gender, educational degrees, disability, German nationality, marital status, geographical region, and whether the father was self-employed when the respondent was 15 years old.
employment, risk tolerance enters the models in linear and square terms, which allows for nonlinearity. For the other traits and personality characteristics we estimate linear approximations.\textsuperscript{24} We standardize all personality variables (except for risk tolerance because of the nonlinearity) by subtracting the variable’s mean and dividing by its standard deviation. This facilitates interpretation of their effects: The marginal effects, evaluated at the mean values of the explanatory variables, indicate the change in the probability of entry, exit, or self-employment that is induced if a variable’s value increases by one standard deviation. The means of the outcome variables are shown at the bottom of the table.\textsuperscript{25}

**INSERT TABLE 4 ABOUT HERE**

We observe that personality variables matter for the transitions probabilities, having controlled for the known socio-demographic determinants of self-employment. Furthermore, the Big Five traits do not seem to capture all relevant personality variables: some specific personality characteristics in specification B have significant partial effects. Therefore, we prefer specification B with the full set of personality variables over specification A.\textsuperscript{26}

We first focus on the effects of the Big Five construct. Openness to experience has a positive and significant effect on the entry probability. Increasing openness by one standard deviation increases the yearly probability of entry by 0.14 percentage points, corresponding to a relative effect of 12.4%, given the entry rate of 1.13% per year. The effect of the entry probability explains the significantly positive partial effect on the probability of being self-employed. Increasing openness to experience by one standard deviation raises the self-employment probability by 1.51 percentage points. Given a self-employment rate in the sample of 8.74%, this corresponds to a relative effect of 17.3%.

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\textsuperscript{24} We test including additional squared terms for all the linearly significant personality variables. All these squared terms are insignificant and are thus dropped from the final specifications.  
\textsuperscript{25} Table S 2 in the supplementary appendix provides the logit coefficients, including those of the control variables. In the transition models only observations from 2000-08 can be included, such that we have fewer observations than shown in Table 3 (which also includes observations from 2009).  
\textsuperscript{26} Based on Akaike’s (1973) information criterion \textit{a posteriori} one would prefer the specification including the Big Five, risk attitudes, locus of control, reciprocity and trust in the models of entry and of being self-employed, whereas reciprocity and trust would be dropped in the exit model. The Bayesian information criterion BIC (Schwarz, 1978) penalizes model complexity more than the AIC and favors more parsimonious specifications.
Extraversion exerts the second largest positive influence on the self-employment probability among the Big Five. An increase by one standard deviation significantly raises the probability of being self-employed by 0.62 percentage points, or 7.1%. Again this is explained by a positive and significant effect on the entry probability of 0.06 percentage points or 5.3%.

Neuroticism does not significantly affect self-employment or the transitions, except for a small negative effect on entry in specification A. Once we include risk attitudes, neuroticism is no longer significant. As the two variables are negatively correlated (see Table 2), this indicates that the effect of neuroticism in specification A captures the effect of risk tolerance. Conscientiousness has no significant effect at all. Furthermore, it is remarkable that just one Big Five factor influences the probability of exit: agreeableness is the only factor significantly increasing the exit probability from self-employment. Increasing agreeableness by one standard deviation raises the yearly probability of exit by 1.1 percentage points, which corresponds to 11.1% relative to the exit rate of 9.4% of the self-employed per year.

Turning to the partial effects of the specific personality characteristics included in specification B, we observe that the level and square terms of risk tolerance are jointly significant at least at the 5% level in all models reported in Table 4. After controlling for the Big Five dimensions, it is clear that risk tolerance stands apart as a separate dimension of personality. The nonlinear effect of risk tolerance cannot be read directly from the table. Instead, we use the estimated logit coefficients to predict the probabilities of self-employment and entry and exit at all possible values of risk tolerance on the scale from 0 to 10 and at the mean values of the other explanatory variables, including the duration of the current employment spell in the entry and exit models. Figure 1 depicts the results, each line representing one of the outcome variables. Both the self-employment probability and the annual probability of entry increase with higher risk tolerance at increasing rates confirming earlier results (Van Praag and Cramer, 2001; Hartog et al., 2002; Caliendo et al., 2009).

The relationship between risk tolerance and the probability of exit from self-employment is U-shaped, as reported by Caliendo et al. (2010). Entrepreneurs within a medium range of risk tolerance have the highest survival probabilities. An explanation is that entrepreneurs who are excessively risk tolerant engage in risky projects with higher failure rates, whereas
too low risk tolerance leads to low expected returns from low-risk projects and makes self-employment unattractive in comparison to dependent employment.

**Figure 1: Estimated probabilities of self-employment and transitions conditional on risk tolerance**

A more internal and less external locus of control significantly increase the probability of self-employment, as Table 4 further shows. This is consistent with expectations and previous results, e.g. results of Begley and Boyd (1987), Evans and Leighton (1989), or van Praag et al. (2009) using US data. Quantitatively, an increase in internal (external) locus of control by one standard deviation raises (lowers) the self-employment probability by 1.36 (1.0) percentage points, which corresponds to a relative effect of 15.6% (-11.4%). The effects of an internal or external locus of control on self-employment are explained by the effects on entry, while there are – as we show in Section 4.4 – only in some specifications significant effects on survival. It should be emphasized that these statistically and economically relevant effects of locus of control prevail (similarly to the effect of risk tolerance) after controlling for the Big Five.

Trust is found to significantly increase the entry probability. An increase in trust by one standard deviation increases the probability of entry by 0.07 percentage points, which corresponds to a relative effect of 6.2%. Caliendo et al. (2011), who focus on the influence of trust on self-employment without controlling for other personality variables, report that trust
increases the entry probability by 7%, which is not significantly different. Neither our analysis nor Caliendo et al. (2011) find any further significant effects of trust.\textsuperscript{27}

Patience and impulsivity do not exert significant effects in these specifications. This may be surprising, given that both economic (Vereshchagina and Hopenhayn, 2009) and psychological (e.g. Sahakian et al., 2008) research suggest links between these variables and entrepreneurship. As we are measuring the partial effects after having controlled for the Big Five, an explanation is that patience and impulsivity are nearly collinear with the Big Five.

The estimated coefficients of the control variables are consistent with prior research.\textsuperscript{28} Women have a significantly lower probability of becoming and being self-employed, and they have a higher exit probability (see also Fairlie and Robb, 2009). Controlling for differences in risk tolerance (in specification B) diminishes the gender effects on self-employment state and entry, which shows that gender differences in risk tolerance explain part of the gender gap in self-employment. Individuals who had a self-employed father are significantly more likely to become and to be self-employed (e.g. Dunn and Holtz-Eakin, 2000). Higher capital income significantly increases the probability of entry and of being self-employed, which may indicate the presence of borrowing constraints (e.g. Evans and Jovanovic, 1989; Hurst and Lusardi, 2004), especially in specification B, which controls for differences in risk tolerance. In the hazard rate models of entry and exit, the coefficients of the polynomial terms describing the duration in the current employment state are jointly significant showing that duration dependence plays a role in the decision to switch state. In the entry model, the results also show that the baseline hazard of entry differs between employees and those not working. This is reflected in the joint significance of the interaction terms between the spell duration terms and the dummy variable indicating non-employment.\textsuperscript{29}

\textsuperscript{27} Positive reciprocity is found to have a small, but significant negative partial effect on the probability of self-employment. This effect is not robust, however: Positive reciprocity becomes significant only when the Big Five are also included, but it is insignificant without these regressors, as shown in Table S 4 in the supplementary appendix. This explains the insignificance of positive reciprocity in the study of Caliendo et al. (2011), which did not include the Big Five.

\textsuperscript{28} See Table S 2 in the supplementary appendix.

\textsuperscript{29} As an additional variable, we considered optimism. The SOEP waves 2005 and 2009 included the following question: “When you think about the future, are you optimistic, more optimistic than pessimistic, more pessimistic than optimistic, pessimistic?” Answers to this question reflect a mix of a respondent’s optimistic
4.3 Explanatory Contributions of the Personality Variables

In this section, we analyze how much traits and personality characteristics add to the explanation of self-employment and of entries and exits beyond what is already explained by the conventional socio-demographic variables. Furthermore, we assess if including the Big Five construct is sufficient to capture the influence of personality, or if the specific personality characteristics significantly contribute to the explanatory power of the models.

A goodness-of-fit measure commonly used for binary response models, such as the logit model, is McFadden’s (1974) pseudo-$R^2$. Like the usual $R^2$ in OLS regression, it lies between 0 and 1, and a higher value indicates a better fit.\(^{30}\) Table 5 shows the pseudo-$R^2$ statistics for the models of the probabilities of being self-employed (top panel), entry (below), and exit (bottom panel). The columns refer to the specifications including different sets of explanatory variables. The leftmost column (1) refers to the model including year dummies only and the next column (2) additionally includes a small set of socio-economic control variables.\(^{31}\) In the exit and entry models, in this column, we also add the duration in the current employment state. In columns (3)-(5) we subsequently add (i) age and age squared, together with prior work experience; (ii) the education dummy variables; and (iii) the dummy variable indicating a self-employed father. Next, the Big Five construct is added (specification A) in column (6), and then step by step the specific personality characteristics are included, until we arrive at the full models in the rightmost column (specification B).\(^{32}\) Below the pseudo-$R^2$, Table 5 shows an index where the pseudo-$R^2$ achieved with the full model is normalized to 100%.\(^{33}\)

nature and his or her objective future prospects, which makes the interpretation difficult. When we include “optimism” with a score from 1 (pessimistic) to 4 (optimistic) in our probability models of self-employment, entry, and exit, in addition to the other personality variables, its coefficients are insignificant in all models, so it could be dropped from the final specifications. The insignificance is consistent with the view that the concept of optimism as a personality characteristic is fully described by the Big Five dimensions.\(^{30}\) Results are qualitatively similar when other pseudo-$R^2$ statistics (McKelvey and Zavoina’s $R^2$ or Efron’s $R^2$) are used (the results are available from the authors on request).\(^{31}\) These are: the number of children, real income from interests, dividends, and rents as an indicator of wealth, years of prior unemployment experience, and dummy variables indicating gender, disability, German nationality, marital status, and geographical region.\(^{32}\) The estimated logit coefficients of the personality variables in the corresponding models for self-employment status appear in Table S 3 in the supplementary appendix.\(^{33}\) The pseudo-$R^2$’s are not very large, even in the full models, as is typical in microdata applications. Obviously, most of an individual’s circumstances that induce him or her to be, become, or give up self-employment, such as specific business opportunities, are unobserved. This does not invalidate the identification of the partial effects of the observed variables, many of which are shown to be significant.
The row below this index provides the difference in the index between two adjacent columns. This difference may be interpreted as an approximation of the share in the full model’s explanatory power that is provided by the variables added in this column.

**INSERT TABLE 5 ABOUT HERE**

The results indicate that the personality variables add a remarkable share of what the full model explains. In the model of the probability of being self-employed, all personality variables together contribute 29.2% to the full model’s explanatory power. The Big Five personality dimensions contribute 13.9%. The explanatory power of the personality characteristics is comparable to the most prominent determinants of entrepreneurship put together: age and prior work experience (both represented by linear and square terms) contribute 15.8% to the full model’s explanatory power, and education (represented by four dummy variables for educational attainment) contributes 17.9%. In contrast to this, to have a self-employed father, which received much attention in the literature (e.g. Dunn and Holtz-Eakin, 2000), contributes only 4.0% to the explanatory power of the full model. Note that when sequentially adding variables, the variable indicating a self-employed father is included in the model before controlling for any personality variables.

If the Big Five dimensions completely described the relevant personality, adding specific personality characteristics should not further improve the model. Risk attitudes and locus of control, however, add more additional information to the model’s explanatory power than the complete Big Five approach (7.9% and 7.0%). Having controlled for all these variables, adding trust, reciprocity, patience, and impulsivity only marginally improves the pseudo-$R^2$.

In the models of entry and exit, the share that the personality variables contribute to the full model’s explanatory power is smaller than in the model of being self-employed. One reason is that the control variables in the transition models include a polynomial of the

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34 Openness to experience accounts for about three quarters of the explanatory power of the Big Five, and extraversion for most of the rest.
35 Previous research expected that a self-employed father explains much of what the personality variables are able to explain, because offspring of a self-employed father might develop a personality inclining towards entrepreneurship during childhood.
duration in the current employment state explaining a large part of the transition probability. In the entry model, all personality variables together explain 20.6% of what the full model explains. In the exit model, all personality variables sum up to 7.6. Again, in the transition models trust, reciprocity, patience, and impulsivity increase the pseudo-$R^2$ only marginally.

As the personality variables are correlated (see Section 3.3), the increase in the pseudo-$R^2$ when an explanatory variable is added may depend on the sequence of addition. To explore the sensitivity of the results, we repeat this section’s exercise inverting the ordering of the personality variables. The results confirm that among the personality variables, the Big Five, risk tolerance, and locus of control have the strongest explanatory power.\textsuperscript{36}

We repeat the analysis (in the original order) using the single items from the questionnaires instead of the aggregated personality variables in the logit estimations to assess how much explanatory power is lost due to aggregating. The pseudo-$R^2$ for the full model becomes somewhat higher, which is not surprising, as more information is used when the scores from the items are included separately instead of aggregating them.\textsuperscript{37} The results with respect to the importance of the sets of the personality variable do not change.

4.4 Additional Regressions and Robustness Checks

In order to check the robustness of our results and to gain further insights into the mechanisms at play, we run extensive sensitivity analyses that we report here. First, we systematically assess whether the results from section 4.2 change if the various personality variables are included in separate regressions. To do so we estimate 14 additional specifications, each including only one of the personality variables and the socio-economic control variables.\textsuperscript{38} Most of those personality variables, which are significant when included jointly with the other personality variables, are still significant when included separately, and vice versa. Variables significant in both approaches never change sign; their coefficients are almost always larger

\textsuperscript{36} Table S 4 in the supplementary appendix shows the corresponding logit coefficients, and Table S 5 the resulting pseudo-$R^2$.
\textsuperscript{37} See Table S 6 in the supplementary appendix for the pseudo-$R^2$ and Table S 7 for the logit coefficients of these single items.
\textsuperscript{38} Table S 8 in the supplementary appendix shows logit coefficients from these separate regressions.
when included separately, which suggests that omitting the other personality variables introduces positive bias. Two variables are significant only when included separately, neuroticism with negative and impulsivity with positive effects on entry and self-employment status. This highlights the importance of analyzing the fundamental traits jointly to derive their partial effects, *ceteris paribus*.39

We also test whether the estimated effects of some personality variables are potentially driven by their correlation with cognitive ability. We use the results from a symbol correspondence test (SCT) administered in 2006 as a measure of cognitive ability.40 It is available for only 20% of the full estimation sample, which is why we exclude the measure of cognitive ability from the main analysis. When re-estimating the model of being self-employed controlling for cognitive ability, we find that the point estimate (and also the marginal effect) is almost zero and insignificant. Most of the personality variables significant before remain significant.41

Another important issue is the question whether personality variables are stable. So far we implicitly assumed that the personality variables observed are constant, at least over the relatively short observation period of up to ten years.42 If personality traits change non-randomly over shorter time intervals, and the changes are correlated with self-employment status or transitions, issues of reverse causality may arise. We tested if transitions into or out of self-employment between repeated interviews induced changes in the personality traits and we find that this is predominantly not the case.43 The only exception is that exit from self-employment significantly increases the level of neuroticism. Therefore one must be cautious with any causal interpretation of the effect of neuroticism in estimations of the probability of exit. As neuroticism was insignificant in our estimations of exit our analysis remains valid.

39 Positive and negative reciprocity are significant only when included jointly with the other personality variables, which is consistent with the observation reported before.
40 The SCT in the SOEP mimics the symbol-digit-modalities-test of Smith (1995). The test corresponds to one of the non-verbal modules of the Wechsler Adult Intelligence Scale (WAIS), which is one of the most often-used intelligence tests (Tewes, 1991).
41 See Table S 9 (Spec. B3) in the supplementary appendix.
42 Psychologists argue that, in particular, personality traits covered by the Big Five approach are stable over lifetimes (see inter alia Caspi et al., 2005). Similarly, Borghans et al., (2008) conclude in their paper that traits are stable across situations and certain time periods.
43 The tests are available from the authors on request.
To further analyze the sensitivity of the results, we estimate a number of variants of the main specification B as discussed in Section 4.2.\textsuperscript{44} Even though reverse causality seems highly unlikely given the tests reported before, we further assess if potential reverse causality influences the results by exclusively using forward measures of personality variables. We estimate the self-employment probability model (i) based on the last cross-section available, 2009, only, and (ii) based on the sample limited to 2005-09 (excluding outcomes observed before the Big Five, locus of control, and reciprocity were initially measured, in 2005) and only using the Big Five observed in 2005, risk attitude observed in 2004 and 2003’s trust, while excluding impatience and impulsivity altogether, because these are never observed before 2008. Thus, in these two specifications no personality variable is observed after the outcome is measured. The estimated coefficients of the personality variables are similar: The 95% confidence intervals overlap. Overall, given the robustness of the results, we conclude that they are not driven by reverse causality.

We conduct four more robustness checks. First, since the average yearly transition rate into self-employment among those not self-employed is only 1.13%, we re-estimate the entry model using the “rare events” estimator suggested by King and Zeng (2003); the coefficients change only slightly (see also Caliendo et al., 2009). Second, as the exit model is estimated based on the comparably small and selective sub-sample of the self-employed, non-random selection into self-employment might introduce selection bias. To address this potential problem, we re-estimate the exit probability as a model with selection (cp. Heckman, 1979), employing the probit sample selection model for binary dependent variables suggested by Van de Ven and Van Praag (1981). The estimated probit coefficients of the significant personality traits are not significantly different from the logit estimates in the baseline model after multiplication with 1.6 for an approximate comparison (Amemiya, 1981). The linear and square terms of risk attitudes consistently indicate a U-shaped relationship between risk tolerance and the exit probability. We conclude that not controlling for potential sample selection does not significantly bias our results.

\textsuperscript{44} Table S 9 in the supplementary appendix shows the detailed results of the robustness tests we describe in the following four paragraphs.
Third, we consider the possibility that the influence of personality variables on the probability of exit from self-employment changes with the duration of self-employment. Instead of including a polynomial function of the duration in self-employment in the model, we define a dummy variable indicating the initial years of self-employment (defined, alternatively, as year 1, years 1-2, years 1-3, or years 1-5) and interact this dummy variable with the personality variables. The “initial years” dummy is positive and highly significant, as the exit probability is high during the first years. This reflects the “infant mortality” of small businesses. However, almost none of the interaction terms with personality variables are significant indicating that the effects of these variables on the exit probability do not differ between the stages of self-employment. The only exception worth mentioning is external locus of control increasing the exit probability after the first two or three years have passed.

Fourth, we re-estimate the models of self-employment state, entry, and exit specifying random effects logit models. This may increase efficiency by making optimal use of the variance-covariance structure in the panel data, but may also be more sensitive with respect to the model assumptions than our baseline logit models with their cluster and heteroscedasticity robust standard errors. The results show that all the personality traits and characteristics significant in the baseline models in Table 4 remain significant and keep their signs.\(^\text{45}\)

5 Discussion

This current study addresses the question which personality variables influence entrepreneurial decision making at different points in time. We use the most recent theoretical developments in personality research and econometric approaches of panel data analysis. Our hypotheses were partly supported, as Table 6 shows, where we provide a summary of the estimation results. We find – as hypothesized – that high values in three factors of the Big Five approach – openness to experience, extraversion, and emotional stability (the latter only

\(^{45}\) Full results of all robustness tests described in this Section are available from the authors on request.
when we do not control for further personality characteristics) – increase the probability of entry into entrepreneurial activities. With respect to the exit decision we find that none of these three factors has any influence on survival in entrepreneurship. Merely, individuals scoring high in agreeableness have a higher exit probability revealing that indeed low ends of agreeableness positively influence the life span of an entrepreneur. Overall we show that the Big Five traits mostly have an influence on the entry decision into entrepreneurship. When we compare the self-employed with others, the results are in line with those of Zhao and Seibert (2006) who focus in their analysis on the comparison of different populations.

- INSERT TABLE 6 ABOUT HERE -

For the specific personality characteristics, we find that the two most prominent variables – locus of control and risk attitudes – have strong partial effects on entrepreneurial entry and exit. Persons scoring high on internal and low on external locus of control, have higher probability of starting a business and of being in business. Additionally we find that after the initial two or three years in self-employment have passed, an external locus of control increases the exit probability from entrepreneurial activities. Risk attitudes have – as hypothesized – a non-uniform influence on entrepreneurial decision making. The higher the willingness to take risks the higher the probability that an individual will start an own business and be in business. Between risk attitudes and entrepreneurial survival there is an inverse U-shaped relationship. Most importantly, all findings on the two variables, locus of control and risk attitudes, hold even after controlling for the Big Five traits making clear that these two variables form separate dimensions of personality. With respect to the further specific personality characteristics we find that trustful persons have a higher entry probability into entrepreneurship. However, impatience and impulsivity add little explanatory power. These two variables are captured by the Big Five approach and risk attitudes.\textsuperscript{46}

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\textsuperscript{46} Recent research (Sahakian et al., 2008) highlights the importance of impulsivity for entrepreneurial status.
The study has several implications some of which we would like to discuss here. First and foremost, we reveal that – with the exception of locus of control – there are some traits and personality characteristics that affect the decision of becoming an entrepreneur and different ones or different parameter values of the same variable affecting the life span as an entrepreneur. This implies that it takes certain variables (like being creative) to start an entrepreneurial career and different characteristics (like being assertive) to successfully develop a venture from the start-up stage to a fully established business. It makes clear why serial entrepreneurs in their extreme form have virtually specialized in starting new ventures but sell them before the businesses became mature.

Our findings are also important for the environment of entrepreneurs. Thinking of support systems like training programs and coaching approaches, it would be worth to install training programs that focus on one’s own non-cognitive skills as such programs may increase entrepreneurial interests over time. Such training programs might be in particular important for those who grew up in an environment that did not offer the support to develop entrepreneurial skills and abilities. Talking about support, coaches, who often assist entrepreneurs during the start-up stage, may analyze what kind of parameter values each entrepreneur has in the relevant personality variables. They may be able to significantly improve their approaches in terms of a ‘personalized support’ if they use information about the status quo of the non-cognitive skills of the coached entrepreneurs. Last but not least, when thinking of capital providers (like venture capitalists or bankers), it is also worth noting that they should be ready to contract with entrepreneurs scoring low in agreeableness (as they have higher survival probabilities), even if it is tougher to bargain with them about margins and rates on the borrowed capital.
6 Conclusion

Based on a unique, representative data set, the German Socio Economic Panel (SOEP), this paper investigates whether non-cognitive skills, in particular personality variables, influence entrepreneurial decision making. While previous empirical research mostly compares data of individuals in differing positions (like entrepreneurs with managers), we use panel data that facilitate a consistent analysis of the influence of traits and personality characteristics on entries into, exit from and, thus, survival in an entrepreneurial status.

The first insight of our analysis is an affirmative one: personality significantly influences entrepreneurial choices and affects entrepreneurial decisions in many ways. Second, the Big Five traits partly explain entry decisions into entrepreneurship, but have limited influence on entrepreneurial survival. Third, the approach of considering specific personality characteristics adds additional information for entrepreneurial entry and survival. Fourth, there are some personality variables that affect the decision of becoming an entrepreneur and different ones affecting the life span as an entrepreneur. Last, but not least, the explanatory power of the personality variables among all observable internal variables (such as age, gender, human capital, working experience, family background, and other characteristics) amounts to almost 30%. Therefore, we show that a comprehensive set of information about traits and personality characteristics can be used to partly predict what it takes to become a successful entrepreneur. Future research should analyze whether there are further specific personality characteristics (not analyzed here) influencing entrepreneurial success and how traits and personality characteristics influence other dimensions of entrepreneurial success such as their income or the decision to employ further individuals in the venture.
## Tables

### Table 1: Hypothesized correlations between traits and personality characteristics

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<td>-</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>impulsivity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>cogn_abil</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Notes: A plus/minus sign indicates that we hypothesize a positive/negative correlation between the personality traits. Brackets indicate some theoretical ambiguity.*

### Table 2: Pair-wise correlation coefficients of traits and personality characteristics

<table>
<thead>
<tr>
<th></th>
<th>openness</th>
<th>conscientiousness</th>
<th>extraversion</th>
<th>agreeableness</th>
<th>neuroticism</th>
<th>will_risk</th>
<th>internal_loc</th>
</tr>
</thead>
<tbody>
<tr>
<td>openness</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>conscientiousness</td>
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<td>1.000</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>0.3575*</td>
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<td></td>
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<td></td>
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<tr>
<td>agreeableness</td>
<td>0.1410*</td>
<td>0.2903*</td>
<td>0.0982*</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>neuroticism</td>
<td>-0.0679*</td>
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<td>-0.1438*</td>
<td>-0.1255*</td>
<td>1.000</td>
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</tr>
<tr>
<td>will_risk</td>
<td>0.1719*</td>
<td>0.1836*</td>
<td>-0.0910*</td>
<td>-0.1644*</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>internal_loc</td>
<td>0.1181*</td>
<td>0.2546*</td>
<td>0.1693*</td>
<td>0.1297*</td>
<td>-0.0864*</td>
<td>0.0808*</td>
<td>1.000</td>
</tr>
<tr>
<td>external_loc</td>
<td>-0.0249*</td>
<td>-0.0861*</td>
<td>-0.1088*</td>
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<tr>
<td>recip_pos</td>
<td>0.1905*</td>
<td>0.2179*</td>
<td>0.1490*</td>
<td>0.1630*</td>
<td>-0.0407*</td>
<td>0.0429*</td>
<td>0.2280*</td>
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<tr>
<td>recip_neg</td>
<td>-0.0648*</td>
<td>-0.1372*</td>
<td>-0.0634*</td>
<td>-0.3455*</td>
<td>0.1183*</td>
<td>0.0646*</td>
<td>-0.0464*</td>
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<td>trust</td>
<td>0.0676*</td>
<td>-0.0685*</td>
<td>0.0276*</td>
<td>0.0517*</td>
<td>-0.1685*</td>
<td>0.0746*</td>
<td>-0.0578*</td>
</tr>
<tr>
<td>patience</td>
<td>0.0186*</td>
<td>0.0967*</td>
<td>-0.0602*</td>
<td>0.2729*</td>
<td>-0.2185*</td>
<td>-0.0231*</td>
<td>0.0454*</td>
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<tr>
<td>impulsivity</td>
<td>0.1726*</td>
<td></td>
<td>0.2684*</td>
<td>-0.0833*</td>
<td>-0.0388*</td>
<td>0.2392*</td>
<td>0.0383*</td>
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<td>cogn_abil</td>
<td>0.0449*</td>
<td>0.022</td>
<td>-0.0557*</td>
<td>-0.016</td>
<td>-0.0334*</td>
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</table>

<table>
<thead>
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<th>recip_neg</th>
<th>trust</th>
<th>patience</th>
<th>impulsivity</th>
<th>cogn_abil</th>
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</thead>
<tbody>
<tr>
<td>external_loc</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>recip_pos</td>
<td></td>
<td>0.2303*</td>
<td>0.0574*</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td>-0.1665*</td>
<td>0.0117*</td>
<td>-0.1250*</td>
<td>1.000</td>
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</tr>
<tr>
<td>trust</td>
<td></td>
<td>-0.0331*</td>
<td>0.0322*</td>
<td>-0.1364*</td>
<td>0.0555*</td>
<td>1.000</td>
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<tr>
<td>patience</td>
<td></td>
<td>-0.0289*</td>
<td>0.0317*</td>
<td>0.0233*</td>
<td>0.0258*</td>
<td>-0.1662*</td>
<td>1.000</td>
</tr>
<tr>
<td>impulsivity</td>
<td></td>
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<td>0.0823*</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Notes: Only correlation coefficients significant at the 10% level or better are listed, those significant at the 1% level are marked with a star. Correlation coefficients with larger significance levels are left blank in the matrix. Source: Authors’ calculations based on the SOEP 2000-09.*
Table 3: Weighted means by employment state

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Full sample</th>
<th>Self-employed</th>
<th>Employees</th>
<th>Not working</th>
</tr>
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<tbody>
<tr>
<td>openess</td>
<td>4.496</td>
<td>4.913 ***</td>
<td>4.454</td>
<td>4.499</td>
</tr>
<tr>
<td>conscientiousn</td>
<td>5.972</td>
<td>5.955</td>
<td>5.991</td>
<td>5.886</td>
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<tr>
<td>extraversion</td>
<td>4.828</td>
<td>5.043 ***</td>
<td>4.813</td>
<td>4.795</td>
</tr>
<tr>
<td>agreeableness</td>
<td>5.413</td>
<td>5.362 **</td>
<td>5.397</td>
<td>5.520</td>
</tr>
<tr>
<td>neuroticism</td>
<td>3.922</td>
<td>3.765 ***</td>
<td>3.875</td>
<td>4.229</td>
</tr>
<tr>
<td>will_risk</td>
<td>4.624</td>
<td>5.518 ***</td>
<td>4.615</td>
<td>4.230</td>
</tr>
<tr>
<td>internal_loc</td>
<td>5.738</td>
<td>5.891 ***</td>
<td>5.739</td>
<td>5.657</td>
</tr>
<tr>
<td>external_loc</td>
<td>3.669</td>
<td>3.424 ***</td>
<td>3.645</td>
<td>3.911</td>
</tr>
<tr>
<td>recip_pos</td>
<td>5.900</td>
<td>5.945 **</td>
<td>5.896</td>
<td>5.899</td>
</tr>
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<td>recip_neg</td>
<td>3.153</td>
<td>3.125</td>
<td>3.167</td>
<td>3.098</td>
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<tr>
<td>trust</td>
<td>2.314</td>
<td>2.409 ***</td>
<td>2.322</td>
<td>2.229</td>
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<tr>
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<td>6.023</td>
<td>5.941 *</td>
<td>6.026</td>
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<tr>
<td>impulsivity</td>
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<td>5.332 ***</td>
<td>5.088</td>
<td>5.113</td>
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<tr>
<td>cogn_abil</td>
<td>29.03</td>
<td>28.88</td>
<td>29.39</td>
<td>27.45</td>
</tr>
<tr>
<td>female</td>
<td>0.511</td>
<td>0.329 ***</td>
<td>0.477</td>
<td>0.769</td>
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<tr>
<td>highschool</td>
<td>0.267</td>
<td>0.447 ***</td>
<td>0.265</td>
<td>0.191</td>
</tr>
<tr>
<td>apprenticeship</td>
<td>0.535</td>
<td>0.395 ***</td>
<td>0.549</td>
<td>0.536</td>
</tr>
<tr>
<td>highertechncol</td>
<td>0.248</td>
<td>0.295 ***</td>
<td>0.247</td>
<td>0.228</td>
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<tr>
<td>university</td>
<td>0.193</td>
<td>0.361 ***</td>
<td>0.192</td>
<td>0.119</td>
</tr>
<tr>
<td>age</td>
<td>41.26</td>
<td>43.63 ***</td>
<td>41.08</td>
<td>41.01</td>
</tr>
<tr>
<td>prworkexp10</td>
<td>1.551</td>
<td>1.719 ***</td>
<td>1.617</td>
<td>1.147</td>
</tr>
<tr>
<td>prunempexp</td>
<td>0.607</td>
<td>0.493 ***</td>
<td>0.476</td>
<td>1.314</td>
</tr>
<tr>
<td>disabled</td>
<td>0.061</td>
<td>0.026 ***</td>
<td>0.063</td>
<td>0.065</td>
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<tr>
<td>german</td>
<td>0.942</td>
<td>0.951 *</td>
<td>0.950</td>
<td>0.901</td>
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<tr>
<td>fatherse</td>
<td>0.078</td>
<td>0.138 ***</td>
<td>0.072</td>
<td>0.076</td>
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<tr>
<td>nchildren</td>
<td>0.655</td>
<td>0.667</td>
<td>0.590</td>
<td>0.970</td>
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<tr>
<td>married</td>
<td>0.619</td>
<td>0.620</td>
<td>0.597</td>
<td>0.725</td>
</tr>
<tr>
<td>divorced</td>
<td>0.083</td>
<td>0.096 **</td>
<td>0.083</td>
<td>0.077</td>
</tr>
<tr>
<td>east</td>
<td>0.201</td>
<td>0.216 **</td>
<td>0.192</td>
<td>0.237</td>
</tr>
<tr>
<td>south</td>
<td>0.286</td>
<td>0.263 **</td>
<td>0.293</td>
<td>0.264</td>
</tr>
<tr>
<td>north</td>
<td>0.121</td>
<td>0.106 **</td>
<td>0.123</td>
<td>0.115</td>
</tr>
<tr>
<td>capincr1000</td>
<td>2.368</td>
<td>9.042 ***</td>
<td>1.805</td>
<td>1.867</td>
</tr>
</tbody>
</table>

Self-empl. rate 0.076
Exit rate 0.080
Entry rate 0.007
Person-years 60470 5293 45870 9307

Notes: The means of the personality characteristics are calculated using survey weights and before standardization. In the column for the self-employed, stars (**/***/*) indicate that the mean of the self-employed is statistically different from the mean of those not self-employed at the 0.1%/5%/10% level. Table A 2 in the Appendix provides the definitions of the variables. Source: Authors’ calculations based on the SOEP 2000-09.
Table 4: Probabilities of self-employment state and transitions: Marginal effects of traits and personality characteristics

<table>
<thead>
<tr>
<th></th>
<th>Self-employment</th>
<th>Entry</th>
<th>Exit</th>
</tr>
</thead>
<tbody>
<tr>
<td>openness</td>
<td>0.0175***</td>
<td>0.0151***</td>
<td>0.0017***</td>
</tr>
<tr>
<td></td>
<td>(0.0025)</td>
<td>(0.0024)</td>
<td>(0.0003)</td>
</tr>
<tr>
<td>conscientiousn</td>
<td>-0.0013</td>
<td>-0.0038</td>
<td>-0.0002</td>
</tr>
<tr>
<td></td>
<td>(0.0025)</td>
<td>(0.0025)</td>
<td>(0.0003)</td>
</tr>
<tr>
<td>extraversion</td>
<td>0.0119***</td>
<td>0.0062***</td>
<td>0.0009***</td>
</tr>
<tr>
<td></td>
<td>(0.0026)</td>
<td>(0.0026)</td>
<td>(0.0003)</td>
</tr>
<tr>
<td>agreeableness</td>
<td>-0.0026</td>
<td>-0.0012</td>
<td>-0.0001</td>
</tr>
<tr>
<td></td>
<td>(0.0025)</td>
<td>(0.0025)</td>
<td>(0.0003)</td>
</tr>
<tr>
<td>neuroticism</td>
<td>-0.0019</td>
<td>0.0027</td>
<td>-0.0004*</td>
</tr>
<tr>
<td></td>
<td>(0.0024)</td>
<td>(0.0024)</td>
<td>(0.0003)</td>
</tr>
<tr>
<td>will_risk</td>
<td>0.0010</td>
<td>-0.0003</td>
<td>-0.0160***</td>
</tr>
<tr>
<td>will_risk_square</td>
<td>0.0007**</td>
<td>0.0001***</td>
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</tr>
<tr>
<td>internal_loc</td>
<td>0.0136***</td>
<td>0.0008***</td>
<td></td>
</tr>
<tr>
<td>external_loc</td>
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<td>-0.0055**</td>
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</tr>
<tr>
<td>recip_pos</td>
<td>-0.0043*</td>
<td>-0.0006**</td>
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</tr>
<tr>
<td>recip_neg</td>
<td>0.0003</td>
<td>0.0006**</td>
<td></td>
</tr>
<tr>
<td>trust</td>
<td>0.0008</td>
<td>0.0007***</td>
<td></td>
</tr>
<tr>
<td>patience</td>
<td>-0.0010</td>
<td>0.0004</td>
<td></td>
</tr>
<tr>
<td>impulsivity</td>
<td>-0.0000</td>
<td>-0.0002</td>
<td></td>
</tr>
<tr>
<td>Control variables</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Wald $\chi^2$</td>
<td>677.958</td>
<td>796.074</td>
<td>668.228</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-16007.334</td>
<td>-15645.870</td>
<td>-2737.756</td>
</tr>
<tr>
<td>Mean outcome</td>
<td>0.087412</td>
<td>0.087412</td>
<td>0.011283</td>
</tr>
<tr>
<td>Person-years</td>
<td>60701</td>
<td>60701</td>
<td>50431</td>
</tr>
</tbody>
</table>

Notes: The marginal effects after logit estimation, evaluated at the means of the explanatory variables, indicate the change in the probability of being self-employed, entry, or exit, when a personality score increases by one standard deviation. Cluster and heteroscedasticity robust standard errors in parentheses. Stars (***/**/***/***) indicate significance at the 1%/5%/10% levels. The logit coefficients for all variables included are provided in Table S2 in the supplementary appendix. Source: Authors’ calculations based on the SOEP 2000-09.
Table 5: Goodness of fit using incremental sets of explanatory variables

<table>
<thead>
<tr>
<th>Specification including as explanatory variables…</th>
<th>Probability of Being Self-Employed</th>
<th>Probability of Entry</th>
<th>Probability of Exit</th>
</tr>
</thead>
<tbody>
<tr>
<td>year dummies + other socio-demographics + age + work experience + education + self + Big 5 + risk tolerance + locus of control + trust, reciprocity + patience, impulsivity</td>
<td>McFadden’s $R^2$ 0.0017 0.0432 0.0639 0.08720.09250.1106 0.1209 0.1301 0.1307 0.1307</td>
<td>% of full model $R^2$ 1.3 32.0 68.9 70.8 84.6 92.5 99.5 100.0 100.0</td>
<td>Difference in %-points 1.3 31.7 15.8 40.0 13.9 7.9 7.0 0.5 0.0</td>
</tr>
<tr>
<td>+ other socio-demographics</td>
<td>Probability of Entry</td>
<td>McFadden’s $R^2$ 0.0038 0.0829 0.0968 0.10720.10910.1218 0.1316 0.1339 0.1370 0.1374</td>
<td>% of full model $R^2$ 2.8 60.3 70.5 78.0 79.4 88.6 95.7 97.4 99.7 100.0</td>
</tr>
<tr>
<td>+ other socio-demographics &amp; work experience</td>
<td>Probability of Entry</td>
<td>McFadden’s $R^2$ 0.0018 0.0856 0.0913 0.09690.09730.1007 0.1034 0.1049 0.1051 0.1054</td>
<td>% of full model $R^2$ 1.7 81.3 86.6 92.0 92.4 95.6 98.2 99.6 99.7 100.0</td>
</tr>
<tr>
<td>+ other socio-demographics &amp; work experience &amp; education</td>
<td>Probability of Entry &amp; + duration</td>
<td>Probability of Exit &amp; + duration</td>
<td>Probability of Exit &amp; + duration</td>
</tr>
</tbody>
</table>

Notes: The socio-demographics in column (2) are the number of children, real income from interests, dividends, and rents as an indicator of wealth, years of prior unemployment experience, and dummy variables indicating gender, disability, German nationality, marital status, and geographical region.

Source: Authors’ calculations based on the SOEP 2000-09.

Table 6: Summary of hypotheses and estimation results

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Self-employment</th>
<th>Entry</th>
<th>Exit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extraversion</td>
<td>H1a</td>
<td>+</td>
<td>+7%</td>
</tr>
<tr>
<td>Emotional Stability</td>
<td>H1b</td>
<td>+</td>
<td>(+)</td>
</tr>
<tr>
<td>Openness to experience</td>
<td>H1c</td>
<td>+</td>
<td>+17%</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>H1d</td>
<td>Agreeableness H1e</td>
<td>+</td>
</tr>
<tr>
<td>Internal locus of control</td>
<td>H2a</td>
<td>+</td>
<td>+16%</td>
</tr>
<tr>
<td>External locus of control</td>
<td>H2a</td>
<td>-</td>
<td>-11%</td>
</tr>
<tr>
<td>Risk tolerance</td>
<td>H2b</td>
<td>+</td>
<td>(incr.)</td>
</tr>
<tr>
<td>Trust</td>
<td>H2c</td>
<td>+</td>
<td>+6%</td>
</tr>
<tr>
<td>Impatience</td>
<td>H2d</td>
<td>Impulsivity H2d</td>
<td>(+)</td>
</tr>
</tbody>
</table>

Notes: The table summarizes (i) the hypotheses about the direction of effects of personality traits and characteristics on the probabilities of being self-employed, entry into self-employment, and exit from self-employment (Sections 2.2-2.3), and (ii) the statistically significant results from the main estimations (Section 4.2). The percentages shown are the estimated effects of an increase in the personality scores by one standard deviation on the probabilities of self-employment or annual entry or exit, relative to the mean rates of self-employment or annual entry or exit, respectively.

1: Only significant when not controlled for further personality characteristics beyond the Big Five.
2: Only significant after the initial two or three years in self-employment have passed (Section 4.4).
3: The effects or risk tolerance on the probabilities of self-employment and entry are positive at increasing marginal rates, while the effect on exit is U-shaped (Figure 1 in Section 4.2).
4: Only significant if not controlled for the Big Five personality traits and risk attitude (Table S 4 in the supplementary appendix).

Source: Authors’ calculations based on the SOEP 2000-09.
Acknowledgements

We would like to thank Rob Fairlie, Philipp Koellinger, Simon Parker, Christian Schade, Rainer Silbereisen, Roy Thurik, and Mirjam van Praag, the seminar participants in Jena, Nijmegen, Rotterdam, and Washington, D.C., and the participants of the Workshop on Entrepreneurship Research at IZA in Bonn for their helpful and valuable comments.

References


**Appendix**

**Table A 1: Personality items in the SOEP questionnaires**

<table>
<thead>
<tr>
<th>Personality trait</th>
<th>Questionnaire wording</th>
<th>Item's short name</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Big Five Factor Model</strong></td>
<td><em>Scale: 1 ('does not apply to me at all') to 7 ('applies to me perfectly')</em></td>
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<tr>
<td>Openness to experience</td>
<td>I see myself as someone who ... is original, comes up with new ideas</td>
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<td>Openness to experience</td>
<td>values artistic experiences</td>
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<td>Openness to experience</td>
<td>has an active imagination</td>
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<td>Conscientiousness</td>
<td>does a thorough job</td>
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</tr>
<tr>
<td>Conscientiousness</td>
<td>does things effectively and efficiently</td>
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<tr>
<td>Conscientiousness (inverted)</td>
<td>tends to be lazy</td>
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</tr>
<tr>
<td>Extraversion</td>
<td>is communicative, talkative</td>
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</tr>
<tr>
<td>Extraversion</td>
<td>is outgoing, sociable</td>
<td>sociable</td>
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<td>Agreeableness (inverted)</td>
<td>has a forgiving nature</td>
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<td>Agreeableness</td>
<td>is considerate and kind to others</td>
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<tr>
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<td>is sometimes somewhat rude to others</td>
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<td>Neuroticism</td>
<td>worries a lot</td>
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<tr>
<td>Neuroticism (inverted)</td>
<td>gets nervous easily</td>
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<tr>
<td>Neuroticism (inverted)</td>
<td>is relaxed, handles stress well</td>
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<tr>
<td><strong>Locus of control</strong></td>
<td><em>Scale: 1 ('disagree completely') to 7 ('agree completely')</em></td>
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<tr>
<td>Internal LOC</td>
<td>How my life goes depends on me</td>
<td>lifedependsone</td>
</tr>
<tr>
<td>Internal LOC (not used)</td>
<td>One has to work hard in order to succeed</td>
<td>workhardtosucceed</td>
</tr>
<tr>
<td>Internal LOC (rev., not used)</td>
<td>If a person is socially or politically active, he/she can have an effect on social conditions</td>
<td>effectonconditions</td>
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<td>External LOC</td>
<td>If I run up against difficulties in life, I often doubt my own abilities</td>
<td>doubtownabilities</td>
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<tr>
<td>External LOC</td>
<td>Compared to other people, I have not achieved what I deserve</td>
<td>notachieved</td>
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<tr>
<td>External LOC</td>
<td>What a person achieves in life is above all a question of fate or luck</td>
<td>fateluck</td>
</tr>
<tr>
<td>External LOC</td>
<td>I frequently have the experience that other people have a controlling influence over my life</td>
<td>otherpeoplecontrol</td>
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<tr>
<td>External LOC</td>
<td>The opportunities that I have in life are determined by the social conditions</td>
<td>conddependsonme</td>
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<tr>
<td>External LOC</td>
<td>Inborn abilities are more important than any efforts one can make</td>
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<td>I have little control over the things that happen in my life</td>
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<td><strong>Reciprocity</strong></td>
<td><em>Scale: 1 ('does not apply to me at all') to 7 ('applies to me perfectly')</em></td>
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<tr>
<td>Positive reciprocity</td>
<td>If someone does me a favor, I am prepared to return it</td>
<td>returnfavor</td>
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<td>Positive reciprocity</td>
<td>I go out of my way to help somebody who has been kind to me before</td>
<td>returnhelp</td>
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<tr>
<td>Positive reciprocity</td>
<td>I am ready to undergo personal costs to help somebody who helped me before</td>
<td>returncostlyhelp</td>
</tr>
<tr>
<td>Negative reciprocity</td>
<td>If I suffer a serious wrong, I will take revenge as soon as possible, no matter what the cost</td>
<td>revenge</td>
</tr>
<tr>
<td>Negative reciprocity</td>
<td>If somebody puts me in a difficult position, I will do the same to him/her</td>
<td>returndisadvantage</td>
</tr>
<tr>
<td>Negative reciprocity</td>
<td>If somebody offends me, I will offend him/her back</td>
<td>offendback</td>
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<tr>
<td><strong>Trust</strong></td>
<td><em>Scale: 1 ('totally agree') to 4 ('totally disagree')</em></td>
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<tr>
<td>Trust (inverted)</td>
<td>On the whole one can trust people</td>
<td>trustpeople</td>
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<tr>
<td>Trust</td>
<td>Nowadays one can't rely on anyone</td>
<td>cantrust</td>
</tr>
<tr>
<td>Trust</td>
<td>If one is dealing with strangers, it is better to be careful before one can trust them</td>
<td>cautionstrangers</td>
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</table>

continued on the following page
### Table A 1 continued

<table>
<thead>
<tr>
<th>Personality trait</th>
<th>Questionnaire wording</th>
<th>Item's short name</th>
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</thead>
<tbody>
<tr>
<td><strong>Risk attitude</strong></td>
<td><em>Scale: 0 ('fully unwilling to take risks') to 10 ('fully willing to take risks')</em>&lt;br&gt;Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks?</td>
<td>will риск</td>
</tr>
<tr>
<td><strong>Patience</strong></td>
<td><em>Scale: 0 ('very impatient') to 10 ('very patient')</em>&lt;br&gt;Are you generally an impatient person, or someone who always shows great patience?</td>
<td>patience</td>
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<tr>
<td><strong>Impulsivity</strong></td>
<td><em>Scale: 0 ('not at all impulsive') to 10 ('very impulsive')</em>&lt;br&gt;Do you generally think things over for a long time before acting – in other words, are you not impulsive at all? Or do you generally act without thinking things over for a long time – in other words, are you very impulsive?</td>
<td>impulsivity</td>
</tr>
</tbody>
</table>

**Notes:** The items on the Big Five factors were included in the survey waves 2005 and 2009 of the SOEP; those on reciprocity and locus of control in 2005; those on trust in 2003 and 2008; on the willingness to take risks in 2004, 2006, 2008, and 2009; and on patience and impulsivity in 2008.

### Table A 2: Description of the control variables

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<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
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<tr>
<td>female</td>
<td>Dummy for females</td>
</tr>
<tr>
<td>highschool</td>
<td>Dummy for individuals who finished higher secondary school with a university entrance qualification</td>
</tr>
<tr>
<td>apprenticeship</td>
<td>Dummy for individuals who finished an apprenticeship</td>
</tr>
<tr>
<td>highertechncol</td>
<td>Dummy for individuals who finished a higher technical college, a health care school, or civil service training</td>
</tr>
<tr>
<td>university</td>
<td>Dummy for individuals who have a university degree</td>
</tr>
<tr>
<td>age</td>
<td>Age of individual</td>
</tr>
<tr>
<td>prworkexp10a</td>
<td>Years of full time work experience prior to the year of observation, divided by 10</td>
</tr>
<tr>
<td>prunemexpa</td>
<td>Years of unemployment experience prior to the year of observation</td>
</tr>
<tr>
<td>disabled</td>
<td>Dummy for physically challenged individuals</td>
</tr>
<tr>
<td>german</td>
<td>Dummy for German nationality</td>
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<tr>
<td>fatherse</td>
<td>Dummy for indiv. whose father was self-empl. when the respondents were 15 years old</td>
</tr>
<tr>
<td>nchildren</td>
<td>Number of children under 17 in the household</td>
</tr>
<tr>
<td>married</td>
<td>Dummy for married and not separated individuals. Omitted category for marital status is &quot;single&quot;/&quot;widowed&quot;</td>
</tr>
<tr>
<td>divorced</td>
<td>Dummy for divorced individuals. Omitted category for marital status is &quot;single&quot;/&quot;widowed&quot;</td>
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<tr>
<td>east</td>
<td>Dummy for individuals living in the area of former East Germany or Berlin</td>
</tr>
<tr>
<td>south</td>
<td>Dummy for individuals living in Baden Wuerttemberg or Bavaria</td>
</tr>
<tr>
<td>north</td>
<td>Dummy for individuals living in Schleswig Holstein or Lower Saxony</td>
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<tr>
<td>capitalincr1000</td>
<td>Real income from interests, dividends, and house rents in 1000 euro in prices of 2005. Some respondents report the exact amount of their financial income, while others just indicate a range. For the latter respondents, we impute the mean income of those who actually give the exact amount within this range.</td>
</tr>
<tr>
<td>durationa</td>
<td>Tenure of current spell (self-employment, regular employment or unemployment/inactivity). For left-censored spells, the duration since the last job change is used, which may be shorter than the overall spell if somebody switched jobs</td>
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<tr>
<td>notempl</td>
<td>Dummy for individuals not in paid work</td>
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<td>x_sq</td>
<td>Square of variable x</td>
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<td>x_cu</td>
<td>Cube of variable x</td>
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<td>x_ne</td>
<td>Interaction term of variable x with the dummy variable notempl</td>
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</table>

**Notes:** Dummy variables equal 1 if condition holds and 0 otherwise.<br>
*a* Uses information from the lifetime employment history in the SOEP.
## Table S 1: Factor analysis

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<th>Item</th>
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Notes: The table shows the rotated factor loadings (pattern matrix) and unique variances (principal factors method; oblique promax rotation). Absolute factor loadings below 0.3 are left blank. Three more factors do not have any loadings above 0.3 and are therefore not shown in the table. See Table A 1 for a description of the variables. Source: Authors’ calculations based on the SOEP 2000-09.
Table S 2: Probabilities of self-employment state and transitions: Full logit estimation results

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**Notes:** The table shows logit coefficients. Cluster and heteroscedasticity robust standard errors in parentheses. Stars (***/**/*) indicate significance at the 1%/5%/10% levels. Year dummies omitted for brevity. Table A 2 in the Appendix provides the definitions of the variables. *Source:* Authors’ calculations based on the SOEP 2000-09.
Table S 3: Probabilities of being self-employed: Incremental sets of personality variables (logit coefficients)

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Control variables: yes

Wald $\chi^2$ | 677.958 | 764.121 | 781.403 | 790.892 | 796.074 |
Log likelihood | -16007.334 | -15821.875 | -15657.481 | -15646.501 | -15645.870 |
AIC | 32082.668 | 31715.749 | 31390.962 | 31375.003 | 31377.393 |
BIC | 32389.134 | 32040.243 | 31733.483 | 31744.565 | 31765.329 |
Mean outcome | 0.087412 | 0.087412 | 0.087412 | 0.087412 | 0.087412 |
Person-years | 60701   | 60701   | 60701   | 60701   | 60701   |

Notes: The table shows logit coefficients. Cluster and heteroscedasticity robust standard errors in parentheses. Stars (***/**/*) indicate significance at the 1%/5%/10% levels. Source: Authors’ calculations based on the SOEP 2000-09.
Table S 4: Probabilities of being self-employed: Incremental sets of personality variables in reverse order (logit coefficients)

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Control variables | yes | yes | yes | yes | yes

Wald $\chi^2$    | 587.190 | 587.962 | 635.887 | 738.350 | 796.074
Log likelihood   | -16270.410 | -16260.450 | -16033.370 | -15817.882 | -15645.870
AIC              | 32602.821 | 32588.900 | 32138.741 | 31711.765 | 31377.339
BIC              | 32882.246 | 32895.366 | 32463.234 | 32054.286 | 31765.329
Mean outcome     | 0.087412 | 0.087412 | 0.087412 | 0.087412 | 0.087412
Person-years     | 60701 | 60701 | 60701 | 60701 | 60701

Notes: The table shows logit coefficients. Cluster and heteroscedasticity robust standard errors in parentheses. Stars (***/**/*) indicate significance at the 1%/5%/10% levels. Source: Authors’ calculations based on the SOEP 2000-09.
### Table S 5: Goodness of fit using incremental sets of explanatory variables in reverse order

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<th>+ patience, impulsivity</th>
<th>+ trust, reciprocity control</th>
<th>+ locus of control</th>
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<th>+ Big 5</th>
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*Source: Authors’ calculations based on the SOEP 2000-09.*

### Table S 6: Goodness of fit using incremental sets of explanatory variables (single items)

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<th>+ risk tolerance</th>
<th>+ locus of control</th>
<th>+ trust, reciprocity control</th>
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*Source: Authors’ calculations based on the SOEP 2000-09.*
Table S 7: Probabilities of self-employment state and transitions: Single items (logit coefficients)

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<td>50431</td>
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<td>4790</td>
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Notes: The table shows logit coefficients. Stars (***/**/*) indicate significance at the 1%/5%/10% levels, based on cluster and heteroscedasticity robust standard errors. Table A 1 in the Appendix provides the wording of the statements that the short item names refer to. Some items are measured on an inverted scale (see Table A 1). Source: Authors’ calculations based on the SOEP 2000-09.
### Table S 8: Probabilities of self-employment and transitions: Separate regressions (logit coefficients)

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**Notes:** Each cell in the table shows a logit coefficient from a separate regression with only the one personality variable indicated on the left and the socio-economic control variables (not shown) as regressors. Will_risk and will_risk_sq are included jointly. Cluster and heteroscedasticity robust standard errors in parentheses. Stars (***/**/*) indicate significance at the 1%/5%/10% levels. The regressions are based on 60701 person-years in the model of the probability of being self-employed, 50431 in the entry model and 4790 in the exit model. In the regressions including cognitive ability, the number of person-years is 11671, 9636, and 995, respectively. **Source:** Authors' calculations based on the SOEP 2000-09.
Table S 9: Probabilities of self-employment state and transitions: Robustness checks (logit coefficients of personality variables)

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<th>B5: Forward measures, period 2005-09</th>
<th>Entry: Rare events logit</th>
<th>Exit: Probit model with selection</th>
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Control var.’s yes yes yes yes yes

Wald $\chi^2$ 247.207 384.793 516.029 239.021
Log likelihood -2986.711 -1497.285 -7415.117 -14093.393
Mean outcome 0.094165 0.094161 0.098270 0.011283 0.008160
Person-years 11671 5480 26539 50431 51714

Notes: The table shows logit coefficients except for the selection model, where it shows probit coefficients. Cluster and heteroscedasticity robust standard errors in parentheses. Stars (***/**/*) indicate significance at the 1%/5%/10% levels. Source: Authors’ calculations based on the SOEP 2000-09.